

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #1: Field Safety

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	10/13/2017	Many	Format	Preparation for publishing protocol	1.00

This Standard Operating Procedure (SOP) describes procedures for conducting field and laboratory aspects of water quality monitoring in a safe manner, recognizing that certain hazards are inherent in both field and laboratory environments. This SOP both (1) identifies hazards associated with field and laboratory settings and (2) outlines approaches to reduce or mitigate those hazards.

The primary tool used to promote safe conduct is the Job Hazard Analysis. This approach is consistent with NPS Director's Order 50 and Reference Manual 50B for Occupational Health and Safety.

Recommended Reading

Lane, S.L., and Fay, R.G., 1997, Safety in field activities: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A9, October, accessed __date__ at <http://pubs.water.usgs.gov/twri9A9/>. Located at V:\Streams\Resources\EXAMPLES OF STREAM PROTOCOLS\USGS\USGS National Field Manual

Introduction and Objective

Encountering hazardous situations is inherent in water quality monitoring activities. Thus, staff members need to be aware of possible hazards and be able to adjust approaches accordingly, so that high-quality monitoring can be conducted without injury or property damage.

The objectives for the Sonoran Desert Network (SODN) water quality monitoring program, and the specific objectives for operations under this SOP, are:

1. To monitor water quality conditions, including accessing monitoring sites, making field measurements, gathering, processing, and analyzing water quality samples in a manner that recognizes hazardous conditions and takes measures to minimize the risk of personnel injury.
2. To maintain a high-quality monitoring effort, avoiding missed data collection and undue expense due to personnel injury or property damage.

Some hazardous conditions are inherent to all monitoring activities being undertaken by SODN staff; others are specific to individual sites. To minimize the possibility of accident or injury, a Job Hazard Analysis will be conducted for each employee engaged in field water quality monitoring. Second, hazards associated with specific sampling sites will be identified in the Field Site Description for each site. These procedures both improve operational safety by identifying hazardous conditions to NPS staff and supervisors and develop approaches to avoid or mitigate the hazards.

Safety always comes first, and because the logistics of field work can require much of a field supervisor's attention, it is the responsibility of everyone in the field to point out safety issues or concerns that otherwise could be overlooked in efforts to complete the field tasks at hand or when distractions occur from problems that may arise.

Risks Inherent in Streams Monitoring

Risks inherent in water quality monitoring in general, and specifically to monitoring the sites selected in SODN parks, include the following:

Working alone. Field staff often will work alone when traveling to and from remote sites and when making measurements and collecting samples in the field. As a result, particular attention must be given to safety.

Long road trips. Travel between parks will require long road trips at all times of the year and under varied weather and road conditions.

Backcountry roads and trails. Accessing water quality sample sites requires travel on secondary roads that are gravel or dirt, and some sites require hikes of up to 30 minutes away. The unsurfaced roads can become impassible during wet weather, and may remain muddy for several days after snowmelt. Hiking is generally done on established trails that vary in difficulty and condition. Some are steep, rocky, or sandy when dry but become muddy in wet weather.

Activities in and on the water. Sample collection and flow measurements will require entering the main current in streams. Extra care is necessary when wading because many streams are swift, stream bottoms can be loose or slippery, and water temperatures can be near freezing in winter. Precautions are needed to (1) recognize and avoid unacceptable risks, (2) use proper techniques to avoid accidents, and (3) be properly equipped for self-rescue. It is recognized that some sites will not be accessible during periods of bad weather. Similarly, it will not be possible to get a wading flow measurement during periods of flood.

If there is any doubt about whether conditions are safe, the correct decision is to forgo sampling until another day.

Varied weather conditions. The Sonoran Desert region is characterized by weather conditions that vary considerably through the seasons, day-to-day, and hour-by-hour. Snow, wind, and temperatures below 32°F can occur in the winter, and summer temperatures are often well above 100°F. Lightning is common during the summer monsoon storms. Hypothermia and heat-related injury are possible, and occasional discomfort is certain. Successful fieldwork requires preparation for this wide range of conditions.

Use of hazardous materials. Some of the reagents used are hazardous and require proper storage, handling, and personal protection, including eye and skin protection.

Job Hazard Analysis

Each National Park Service employee performing field inventory and monitoring activities in the SODN will, in conjunction with his/her supervisor (and, if appropriate, other knowledgeable persons), develop a Job Hazard Analysis (JHA) of the task to be performed.

Routine and Emergency Communication

Using established lines of communication and a standardized Check-in/Check-out procedure are essential to ensuring that assistance can be provided in case of a mishap or delay. This is particularly important because SOPN field staff often work alone. SOPN field staff should contact park staff to notify them of the time and location of work in each park. A SODN cell phone is usually the best method for routine field and emergency communication in and near parks, except at GICL where there is no cell reception.

Vehicle Accident Procedure

In the event of a vehicle accident, ensure the safety of all passengers and move the vehicle from traveled lanes if possible. Contact emergency personnel and seek medical attention. Accident reporting forms are located in each vehicle.

Chemical Storage and Use

Chemicals must be stored according to their Material Safety Data Sheet (MSDS) information. The MSDS sheets for all chemicals are kept in a clearly marked folder in the lab.

A list of all chemicals (Appendix A and B) must be posted on the outside of the cabinet door (or wherever they are stored). This is done so that: (1) emergency personnel are able to identify the contents in case of an emergency and (2) people who are sensitive to certain materials are able to avoid exposure.

Appendix A: Example SODN Job Hazard Analysis for Field Activities

JOB HAZARD ANALYSIS (JHA)		Date: 07/2011	☐ New JHA ☐ Revised JHA
Park Unit: All SODN	Division:	Branch:	Location:
TASK TITLE: Monitoring perennial streams- field activities		JHA Number:	Page <u>1</u> of <u>1</u>
Job Performed By: SODN Streams Crew	Analysis By: Kara Raymond	Supervisor: Evan Gwilliam	Approved By: Evan Gwilliam
Required Standards and General Notes:			
Required Training:	Basic fieldwork and backcountry competence		
Required Personal Protective Equipment:	Warm clothes, sun and rain protection, insect repellent, life vest, waders, communication equipment, shovel, and jack.		
Tools and Equipment:	Flow meter, 50m tape, chain pin, clamps, multiparameter probe, bottle, decanter, filters, funnel, tubing		
Sequence of Job Steps	Potential Hazards	Safe Action or Procedure	
1. Highway driving	a) Varied road conditions and road hazards such as animals and other obstructions b) Fatigue c) Behavior of other drivers	Be well rested before road trips and constantly alert to obstructions and behavior of other drivers. Sleep if over tired on the way home after long days.	
2. Dirt road driving	a) Rough and rutted roads, high- clearance driving b) Muddy roads c) Narrow roads with short sight distances d) Animals and other obstructions	Be well-rested before road trips and constantly alert to obstructions and behavior of other drivers. If overtired, stop to sleep on the way home after long days.	
3. Inclement weather driving	a) Slippery roads and poor visibility	Drive slowly. Watch for snow, ice, ruts, washed-out roads, washboard surfaces, loose gravel, and flash floods. Be well-rested before road trips and constantly alert to obstructions and behavior of other drivers. If overtired, stop to sleep on the way home after long days.	
4. Hiking	a) Steep, loose terrain b) Uneven footing c) Long distances	Wear sturdy shoes and don't rush on uneven terrain. Distribute weight low and close to back in backpack. Rest frequently and drink lots of water. Avoid hiking during mid-day in summer. Adjust work schedule accordingly. Be wary of dangerous animals.	
5. Stream access	a) Swift currents, deep water b) Flood flows c) Cold water and ice d) Contaminated water	Approach streams cautiously. Don't enter stream if visual estimate of product of depth and velocity is >10 (depth in ft and velocity in ft/s). Be wary of slippery and loose stream beds and dangerous animals.	

6. Deal with environmental conditions	a) Temperature and sun exposure b) Adverse weather (rain, snow, lightning and wind)	Wear sun protection and have appropriate extra clothing in case weather changes. Keep to low areas during lightning. Watch for flash floods.
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Appendix B: Example SODN Job Hazard Analysis for Lab Activities

JOB HAZARD ANALYSIS (JHA)		Date: 07/2011	☐ New JHA ☐ Revised JHA
Park Unit: All SODN	Division:	Branch:	Location:
TASK TITLE: Monitoring perennial stream- lab work		JHA Number:	Page <u>1</u> of <u>1</u>
Job Performed By: SODN Streams Crew	Analysis By: Kara Raymond	Supervisor: Evan Gwilliam	Approved By: Evan Gwilliam
Required Standards and General Notes:			
Required Training:	Basic laboratory experience		
Required Personal Protective Equipment:	Rubber gloves, cloth apron, ventilated room, eye protection, wipes for acid and solvent spills, chemical storage cabinets, appropriately labeled bottles and containers, pressure cooker and hotplate for disposal of bacteria cultures.		
Tools and Equipment:	Detergent, ph standards, conductivity standards, deionized water, pressure cooker, exhaust fan.		
Sequence of Job Steps	Potential Hazards	Safe Action or Procedure	
1. Wash and prepare field sampling equipment	a) Eye and skin irritation from detergent b) Standing one place for long periods of time	Wear eye protection, rubber gloves, apron, know how to clean spills, neutralize acid in baking soda before disposal, work with exhaust fan running, take frequent breaks, comfortable shoes for standing, wash hands after processing.	
2. Calibrate multiparameter probe	a) Standing one place for long periods of time b) Eye and skin irritation from pH and conductivity standards	Wear eye protection, rubber gloves, apron, know clean up acid spills, work with exhaust fan running, take frequent breaks, comfortable shoes for standing, wash hands after processing.	
3. Process field surface water samples	a) Back strain from lifting heavy cooler with samples and ice	Lift with legs, not back.	

4. Process bacterial samples	a) Danger of ingesting bacterial media b) Potential inoculation or ingestion of bacterial colonies after incubation	Wear rubber gloves, eye protection, and apron. Do not puncture bacteria containing plates after incubation, remove flammables from work area, do not let pressure cooker run dry, run exhaust fan during sterilization procedure. Keep bacteria plates in biohazard bags after counting colonies. Wash hands vigorously after handling bacteria plates.
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Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #2: Staff Training

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	07/11/2011	Raymond	Added text	streamlined	0.02
0.02	10/13/2017	Many	Format & minor text corrections	Preparation for publishing protocol	1.00

This Water Quality Monitoring Standard Operating Procedure (SOP) describes the level of training for field and laboratory personnel conducting water quality sampling in SODN Units. All field measurements and sampling in these units are conducted using procedures and protocols consistent with those of the U.S. Geological Survey (USGS). Therefore, training will be in USGS methods.

The current staffing structure, and that for the foreseeable future, includes two levels of professional expertise and, therefore, two levels of training. The monitoring program is lead by the SODN aquatic ecologist who is responsible for program management. The hydrological technician is responsible for field measurements, sampling, laboratory management and quality control. In addition, seasonal or temporary staff is hired each year under the supervision of the lead aquatic biologist/hydrologist to participate in field measurements and sampling, and laboratory support activities.

Training Requirements

Aquatic Ecologist and lead Hydrologic Technician

The primary standard for training for the lead aquatic biologist/hydrologist is the two week USGS training course entitled **Field Water-Quality Methods for Ground Water and Surface Water** (QW1028TC) or an equivalent. This course is generally offered twice per year in Lakewood, Colorado. Attendance by NPS staff is permitted on a space available basis. The course includes classroom and field demonstration of all aspects of surface and groundwater sampling.

In addition, this training will be supplemented with regular reference to this set of SOPs and the USGS National Field Manual for Water Data Collection, communication with the USGS office in Grand Junction. When partnering with USGS, they will provide 2 quality reviews annually of NPS field and laboratory techniques where USGS field monitoring staff accompany NPS staff on monitoring trips to observe, discuss and report on supplies, equipment and techniques used by the NPS staff. These must be

found to be acceptable to the USGS in order for the data to be acceptable to the USGS as described in the SODN Streams Monitoring Protocol.

In the event of staff turnover in the lead position, replacement personnel will obtain the required USGS training as soon as practical. In the interim, training will be obtained trained staff performing water quality monitoring for SOPN. It is expected that new hires will arrive with basic knowledge of the principles of water quality monitoring, and field and laboratory skills in the operation of common water quality equipment. These elements will be included in the advertisement of vacancies and ranking of applicants.

Technicians and Interns

Technicians are hired with the expectation that new staff start with basic skills in field and laboratory procedures, safety, and some knowledge or experience in water quality sampling will be desirable.

Technicians will be provided hands-on training in the field by the lead aquatic biologist/hydrologist. Training personnel should refer to these SOPs as a guide and seek out additional information in the suggested references. This training will include, at a minimum, the following topics:

- Purpose and objectives of monitoring
- Field safety (travel, river and laboratory)
- Lab safety
- Preparing for the field
- Preparing/handling of sample bottles
- Field measurements (discharge, turbidity)
- Bacteria sampling
- Multi-parameter probes (pH, Alkalinity, Temp, DO, SC)
- Equipment care, cleaning & calibration
- Sampling theory
- Surface-water sample collection
- Aquatic habitat surveys
- Macroinvertebrate collection
- Channel morphology
- Surveying
- Data entry and sample tracking
- Photo documenting
- Field and laboratory demonstrations
- Troubleshooting and contingencies
- Reference Materials (USGS National Field Manual, SOPN Water Quality SOPs)

A technician will be considered competent in the field methods when they have completed all field tasks while supervised at least three times. The lead aquatic biologist/hydrologist and lead technician must certify that technicians and interns are proficient in stream protocol methods for them to work without direct supervision. A certificate of proficiency will be printed and signed by the technician or intern, aquatic ecologist and lead hydrologic technician. This will ensure accountability and a minimum level of competency among all personnel associated with the collection and management of Streams Protocol data.

Unskilled workers

Untrained SODN staff, interns or volunteers have minimal knowledge and skill at a particular, however they can provide valuable support and help with field and office tasks. They can conduct a task only under the direct supervision of the SODN aquatic ecologist, lead hydrologic technician or technician.

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #3: Site Selection

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

The criteria and rationale used to select which water bodies to sample in SOPN parks, the sampling location, and sampling frequency of the water quality modules are outlined in the protocol narrative. This SOP presents a description of the criteria used to select sample sites in streams, how to develop a representative sampling technique for the site.

Site Selection Objectives

SODN seeks to sample vital signs and composite parameters, providing optimal statistical robustness and scientific rigor, in an efficient spatial and temporal comprehensive way to provide park managers with an integrated system for understanding ecological processes in SODN units, and at the same time create a data set that is comparable with other federal state monitoring efforts. This requires carefully locating the sampling site and collecting samples in a repeatable and representative manner.

Following are guidelines that may be useful in selecting sampling sites. These guidelines are written to be as broadly applicable as possible to all manner of flowing waters, and give field personnel guidance in selecting appropriate sites. For this reason the guidelines can be followed verbatim, or they can be used with professional judgment to streamline the site selection process.

Prior to Site Selection

Office review

Review the protocol narrative to understand objectives, data needed, equipment needs and sampling methods. Understand the purpose for which the various types of data will be collected. Obtain and review all available historic information.

Field reconnaissance

Hike the stream segment enclosed by park boundaries during base flow conditions. Go outside park boundaries if bounded by other public lands. Take field notes, GPS points and pictures of potential sampling locations and areas of concern.

1. Note sites that can be easily accessed at all times of the year.
2. Note sites that can be accessed at all times of the year keeping in mind some times of year may make access impractical.
3. Note cross sections that are least likely to change in shape due to erosion or deposition.
4. Note proximity to gauging station.
5. Note locations where staff gages could be installed to develop rating curves. These locations will have a stable channel and will allow observation of extreme high and low stages. The gage can be securely attached to an immovable object. Reference bench marks can be established.
6. Note potential sources of contamination at the site, based on target analytes to be collected.
7. Note tributary inlets.
8. Note the proximity of roads, trails, bridges and buildings, which may be sources of contamination.

Site Selection

Index Stream Segment

The index stream segment is the sampling area for the channel morphology and riparian vegetation module. The index stream segment should be 0.5-3 km. In parks where the administered length of the stream is between 0.5-3 km, the whole administered length is considered the stream segment, bounded by the park boundaries. In parks where the administered length of the stream is >3km, tributary inlets, dams or bridges can act as boundaries for the index stream segment. In parks bordered by other public lands, it may be beneficial to consider extending the index stream segment beyond the park boundaries.

Selecting landscape level stream segments will be detailed in later updates to this SOP.

Index Reach

The index reach is the sampling area for the macroinvertebrate and habitat module. The index reach is nested within the stream segment and should be 0.3- 2km long. Choose the location of the index reach with regard to:

1. Qualitative determination of representativeness of the system
2. Access issues related to safety
3. Inclusion of present or potential gaging sites
4. No inlets of perennial streams, intermittent streams or washes

Index Site

The index site is the sampling point for the quarterly sampling and continuous discharge module. The index reach is nested within the index reach. Choose the location of the index reach with regard to:

1. Qualitative determination of representativeness of the system.
2. Access issues related to safety.
3. Colocation of present or potential gaging sites.
4. In straight reaches having uniform flow, stable bottom and well-mixed along the cross-section.
5. Far enough above and below confluences of stream flow or sources of contamination.

Quality Assurance Quality Control of Index Point Representativeness

The Index Point is selected to be representative of the entire stream segment, provided the criteria given above. However, results at the index point do not provide definitive quantitative evidence applicable to the entire stream segment. Measurement of specific conductivity at all stream segment cross-sections will be performed annually at each site as a quality assurance quality control procedure, to provide further indication that results at the index point are characteristic of the entire stream segment.

1. Calibrate sensors on multiparameter probe according to (SOP 19).
2. Measure specific conductivity at all stream segment cross-sections (normally 11). Effort should be made to complete this on a stream segment in a reasonable amount of time, to prevent changes in weather and flow from effecting the results.
 - 2.1.1. Start at the downstream most cross-section.
 - 2.1.2. Take three specific conductivity measurements at each cross-section.
 - 2.1.2.1. The three measurements are taken at $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ of the wetted width from river right to river left.
 - 2.1.2.2. All the specific conductivity reading to fully stabilize at each point before recording the reading and continuing to the next point.
 - 2.1.3. Proceed upstream repeating this process at each cross-section.
3. Upon finishing recalibrate the multiparameter probe to assess probe drift during sampling.
4. Calculate the mean value from the measurements. If all the results fall within +/- 5% of the mean value, it can be considered that water quality is generally consistent throughout the entire segment. This does not say with any certainty that the water from the stream is the same throughout the segment, but indicates that it is likely that the samples collected at the index site are generally similar to results collected anywhere else in the stream segment.

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #4: Cleaning and Decontamination of Field Equipment

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	02/24/2011	Raymond	Added text and edited	Made relative to SODN	0.02
0.02	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This Standard Operating Procedure (SOP) describes how to properly decontaminate used sampling equipment. Non-dedicated sampling equipment (i.e., equipment that is used to collect more than one sample) must be decontaminated between samples to prevent cross contamination.

These procedures are appropriate for decontamination that is performed either in the field or in a laboratory setting. The procedures established in this SOP are generalized to an extent. Some pieces of equipment or instrumentation may come with instruction manuals that describe a decontamination or cleaning procedure that is different than the procedure described in this SOP. Field staff should follow the decontamination procedure specifically listed in an equipment instruction manual unless it is determined that the manufacturer's recommended procedure is ineffective.

Health and safety

Work in a well-ventilated area. Appropriate personal protective equipment (PPE) must be worn when following decontamination procedures. At a minimum, the PPE should include safety glasses and protective gloves. Additional PPE may be necessary depending upon the particular type of equipment being decontaminated, the specific hazards of the contaminants, the specific type of chemicals being used for decontamination, the setting (i.e., whether in the field or in the lab), and any site specific Health and Safety Plan (HASP) requirements that may apply.

Cleaning procedure

Non-electronic, immersible sampling equipment

1. Remove gross contamination.
 - 1.1. Use tap or deionized water and a scrub brush.

- 1.2. If available hot water is generally more effective than cold water.
2. Spray with 10% bleach
 - 2.1. Rinse equipment, preferably with deionized water.
3. Soak sampling equipment with 10% solution of Liquinox or other phosphate-free detergent.
 - 3.1. Use scrub brush if helpful.
 - 3.2. Repeat if necessary.
4. Rinse equipment, preferably with deionized water.
5. Let air dry on a clean surface.
6. Store equipment in a clean location after it has fully dried.
7. If the equipment is needed for further sampling as soon as possible, then clean paper towels may be used to dry off the equipment.
8. If there is calcium buildup, soak in 5% HCL to remove.
 - 8.1. Rinse equipment, preferably with deionized water.

Electronic, non-immersible or fragile sampling equipment

1. Refer to operating manuals for specific decontamination and cleaning instructions.
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2. For instruments without specific decontamination procedure, follow the general decontamination guidelines below.
 - 2.1. Wipe off dirt using paper towels moistened with deionized water, taking care to avoid getting electronics wet.
 - 2.2. Use kimwipes for delicate instruments, such as pH probes to avoid potential damage.
 - 2.3. If pieces of the equipment are easily removed that are immersible, then pieces may be cleaned following the steps listed under section **Non-electric, immersible sampling equipment**.
 - 2.4. Let air dry on a clean surface.
 - 2.5. Store equipment in a clean location after it has fully dried.

Decontamination bacterial samples

1. Decontaminate used bacterial sample plates using a pressure cooker.
 - 1.1. Fill container 2/3 full with tap water.
 - 1.2. Secure lid and set cooker for 30 min.
 - 1.3. After 30 min turn off cooker and let trays cool.
 - 1.4. Dispose of trays in trash.

Disposal

Liquinox

Liquinox is not considered hazardous under the Resource Conservation and Recovery Act (RCRA) regulations. In the lab, dispose of Liquinox in a sanitary sewer system. In the field, Liquinox can be safely discarded on the ground in the small amounts associated with field contamination. Do not dispose of liquinox directly into any waterway.

Hazardous cleaning agents

In the event that other more hazardous chemicals are used in decontamination, as may be required by manufacturers' recommended decontamination procedures, or site specific conditions, then proper disposal may require more stringent controls. In general, spent or contaminated organic solvents and acids should be considered hazardous waste and, as such, should be containerized in the field and disposed of

following manufacturer guidelines. For safe storage and proper disposal, spent solvents should be containerized and kept separate from spent acids.

Sonoran Desert and Southern Plains Network Streams Monitoring Protocol

SOP #5: Data Management

Version 1.00
(October 13, 2017)

Revision History Log						
Previous Version #	Revision date	Author	Changes made	Section and paragraph	Reason for change	New Version #

This standard operating procedure (SOP) describes the procedures for managing and maintaining data collected by the streams monitoring protocol for the Sonoran Desert Network (SODN) and Southern Plains Network (SOPN). The SOP was developed in accordance with strategies and guidance for data processing and quality assurance/quality control (QA/QC) specified in the SODN data management plan (Angell 2005). The instructions are presented within the framework of the typical annual work flow for a monitoring project, which includes three phases: (1) implementation, (2) product integration, and (3) evaluation and closure. Staff role(s) primarily responsible for ensuring the completion of each step are indicated in parentheses.

Annual Implementation

The protocol leader for each network oversees all aspects of the project implementation phase, which is repeated each year. Data management staff acts primarily as facilitators to support database applications, GIS, GPS, data QA/QC and certification procedures, data summarization, and data analysis. The implementation phase is further subdivided into three stages: (1) preparation, (2) data acquisition and processing, and (3) product delivery and review.

Preparation

- 1. Conduct the kick-off meeting for the current field season approximately one month prior to beginning sampling.** Schedule at least two pace meetings during the field season to assess progress and address any problems that may affect completing the work on schedule. Save the kick-off meeting notes in a central location. Refer to Section 8.1 of the protocol narrative for additional information on the annual project schedule and work flow. **(Protocol Lead/Data Manager)**

2. **Ensure that the “product tracking” portion of the kick-off meeting notes is completed. (Data Manager)**
3. **Ensure that the Streams project workspace is in place on the active or working drive and contains only files relevant to the current year/season.** Files from the previous year should have been transferred to the archive drive. **(Protocol Lead/Data Management Staff)**
4. **Ensure that the current user interface for the databases are functional** and can either be replicated or installed to the field computer(s) that will be used for data entry in the field. **(Data Manager).**
5. **Upload necessary GIS layers/maps, associated background layers, and ArcPad application(s) to the project GPS units. (Field Crew Leader)**
6. **Print paper data sheets, sampling point maps, “Revisit” data sheets, and lists of park taxa for use in the field. (Protocol or Field Crew Leader)**
7. **Ensure that names and contact information for field-crew members are entered into the “Contacts” database. (Protocol Lead/ Data Manager)**

Data acquisition and processing

Data collection and entry

Acquire field data as specified in this protocol and associated SOPs. Data are acquired using four methods: (1) manually recording data on paper field data sheets, (2) entering data directly into the project database on the field computer(s), (3) GPS handheld devices collect spatial data, and (4) logger data downloaded from various water quality and quantity data loggers. **(Field Crew)**

Paper field data sheets.—

1. **Record data neatly and legibly on the data sheet in the appropriate spaces, including all fields in the “Location and Events Information” box.** Record data in the correct formats and use only values from printed code lists, where applicable. **(Field Crew)**
2. **Before moving to the next field data sheet or sampling location, review each data sheet to ensure that all required parameters have been recorded and there are no obvious errors.** If corrections are required, incorrect values may be erased and replaced with correct values. **(Data Recorder)**
3. **At the end of each field day, review all the field data sheets for that day.** If corrections are required, incorrect values may be erased and corrected on the data sheet. Initial and date the “proofread by” space on each data sheet. This must be completed in order to move forward with data processing. **(Field Crew Leader)**
4. **At the end of each tour or other logical period of time, scan each data sheet, ensuring that the results are legible and complete (i.e., nothing is cut off at the edges).** Initial and date the “Scanned by” space on the top right of original data sheets **before** making the scan. File the scanned originals in the ‘To Be Entered’ folder in the seasonal fireproof file cabinet. Scans (PDFs) should be saved with embedded metadata as original scans in the scan folder for the project. **(Field Crew)**
5. **Conduct a data-entry trial and quality review after one day (or another logical period) of manual data collection.**
 - a. Enter the test data into the database and verify them according to the instructions in the “tabular data verification, validation, and certification” section of this SOP. **(Field Crew)**

- b. Review the test dataset. **(Protocol leader/ Data Management Staff)**
 - c. If the data meet overall project quality requirements, continue data collection. **(Field Crew)**
 - d. If data quality is not acceptable, provide additional training to the observers, who then repeat the data-entry trial and quality test. **(Protocol lead/Data Management Staff)**
 - e. If data quality has not improved to meet standards after the second trial, examine other aspects of the protocol and the database for factors that may be contributing to the difficulty in meeting data-quality requirements. Implement any desired changes and repeat the steps in this section until data quality meets the requirements. **(Protocol lead/Data Management Staff)**
6. **Regularly enter the data into the project database according to the instructions in the Streams Monitoring Database User Guide.** If at all possible, do not wait until the end of the field season to begin entering data from data sheets into the database. Keeping current with data entry aids in finding and correcting errors while the information is still fresh in the minds of the field crew. Initial and date the “Entered by” space on each data sheet after the data are entered. **(Field Crew)**

Electronic data entry.—

- 1. **Use the data-entry forms to enter data directly into the digital project database.** The database has built-in checks and drop-down lists to streamline data entry and help ensure data quality. **(Field Crew)**
- 2. **Before moving to the next field form or sampling location, review each digital data form to ensure that all required parameters have been entered and there are no obvious errors.** If corrections are required, make them at this time. **(Field Crew)**
- 3. **At the end of each day, create a PDF print out of the digital data from that day and review them.** If corrections are required, make them in the digital database using the “edit data” function and create a new PDF of the corrected data. Using the typewriter function in Adobe Acrobat, initial and date the “proofread by” space on each data sheet. **(Field Crew Leader)**
- 4. **Back in the office, print any digital data on archival paper.** File with the rest of the original paper datasheets in the seasonal fireproof file cabinet. **(Field Crew)**
- 5. **The first day of electronic data collection serves as the data-entry trial.** The field crew leader’s review of the data collected that day serves as the quality review. If data quality is not acceptable, follow the procedures in Step 5 of the previous section (“Conduct a data-entry trial and quality review after one day [or another logical period] of manual data collection”). **(Field Crew Leader)**
- 6. **For extended field tours,** backup or copy the database(s) to either an external hard drive or flash drive daily. Use the Backup Database command on the database front-end. **(Field Crew Leader or Field Crew)**
- 7. **For short field tours or day trips,** replicate the dataset with the master database on the server. **(Field Crew Leader/Data Management Staff)**

Spatial data collection.—

1. **Collect spatial data of the highest-possible quality** according to the instructions in the data collection SOPs and the program's GOPs on using the various handheld units. **(Field Crew)**
2. **Check-in the data to the Field/Uncertified version of the project geodatabase.** **(Field Crew)**
3. **Inform the data manager or cartographic technician if post-processing is needed,** or if any other data points need to be moved into the project geodatabase. **(Field Crew Leader)**
4. **Post-process the data, if needed.** **(Data Management Staff)**

Persistence data collection. –

1. **Follow appropriate networks' instructions in order to properly setup and download data from persistence sensors.** All persistence sensor data collected in the field should be downloaded and saved to protocol-specific folder upon returning from the field. **(Field Crew)**
2. **Inform Data Management staff if above step is not completed, so that s/he may complete or coordinate the task.** **(Field Crew)**
3. **Persistence sensors should be deactivated or have a new mission enabled** upon downloading of data, depending on need. **(Field Crew)**

Photograph acquisition.—

1. **Take the digital photographs of the highest-possible quality, as specified in SOPs.** **(Field Crew)**
2. **Download the images daily (if possible; if not, as soon as practical) to the appropriate folders.** **(Field Crew)**

Data verification, validation, and certification

Paper field data sheets.—

1. **Follow the instructions in the “QA/QC Procedures for Tabular Data” Data Management Guidance Document to verify, validate, and certify the seasonal dataset.** **(Field Crew/Field Crew Lead)**
2. **If needed, make corrections to original/printed data sheets.** With pencil draw a line through the incorrect value and write either directly above or below record the corrected value. **(Field Crew)**

Electronic data entry.—

The need for data verification has been eliminated by entering data directly into the database, and the dataset has been partially validated during data entry and the subsequent reviews of the data forms.

1. **Follow any additional validation procedures specified in the data collection SOPs, and run any automated database validation checks within the database.** **(Field Crew/Field Crew Lead/Protocol Lead)**
2. **Review the results and make any necessary changes to data in the database.** **(Field Crew/Field Crew Lead/Protocol Lead)**

3. **If needed, make corrections to original printed data sheets.** With pencil draw a line through the incorrect value and write either directly above or below record the corrected value. **(Field Crew/Field Crew Lead/Protocol Lead)**
4. **Keep a list of all corrections made, relevant comments about the dataset, and any extreme values determined to be correct to confirm their validity for future users of the data.** Report this information in the “quality assurance review” section of the Project Data Certification form. **(Protocol or Field Crew Leader)**
5. **Final review of dataset** for common logical errors, reconcile if found, create new database or application validation rule(s) to avoid error(s) in future data collection. **(Data Manager)**

Scanned data sheets.—

Scanned data sheets will serve as local copies. Once all of the tabular data are certified, new scans should be generated to reflect all of the corrections made on the original paper datasheets that were made during the QA/QC process.

1. **Scan each corrected original data sheet, ensuring that the copies are legible and complete (i.e., nothing is cut off at the edges).** Prior to creating the final scan, ensure that all lines in top right for various data processing tasks have been initialed. Store final scans in same location as original scans except in a Final Scans folder designated by Unit code. File the originals back into the seasonal fireproof file cabinet. **(Field Crew)**

Spatial data.—

1. **Validate spatial data by evaluating the positions of orifice(s), water sampling locations, terminus, exotic plants and sensors against a backdrop of other spatial layers,** such as digital raster graphics, DOQQs, park boundary layers, etc. Ensure datasheet coordinates match those of the features you have validated. Initial next to ‘Verified by’ on the top right of the data sheet containing spatial coordinates. **(Field Crew/Field Crew Lead)**
2. **Certify all spatial datasets by completing a “Project Data Certification” form.** **(Protocol or Field Crew Leader)**
3. **Final review of dataset** for common logical errors, reconcile if found, create new geodatabase or application validation rule(s) to avoid error(s) in future data collection. **(Data Manager)**

Photographs.—

1. **Review photos and follow appropriate network’s instructions on managing photo data and metadata.** You may retain a poor-quality photo if the subject is highly unique or unusual. **(Protocol or Field Crew Leader)**
2. **Insert metadata and rename the photos as specified in network protocols.** **(Field Crew)**
3. **Ensure that photos are appropriately organized in the photograph subfolders; you may create additional subfolders as needed.** **(Protocol leader)**
4. **Validate photos by ensuring that all required metadata is present and appropriate to photo. If it is not, repeat procedures from step 4 to correct data.** Verify photos are correctly renamed and in the correct location. **(Field Crew)**

Sensitive data.—

1. **Evaluate the dataset according to the information and procedures in the “Sensitive Data Management Strategy” guidance document, “Director’s Order #66,” and “Reference**

Manuals 66A and 66B” to determine whether it includes any potentially sensitive data or policy implications that should be withheld from public distribution. (Protocol leader/Data Manager)

- 2. Document the results of this evaluation in the “sensitive data” section of the “Project Data Certification” form, so that appropriate steps may be taken when reporting and distributing the data. (Protocol leader)**
- 3. Identify and flag surveys or events in the tabular database which contain sensitive information using the evaluation conducted in step one, above. (Protocol leader/Data Manager)**

Voucher specimens and photographs.—

- 1. Process any voucher specimens collected during field work according to the instructions in the “Botanical Curation Procedures” guidance document.**
- 2. Process any voucher photographs taken during field work according to the instructions in the “Digital Photograph Management Strategy” guidance document.**

All Data.—

- 1. Certify the seasonal dataset by completing all sections of the Project Data Certification form and submitting it to the data manager. See data management guidance document “QA/QC Procedures for Tabular Data.” (Protocol or Field Crew Leader)**
- 2. Notify project leader that data are certified and ready for analysis and reporting (Data Manager)**

Product development, delivery, and review

Analysis and reporting

The project leader is responsible for analyzing monitoring data and reporting the results, with support from the data management staff. Refer to the “Report Management Strategy” guidance document for the work flow.

- 1. Maintain the automated data analysis and reporting queries for certified datasets. (Data Management Staff)**
- 2. Design new analysis and report functions when necessary (see the Data Maintenance/Database Revisions section of this SOP). (Project Lead/Data Management Staff)**
- 3. Store the results of summaries and analyses in the Analysis folder in the project workspace. (Project Lead)**
- 4. Store current-season project reports, resource briefs, and similar products in the appropriate subfolders in the Products folder in the project workspace. (Project Lead)**

Metadata development

- 1. Update the project tabular database with FGDC-compliant metadata record and the data dictionary. (Data Manager)**
- 2. Embed metadata into photographs according to guidance in the Image Processing SOP. (Field Crew)**

3. **Create an initial FGDC-compliant metadata record and a data dictionary for any other digital datasets using the NPS Metadata Tools & Editor and the NPS Database Metadata Extractor.** Update these documents as needed after each field season. **(Field Crew/Field Crew Lead)**

Spatial data.—

1. **Create an FGDC-compliant metadata record for the protocol gedoatbase.** Update existing metadata records as needed. **(Field Crew/Field Crew Lead)**
2. **Include the Biological Data Profile, if appropriate. (Project or Field Crew Leader/ Data Manager)**

Data delivery and product review

1. **Review all raw and derived data products (tabular and spatial), metadata, photographs, reports, and other products to ensure that they fulfill the project objectives and meet program's product specifications.** Digital files should be clearly named according to program's standards and stored in the appropriate folders in the project workspace. Return products that do not pass the review to the originator for revision. **(Project leader/ Data Manager)**
2. **Deliver the final products by entering the delivery date in the “product tracking” portion of the kick-off meeting notes, and notify the data manager via e-mail that they are complete. (Project leader)**
3. **Review the completed products to ensure they have all been received, are in the right formats, and are ready for cataloging, integration, and distribution.** Return products that do not pass the review to the project leader for revision. **(Data Manager/Science Writer-Editor)**

Product Integration

Data management staff is responsible for most of the tasks in the product integration phase, with some assistance from the project leader and other staff. During this phase, project data are integrated into national databases and metadata records and non-sensitive products are cataloged, archived, stored, and distributed to their intended audiences. Refer to the “Sensitive Data Management Strategy” guidance document which outlines how to handle sensitive data products appropriately.

National databases and applications

- **IRMA (Integrated Resource Management Applications)**

Use the online IRMA Natural Resource Information Portal (<https://irma.nps.gov/>) to catalog and upload metadata and products. **(Data Manager/Assistant Data Manager)**

- **NPSpecies Database**

After the certification process is complete, add new species and supporting evidence recorded during the field season through the NRInfo NPSpecies Application **(Data Manager/Assistant Data Manager)** OR submit the entire seasonal database to NPSpecies staff for uploading to the database. **(Data Manager/Assistant Data Manager)**

- **NPSStoret Database**

After the certification process is complete, add new macroinvertebrate, water quality and quantity, and water discharge during the field season through the NPSStoret Application **(Data**

Manager/Assistant Data Manager) OR submit the entire seasonal database to NPStorret staff for uploading to the database. **(Data Manager/Assistant Data Manager)**

Network Protocol Products

- **Web Sites**

The NPS Internet web sites automatically query the IRMA Data Store Application and display links to the streams monitoring project reports.

- **Reference Library**

Store a printed copy of each annual and synthesis-and-trend report in labeled folders in the Reference Library files. **(Data Management Staff)**

Notify parks when these products are available. (Project leader)

Archiving and records management

Project folder review

1. **Go through the seasonal folders and ensure that all files are appropriately named and versioned. (Project Lead/Data Management Staff)**
2. **Determine which folders to retain on the V:\ drive, which ones to transfer to the master project file on the S:\ drive,** (refer to the “Archiving Instructions” guidance document for more information), **and which files to delete** (refer to “Director’s Order #19” and the accompanying “Records Disposition Schedule” and the “Management Handbook” for detailed information on what constitutes a record and which records may be destroyed). **(Project Lead/Data Management Staff)**

Seasonal files

1. **Transfer digital files to the master project folder on the S:\ drive. (Data Management Staff)**
2. **Transfer original paper and other project files to the designated off-site repository. (Data Management Staff)**
3. **Export the tables in the master project database as ASCII text files and store them with the master project database. (Data Manager)**

Backup procedures

Integrate the data into the network backup routine. For backup procedures, see the SODN Digital Data Backup SOP.

Evaluation and Closure

The evaluation and closure phase involves all project and data management staff in an annual review to evaluate the success of the field season and verify that all data and products are complete and available.

Season close-out meeting

Conduct the season close-out meeting following the completion of the field season, to assess how well the project met its objectives and determine what might be done to improve various aspects of the methodology, implementation, and formats of the resulting information. Refer to the close-out meeting

checklist for additional information on evaluating the field season. **(Program Manager, Project Staff, and Data Management Staff)**

Data Maintenance

Although all data are carefully checked before being analyzed and reported, certification does not guarantee that the data are entirely free of errors; the next section provides guidelines for making and tracking edits to certified data, if necessary. Similarly, changes in sampling methods and techniques may lead to revisions of the structure or functions of the database; the next section also provides guidelines for making and documenting necessary revisions to the project database.

Data editing

1. **The project leader and data management staff work together on any edits to certified archived data.** At this stage, printed, original, and copied data sheets **are not** altered. Field data sheets are reconciled to the database using the edit data table and reports. **(Project leader/Data Manager)**
2. **Make the necessary changes to the dataset. (Project Lead/Data Management Staff)**
3. **Print a copy of the change log and file it with the field data sheets; file a copy of the report with the copied data sheets. (Project Lead/Data Management Staff)**

Database revisions

1. **Before making any major revisions to either the structure or functions of the front- or back-end database, make an archive copy to allow tracking of changes over time. (Data Manager)**
2. **Store the archive copy in the Archive folder in the Processed_Data folder on the S:\ drive. (Data Management Staff)**
3. **Rename the master database using the next version number, and make the changes.** Notify frequent users of the database that the updated version is available and summarize the updates. **(Data Management Staff)**

References

Angell, Deborah L. 2005. Sonoran Desert Network data management plan. National Park Service Inventory and Monitoring Program, Sonoran Desert Network, Tucson, Az.
<http://science.nature.nps.gov/im/units/sodn/datamanagement.cfm>.

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #6: Revising the Protocol Narrative and SOPs

Version 2.00
(March 31, 2011)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
1.00	3/31/2011	K. Beaupre	Extracted revision detail to another DM document. Left overarching rules and guidance	More efficient method of maintaining these documents and information	2.00

This SOP explains that all protocol documents; the protocol narrative, appendixes, SOPs, and datasheets are highly controlled and managed. This is done to ensure that only authorized and approved modifications are made to these documents and to maintain a complete version history of this protocol to ensure all data can be synthesized, analyzed, and reported.

Anyone who finds a revision of these documents necessary should refer to *SWNC Versioning and Control Procedures*. They should also understand protocol versioning methods to ensure that the active version of a protocol document is revised and make the revisions in a timely manner in order to minimize disruptions to project operations.

All modifications to these documents will be discussed with all interested stakeholders; however, the final decision on any modifications lies in the purview by the protocol lead network.

To ensure the use of the most current the protocol narrative, appendixes, SOPs, and datasheets; please go to <https://irma.nps.gov/DataStore/Reference/Profile/2256789>.

Master Version Table

Protocol Version	Date of Change	Narrative	Standard Operating Procedure																										
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #7: Discharge

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	10/13/2017	Many	Format and minor text changes	Preparation for publishing protocol	1.00

This SOP explains the procedure for measuring discharge in wadeable streams using velocity meters. Stream discharge measurements will be taken quarterly in all SODN water quality monitoring sites. In the event of floods, additional discharge measurements may be taken. Care should be taken to follow recommendations found in Turnipseed and Sauer 2010. SODN currently uses a SonTek Doppler velocimeter.

Recommended Reading

Turnipseed, D. P., and V. B. Sauer. 2010. Discharge measurements at gauging stations. U.S. Geological Survey techniques and methods book 3, chapter A8. <https://pubs.usgs.gov/tm/tm3-a8/>.

Set up the tagline

1. Choose cross-section for discharge measurement.
 - 1.1. Within the index reach as near the index point as possible.
 - 1.2. As close as possible to any present water level gages (GICL, MOCC, MOWE).
 - 1.3. Streambed is free of large rocks, weeds, and protruding obstructions that create turbulence. If obstructions are present, move obstructions downstream of cross-section.
 - 1.4. Streambed has a flat profile to eliminate vertical components of velocity.
 - 1.5. All of the flow is directed downstream (i.e. there are no eddies) and lines of flow are as near parallel as possible.
2. Secure tagline on one side of stream, pull taut perpendicular to the channel, and secure on the other side of the stream.
3. Divide the cross section into 25-35 partial sections.
 - 3.1. Adjust spacing between partial sections so that no more than 5% of the flow is in any one partial section. This means that where water is deeper and swifter measurement points are spaced closer together, while in shallow and slow water they are spaced further apart.

Taking a discharge measurement

1. Record starting edge information.
 - 1.1. Before starting record water level from gauge if present.
 - 1.2. Record the location of the starting water's edge on the tagline.
 - 1.3. Record the water depth at the water's edge (usually '0').
2. Stand downstream of the current meter at an arms-length distance from the current meter so as not to disturb the flow path.
3. Place wading rod at observation point location.
 - 3.1. Use bubble level to keep wading rod perpendicular to water surface.
 - 3.2. Make sure the current meter sensor is parallel to flow.
4. Record the distance from each observation point to a reference point on the bank along the tag line.
 - 4.1. Record the water depth at each observation point.
 - 4.2. Set the wading rod.
 - 4.2.1. When the water depth is <1.5ft velocity should be measured at a depth which is 0.6 of the depth from the surface water in the channel. Move the top setting wading rod to reflect depth at that location, which automatically puts the probe at the 0.6 depth.
 - 4.2.2. When the water depth is >1.5ft velocity should be measured at 2 depths, 0.2 and 0.8 of the depth from the surface water in the channel.
 - 4.2.2.1. For the 0.2 depth move the top setting wading rod to twice the actual depth at that location depth (i.e. set the wading rod to 3.2 ft when actual depth is 1.6 ft).
 - 4.2.2.2. For the 0.8 depth move the top setting wading rod to reflect half the actual depth (i.e. set the wading rod to 0.8 ft when actual depth is 1.6 ft).
 - 4.3. Record the velocity at each observation point, averaged over 40 seconds using a current meter.
 - 4.4. The discharge of each partial section is calculated as the product of mean velocity times depth at the vertical times the sum of half the distances to adjacent verticals. The sum of the discharges of each partial section is the total discharge.
 - 4.4.1. When water depth is >1.5ft, take the mean of the velocity at the 0.2 and 0.8 depth.
 - 4.5. Record ending edge information.
 - 4.5.1. Record location of the starting water's edge on the tagline.
 - 4.5.2. Record the water depth at the ending water's edge (usually '0').
 - 4.5.3. After finishing record the water level from gauge if present.

Equipment List

Equipment	Quantity	Pre-trip	Post-trip
Current meter	1	Pack	Clean
Wading rod	1	Pack	Clean
30m tagline	1	Pack	Clean
Chain pin	2	Pack	Clean
Clips	2	Pack	Clean
AA Batteries	8	Pack	Restock

References

- Turnipseed, D. P., and V. B. Sauer. 2010. Discharge measurements at gauging stations. U.S. Geological Survey techniques and methods book 3, chapter A8. <https://pubs.usgs.gov/tm/tm3-a8/>.
- Chapter 4- Measurement of stage from *Measurement and Computation of Streamflow*:
- *Volume 1. Measurement of Stage and Discharge*, USGS WSP 2175

- Chapter 5- Measurement of discharge by conventional current-meter method from
- *Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge*, USGS WSP 2175
- Current meter operating manual located at V:\Global_SOPs\Water_Discharge.
- Discharge measurement with SonTek Flowtracker
- Flowtracker Quick Start Guide

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #8: Surveying Cross-sections and Longitudinal Profile

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	7/9/09	McIntyre	Revised methods and techniques. Revised intro text.	Updating methods to reflect programmatic changes	0.02
0.02	10/13/2017	Many	Format	Preparation for publishing protocol	1.00

This Standard Operating Procedure (SOP) explains the procedure for collecting the “for surveying channel cross-sections for the stream channel morphology vital sign implemented under the Streams Monitoring Protocol at Sonoran Desert Network parks. This procedure utilizes either a transit total station or survey-grade GPS to collect survey data and a handheld PC with integrated GPS to guide data collections. The methods for collecting channel cross-sections and a longitudinal profile are based on established procedures (Harrelson et al. 1994). See the appropriate Global Operating Procedure for information on the operation of the equipment used in this SOP.

Establishing the Cross-sections (1-2 people)

Up to eleven channel cross-sections are systematically located within the sampling reach. Prior to imitating stream monitoring at a park, the SODN ecologist utilizes aerial imagery and other geographic information to determine the location of the cross-sections.

1. Load the sampling locations shapefile (“park_sampling_locations”) onto a GeoXT with ArcPad and navigate to the end of the cross-section. If you cannot safely reach the end of the cross-section, stop at the point nearest to the end to which you can safely navigate.
2. Mark the end of each cross-section by driving in a piece of ½ inch rebar, leaving approximately 2 inches above the surface. Cap the rebar with a yellow plastic cap and record a point in the GeoXT.
3. Repeat steps 1-2 for the opposite end of the cross-section.

Surveying the Cross-sections (1+ people)

Surveying the channel cross-sections can be accomplished by one or more, depending on the survey instrument being used. If the survey instrument is a transit total station, then a minimum of two people are required. However, if a survey grade GPS is the survey instrument, then one or more people are required.

1. Start the cross-section survey at the rebar on the left side of the stream (when facing downstream). Record a point using the survey equipment and associated handheld data collector (HDC) at the base of and at the top of the rebar.
2. Along the cross-section (as delineated by the “park_sampling_locations” shapefile in ArcPad), use the survey equipment to record a point at major slope breaks and at important features such as indicators of active floodplain boundaries, indicators of high flow, changes in elevation and other features of interest. For important features, record the appropriate code from Table 1 in the HDC being used with the survey instrument.

Table 1. Codes used in cross-section surveys

Code	Description
RL	Rebar on Left Side of Stream
RR	Rebar on Right Side of Stream
LT	Low Terrace
MT	Middle Terrace
HT	High Terrace
LB	Left Bank
RB	Right Bank
BKF	Bankfull Indicator
LEW	Left Edge of Water
REW	Right Edge of Water
T	Thalweg
PB	Point-Bar
HW	High Water Mark

3. If water is present in the channel, record a point at the left edge of the water and record the appropriate code from Table 1 in the HDC. Place a pin flag at the left edge of the water along the cross-section. The pin flag will help identify the cross-section in photographs.
4. Once in the water, record points every 2 feet and to capture major slope breaks.
5. Use the survey rod to probe for the thalweg (deepest spot in channel along the cross-section). Record a point at the thalweg and record the code “T” in the HDC.
6. As you exit the water, record a point at the right edge of the water and record the appropriate code from Table 1 in the HDC. Place a pin flag at the right edge of the water along the cross-section.
7. Continue along the cross-section (as delineated by the “park_sampling_locations” shapefile in ArcPad) towards the rebar marking the right end of the cross-section. Use the survey instrument to record a point at major slope breaks and at important feature such as indicators of active floodplain boundaries, indicators of high flow, changes in elevation and other features of interest. For important features, record the appropriate code from Table 1 in the HDC.

Surveying the Longitudinal Profile (1+ people)

Surveying the longitudinal can be accomplished by one or more, depending on the survey instrument being used. If the survey instrument is a transit total station, then a minimum of two people are required. However, if a survey grade GPS is the survey instrument, then one or more people are required.

1. The longitudinal profile survey measures the elevation of the thalweg, water surface, and terraces. While this SOP describes surveying these types of indicators independently, you should survey all of these points during a single pass as you walk downstream.
2. Start the longitudinal profile survey at the upstream end of the reach. Use the survey instrument to record a point in the deepest portion of the channel (thalweg) and note the appropriate code from Table 2 in the HDC.
3. Record points at the water's edge (if present) using the survey instrument and record the appropriate code from Table 2 in the HDC.
4. In the channel, use the survey instrument to record a point at major slope changes along the thalweg. At thalweg points, record the habitat type in the HDC using the names in Table 3. Use the surveyor's rod to measure the water depth and record it in the HDC.

Table 2. Codes used in longitudinal profile surveys.

Code	Description
T	Thalweg
BKF	Bankfull Indicator
PB	Point-Bar
HW	High Water Mark
TopRif	Top of Riffle
EndRif	End of Riffle
TopPool	Top of Pool
DpPool	Deepest point in a pool
EndPool	End of Pool
LEW	Left Edge of Water
REW	Right Edge of Water
LT	Low Terrace
MT	Middle Terrace
HT	High Terrace
LB	Left Bank
RB	Right Bank

Table 3. Habitat types and descriptions

Habitat	Description
Dry Channel	No water in the channel;
Pool	Still water, low velocity, smooth, gassy surface, usually deep compares to other parts of the channel;
Glide	Water moving slowly, with a smooth, unbroken surface, low turbulence;
Run	Refers to segments of streams where there is moderate velocity water, but non-turbulent conditions which do not break the surface tension of the water and do not produce whitewater.
Riffle	Refers to the portions of streams where moderate velocities and substrate roughness produce moderately turbulent conditions which break the surface tension of the water and may produce whitewater. Riffle (EMAP)water moving, with small ripples, waves and eddies, waves not breaking, surface tension not broken, sound is “babbling,” “gurgling”
Rapid	Water movement rapid and turbulent, surface with intermittent whitewater with breaking waves, sound is continuous rushing, but not as loud as a cascade
Cascade	Water movement rapid and very turbulent over steep channel bottom, most of the water surface is broken in short, irregular plunges, mostly whitewater, sound is roaring
Falls	Free falling water over a vertical or near vertical drop into plunge, water turbulent and white over high falls, sound is from splash to roar
Marsh	Backwater area

- As you move downstream, record points at the water’s edge approximately every 100 meters. Be sure to record points at the pin flags left from the channel cross-section surveys. Make note of these points in the HDC. This helps tie together the cross-section and longitudinal profile surveys.
- As you move along the longitudinal profile, collect points outside of the channel such as indicators of high flow, terraces and other features of interest. For important features, record the appropriate code from Table 2 in the HDC.
- Continue the longitudinal profile survey until you reach the end of the sampling reach.

Table 4. Equipment List

Equipment	Quantity	Location	Pre-Trip	Post-Trip
Survey instrument and associated handheld data collector (HDC) and peripherals	1	Suite 303	Make sure it is included	Download, clean and put in storage
Survey marker stakes	22	lab	Make sure it is included	N/A
Rebar caps stamped w/ SODN	22	lab	Make sure it is included	N/A
GeoXT	1	Suite 308	Load with “park_survey_location” shapefile and other appropriate data	Download, clean, and put in storage
Digital camera	1	Suite 308	Make sure it is included	Clean and put in storage
Pin flags	22	field cabinet	Make sure it is included	Clean and put in storage

Literature Cited

Harrelson, C., C. Rawlins, and J. Potyondy. 1994. Stream channel reference sites: An illustrated guide to field technique. USFS General Technical Report RM-245.

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #9: “Wolman” Type Pebble Count

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01					0.02
0.02	10/6/2008	Gwilliam	Revised methods and techniques. Revised intro text.	Updating methods to reflect programmatic changes	0.03
0.03	4/29/2009	McIntyre	Revised methods, techniques, and Table 1. Slight revisions to intro text.	Updating methods to reflect use of gravelometer	0.04
0.04	10/13/2017	Many	Formatting and small corrections	Preparation for publishing protocol	1.00

This Standard Operating Procedure (SOP) explains the procedure for collecting the “Wolman” Pebble Count for the stream channel morphology vital sign implemented under the Streams Monitoring Protocol, and the Washes Monitoring Protocol at Sonoran Desert Network parks. The pebble count characterizes bed material and is conducted using a step-toe procedure on washes and streams.

This SOP is conducted only on dry or wadeable portions of the stream or wash. NOTE: This SOP will not be implemented in water over the heads of workers.

Conducting the Wolman Pebble Count on Washes or Wadeable Streams (2 people)

The Wolman Pebble Count is conducted over the entire sampling reach. A **minimum** of 200 particles should be measured within the stream bed. When measuring in conjunction with macroinvertebrate sampling, a minimum of 20 particles should be measured between each macroinvertebrate sampling location. If water depth prevents a sample from being safely collected, proceed up- or downstream until you can safely collect a sample.

1. Start at one end of the sampling reach. Randomly select a side of the river to begin the count.
2. At the edge of the channel bed on the chosen side the observer tosses a stone to randomly select a starting point.
3. Standing where the stone stopped, the observer takes X steps towards the stream bed at a 45° (± 15°) to the stream flow. The number of steps depends on the size of the reach but should be consistent throughout the count.

4. Averting his/her gaze, the observer picks up the first particle touched by the tip of your index finger at the toe of his/her shoe. If the particle is embedded, go to step 5.2.
5. The observer classifies the particle using the gravelometer.
 - 5.1. If the particle is not embedded, pick up the particle to see which opening it fits through on the gravelometer.
 - 5.2. If the particle is embedded and it is cobble size or larger and the three axes can not be measured take the intermediate measurement of those you can measure. The intermediate axis is shown in Figure 1. If this substrate category seems inaccurate, use your best judgment to assign the appropriate category.
6. The observer calls out the measurement to the recorder.
7. The recorder tallies the measurement by size class (Table 1) and repeats it back for confirmation.
 - 7.1. For cobbles, if the cobble was *not embedded*, the recorder tallies the measurement by size class in the “**non-embedded**” / “**NE**” row. If the particle was **embedded**, the recorder tallies the measurement by size class in the “**embedded**” / “**E**” row.
8. The observer takes X steps towards the opposite bank. Once the observer reaches the bankfull elevation at the opposite bank s/he turns around and traverses towards the initial bank.
9. Repeat Steps 4 to 8 until the observer reaches the downstream end-point of the sampling reach.
10. If the minimum numbers of particles (e.g., 100 in the case of the Washes Protocol) have been measured, the pebble count is complete. If less than 200 (100) particles have been measured, the observer travels upstream and repeats steps 6-10 until 200 (100) particles have been measured.

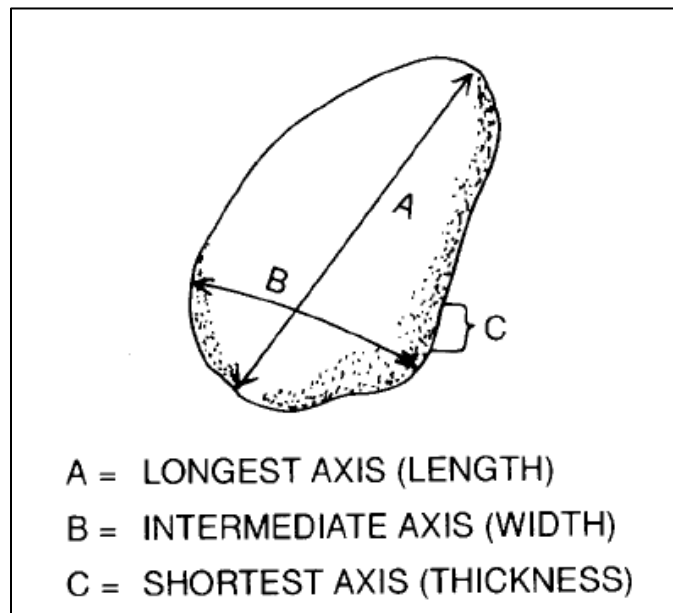


Figure 1. Intermediate axis measurement.

Table 1. Wolman pebble count size classes using Gravelometer.

Description	Size Class Range (mm)
Silt/Clay	silky
Coarse Sand	2
Fine Gravel	2.8 to 8
Medium Gravel	11 to 16
Coarse Gravel	22.6 to 32
Very Coarse Gravel	45 to 64
Small Cobble	90 to 128
Large Cobble	180, $181 \leq X < 256$
Small Boulder	$256 \leq X < 512$
Medium Boulder	$512 \leq X < 1024$
Large Boulder	$1024 \leq X < 2048$
Very Large Boulder	$2048 \leq X < 4096$
Bedrock	$4096 < X$

Equipment List

Equipment	Quantity	Location	Pre-Trip	Post-Trip
Laptop or Tablet PC with the latest Streams or Washes database	1	Suite 308	Load database, check to see if computer and database functions	Merge data with master database
Wolman Pebble Count Datasheets	1/reach	server	Print out several copies	Enter data into database if needed, then copy and file
clipboard	1	field cabinet	Make sure it is included	Clean and put in storage
Gravelometer	1	Lab	Make sure it is included	Clean and put in storage
plastic metric ruler	1	lab	Make sure it is included	Clean and put in storage

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #10: Mapping Wetted Width

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	07/12/2006	S. Studd	Additions	Edits to draft, post field use	0.02
0.02	05/05/2009	Kristen Beaupre'	Charged to reflect new sampling reach design, and use of GeoXT	sampling reach redesigned	0.03
0.03	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This standard operating procedure gives step-by-step instructions on how to map the wetted width for the streams protocol. This SOP assumes the individual(s) collecting GPS data, are aware of the GPS and GIS standards of the National Park Service (NPS) and also of Sonoran Desert Network (SODN). This information can be found in the SODN Spatial Data Management Strategy (P:\Data_Management\GIS). This SOP also assumes that the individual(s) collecting GPS data, know how to operate a Trimble GeoXT, ArcPad 8.0, and are using Streams templates for data collection. More information about GeoXTs and ArcPad can be found at V:\Global_SOPs\Handhelds.

Stream Wetted Width Template

The ArcPad template for the GeoXT is located; V:\Streams\Protocols\Sampling_Forms\GIS_Templates. Load the template to the GeoXT and save it to the Template folder. Ensure to check-out the GeoXT on the equipment calendar.

Data Collection in the Field

Ensure that the GeoXT's GPS preferences are set-up according to SODN standards. These standards and the steps to set up the GeoXT are located in the [Collecting GPS Trimble v100](#) document.

The wetted width data will be collected during the summer quarterly sampling period (July thru September) for each park, annually. Either one or two people can map the reach. If two people; ensure that each individual is mapping different banks. The right and left bank will be mapped for the entire park. The wetted width is defined as the distance from waters edge to waters edge on each side of the bank. The length of the reach is defined as the portion of the stream within the park boundaries.

Overhanging vegetation may prevent the individual from walking directly along the waters edge. In this case the mapping unit should be held at arms length as close to over the waters edge as possible. If an area presents obstacles that prevent positioning the unit adequately close the waters edge, you can utilize the **User Pause** function by tapping on the **RUN** tab. This allows you to pause the drawing of the line while you move to a new location. Once at the new location (i.e. around the obstacle), you can resume drawing. The unit will connect the line from where you stopped to where you resumed. It may still be advisable in some cases to walk the length of the reach prior to mapping to ascertain any areas which will prove difficult and to determine a route beforehand.

Once the GPS data has been collected; attribute the linear shapefile and save it to the GeoXT. Verify that the GPS data has been saved and then close ArcPad.

Back in the Office

The data collected from the field will be downloaded into the V:\Streams\Data_Spatial\Raw_Data\Park folder. The Assistant Data Manager should be notified via email that this data is ready to be processed. The Assistant Data Manager will ensure that the GPS data collected meets the standards of SODN and the NPS and also verify the quality of the data collected. The GPS data will be appended to the master shapefile (V:\Streams\Data_Spatial\Processed_Data\Park) and the metadata will be updated to reflect the addition of a new feature.

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #11: Segment Physical Characterization

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This Standard Operating Procedure explains the procedure for measuring the physical characteristics of streams as part of stream monitoring conducted by the Sonoran Institute. Much of the text and diagrams is based on the manual “Environmental Monitoring and Assessment Monitoring Program Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams” (Peck et al. 2003).

Overview of Sampling Methods

1. Four measures of physical habitat and supplementary descriptive information are collected within the sampling reach.
2. Data collection begins at the bottom of the reach and proceeds upstream.
3. Sampling for all measures occurs at each of the 11 cross-section transects (A through K if 11 are possible to install).

Channel Classification/Water Column Description

1. Channel classification/water column descriptions are made at each of the 11 cross-section transects (A through K).
2. Choose a single dominant description for **flow class** within an imaginary 10m wide belt transect centered over the cross section and the full width of the channel using the descriptions in Table 1.

Table 1. Flow class categories and descriptions (Peck et al. 2003)

Dry Channel	No water in the channel;
Pool	Still water, low velocity, smooth, gassy surface, usually deep compares to other parts of the channel;
Glide	Water moving slowly, with a smooth, unbroken surface, low turbulence;
Run	Refers to segments of streams where there is moderate velocity water, but non-turbulent conditions which do not break the surface tension of the water and do not

	produce whitewater.
Riffle	Refers to the portions of streams where moderate velocities and substrate roughness produce moderately turbulent conditions which break the surface tension of the water and may produce whitewater. Riffle (EMAP) water moving, with small ripples, waves and eddies, waves not breaking, surface tension not broken, sound is “babbling,” “gurgling”
Rapid	Water movement rapid and turbulent, surface with intermittent whitewater with breaking waves, sound is continuous rushing, but not as loud as a cascade
Cascade	Water movement rapid and very turbulent over steep channel bottom, most of the water surface is broken in short, irregular plunges, mostly whitewater, sound is roaring
Falls	Free falling water over a vertical or near vertical drop into plunge, water turbulent and white over high falls, sound is from splash to roar
Marsh	Backwater area

- Choose a single dominant description for **erosion class** within an imaginary 10m wide belt transect centered over the cross section and the full width of the channel. Options for erosion class are erosional (E) and depositional (D).
- Choose a single dominant description for **water color** within an imaginary 10m wide belt transect centered over the cross section and the full width of the channel. Water color options include clear, brown, blue-green, green, etc.
- Choose a single dominant description for **water mixing** within an imaginary 10m wide belt transect centered over the cross section and the full width of the channel. Water mixing options include well-mixed, stratified, poorly mixed, unknown..
- Choose a single dominant description for **odor** at each cross section. Water odor options include none, sewage, chlorine, fishy, rotten eggs and other.

Notes on Stream Segment

- General observations are made along the stream segment.
- Conduct a visual assessment noting any:
 - Films on the surface of the water,
 - Foams or bubbles on the surface of the water,
 - Decaying vegetation or other organic matter in or near the water,
 - Algae growth or “scum” on the surface of the water (note the percentage of surface covered),
 - Dead fish or other aquatic organisms in or near the water,
 - Signs of life in the water such as macroinvertebrates, fish or amphibians,
 - Unusual deposits on the shore or emergent vegetation,
 - Evidence of sediment deposition from a recent storm, streambank erosion, signs of high sediment/turbidity deposition along the channel, or debris from recent storms.
- Conduct an olfactory assessment noting any:
 - Smells of rotting vegetation or animal matter;
 - Acrid or bitter smells,
 - Sour (sulfurous or “rotten egg”) smells,
 - Smells associated with chlorine (“smells similar to a swimming pool”),
 - Smells associated with urine, ammonia, or vinegar,
 - Moldy or musty smells,
 - Motor oil, gasoline, diesel or other “chemical” odors,
 - Any “almond-like” smells,
 - Other unusual or particularly strong odors.
- Conduct a recreation assessment noting any:

- 4.1. Recent recreational use of the floodplain. Note type of recreation.
- 4.2. Note any animals (cows, horses, dogs, etc.) in the area.

Aquatic Habitat Observations

1. Aquatic habitat observations are made at each of the 11 segment cross-section transects (1 through 11) as you traverse the sampling reach.
2. For each of the following categories, record the percentage class of the total streambed area (10m belt transect centered along cross-section). Classes are 0= Absent; 1= Sparse (1-9%); 2= Moderate (11-40%); 3= Heavy (41-75%); 4= Very Heavy (76-100%).
 - 2.1. Filamentous algae.
 - 2.2. Macrophytes. Macrophytes are aquatic plants, growing in or near water that are emergent, submergent, or floating.
 - 2.3. Large woody debris with diameter > 0.3m.
 - 2.4. Small woody debris with diameter <0.3m.
 - 2.5. Live trees and roots (those in the channel or roots on the bank and exposed).
 - 2.6. Overhanging vegetation that is within 1m of the surface of the water.
 - 2.7. Undercut banks. Record the percent of the bank that has undercut banks.
 - 2.8. Boulders (between 25-400cm).
 - 2.9. Any artificial structures.

Photographing the Cross-sections

Take at least four photographs of the cross-section where the stream bisects it, in each of the four directions relative to the stream—up to downstream, down to upstream, left to right bank and right to left bank. The photos should always be landscape oriented and capture at least one of the two cross-sectional bank flags or the measuring tape so as to identify where the actual cross-section lies. The photos will be used to help interpret the cross-section data.

1. Take a left-to-right photo from a standing position on the left bank, looking to the right bank (stream will be flowing from right to left). Include all or most of the wetted width of the transect cross-section (this will be difficult if there is vegetation or a steep bank preventing a good view).
2. Take an upstream-to-downstream photo while standing upstream of the cross-section transect. Include both banks.
3. Take downstream-to-upstream photo while standing downstream of the cross-section transect. Include both banks.
4. Take a right-to-left photo from a standing position on the right bank, looking to the left bank (stream will be flowing from right to left). Include all or most of the wetted width of the transect cross-section (this will be difficult if there is vegetation or a steep bank preventing a good view).
5. Take note of photo number on datasheet and note any extra photos taken.

Densiometer Canopy Cover Measurements

1. Canopy cover is measured at 6 locations at each of the 11 cross-section transects within a sampling reach using a modified convex spherical densitometer (Model B). The densitometer must be marked with tape exactly as shown in Figure 1 to limit the number of square grid intersections to 17 (Peck et al. 2003). Densiometer readings can range from 0 (no canopy cover) to 17 (full canopy cover within the range of view).

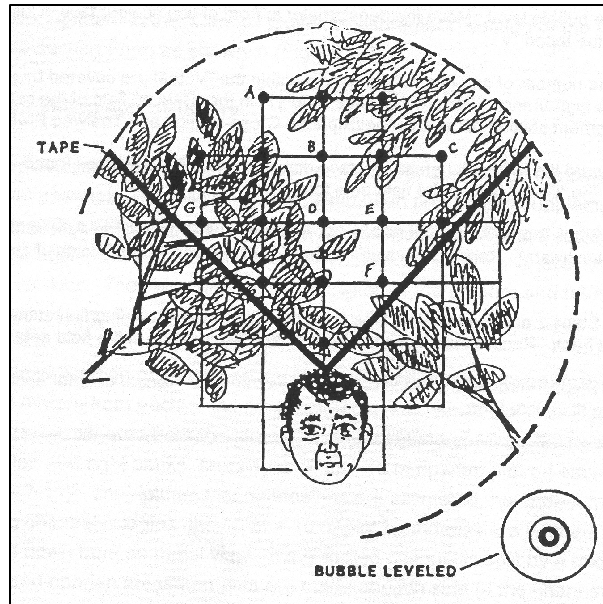


Figure 1. Proper positioning of the densitometer is indicated by the bubble level and having the observer's head at the base of the "V." Canopy measurements are indicated by the number of grid intersections that are covered by vegetation or branches (Peck et al. 2003).

1. At each cross-section transect a total of six measurements are taken: four at mid channel, and one each on either side of the channel: at mid-channel take the four measurements: facing upstream (Center Up), downstream (Center Down), facing the left bank (Center Left) and facing the right bank (Center Right); at each side of the channel, take measurements 1 m from the bank, facing toward the bank (Left Bank and Right Bank).
2. Hold the densitometer 0.3 m (1 ft) above the surface of the stream.
3. Make sure the densitometer is level using the bubble level.
4. Move the densitometer in front of you so your face is just below the apex of the taped "V" (see Figure 1).
5. Count the number of grid intersection points within the "V" that are covered by a tree, a leaf, or a high branch.
6. Record the value (0 to 17) in the appropriate place on the datasheet.

Bank Characteristics

1. Bank characteristics observations are made at each of the 11 segment cross-section transects (1 through 11) on both river left and river right.
2. Choose a single dominant description for dominant land-use. Options for land use include cropland, pasture, farmstead/barnyard silviculture, urban residential/commercial, urban industrial, rural residential, right-of-way, grassland, shrubs or woodland, wetland and other.
3. Estimate bank angle to the nearest 10°.
4. Measure the vertical distance from the thalweg to the top of the bank. If a bank cannot be directly measured, estimate the height.
5. Estimate the bank vegetative cover within an imaginary 10m wide belt transect centered over the cross section and the full width of the channel.to the nearest 10%.
6. Record the presence or absence of bank erosion within an imaginary 10m wide belt transect centered over the cross section and up the banks.

Bank Erodibility Hazard Index

1. Bank erodibility metric observations are made at each of the 11 segment cross-sections (1 through 11).
2. For each of the following categories, rate the erosion potential as low, moderate or high. Refer to the Bank Erodibility Hazard Index chart (Figure 2) to determine erosional potential.
 - 2.1. Ratio of bank height to bankfull height. A ratio of 1.0-1.19 is low, 1.2-2.0 is moderate, and greater than 2.0 is high.
 - 2.2. Bank angle. An angle of 0-60 degrees is low, 61-80 is moderate, and greater than 80 is high.
 - 2.3. Density of roots, percent of total bank height with roots. A percent of 100-55 is low, 54-30 is moderate and 29-0 is high.
 - 2.4. Soil stratification. No stratification is low, few stratifications below bankfull are moderate, and many stratified layers at bankfull height are high.
 - 2.5. Particle size. A dominance of bedrock, boulders or cobble is low, gravel is moderate and sand is high.

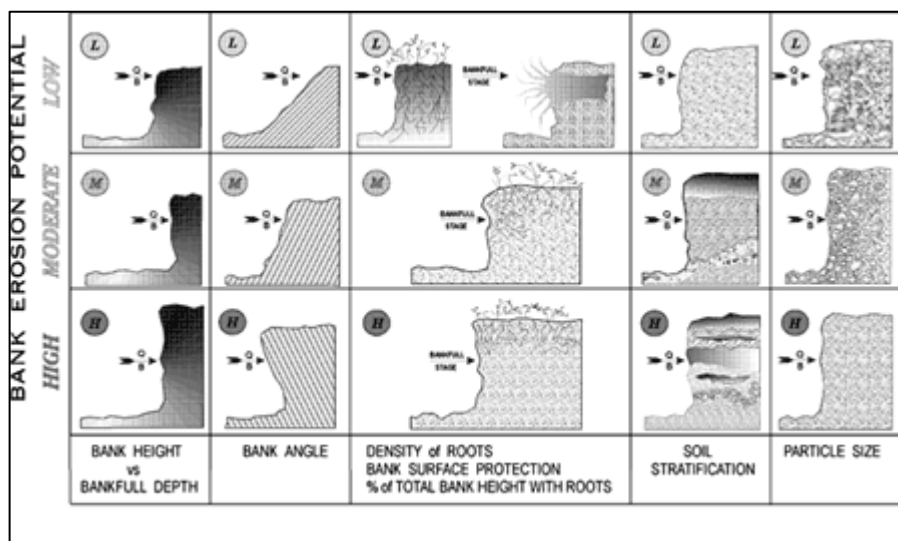


Figure 2. Bank Erodability Hazard Index chart.

Wetted Dimensions

1. Aquatic habitat observations are made at each of the 11 segment cross-section transects (1 through 11).
2. Stretch a metric measuring tape taught across the bankfull width at each segment cross-section, perpendicular to the flow.
3. Measure the bankfull width.
4. Record the number of channels.
5. Measure the wetted width. If there are multiple channels, record the width of each and add together for the complete wetted width.
6. Measure the thalweg depth to the bankful height.

Characterizing Quantitative Riffle Sample Locations

Four parameters are measured at each riffle sampled for the quantitative macroinvertebrate sample.

1. Measure the intermediate axis of 30 pebbles using a gravelometer, following the Wolman Pebble Count Method.
2. Measure flow at thalweg ft/s.
3. Measure thalweg depth to nearest 0.1m.
4. Estimate embeddedness of five cobble sized pebbles to the nearest 10 percent.

Photographs

Equipment List

Equipment	Quantity
Datasheets	1
pencils	many
1 convex spherical canopy densiometer, Model B	1
50+ foot measuring tape, marked in feet tenths	1
Folding metric ruler	1
Digital camera	1
Gravelometer	1
Flow meter	1

References

Peck, D.V., J.M. Lazorchak, and D.J. Klemm (editors). 2003. Environmental Monitoring and Assessment Program -Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams. EPA/XXX/X-XX/XXXX. U.S. Environmental Protection Agency, Washington, D.C.

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #12: Using the Total Station

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.03	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This Standard Operating Procedure explains the procedure for operating the Nikon DTM-330 Total Station transit to survey channel morphology points by (1) establishing new permanent stations and relay points or (2) from existing stations and relay points at Sonoran Desert Network Parks. Setting up and operating the Total Station unit is a very complicated process. It is recommended that procedures B and C be practiced in the office prior to field sampling.

Once surveyors become efficient at surveying practices, the various tasks (longitudinal profile, channel cross-section, etc.) may be completed in any order and piecemeal, if that is most efficient. The specific terrain and work schedule of a particular reach will determine what the most efficient surveying sequence is.

Transporting the Total Station in the field (3+persons)

1. Table 1 lists field equipment necessary for surveying. This equipment should be securely stowed during travel.
2. Remove the Total Station unit from the hard-sided case, ensuring that the horizontal and vertical control knobs are locked to prevent movement of the transit head, and that the lens cap is in place. ***Do not remove the transit from the case except for field transport and use!*** Place the unit in the large dry bag and seal the bag before stowing the unit in the orange Seco travel backpack.
3. Place the remaining equipment in Table 1 in rucksack, including the GPS/PocketPC and cable (Table 1), and photopoint equipment (Table 1); and include the general field and safety equipment in Table 2.
4. Navigate to the site using sitemaps (SOP 5) and GPS systems. If necessary, locate existing plot markers and monuments using the Schonstedt metal detector (SOP 6). Avoid areas of standing water and dense vegetation as much as possible to avoid damaging the fragile Total Station components.

Setting up the Total Station (1 person)

The total station can be erected over a new location (i.e., when beginning a new survey) or over a known location (i.e., permanent monument, previously occupied location, traverse point). Total station should be positioned on a stable surface in a location with maximum visibility of the transects and/or possible traverse locations.

1. Unpack the tripod, torpedo level, plumb bob, folding ruler and compass near the location.
2. Sighting North: Holding the compass over the monument/marker/location where you will place the Total Station, sight on prism pole operator (easiest), or other prominent feature, aligned with magnetic north (the compass declination should be set to 0 degrees). This feature should be at least 3 meters from the Total Station.
3. Tripod setup: Release the tripod leg slide catches and raise the tripod head to a height approximately 25 cm below eye-level for the operator. Tighten the leg slide catches. Attach the plumb bob to the hook beneath the tripod plate—the plumb bob hangs straight down and will help you either identify the exact ground location of the total station or set up the station exactly over an existing point.
4. Use a torpedo level as the first-tier course levelling with each of the three tripod legs.
 - 4.1. Position tripod generally over the monument or marker.
 - 4.2. Step down on one leg of the tripod.
 - 4.3. Holding the two free legs of the tripod, center the tripod over the monument or marker (within 2 cm is sufficient).
 - 4.4. Step down on each tripod leg base until it is firmly anchored, and lock the leg slides.
5. Place Total Station on tripod.
 - 5.1. Remove the Total Station unit from the dry bag.
 - 5.2. Place it carefully on the tripod plate (which should be clean and dry), aligning the triangular base of the total station with the triangular plate of the tripod so that the three black thumb screws are directly above the tripod legs.
 - 5.3. Thread the plate bolt into the Total Station until tight, then back off one quarter (90°) turn, supporting the weight of the Total Station until it is securely fastened to the tripod.
6. Leveling the Total Station involves increasing checking and rechecking the accuracy of its location above a monument and increasingly refining the precision of level using a torpedo (coarse) level, bubble level, and straight (fine) level. Periodically check the position of the Total Station by looking through the ground sight and using the plumb bob.
 - 6.1. If setting up over an existing marker, it may be helpful to slide the Total Station over the plate until the plumb bob points at the marker (retighten the plate bolt firmly).
 - 6.2. Bubble level: Locate the circular (or “fish eye”) bubble level on the base of the Total Station unit (Figure 4.1). If bubble is not centered, support the weight of the Total Station and release the leg slides on the tripod. Tilt the Total Station/tripod plate until approximately level, then lock the leg slides and check for plumb bob point over target. Remove plumb bob and re-check that Total Station is over the monument by looking through the side sight.
 - 6.3. Straight level: Release the upper plate clamp (horizontal axis) and rotate the Total Station body until it is aligned with two of the black leveling screws and adjust the two screws until the plate level indicates level (bubble centered). Rotate the Total Station 90° to align the unit, using only the remaining leveling screw, and adjust until the plate level indicates level along this axis. Rotate the unit back to the original position and re-check the plate level. Then rotate 180° and recheck level, adjusting as necessary. Avoid bumping the tripod after level has been reached.
7. Monument the position:
 - 7.1. If erecting Total Station over an existing point, a monument already exists.

- 7.2. If erecting the Total Station over a new location, mark exactly (within 1 cm) where plumb bob touches ground with a temporary monument.
8. Recon setup:
 - 8.1. Attach the Trimble Recon holder to a tripod leg.
 - 8.2. Insert the Recon into the holder.
 - 8.3. Connect the Recon to the Total Station using the link cord.
9. Turn on Total Station.
 - 9.1. Push the power key "<PWR>" on the Total Station.
 - 9.2. Remove the lens cap, loosen the vertical clamp, rotate the objective lens along the vertical axis until the unit beeps twice.
 - 9.3. Using the horizontal and vertical clamps, sight on the "magnetic north" feature identified with the compass in step #4. You may need to verify north again with a compass. Lock the horizontal clamp.

For steps 13-18, see Recon manual for additional details and troubleshooting information for the Survey Pro interface

10. SurveyPro software setup.
 - 10.1. Turn on the Recon.
 - 10.2. Start → Programs → Survey Pro.
 - 10.3. The Survey Pro window will open.
11. Open a New Job (for existing job, see Step 15).
 - 11.1. Click new.
 - 11.2. The new job should be stored in the default directory.
 - 11.3. Job Name = samplingreach_yyyy (i.e., MOCA1_2006); all surveying in 2006 at this reach will be recorded in this job.
 - 11.4. Click Next.
12. Select the appropriate units for the job.
 - 12.1. Azimuth Type = North Azimuth
 - 12.2. Units for Distances = US Survey Feet
 - 12.3. Units for Angles: Degrees
 - 12.4. Uncheck Adjust for Earth Curvature / Refraction
 - 12.5. Uncheck Use Scale Factor
 - 12.6. Click Next.
13. Enter First Point information.
 - 13.1. Point Name = 1
 - 13.2. Northing = 5000usft
 - 13.3. Easting = 5000usft
 - 13.4. Elevation = 100usft

Azimuth Type: North Azimuth

Units for Distances: US Survey Feet

Units for Angles: Degrees

☐ Adjust for Earth Curvature / Refraction

☐ Use Scale Factor: 1.0

< Back Next >

Enter First Point

Point Name: 1

Northing: 5000.0 usft

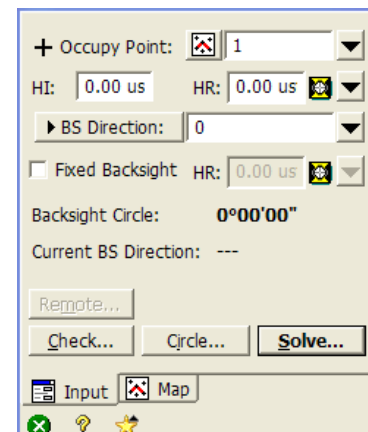
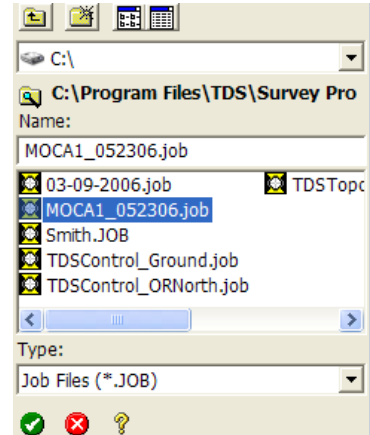
Easting: 5000.0 usft

Elevation: 100.0 usft

Description: Start

< Back Finish

- 13.5. Description = Start
- 13.6. Click Finish.
14. Open an Existing Job for a sampling reach (for new job, see Step 14).
- 14.1. Highlight the filename in the window and click Open, OR
- 14.2. Click on browse.
- 14.2.1. Select appropriate file from default directory.
- 14.2.2. Click on the green circle with a check mark.
- 14.3. The main SurveyPro Menu opens.
15. Setup a new backsight for the Total Station so the Total Station knows its location (for backsighting a previously existing point, see Step 17).
- 15.1. Highlight Survey from the main menu.
- 15.2. Click on A Backsight Setup from the submenu.
- 15.3. The Backsight Setup window opens.
- 15.3.1. Select the appropriate occupy point.
- 15.3.1.1. For a new job, Occupy Point = 1 (subsequent points will be automatically numbered 2, 3, 4, etc.).
- 15.3.1.2. For an existing job, the Occupy Point is the location at which you are setting up (refer to field notebook).
- 15.3.1.3. If you are completing a traverse using the “Traverse Now” function, the Total Station will assign the correct number.
- 15.3.2. Using the folding rule, measure the vertical distance from the soil surface to the horizontal axis marking (“+”; Figure 4.1) in engineers English units. Enter the height of instrument (to the nearest .01 usft) in the HI box.
- 15.3.3. Set HR to the height of the prism (ie. 8.00 usft).
- 15.3.4. Set initial Backsight Direction (to use existing backsight, see v.).
1. Use magnetic north as initial backsight direction
 2. Click on the ► BS Direction / ► BS Point box until it reads ► BS Direction
 3. Enter 0 as the BS Direction
 4. Sight the Total Station on the prism pole reflector, which should be located at the sighted object identified in Step B-2 as being in line with magnetic north
- ii. Set a Backsight Point using a known location (to set initial Backsight Direction, see iv.): use this method for traversing or after powering on to continue an existing survey
1. Click on the ► BS Direction / ► BS Point box until it reads ► BS Point
 2. Enter the appropriate point number as the BS Point (note that you can either pick the point number from a list or from a map by clicking on the ▼ next to the BS point box
 3. The Backsight Circle should read 0°00’00”
 4. Sight the Total Station on the prism pole operator who is standing at the appropriate BS Point
- iii. Click solve
- iv. The Backsight Circle window opens
1. Ensure that the BS Circle = 0



2. Click Send Circle, and the Recon will make a unique noise as verification that the operation is complete
3. Click on the green circle with checkmark to see a map of the backsight location, click to highlight the desired backsight location
4. Click yes
5. Click on the green circle with X to return to the main menu
2. Backsight an existing point (for creating new backsight, see Step 16); if the Total Station is occupying a previously known point (such as during a traverse, or if you return to continue surveying a partially surveyed reach), you will want to backsight to a previously known point.
3. Prepare to record points in the field
 - a. Highlight Survey from the main menu
 - b. Click on B Traverse / Sideshot
 - c. The Traverse / Sideshot window opens
4. Noting Total Station location: each Total Station location should be GPSed and sketched in the Total Station field notebook and temporarily monument with pin flags or other method until surveying of that reach is complete. This facilitates returning to locations to continue surveying and the post-field manipulation of surveying data.

B. *Recording points in the field – General Procedure (2-3 people)*

Prism Pole Operator	Total Station Operator
1. Before walking from the station to the first point, ensure that you have: • 15' prism pole/w tip • 30° prism with lens cap • radio and vest <i>Leave the lens cap in place while in transit between points to avoid scratching the prism.</i>	• radio and vest
2. Upon reaching a point: • remove the lens cap • raise the prism pole to a height where vegetation will not obstruct the view from the Total Station. • if the view is unobstructed, use a relatively short pole height (e.g., 7.0' or 8.0') to minimize any "pole wave" from wind. • if the prism pole height exceeds 10' or the point is substantially higher than the Total Station, tilt the head of the prism up to 30° down using the scales on the side. • always communicate height adjustments to the Total Station operator	
3. "The code for this point is XX-YY" using the prefixes and codes in Table 4.	Type in the code in the Description box and verbally confirm it with the prism pole operator
4. "The prism height is Z.Z ft"	Type in the height in the HR box and verbally confirm it with the prism pole operator
5. "Can you see the prism?"	
	"Yes" (go to step 6) or "No" (go to 5a)
5a. Adjust the prism height and/or "wave" the pole to attract the eye of the Total Station operator. Repeat "Can you see the prism?"	
	"Yes" (go to step 6) or "No" (go to 5a)

Prism Pole Operator	Total Station Operator
6. Check to be sure the pole tip is over the point, the prism head is facing the Total Station, and the rod is level (bubble level) and still.	Sight on the center of the prism using the upper plate horizontal and vertical clamps. Lock them and use the fine adjustment knobs on the Total Station. Focus the cross-hairs using the eyepiece focal adjustment ring. The cross-hairs can be difficult to see in some conditions. Direct prism pole operator to turn "clockwise" or "counterclockwise" if the prism is not facing the Total Station. The unit will beep twice in succession if the target has been acquired by the laser. "Are you ready?"
7. Recheck #6 and respond "ready" or "not ready"	
8. Remain still	If response is "ready", respond with "measuring" and press the Side Shot button on the Recon.
	After Total Station beeps twice, and the Recon makes a camera shutter sound say "you're done." You are ready for your next point.
Move to the next point. If working in tandem with another prism pole operator, keep the prism facing away from the station while the other operator is measuring.	

C. Traversing with the Total Station (2 people)

1. When you can no longer shoot points from the current Total Station location, it is time to traverse with the Total Station. **DO NOT TAKE DOWN THE TOTAL STATION**
2. The prism pole operator, and possibly the Total Station operator, should scout out a new location for the Total Station that will have the clearest possible visibility.
3. The Total Station operator looks through the Total Station side sight and places a pin flag or nail in the cross-hairs, if a marker does not already exist. The Total Station operator then marks the station location on the GPS. The Recon remains on the Traverse / Sideshot screen.
4. The prism pole operator stands with the prism pole at the new station location and says "I'm at the traverse point, the prism height is Z.Z ft".
5. The Total Station operator types the height in the HR field and asks "Are you ready?" The Description field will be automatically filled in with TR.
6. The prism pole operator ensures that the prism is level and says "Ready"
7. The Total Station operator presses the Traverse button on the Recon and says "Measuring." After Total Station beeps twice, and the Recon makes a camera shutter sound say "you're done." The Traverse Now or Later? screen opens on the Recon.
8. The prism pole operator places a pin flag or a nail in the sand where the tip of the prism pole was for the last shot.
9. Verify that the current and future Total Station locations are marked with a GPS as well as sketched and numbered in the survey field notebook.
10. When you are ready to move the Total Station, press Traverse Now (make sure you verify that you are on the correct section)
11. Take down the Total Station and transport it to the relay point (see Section G)
12. Set-up the Total Station following Steps 1-13 in Section B.
 - a. If you used the Traverse Now function, the Occupy Point and Backsight Point will be automatically and correctly entered for you
 - b. If you used the Traverse Later function, enter the appropriate Occupy Point and backsight to the point the Total Station previously occupied

D. *Editing Points*

If is periodically necessary to edit survey data or look at previously collected data to refresh your memory on previously surveyed points.

1. Press the green “X” to exit the Traverse/Sideshot page and return to the main menu
2. Press Job, then Edit Points
3. Scroll to the point of interest and double click to open the point’s information
4. If changes are made, click on the check mark in the lower left and a chime will verify that data has been changed
5. Document all edits in the surveying field notebook

E. *Taking Down the Total Station (1 person)*

It is not necessary to save a Job; the data is saved automatically as it is created.

The Total Station and Recon have flash memory and so retain data even if there is an unexpected loss of power.

1. To power down the surveying equipment temporarily (during traverse or lunch break):
 - a. Press the Power button on the Recon to put the Recon into sleep mode
 - b. Press the <PWR> button on the Total Station, then press the <4> button on the Total Station to put the Total Station into sleep mode
2. To power down the surveying equipment for storage (overnight, after surveying is complete):
 - a. Press the Power button on the Recon to put the Recon into sleep mode
 - b. Press the <PWR> button on the Total Station, then press the <ENT> button to turn off the Total Station
3. Remove the Recon and its connection cable from the tripod and Total Station and store it in the surveying backpack
4. Tilt the Total Station objective down to protect the lens and lock down both the horizontal and vertical clamps
5. Carefully remove the Total Station from the tripod, place it in the dry bag, then in the surveying backpack
6. Break down the tripod and place it in the tripod bag
7. Pack all other equipment in the appropriate place (including prism poles and reflectors)

Table 1. Survey Equipment

Equipment	Location	Pre-Trip	Post-Trip
Nikon DTM-330 Total Station (in travel case)	PM office cabinet*		
GPS/Pocket PC ("Battleship") and communication cable. Extra battery for GPS/Pocket PC, holder for attaching to tripod	PM office cabinet	Charge batteries confirm GPS is working before leaving office	Clean and recharge batteries
Plumb bob, string, compass, extra battery, charger, Nikon manual, lens cleaner, download cable (in travel case)	PM office cabinet*	Discharge then recharge batteries (see manual)	Replace string and cleaner as necessary
Torpedo level, dry bag, chain pins (10), surveyor's chain (length), folding rule (1 ft), flagging (3), small binoculars, Rite in Rain level book with 2 indelible pens (in Orange Seco Backpack)	PM office cabinet*		Clean dry bag, replace chain pins if bent, flagging as necessary
Seco 30° Single prisms with background plates (2 in green Nikon cases)	PM office cabinet*		Clean lens with clean water and soft cloth
Seco 15' prism poles with pointed and flat tips (2 in green Hammerhead cases)	PM office cabinet*		Disassemble, clean, oil, grease threads
Nikon tripod with combination wrench and spike caps (in green Nikon case)	PM office cabinet*	Adjust/tighten legs and slides	Clean base plate with water
Freight backpack with bungee cords	Lab		
Laminated sitemaps with benchmark and station coordinates, protocol (in binder)	PM office cabinet*		
Photopoint Equip: Digital camera, chalkboard, and chalk	Lab		
Kestrel 4000 climate instrument + AAA batteries (4)	PM office cabinet*;	Check voltage on batteries	Remove batteries for storage
Repair/maintenance kit (grease, 3-in-1 oil, prism pole die, multi-meter, electrical tape, hex keys, toolkit) at CAMP	PM office cabinet*		
Transit Software manual and field laptop – at CAMP	PM office cabinet*	Check battery power, software, and Access database file(s)	Remo

Table 2. General Field and Safety Equipment

Equipment	Location	Pre-Trip	Post-Trip
Water containers (=1 gallon person ⁻¹ day ⁻¹), water filters (backcountry), electrolyte drink/mix (opt.)	Lab or personal equipment		
Field radios, quick charger, field radio vest (opt.), vehicle charger (opt.)	QE office cabinet*	Charge radio	Charge radio
Personal first aid kit (1/person), basecamp first aid kit (opt.)	Lab	Check to ensure all modules are present	Replace any modules used
Sun protection (hat, sunglasses, sunscreen)	Personal equipment		

Cell phone (front country) or satellite phone or park radio (backcountry)	QE office cabinet*	Charge phone/radio batteries	Charge phone/radio batteries
PPE (gloves, safety glasses, etc.) – as necessary depending on activity	Lab and field vehicle	Check that PPE are present	Check that PPE are present

Table 3. Stakeout Equipment

Equipment	Location	Pre-Trip	Post-Trip
Rebar, 60D nails (qty depends on site; always bring +10%), 2.5 lb. sledge, gloves, safety glasses, fencing wire, linesman pliers, tags (in tool bag), compass, sharpie, pin flags or relay markers	Lab		
Loggers tape (length), 300' open reel tape (1 ft), 100' reel tape (1 ft), surveyor's string, line level (2), pin flags (50), flagging (3), Sharpie markers (2), compass (in green duffel)	PM office cabinet*		Replace flags, flagging, and markers as necessary
Schonstedt Metal Detector (if relocating) + 9V batteries (2; in yellow case)	PM office cabinet*	Check voltage on batteries	Remove batteries for storage
Laminated sitemaps with benchmark and station coordinates, protocol (in binder)	PM office cabinet*		

Table 4. Prefixes, Codes and Descriptions for Recording Points on Total Station

Prefix	Description
LP-	Longitudinal Profile
XS1-	Cross-Section #1
XS2-	Cross-Section #2
XS3-	Cross-Section #3

Add macro

Code	Description
B	Bankfull Indicator
BM	Benchmark
BP	Bottom of Pool
BS	Backsight
ER	End of Riffle
FP	Floodplain
FS	Foresight
LB	Left Bank
PB	Point Bar
RB	Right Bank
RP	Relay Point
RL	Rebar Left
RR	Rebar Right
T	Thalweg
TER	Terrace
TR	Top of Riffle

TR	Traverse Point
WL	Left Edge of Water
WR	Right Edge of Water
WS	Watersurface

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #13: Before the Riparian Vegetation Field Season

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This SOP also gives a description of the procedures to follow prior to hiring and training and conducting field work. Pre-season planning such as creating schedules and organizing equipment facilitates the completion of monitoring work and allows for budget planning. All of the equipment and supplies listed in Table 1 should be organized and made ready for the field season, and copies of the field data forms should be made. Prior to field sampling all observers should review the entire protocol, including SOPs.

Preparation for Stream Sampling: Riparian Vegetation

The Project Manager and Lead Technician will be responsible for all aspects of preparations for the field season. Important preparations include:

1. **Post job positions** (if appropriate) for seasonal employees or students two to three months ahead of scheduled field work.
2. **Review protocol narrative and all SOPs.** Understand the goals and procedures of the monitoring program and begin preparations for training and field surveys. Discuss with appropriate I&M personnel any proposed or recent changes to the sampling protocol. If a change has been implemented since the last field season, be sure that all field forms, databases and appropriate sections in relevant SOPs have been updated.
3. **Begin preparations.** Discuss the season's objective and schedule with I & M personnel. Develop a timeline and field schedule based on the current year's schedule and other responsibilities of individual crew members.
4. **Contact parks.** Contact appropriate park personnel to discuss any changes in the policy for researchers of specific conditions that may have changed since the last season (e.g. fires that may have affected sites or areas may have closed.) Contact with park personnel may be especially

important at Organ Pipe Cactus NM and Coronado NM because of the border-security situation in those parks. Also, discuss housing availability and needs with appropriate parks. Fill out web-based permit requests if needed or simply locate and copy existing research permits for each park. Post field schedule on Google calendar.

5. **Review field notes, reports and project log from previous sampling period.** For each of the cross-sections to be sampled review available documents. At the end of each park sampling effort crew leaders will write a brief field summary report (*template location?...*), which will include a discussion on the general field conditions of the period and access issues to sites.
6. **Identify all cross sections and transects to be sampled.** Existing cross-sections will be available in shapefile format and should be loaded onto mapping units.
7. **Print and copy the field data forms.** Print a few sets on RITE-in-the-Rain paper. These are for back-up purposes should electronic data entry fail, except for the unknown plant datasheet which must always be completed on paper.
8. **Upload shapefiles onto the RECON/GeoXT units.** All relevant shapefiles should be uploaded to the handheld unit and opened to ensure proper functionality and display.
9. **Survey electronic equipment.** Check laptop, radios, mapping units and replace batteries if needed at beginning of the season.
10. **Enroll observers in CPR/First Aid course.** Organize a one-day CPR/First Aid and or wilderness first aid course for all technicians. These courses are taught regularly by the Southern Arizona Chapter of the American Red Cross (<http://www.sazredcross.org>.)
11. **Provide instructional material to new crew members.** In the event SCA interns or people relatively new to the area are hired, provide them with protocol relevant materials, as well, as desert safety information before the field season starts.

Scheduling Field Work

1. Monitoring efforts at SODN parks will require a field crew of at least 2 observers. Typically, cross-sections/transects can be completed per day. To ensure safety, all observers will work within the same reach and carry cell phones to communicate. Crew members will typically be asked to work a schedule consisting of 10 hour days.
2. Preliminary field schedules will be drawn up prior to the beginning of sampling. Riparian vegetation surveys will be timed to best capture optimal phenology.
3. Because of the possibility for the need of a ranger escort at many parts of Organ Pipe Cactus National Monument and Coronado NM, the park contact person must be notified at least 4 weeks prior to field work to ensure that rangers are able to accompany crews. Therefore it will be imperative to maintain scheduling flexibility in parks and areas that require coordination with law enforcement personnel.
4. Park housing or camping arrangements should be made 1 month in advance of first sampling date.

Organizing Supplies and Equipment

See Table 1 for a list of equipment needed prior to commencing field work. At least one month prior to the beginning of each season, the Project Manager should tally all equipment and inspect and test it for damage.

Table 1. List of equipment for riparian vegetation monitoring protocols. Number indicted are per plot. When preparing for the field season, each crew should have at least one backup of all major equipment.

Equipment	Quantity	Location	Pre-Trip	Post-Trip
GEO XT unit	2	V and G drives	Make a park project w/RIP VEG database	Download points/project
compass	1 per person	Your backpack		
Chain pins	4	Lab		
20 meter tape	2	Lab		
Plant press	1	Lab	Prepare newspaper, cardboard, and markers	
Transect/Frequency plot datasheets	?	V:\Streams\Protocols\Sampling_Forms\MODULE 4_RIPARIAN VEGETATION	Make copies on waterproof and regular paper	Photocopy and file appropriately
Bo-peep stick (2 meters in length)	1-2			
Dbh tape	1-2			
Periscope	1-2			
Clipboard	2			
Pencils	Several per person			
Chargers: camera, laptop, gps	1 camera 1 laptop 2 gps	Office		
Maps: topo maps, GIS maps of cross-sections and transects	?		Make GIS maps Pack a topo	File GIS maps with datasheets
Plant List/Guide	1-2	L drive	Most recent copy	
Camera	1	Cabinet in Kristen's office	Charge	download
Laptop (tough book)	1	K8's desk/Veg Map's desk	Ensure RIP VEG database is working	Put current front end in the to be appended from field folder

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #14: Riparian Vegetation Sampling

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	6/11/2012	Studd	Additional detail, combined two SOP into one		0.02
0.02	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This Standard Operating Procedure explains the procedure for installing and reading:

- **Zone** riparian vegetation transects and frequency plot
- **Greenline** riparian vegetation transect and frequency plots, both terrestrial and aquatic
- Density plots
- Mapping legacy trees and taking GPS points at plot corners and transect ends

All of the above measures are completed on either side of the river along each cross-section of a stream reach. Some of the measures are co-located or have a location derived from another measure. Therefore this SOP attempts to list these in the order they would likely be most efficiently conducted. Before establishing any new sampling location, this SOP should be read in its entirety as minor modifications to the order can be made based on crew size and experience. This has been written assuming a crew size of 4 people.

Generally, the following workflow is necessary to complete all tasks correctly:

- Establish the greenline location and use the tape bearing to establish subsequent zone transects on the same side of river (Section 2)
- Conduct greenline transect (Section 2.2) and associated frequency plots both terrestrial (Section 2.3) and aquatic (Section 2.4)
- Conduct zone transects and associated frequency plots (Section 2.5). This can be concurrent with other measures if crew size permits.
- Lay out 20 x 50m density plot using greenline as the short baseline (Section 3)
- Conduct all 5 sampling parameters on the density plot (Section 3.1 – 3.5)
- Map any witness (legacy) trees within the plot or anywhere outside the plot (Section 3.6)

Riparian Vegetation Transects: Overview

Riparian vegetation transects are randomly located along the permanently marked stream cross-sections of perennial water courses and are generally aligned parallel with the stream. These transects are located in two distinct types of locations but employ the same sampling methods (see Figure 1).

- **Zone transects** are randomly located on stream cross-sections and examine the community composition and change in riparian vegetation in the extended riparian area.
- **Greenline transects**, are *subjectively* located at the first line of perennial vegetation directly adjacent to the stream and examine the community response to river flow and hyporheic processes. Greenline transects form the basis of the density plot (section 3) and are typically the first thing to be established based on the current location of the stream.

Each riparian vegetation transect is composed of:

- A *20m point-intercept line*, raised to approximately 1.5m in height and with the 10m mark centered on the cross section. Plant species are recorded each meter along the transect in four height strata; at the surface layer (0m – 0.025m), herbaceous layer (0.025m – 0.5m), sub-canopy layer (0.5 -2m), and canopy layer (above 2m).
- An *associated frequency plot* recording all perennial species encountered that have not already been recorded along that transect's line. This plot measures one meter on either side of the 20m point-intercept transect tape (20m x 2m), or conversely 2m above (inland) of the tape when conducted at the greenline location (see section 2.2 for more details).
- Photo documentation looking downstream from 0 -20m.
- GPS data collection at transect ends for the zone transects.
- ***Aquatic macrophyte frequency plots*** are only associated with the greenline and are located in the wetted width of the stream, centered on the cross-section. One macrophyte plot is sampled on each side of the river, and as such is estimated to extend from the river bank to approximately half way across the wetted width (20m x variable width). Tapes are not laid to delineate this area; rather the extent is visually estimated. These plots will determine the status of aquatic macrophytes and determine trend in species frequency.

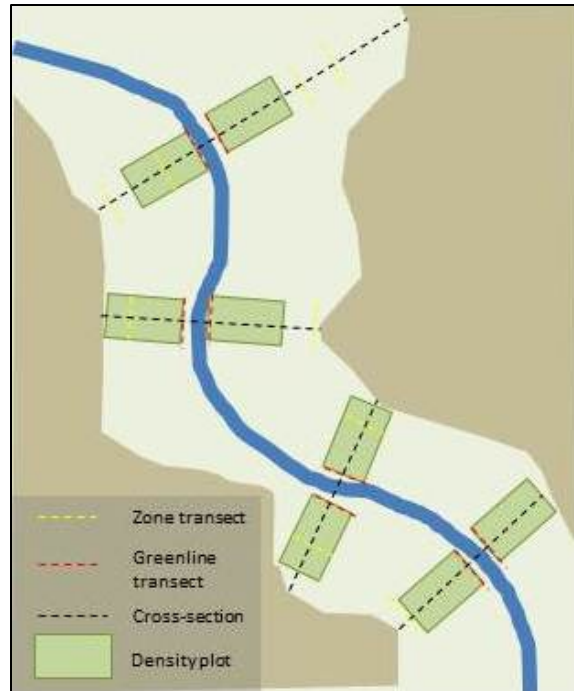


Figure 1. Transect and plot orientation relative to stream location and cross sections. Greenline transects serve as the baseline for density plots, and set the compass bearing for zone transects (at least on the initial establishment). Zone transects are randomly located along the cross-section and may or may not intersect with the density plot.

Navigating to and installing transects

Coordinates for zone transect locations have been previously determined using a spatially balanced random selection technique (e.g., RRQRR). There are often more points generated than will need to be sampled each time so consult with the project lead before the field season to determine the total number needed.

All points are located along the permanent cross-sections at each park. Cross sections run more or less perpendicular to the general direction of the stream or river, and therefore transects will be roughly parallel to the stream and perpendicular to the cross-sections. Greenline point locations have not been pre-generated but are determined in the field afresh each time they are sampled and are also located on the cross section. Refer to park specific shapefiles located at V:\Streams\Riparian_Vegetation\Data_Spatial\Processed for more information and particular transect numbers and locations.

Greenline vegetation transect set-up and orientation

1. Load pertinent base layers for navigation and orientation (boundary, inholdings, streams, roads, trails, contours etc.) and the appropriate geodatabase (GDB) containing transect points, cross-sections and previous mapped witness trees on to the handheld device (SODN currently uses Trimble or Juno devices). In addition to bringing USGS quad topographic maps, the crew lead can design and print smaller “cross-section-centric” topographic maps within a GIS to assist in fine scale navigation. The GDB should also contain templates for collecting points at density plot corners, transect ends and mapping large legacy trees.

2. Using a handheld GPS unit with the cross-sections and transect point locations showing, navigate to the first cross-section at the first greenline location which will be adjacent to the stream.
NOTE: The order in which cross-sections are sampled is of no matter, so plans should be made simply to work most efficiently across the stream segment as a whole.
3. Transect orientation: Once you have arrived at the stream edge of the first cross-section determine where the greenline tape will be placed. The tape should be laid to capture the first 'true' or full line of perennial vegetation away from the wetted width. This is often within 1m of the wetted width but can be also be many meters away when erosional features cause cut-banks or sand-bars.
NOTE: if the greenline falls on a steep or un-stable bank at the water's edge place the tape toward the top of the bank. The objective is to best capture obligate wetland plant species while avoiding running the tape into the stream.
4. Run the tape with zero meters upstream and the 20m mark downstream, and with the 10m mark centered on the cross section. Using two tripods raise and secure the tape at approximately 1.5m high. Once in place, take a compass bearing from 0 → 20m (downstream) and record it on the datasheet. This will be the bearing that all zone transects will follow when they are established for the first time; **subsequent readings of zone transects will use the same bearing as the original time, whereas greenline bearings will be re-set each time they are sampled.**
5. All transects (greenline and zone) are read on the river-side of the tape so the observer will walk on the non-river side while reading the transect (walk on right of tape on river right and on left of tape on river left).

Vegetation Sampling – Line-point intercept

1. Vegetation is recorded within four height categories using the point intercept method. Starting at 1m and repeating every meter up to 20m, lower a plumb bob on retractable string, from the raised tape to the ground level on the non-walking side of the tape. This results in a total of 20 points per transect. Record vegetation intercepted at each point by the plumb bob in each of three height strata and record the ground surface cover using the codes listed below (Table 1).
2. Record the first species touching the plumb-bob in each height class: herbaceous vegetation (0.025-0.5m), sub-canopy (>0.5m-2.0m) and canopy (>2.0m). If multiple species are hit in a given height category, only record the first (uppermost) species to intercept the plumb-bob when it is lowered through the sub-canopy and canopy layers. A single individual can be recorded in multiple strata; for example if a shrub was "hit" near the base of the plant and also at its top branches, it could be recorded in the herbaceous vegetation (0.025- 0.5m) and the Sub-canopy (0.5 – 2m) height classes. However if the same plant is "hit" twice in the same height category, record it only once. Only one species is recorded in each height class.
3. To identify a point hit in the upper canopies use the periscope (densitometer) positioning it directly above the appropriate mark on the meter tape so that the bubbles in both levels are centered. Only record species that are in the crosshairs of the periscope. If there is more than one species in the canopy, record the first species that intersects the crosshairs, which will be the one that is closest to the ground and closer to the viewer. It is assumed that if you have a canopy hit you would not be able to see what is above that point.
4. If a "hit" falls on a dead plant that is still attached to the ground or parent plant, i.e. recently dead, record the hit as snag. If you hit dead material that is not attached and it is on the ground record this as litter.
5. Perennial vegetation is recorded to species and annual vegetation is recorded to life form with the exception of a suite of annual non-native plants that should be recorded to the species level (See list in Appendix B). Use standardized 6 letter codes for all perennial species.
6. Identify native annual species by life form using the following codes: Annual grass = AG, Annual forb = AF, Annual vine = AV.

7. For unidentifiable plants, collect a specimen off the transect line if possible and press plant in plant press following SODN standard plant collection guidelines. Fill out and attach a printed 'unk' label to the newspaper. Also record the unknown on the unknown plant datasheet using the same morphological name as on the label. Be sure to fill out all other information such as the date, park, cross-section and transect it was collected on. (V:\Global_SOPs\Vegetation_SamplingForms).
8. Take a single photograph from the zero meter end of the tape looking downstream to the 20m end. Document the camera name and photo number on page 2 of the riparian vegetation transect datasheet.
9. Take additional photographs of unique or unknown insects, mammals or plants to share in Trip Summary reports, the SODN website or Facebook. Record these on the transect data sheet.
10. Take a GPS point at both ends of the transect using the SurveyLocations template found in the Rip_Veg.gdb (V:\Streams\Data_Spatial\Processed_Data).

Table 1. Surface feature codes for line-point intercept measures.

Code	Surface Feature	Definition
PB	Plant base	Vegetation basal growing structure (exposed root, bunch grass crown)
F	Fines	Loose mineral particles 0-2 mm in diameter
GF	Gravel, Fine	Particles 2-16 mm in size; ant to beetle-sized
GC	Gravel, Course	Particle 16-63 mm in size, beetle to baseball sized
CB	Cobble	Particles 64-256 mm in size; baseball to basketball sized
BL	Boulder	>256 mm in size; larger than basketball
B	Bedrock	Exposed bedrock
WA	Water	Flowing or pooled water
BSC	Biological soil crust	Cyanobacterial crust, sometimes in community with mosses and lichens
L	Litter	Detached organic material that is less than 2.5 cm in diameter
S	Snag	Litter/dead material above the ground level
WD	Woody debris	Detached woody plant material that is greater than 2.5cm in diameter and in contact with soil

Vegetation sampling – frequency plots

1. After completing the transect set up a frequency plot measuring either 1m on both sides of the transect (default) or 2m on the non-stream side of the transect (in cases where a full meter cannot be sampled at the river-side greenline without going into the wetted width of the stream). To accomplish this, measure the distance and lay out additional tapes, pin-flags or meter sticks to delineate the area.
2. Within the 20m x 2m plot, record all perennial vegetation and non-native annuals not “hit” along the greenline, using 6 letter species codes.

Aquatic Macrophyte frequency plot (Greenline only)

1. An aquatic macrophyte frequency plot is also sampled in conjunction with the greenline and is located within the wetted width of the stream, centered on the cross section (Figure 2). One macrophyte plot is sampled on each side of the river, and as such is estimated to extend from the river bank to approximately half way across the wetted width (20m x variable width). Tapes are not laid to delineate this area; rather the extent is visually estimated.

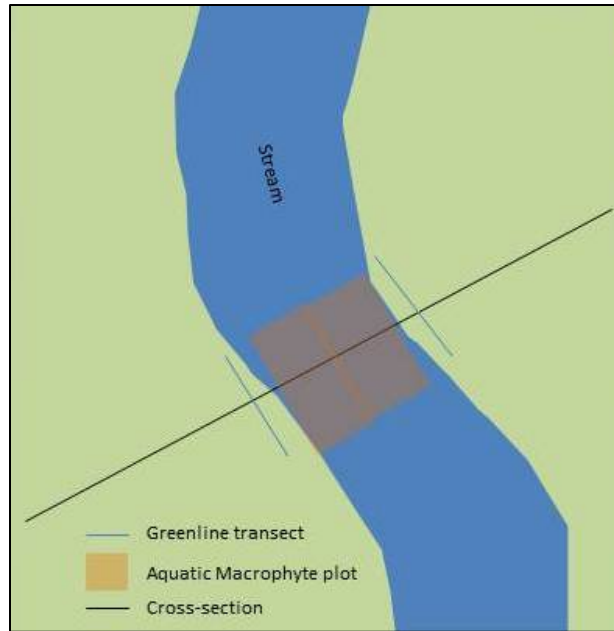


Figure 2. Aquatic macrophyte plot.

2. Record all plant species seen growing within the water or along the edges of the water. (A macrophyte is an aquatic plant that grows in or near water and is emergent, submerged, or floating). These plots will determine the status of aquatic macrophytes and determine trend in species frequency.

Zone transects: set-up and sampling

1. Zone transects are located at randomly located pre-determined points along each cross-section at various distances from the stream channel. Each point generated serves as a potential transect location however some may not be used due to local topography or vegetation characteristics (see below).
2. Navigate to each of the points in turn using the handheld GPS and establish a line transect using the same bearing as used for the greenline transect (see section 2.1.4). At each zone transect complete the 20m line-point intercept sampling and a frequency plot using the same procedures outlined in sections 2.2 and 2.3 above. Each transect has its own data sheet.
3. Take a single photograph from the zero meter end of the tape looking downstream to the 20m end. Document the camera name and photo number on page 2 of the riparian vegetation transect datasheet.
4. Take a GPS point at both ends of the transect using the SurveyLocations template found in the Rip_Veg.gdb (V:\Streams\Data_Spatial\Raw_Data\GICL\).
5. If you arrive at a zone transect location and find that the area is difficult or unsafe to access, traverse or sample, do not sample and add the next transect from the zone transect GRTS draw list. Notate on a riparian vegetation datasheet the transect number and reason for not sampling. The next transect will be the next in numeric order and will likely NOT be on the same cross-section or river side, as these sites are randomized throughout the park. Add this next location to the work plan and sample it when it best fits the overall schedule.
6. If you arrive at a transect and the vegetation is clearly not at all typical or indicative of riparian influenced systems (i.e. is a Pine Forest, desert scrub or upland system) then do not sample and proceed with recording why as in 2.5.4. If in doubt – SAMPLE.

7. If the transect has some uplands species or appears to be a remnant riparian-influenced system that is currently not within the active riparian corridor – continue with sampling. We do want to sample this community. If in doubt – SAMPLE.

Density Plot Overview and Set-up

This section explains the methods for reading riparian vegetation density plots. Density plots are co-located with the greenline transects (see section 2.1), on each side of the river along each cross-section. Each plot is either 20m wide and 50m long or a modified dimension appropriate to the landscape- see below. The greenline transect forms the short edge of the density plot adjacent to the stream edge (see plot diagram below). Three sub-plots B, C and D are nested within the larger 20m x 50m plot, A. Density plots measure the density (stems/ha) and stand basal area (m^3/ha) of shrubs, and trees larger than 2m tall and those less than 2m tall. This plot also records abundance and composition of herbaceous species adjacent to the stream. A nested plot approach is being used, based on a 20m x 50m plot, with smaller plots nested within (Figure 3).

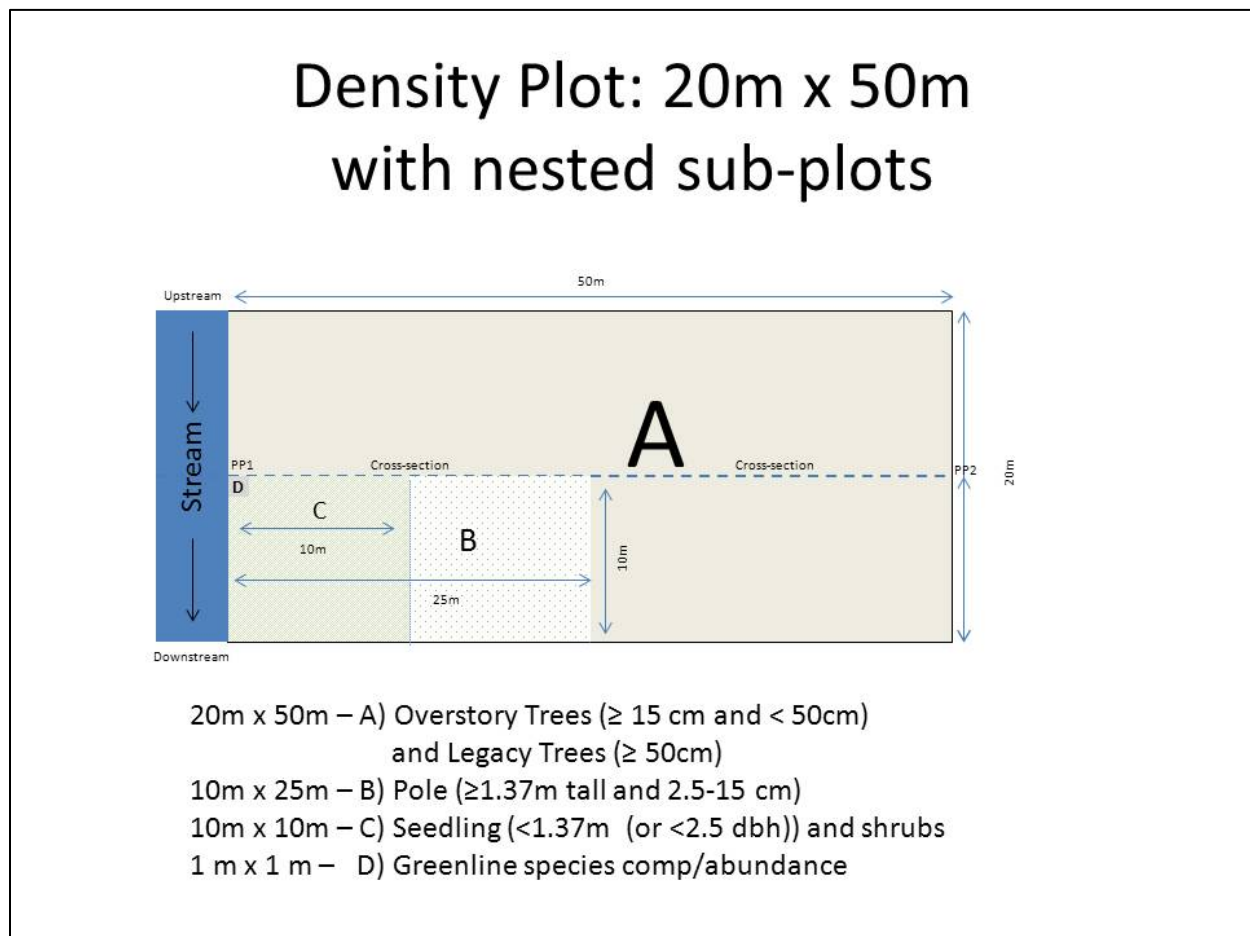


Figure 3. Density plot.

Plot set-up and boundary rules, Diagram and event description

1. After establishing the greenline transect and bearing you can lay out tapes to create the 20 x 50m frame of the density plot. At each end of the greenline transect, run a tape 50m inland at a bearing 90 degrees different from (perpendicular to) the greenline. If one of these tapes is 100m long it

can be used to complete the top line of the plot by securing and turning the tape 90 degrees again and running it toward the other 50m tape just laid out. Otherwise use a separate 20m tape to complete the interior short edge of the plot.

2. From the center of the greenline tape (at 10m) run a 30 m tape at the same perpendicular bearing as the 50m tapes to create a midline defining the upper edge of sub-plots B and C. Note: if available use a 50m tape and extend it all the way to the end of the plot. This will be useful in keeping track of which trees have been measured already by visually bisecting the entire plot.
3. Run two more tapes from the plot's downstream 50m edge up to the mid-line at 10 m and 25 m, to complete sub-plots B and C. Each of these will be laid out a 10 m length and will be parallel to the greenline transect.
4. If a tree happens to fall in line with any of these tapes along the plot boundaries, only include it within a particular plot if greater than or equal to 50 % of the basal area of the tree falls within the compass sighting.
5. There are some situations in which the full-sized density plot cannot be placed such as when a steep embankment is encountered. If this is the case, the plot may be reduced by half (20m x 25m). Indicate on the datasheet if modifications have been made to the size of the plot by writing the X and Y distance of the density plot. **If the half-sized plot does not fit, only run the greenline and do not complete a density plot.** On the density plot datasheet, indicate plot location (river right or left) and why it could not be completed.
6. Remember that zone transects follow the greenline bearing ONLY on the initial set-up visit. In subsequent years the zone transects will follow the same bearing used at initial set-up, whereas the greenline bearing can change each year.
7. Two photographs should be taken of the plot, one from the center of the greenline looking into the plot (PP1), the other standing at the inland end of the plot looking back towards the stream (PP2). Record the photo bearings on the first page of the data sheet set. Other photographs can be taken of interesting and unusual objects; however these should not be included in the 'data' photo files.
8. Take a GPS point at all four corners of the plot using the SurveyLocations template found in the Rip_Veg.gdb (V:\Streams\Data_Spatial\processed_Data).
9. On the plot density data sheet record plot location (river right/left), cross section number, date, observer names etc. and amount of time required for plot set-up. Notate tape lengths and bearings. A brief narrative describing the plot should be recorded. Include the dominant tree species and height(s), overall vegetation community composition, evidence of flooding on vegetation, sediment type and any other pertinent observations.
10. Even if a density plot is not completed, the cover sheet with the plot diagram must still be filled out and include a short description of why it was not done.

Overstory trees: 20m x 50m plot (or modified to 20m x 25m)

1. Within the larger 20 x 50m plot, every tree **over 2m** in height and with a dbh (diameter at breast height) of at least 15cm is measured at breast height (~1.37m) and recorded on the 3rd page of the density plot data sheet. Record different species on separate lines. Record 'dead and standing' individuals separately from their live counterparts by annotating (on a separate line) a "D" after the species code. The diameter at breast height is recorded in centimeters and is sampled using a specialized dbh tape.
2. If there are multiple stems belonging to one individual tree, record the dbh of each stem in parentheses and separate individual trees with semi-colons. See NOTES section below for more information on what to do this and other unique situations.
3. Using chalk sticks or chalk paddles mark each tree as it is measured to ensure a census and to avoid double counting. Always mark trees on the river side of the stem. Proceed systematically through the plot to capture all trees.

4. If any legacy/witness trees (any tree larger than 50cm diameter at breast height) fall within the overstory subplot, record them as you would a “regular” tree on the datasheet. ***In addition***, take a GPS point using the appropriate GDB template and attribute the point with species, approximate height, number of stems and dbh.
5. It is required that at least a ten minute minimum survey time is met for this sampling. However it is recommended that every effort be put forth to ensure a complete census regardless of the time it takes.

The observer should follow these rules to obtain accurate and repeatable measurements:

- Include all tree species, including upland species that are rooted within the density plot boundaries. Some woody species, such as *Salix exigua*, *Robinia neomexicana*, *Celtis* spp, are not measured as trees but are considered to be shrubs (see Appendix C for a list of some example species; this list will vary from park to park).
- Standing dead trees should be recorded as such by notating (D) after the species code.
- For trees on slopes, measure DBH while standing at the midslope side of the tree.
- For clonal tree species and trees forked below breast height, treat each bole as an individual tree. Measure all stems ≥ 2.5 cm at breast height. Record the measurements on the datasheet in parentheses () to indicate they are from the same tree.
- If an irregularity (e.g. swelling, damage) occurs at breast height, take the measurement above or below the irregularity, between 1 and 2 m in height if at all possible. Make a note of the altered height of your measurement.
- If the tree is leaning measure at the point of BH as if the tree were standing fully upright.
- For *Juniperus* spp., measure diameter at the root crown (DRC) just above the soil line at the base of the tree. See below.

Measuring diameter at root crown (DRC) for Juniperus trees.

DRC is used to measure juniper trees due to their multi-stemmed growth habit. The following rules should be used for measuring *Juniperus* spp.:

- When possible, a tree stem should be measured by wrapping a diameter tape around the stem just above the soil line. Record “DRC” after the species code on the datasheet.
- When using a diameter tape is not feasible, the root crown should be measured using a meter stick. This method should be used when trees have lateral branches at ground level, diagonal branches $< 45^\circ$ at ground level and for multi-stemmed individuals of *Juniperus monosperma* whose stems originate below ground. When the tree has a root collar, or swelling associated with the roots, the diameter should be measured above the collar.
- When a stem that is joined below ground to other stems of a *Juniperus monosperma* is dead, this stem should not be included in the DRC.
- When individuals of *Juniperus deppeana* and *Juniperus osteosperma* (species that are generally single-stemmed) are multi-stemmed and the stems are joined below ground, each stem should be measured separately. For *Juniperus monosperma*, stems that are joined below the soil line are measured together.
- When stems of *Juniperus deppeana* or *Juniperus osteosperma* are leaning, the diameter should be measured perpendicular to the trunk.
- Overstory trees are considered to be those > 15 cm DRC (diameter at root crown). When it is not clear how a tree should be measured, include comments in the comment field of the datasheet to clarify how a tree was measured. This helps to ensure that the tree will be measured consistently for all visits.

Pole subplot “B” (10m x 25m plot or modified 10m x 12.5m)

1. Subplot B is located on the downstream lower quarter of the large plot (see diagram).
2. Poles are here defined as any tree species that is at least 1.37 m tall with a **dbh** of 2.5 – 15 cm. Record every pole within the 10 x 25 m subplot with different species as a separate row on the datasheet. Separate individual measurements with semicolons, and as before record ‘dead and standing’ individuals separately from their live counterparts by annotating (on a separate line) a “D” after the species code. The diameter at breast height is recorded in centimeters and is sampled using a specialized dbh tape.
3. In some instances post-disturbance poles will commonly be seen resprouting from the base of damaged or dead trees. In these instances record these poles on a separate line and annotate D/R after the species code to indicate Dead/Resprouting. This will enable us to analyze the survival rate of these pole types, but also to distinguish these from regular recruitment events from seed or other vegetative growth.
4. Record the start and finish time on the datasheet and ensure that the 10 minute minimum sampling time is met.

Saplings/Seedlings/Shrubs subplot “C” (10m x 10m or modified 10m x 5m)

1. Seedlings and saplings are here defined as any tree species that is less than 2 m tall or that has a **dbh** of less than 2.5cm or both. Tally every seedling/sapling rooted within the 10 x 10 m subplot by species. As before record ‘dead and standing’ individuals separately from their live counterparts by annotating (on a separate line) a “D” after the species code.
2. Record the start and finish time on the datasheet and ensure that the 10 minute minimum sampling time is met.
3. Within this same 10 x 10m area, also estimate canopy cover of all shrubs present. Shrubs are recorded by species by separated by height class, being either less than or greater than 2m tall. Cover classes are given on the datasheet and shown below in Table 2.

Greenline quadrat subplot “D” (1m x 1m)

1. Subplot D is set-up on the outside edge (the edge of the tape furthest from the water’s edge) at the 10m mark along the greenline tape (the quadrat will run from 10m to 11m along the greenline). Using a square pvc frame one meter on a side, or tape cut into one meter lengths, delineate the sampling frame.
2. Within this quadrat, record every species and assign it a cover class using the categories shown in Table 2. This data will be recorded on the backside of the cover page of the Density plot datasheet sheet.
3. All species less than 2 m in height are recorded regardless of lifeform (i.e. it includes grasses, forbs, shrubs and small trees). Estimates are made of foliar cover which accounts for any gaps in the canopies. Count only species rooted in the plot.
4. If the quadrat location is more than 75% obstructed/filled by a tree > 2m tall (live or dead) or a bolder, move the quadrat 0.5 m at a time downstream until it can be sampled. Record the new location on the datasheet.

Table 2. Cover classes used for estimating cover in subplot C and D.

Cover Class	Percent Cover
1	< 1%
2	1-5%
3	6-10%
4	11-25%
5	26-33%
6	34-50%
7	51-75%
8	76-95%
9	96-100%

Witness tree mapping (AKA legacy trees)

1. Legacy or ‘witness tree’ is the term used for very large or very old trees that are often indicative of an earlier state or location of a stream and its influence on vegetation. ***They are defined by having a DBH of at least 51cm.*** Each of these trees is mapped using a GDB template. Trees are mapped wherever they occur, both inside and outside the plots and transects.
2. Every tree of this size within the plot must be mapped, and efforts should be made to capture as many outside of the plots and away from the cross-sections as possible. Typically this is easiest to do while en route between locations.
3. At each tree location take a point and fill out the attributes for species, estimated height, DBH in cm, and notes. If the tree has multiple stems at DBH, record all boles in the table or use the notes field if needed.
4. If you are re-sampling existing density plots and transects, be sure to the layers from when witness trees were mapped before and attempt to re-visit each tree in addition to capturing some that may have been missed.

Works Cited

Elzinga, C.L., Salzer, D.W., and Willoughby, J.W., 1998, Measuring and monitoring plant populations: Denver, Colo., Bureau of Land Management, Tech. Reference 1730-1, BLM/RS/ST-98/005+1730.

Scott, M.L., and Reynolds, E.W., 2007, Field-based evaluation of sampling techniques to support long-term monitoring of riparian ecosystems along wadeable streams on the Colorado Plateau: U.S. Geological Survey Open-File Report 2007-1266, 57 p.

Appendix A

Equipment list

ITEM	NUMBER	LOCATION/NOTES
GEO XT/ Juno unit	2	V: and G: drive hold basedata and sampling locations respectively
Compass	1 each	-
Chain pins	12	Lab
100 m tape	2	Lab
50 m tape	1	Variations on tapes possible – bring enough to fit crew size & concurrent tasks
30 m tape	3 -5	
Tripods	Min 2 (4 if possible)	
Transect datasheets	5-7 per x - section	V:\Streams\Protocols\Sampling_Forms\MODULE 4_RIPARIAN VEGETATION
Density Plot datasheets	2 sets per cross-section	V:\Streams\Protocols\Sampling_Forms\MODULE 4_RIPARIAN VEGETATION
Plumb bob	1 per team	
Dbh tape	2 per team	
Electronic Calipers	2 per team	
Chalk paddles	2 per team	
Periscope	1 per team	
Hypsometer	1 per team	
Clipboard	4	
Pencils	several	
Laptop and cords, jump drive	1	Office
Camera & charger	1 per crew	
Maps: topo maps, GIS maps of cross-sections and transects	Many copies	
Plant Species List	1 each	L drive
Field guides, floras	Several	

Appendix B

Exotic Species Codes

This is not an exhaustive list but rather the most common species encountered in SODN parks.

<i>Avena fatua</i>	wild oats
<i>Bromus rigidus</i>	ripgut brome
<i>Bromus rubens</i>	red brome
<i>Bromus tectorum</i>	cheatgrass
<i>Brassica tournefortii</i>	Sahara mustard
<i>Centaurea melitensis</i>	Malta starthistle
<i>Centaurea solstitialis</i>	yellow starthistle
<i>Conium maculatum</i>	poison hemlock
<i>Chenopodium murale</i>	nettleleaf goosefoot
<i>Cirsium vulgare</i>	bull thistle
<i>Enneapogon cenchroides</i>	soft feather pappusgrass
<i>Eragrostis echinochloidea</i>	tickgrass
<i>Eragrostis cilianensis</i>	stinkgrass
<i>Erodium cicutarium</i>	redstern stork's bill
<i>Hordeum murinum</i>	barley
<i>Lamium amplexicaule</i>	henbit
<i>Marrubium vulgare</i>	horehound
<i>Melilotus spp.</i>	sweetclover
<i>Medicago spp.</i>	alfalfa
<i>Phalaris spp.</i>	canarygrass
<i>Salsola sp.</i>	Russian thistle
<i>Schismus spp.</i>	common Mediterranean grass
<i>Sisymbrium irio</i>	London rocket
<i>Sonchus spp.</i>	sow thistle
<i>Tribulus terrestris</i>	puncturevine

Appendix C

Example: Partial list of woody riparian species with annotation of tree versus shrub.

Family	SciName	Common Name	Nativity	Lifeform	Status
Cornacea	<i>Cornus sericea</i>	redosier dogwood	Native	Shrub	FACW
Fabracea	<i>Amorpha fruticosa</i>	desert false indigo	Native	Shrub	FACW
Grossulariaceae	<i>Ribes aureum</i>	golden currant	Native	Shrub	FAC
Rhamnaceae	<i>Frangula betulifolia</i> subsp. <i>betulifolia</i>	beechleaf frangula	Native	Shrub	FACW
Salicaceae	<i>Salix irrorata</i>	dewystem willow	Native	Shrub	FACW
Betulaceae	<i>Alnus oblongifolia</i>	Arizona alder	Native	Tree	FACW
Cannabaceae	<i>Celtis reticulata</i>	netleaf hackberry	Native	Tree	FAC
Juglandaceae	<i>Juglans major</i>	Arizona walnut	Native	Tree	FACW
Juglandaceae	<i>Juglans microcarpa</i>	little walnut	Native	Tree	FAC
Oleaceae	<i>Fraxinus velutina</i>	velvet ash	Native	Tree	FAC
Platanaceae	<i>Platanus wrightii</i>	Arizona sycamore	Native	Tree	FACW
Salicaceae	<i>Populus angustifolia</i>	narrowleaf cottonwood	Native	Tree	FACW
Salicaceae	<i>Populus fremontii</i>	Fremont cottonwood	Native	Tree	FACW
Salicaceae	<i>Populus X acuminata</i>	lanceleaf cottonwood	Native	Tree	FAC
Salicaceae	<i>Salix exigua</i>	narrowleaf willow	Native	Tree	FAC
Salicaceae	<i>Salix lasiolepis</i>	arroyo willow	Native	Tree	FACW
Salicaceae	<i>Salix taxifolia</i>	yewleaf willow	Native	Tree	FAC
Sapindaceae	<i>Acer negundo</i>	boxelder	Native	Tree	FACW

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #15: Riparian Vegetation Daily Data Management

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This SOP outlines specific, daily data management tasks that must be completed for all data collected in the field, including tabular data, spatial data, and photographs. File-naming conventions and storage locations are SODN-specific.

Compile Data Sheets

1. **Compile data sheets and place them in a manila folder labeled “PARK_YYYYMMDD”.**
2. **Use the database print-out function to generate paper sheets for data that are collected electronically.** Store these with the other data sheets.
3. **Enter any non-spatial data that was not entered directly into the database in the field.**
4. **Verify that all data sheets are complete and attempt to verify the identity of any unknown plants.** Adjust data sheets and database as needed.
5. **Copy data sheets and store separately from originals.**

Transfer Photos

1. **Transfer photos onto computer (en masse)**
 - 1.1. **Label Density plot photos: “PARK_XS##_DP_RRorRL_PP#_YYYYMMDD”.**
 - 1.2. **Label Green line photos: “PARK_XS##_GL_RRorRL_YYYYMMDD”.**
 - 1.3. **Label Transect photos: “PARK_XS##_TransectUniqueID_YYYYMMDD”.**
2. **Store photos on office computer in V:\Uplands\Photos\Data...then by park.**

GIS Data Transfer

1. **Transfer photo point/corner point shapefiles to office computer by opening the ArcMap checkout project and complete check in procedures.**
2. **Open ArcCatalog and navigate to Streams_ geodatabase.**
3. **Choose Preview tab in large right window of ArcCatalog interface.**
4. **Within lower drop-down box, chose either Geography or Table to view those portions of the feature class.**
5. **Use the Geography preview to check that the points are well-spaced and are twelve in number.**
6. **Use the Table preview to check that the file has been correctly and fully attributed.** If necessary, utilize the editor toolbar in ArcMap to make any changes (see next section, Editing Spatial Files).

Editing spatial files

1. **Open ArcMap.** Use the Add Data tool to open the files needing edits. Click through the error on projection.
2. **From the Editing toolbar, choose “Start editing”.**
3. **Choose proper file to edit.** Check the editing target on the toolbar if you have multiple field-data files loaded into your project for editing.
4. **Make changes to attributes, delete extra points, etc.** Then use the Editor drop-down menu on the Editor tool bar to Save Edits.
5. **Edit next file.** When all edits are complete, choose Stop Editing on the same drop-down menu in the Editor tool bar.
6. **Highlight shapefiles on ArcMap Table of Contents and right-click.** Choose Remove. Exit ArcMap.

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #16: After the Riparian Vegetation Field Season

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.01	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This SOP explains procedures to be followed after a period of sampling has been completed at a SODN park in any given year.

In cases when field work continues with no break at another park, Step 1 will not apply, except in terms of replacement items.

1. **Inspect all equipment for damage and note any missing equipment for the next field sampling period.**
2. **Clean and repair all equipment prior to returning it to the project leader.**
3. **Re-shelve all reference manuals in their appropriate places.**
4. **File other reference materials and extra data forms in their appropriate filing cabinet.**
5. **Clean the insides and outsides of all vehicles used in the field.**
6. **Prepare a field summary for delivery to park staff.** This report should summarize the type of sampling that was done, and at which locations. Note any pertinent, interesting, or unusual preliminary results, along with any observations of disturbance, human or animal activity, deviations from the SOP, and/or access issues. The report will follow a template structure and be approximately 3–5 pages long, including a map and standard appendix. This template is located at (V:\Streams\Products\Templates) “Riparian_Vegetation_trip_summary_template.”
7. **Prepare an internal logistics report for SODN records.** This report should detail all the logistical topics that are relevant to the park-specific field sampling period, such that it will be of use when those same plots are re-sampled and the data analyzed. The template is located in (V:\Streams\Products\Templates) “Field_Summary_Template.” Store this report in the fireproof cabinet with the data sheets as well as electronically. The report should include information on the following topics:

- Travel and housing availability.
 - Point of contact at park.
 - Safety issues or concerns, and how those were accommodated.
 - List of all plots sampled. For each, note any changes made to location, markers or photograph locations. Describe any major disturbances on the plots and best access.
 - Weather conditions over the period that may have affected phenology or field conditions.
 - Crew members and experience levels (if appropriate).
 - List problems (general and protocol-specific), missing data, lost equipment, etc.
 - Other useful information.
8. Refer to data management SOP to ensure all data is properly achieved.

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Streams Monitoring Protocol

SOP #17: Quarterly Sampling

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
None	02/22/2011	Raymond	Added text	No SOP existed	0.001
0.001	10/15/2014	Raymond	Added text	Additional prep	0.002
0.002	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

Overview

This Water Quality Monitoring Standard Operating Procedure (SOP) describes tasks that need to be completed prior to each quarterly season's field work. There is a three month period for each quarterly sampling season:

- Fall sampling- October, November, December
- Winter sampling- January, February, March
- Spring sampling- April, May, June
- Summer sampling- July, August, September

Pre-season planning, such as creating schedules and organizing equipment, facilitates the completion of monitoring work and allows for budget planning. All supplies listed in Table 1 (see end of this SOP) should be organized and prepared prior to the start of each quarterly sampling period, and copies of the field data forms in should be made. Prior to field sampling, all observers should review the entire streams protocol, including SOPs.

Recommended Reading

Wilde, F.D., ed., 2004, Cleaning of Equipment for water sampling (ver. 2.0): U.S. Geological

1. Pre Quarterly Sampling Procedures

The project leader will be responsible for all aspects of preparations for the field season.

Important preparations include:

- 1.1. Review protocol narrative and all SOPs.** Understand the goals and procedures of the monitoring program and begin preparation for training and field surveys. Discuss with appropriate I&M personnel any proposed or recent changes to the sampling design or protocol. If a change has been implemented since last season, be sure that all field forms, databases, and appropriate sections in relevant SOPs have been updated.
- 1.2. Contact parks.** Contact appropriate park personnel to schedule a site visit at least a month prior to sampling. Quarterly sampling site visits at each park should occur at approximately the same time each year. Discuss any changes in their policy for researchers or specific conditions that may have changed since the last field season. Post field schedule on network's online calendar.
- 1.3. Plan lodging.** For site visits that require overnight stays, the availability of lodging should be discerned at least one month prior to the site visit. If park housing is not available, then on-site or nearby camping accommodations and conditions should be considered. Staying in a motel should only be considered if staying in park lodging or nearby camping is not available.
- 1.4. Reserve transportation.** An appropriate government vehicle should be reserved for each trip at least a month prior to each site visit. A safety walk around should be conducted on the vehicle prior to departure.
- 1.5. Prepare field equipment and check for integrity.** See Table 1 for a list of equipment needed prior to commencing fieldwork. Clean all equipment that is reused and comes in contact with stream water, according to USGS protocols. Check equipment, such as tapes, decanters and chain pins for structural integrity, and replaced if necessary. Check all battery operated equipment and replace if necessary. Ensure sufficient quantities of disposable supplies for the whole quarterly sampling season. Order more supplies if necessary. Request a supply of water quality testing bottles and coolers from the testing company a month prior to the start of sampling.
- 1.6. Print and copy field data forms.**

1.7. Provide instructional material to new crew members. In the event that SCA interns or people relatively new to the area are hired, provide them with protocol-relevant materials before the field season starts.

1.8. A pre-sampling meeting between the aquatic ecologist and the physical technician should occur at the start of each sampling period. Other staff may be invited to attend. Prior to the meeting the physical science technician should fill out the Pre-Sampling Checklist, summarizing site visit arrangements and equipment conditions. The aquatic ecologist and physical technician will discuss the site visit arrangements and resolve any concerns. They will also address other activities to be completed during the upcoming quarterly sampling season. Both the aquatic ecologist and the physical science technician sign and date the Pre-Sampling checklist.

1.9. Prepare necessary Personal Protective Equipment (PPE) for personnel. Ensure that appropriate PPE is provided for the task, such as waders, rubber boots, and personal flotation devices (PFD's).

Table 1. Quarterly Sampling Equipment

Activity	Equipment
General	• Waders, boots, or shoes suitable for conditions • Personal floatation devices • Quarterly sampling data sheet • Park keys, if applicable
Core Water Quality Parameter Discrete	• YSI probe • Calibration cup • Flow cup and protective sleeve • pH buffers- 7, 10 • Conductivity buffer- 200, 1413 $\mu\text{S}/\text{cm}$ • 2 extra C batteries • Maintenance kit • Hanna pH/EC/TDS/Temp tester (as backup)
Core Water Quality Parameter Continuous	• Sonde • Terminal and cable • 4 AA batteries • YSI cleaning supplies • 1 liter of pH 7 and pH10 buffers • 1 liter of 1413 $\mu\text{S}/\text{cm}$ and 200 $\mu\text{S}/\text{cm}$ conductivity solution • Lubricant • YSI cleaning supplies
Water Quantity Discharge Measurements	• Flow tracker • Wading rod

	• 30m tape • 100m tape • 2 chain pins • 2 red clips • 8 extra AA batteries
Water Quality Grab Sampling	• 6L decanter • Funnel and funnel tubing • 2 filters per sample • Gloves • Labelled lab bottles and coolers for all parks and QA/QC • COC completed for all parks and any QA/QC • 2- 2.5 gallon ziplock/trash bags per sample cooler • 1- quart size ziplock per sample cooler
Shipping Grab Sample	• 1- Large trash bag per sampling event • 2- Small trash bags per sampling event • Packaging tape • FedEx Shipping label
Bacteria Sampling	• Incubator and power cords • Temperature tidbit • Quanti-tray sealer and power cords • 3 Quanti-trays per sampling event • 3- 120ml bottles per sampling event • 3- Colilert reagent packets per sampling event • UV light
Turbidity Sampling	• Hach turbidity meter • Primary calibration vials • 3 Empty vials • 4 extra AA batteries
EPA Emerging contaminant	• PPCP and Waste Indicator bottles as scheduled • Labels • Ziplok bags • Cooler

2. Quarterly Sampling Overview

Quarterly Sampling measurements include core water quality parameters, bottle sampling for other constituents, bacteria sampling, turbidity and discharge measurements.

2.1. All sample and measurements are taken at the index site. The index site is collocated with USGS gaging stations if present in the stream. In the absence of a USGS gaging

station the index reach is located where permanent monitoring equipment is or can be installed.

2.2. Core water quality and discharge measurements are taken concurrently with bottle samples. This is possible if at least two field personnel are present. However, in the event that only one field personnel is present then discharge measurements should be taken directly after bottle sampling.

2.3. Preferable collect bacteria samples and emerging contaminant samples at the same time as bottle samples. If this is not possible due to timing needed to process samples, then bacteria and turbidity grab samples can be collected and processed up to two days before other sampling.

2.4. Deploy or retrieve the sonde during the visit. The sonde is deployed for 2–4 weeks, so either deployment or retrieval can occur during the visit.

2.5. Refer to SOP's for specific standard operating procedures.

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #18: Continuous Water Quality Data

Version 1.00
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Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
None	11/26/2012	Raymond	Added text	No SOP existed	0.001
0.001	03/28/2014	Palacios	Added text	Changed to fit sonde procedures	0.002
0.002	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This SOP provides step-by step instructions for using a logging multi-parameter Sonde water quality meter to collect continuous data. The water quality meter should be deployed for at least 2 weeks every quarter, deployed or retrieved at the time of other quarterly sampling. Do not deploy during winter in parks where air temperature is likely to drop below -6.67°C and the sonde is partially outside of water (BEOL, GICL, and PECO)

The SODN and SOPN Stream Monitoring Program currently use YSI 600XLM sondes.

Recommended reading:

Wagner, R.J., R.W. Boulger Jr., C.J. Oblinger, B.A. Smith. 2006. Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and data reporting: U.S. Geological Survey Techniques and Methods 1– D3, 51.

Wilde, F.D., ed., variously dated, Field measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6, with sec. 6.0–6.8, accessed [12/18/2012], at <http://pubs.water.usgs.gov/twri9A6/>

1. Premobilization of equipment in the office

Premobilization occurs one to two weeks in the office before taking equipment into the field at the start of each quarterly sampling period. The purpose is to make sure equipment is

functioning properly and that calibration solutions remain uncontaminated. Use data sheet: Pre-mobilization of core parameter equipment.

1.1 Check pH sensor via 2 point method (7.0 and 10.0)

- 1.1.1 Inspect the pH sensor. Check for damage and rinse any precipitate off the sensor with water.
- 1.1.2 Rinse the pH sensor, thermometer and calibration cup with pH 7. Discard the buffer into a waste container. Repeat twice more for a total of three rinses.
- 1.1.3 Begin calibration by pouring fresh pH 7 buffer into the calibration cup and submerging the pH sensor. Swirl the calibration cup gently to remove any air bubbles around the pH sensor.
- 1.1.4 Record the theoretical pH value, buffer lot number, and expiration data.
- 1.1.5 When pH reading stabilizes, record the temperature and pH value. Click calibrate and record the temperature, pH value and millivolts reading. Discard the pH 7 buffer into the waste container.
- 1.1.6 Repeat steps 1.2.2 – 1.2.5 using pH 10.
- 1.1.7 The pH sensor is in acceptable condition if it calibrates correctly, and if the sensor reads between millivolts between -50 and 50 in pH7 and between -130 and -230 in pH10. Replace pH sensor if the conditions above are not met.

1.2 Check temperature sensor

- 1.1.1. Fill container $\frac{3}{4}$ with tap water. Place a NIST thermometer and conductivity/temperature sensor in the container and allow both to stabilize. Record both temperature readings on the datasheet.
- 1.1.2. Ensure the conductivity/temp sensor reading is within 1°C of the NIST thermometer reading. If not, the conductivity/temp sensor may need to be replaced.

1.3 Check specific conductivity sensor

- 1.3.1 Inspect conductivity/temperature. Check for damage and rinse any precipitate off the sensor with water.
- 1.3.2 Rinse the conductivity sensor and calibration cup three times with the 1413 $\mu\text{S}/\text{cm}$ conductivity standard. Each time discard the standard in a waste container.
- 1.3.3 Begin calibration by pouring fresh 1413 $\mu\text{S}/\text{cm}$ conductivity standard into the calibration cup and submerging the conductivity standard. Swirl the calibration cup to expel air bubbles trapped in the sensor.
- 1.3.4 Record specific conductivity value, buffer lot number, and expiration date
- 1.3.5 When the specific conductance reading stabilizes, record temperature and specific conductance reading. Click calibrate, and record temperature and specific conductance reading. Discard the 1413 $\mu\text{S}/\text{cm}$ standard in the waste container.
- 1.3.6 The conductivity sensor is in acceptable condition if it calibrates correctly. Check with a 200 $\mu\text{S}/\text{cm}$ solution, if available.

1.4 Check dissolved oxygen sensor

- 1.4.1 Replace the dissolved oxygen membrane.
- 1.4.2 Add 0.5 cm layer of water to the calibration cup, this will ensure 100-percent humidity.

- 1.4.3 Screw the calibration cup onto the sensor loosely, allowing for ventilation.
- 1.4.4 Allow the sensor to stabilize. Record temperature, barometric pressure, dissolved oxygen %, and dissolved oxygen mg/L. Click calibrate and record barometric pressure, dissolved oxygen %, and dissolved oxygen mg/L.
- 1.4.5 The dissolved oxygen sensor is acceptable if it stabilizes and the calibrated percent oxygen reading is between 75-95%.

2. Deployment calibration

All calibrations should be completed at the deployment site. Record calibration on datasheet: Probe Calibration Check.

- 2.1. Place 4 completely charged batteries into the probe.
- 2.2. Connect probe to monitor and turn on.
- 2.3. pH calibration
 - 2.3.1. On monitor main menu, navigate to: "Sonde Run" and record temperature
 - 2.3.2. Press "esc" to return to main menu. Monitor will say "disconnecting"
 - 2.3.3. On main menu, navigate to: "Sonde Menu" > "Calibrate" > "Ise1 pH" > "2 point"
 - 2.3.4. Enter the corrected pH value from a pH table and record on datasheet.
 - 2.3.5. Rinse pH sensor three times with the first buffer (yellow- pH 7) by pouring enough buffer into the calibration cup to cover the pH sensor, screw on to sonde and swirl the buffer to rinse the sensor. Discard buffer appropriately and Repeat.
 - 2.3.6. Pour enough buffer into the calibration cup to cover the pH sensor, immerse sensor and wait for pH reading to stabilize.
 - 2.3.7. Record the buffer lot number, buffer expiration, temperature and pH reading.
 - 2.3.8. Select "Cal" to lock in the pH 7 calibration
 - 2.3.9. Record the post calibration temperature and pH reading
 - 2.3.10. Repeat steps 1.1.6. – 1.1.10. using the blue – pH 10 buffer. This, along with pH 7 buffer, brackets the pH values for the water to be sampled.
 - 2.3.11. After calibrating, the monitor will return to the "pH calibration" menu. Press "esc" to return to the "calibrate" menu
- 2.4. Conductivity calibration
 - 2.4.1. Inspect the conductivity probe for damage, clean if necessary
 - 2.4.2. On navigate to "Calibrate" > "conductivity" > "spCond"
 - 2.4.3. The SpCond of 1.413 should already be inputted. Verify and press "enter." Record on data sheet.
 - 2.4.4. Rinse probe three times with the first buffer (1.413 mS/cm) by pouring enough buffer into the calibration cup to cover the sensor, screw on to sonde and swirl the buffer to rinse the sensor. Discard buffer appropriately and Repeat.
 - 2.4.5. Pour enough buffer into the calibration cup to cover the conductivity sensor, immerse sensor and wait for conductivity reading to stabilize.
 - 2.4.6. Record the buffer lot number, buffer expiration, temperature and conductivity reading.
 - 2.4.7. Select "Cal" to lock in the calibration
 - 2.4.8. Record the post calibration temperature and conductivity reading
 - 2.4.9. After calibrating, the monitor will return to the "Cond calibration" menu. Press "esc" to return to the "calibrate" menu

- 2.4.10. Press “esc” three more times to disconnect device.
- 2.4.11. Rinse tube with the specific conductance 200 mS/cm buffer three times.
- 2.4.12. Select “Sonde run” from the main menu
- 2.4.13. Record the mS/cm, Buffer lot No, Expiration date of buffer, temperature and reading.
 - 2.4.13.1. The purpose of measuring the second standard is to check instrument calibration over a range of two standards. The difference from the standard value should not exceed 5 percent.
 - 2.4.13.2. If the difference is greater than 5 percent, repeat the entire calibration procedure.
- 2.5. Dissolved oxygen calibration.
 - 2.5.1. Inspect the dissolved oxygen probe for damage, clean if necessary
 - 2.5.2. Add 0.5 cm layer of water to the calibration cup, this will ensure 100-percent humidity.
 - 2.5.3. Rinse probes with water and Add 0.5 cm layer of water to the calibration cup to ensure 100% humidity. DO NOT fully screw on or immerse the probe.
 - 2.5.4. On main menu, navigate to: “Sonde Menu” > “Calibrate” > “optic-T dissolved oxy” > “ODOSat %” > “1 point”
 - 2.5.5. The barometric pressure should already be inputted. Verify and press “enter”
 - 2.5.6. Allow the sensor to stabilize, which may take 10 minutes.
 - 2.5.7. Record the ODO%, Buffer lot No, Expiration date of buffer, temperature and reading
 - 2.5.8. Select “calibrate” by pressing enter.
 - 2.5.9. Record the new temperature and ODO%. (ODO % should range from 80-90%. If this is not the case, press “esc” and begin calibration again.)
 - 2.5.10. Select “continue” by pressing enter again.
 - 2.5.11. Press “esc” three times to return to the “main” menu (not the “650 main menu”)

3. Logging set-up

- 3.1. Navigate to “run” > “unattended sample”
- 3.2. Select “stop logging” and “yes” to stop logging
- 3.3. Verify the interval is “00:15:00” and the date and time are correct
- 3.4. Navigate to “file” and press enter to enter a new file name. Press enter again to finish.
 - 3.4.1. Name the file by the park unit code, month and day, “UNITMMDD”
Example: GICL1104
- 3.5. Navigate to “site” and enter the correct site name. Press enter again to finish
- 3.6. Verify that the new batteries have enough life to support logging – should be approximately thirty days with new batteries.
- 3.7. Verify that the first sample will occur shortly after probe will be placed in the water.
- 3.8. Select “start logging” and “yes” to begin logging
- 3.9. Verify logging status
 - 3.9.1. Press “esc” to return to the “main” menu
 - 3.9.2. Navigate to “status” and verify that Logging is Active. Press “esc” to disconnect probe.

4. During deployment

Store datasheet in sonde terminal case. The water quality meter will be deployed for 2-3 week. During deployment pay attention to stream flow at the deployment site. If an event above bankfull is likely, posing potential to disturb the housing mount, remove the water quality meter if safe. If water level is low, likely to not be covering the sensors, remove or adjust the position of the water quality sensors. If sensors dry out, they may need to be replaced.

5. Retrieval and calibrations

- 5.1. The water quality meter should be retrieved 2-3 weeks after deployment
- 5.2. Retrieve probe, connect to handheld console and immediately upload the data.
 - 5.2.1. Navigate to “file” > “sonde menu” > “file” > “quick upload” > “PC6000”
 - 5.2.2. “esc” out to “650 main menu”
- 5.3. Place the water quality meter back in the stream. Once readings stabilize, record results on data sheet.
- 5.4. Clean water quality meter using tap water, lint-free wipes, pipe cleaner brush and q-tips.
- 5.5. Place the water quality meter back in the stream again. Once readings stabilize, record results on data sheet.
- 5.6. Calibrate the pH, dissolved oxygen and conductivity probe as in section 4. Record results on the data sheet.
- 5.7. Place the water quality meter back in the stream.
- 5.8. Select “sonde run” and record temperature, specific conductance, Do %, DO (mg/l) and pH.
- 5.9. Take probe out and clean with water and q-tips to remove silt and debris. To clean the pH probe, fluff a q-tip and gently clean around bulb to prevent breakage. Use a bottle brush to clean the inside of the specific conductivity probe. Use a q-tip to wipe of debris from the bottom optic oxygen sensor.
- 5.10. Place probe back in water.
- 5.11. Record temperature, specific conductance, Do %, DO (mg/l) and pH.
- 5.12. Press “esc” to return to “50 Main menu”
- 5.13. Recalibrate device (step 1) and record results to check for drift.

6. Final reading

- 6.1. Place casing on probes and return to water
- 6.2. Select “sonde run”
- 6.3. Record temperature, specific conductance, DO %, DO (mg/l) and pH.
- 6.4. Press “esc” to disconnect

7. Cleaning and storage

After returning from the field clean the water quality meter thoroughly. Ensure that electrical parts are kept dry and clean.

- 7.1. pH sensor- rinse with tap water
- 7.2. Conductivity sensor- remove chemical residue with a detergent. Oil and other residues can be removed using a 5% hydrochloric acid solution or a 10% solution of white

vinegar. Let the probe soak for no more than 5 minutes, then use a soft bristle brush to gently scrub the sensor.

- 7.3. Dissolved oxygen sensor- rinse with tap water
- 7.4. Remove batteries from the water quality meter
- 7.5. Clean all o-rings and add a thin layer of lubricant
- 7.6. Add a thin layer of tap water to the calibration cup and screw on securely.

8. Routine maintenance

- 8.1. Replace dissolved oxygen membrane every 18 months if applicable.
- 8.2. Replace dissolved oxygen sensor if it does not calibrate, has a slow response time, or erratic readings. Replaced infrequently.
- 8.3. Replace pH sensor every 18 months. Replace more frequently if sensor does not calibrate, has a slow response time, or erratic readings.
- 8.4. Replace the conductivity sensor if it does not calibrate, has a slow response time, or erratic readings. Replaced infrequently.

Equipment List

Equipment	Quantity	Pre-trip	Post-trip
YSI 6820 Multiprobe sonde	1	Ensure integrity	Clean
pH calibration buffer	Bottle of 4, 7, 10	Pack	Refill
Conductivity buffer	Bottle of 200 and 1413 $\mu\text{S}/\text{cm}$	Pack	Refill
Calibration cup	1	Pack	Clean
Flow cup	1	Pack	Clean
connection cord	1	pack	clean
AA and C Batteries	1	Pack	Restock
Dissolved oxygen membranes	3	Pack	Restock
Dissolved Oxygen probe solution	1 bottle	Pack	Restock
carrying cases	2	Ensure integrity	Clean
32 oz bottle of deionized water	1 bottle	Pack	Restock
clipboard with SOPs, datasheets, notebook and pen	2	Pack	Restock
Cleaning supplies	1	Pack	Restock
sonde cage attachment	1	pack	clean
carrying cases	1	Pack	Clean

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #19: Water Quality Core Parameters

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.000	11/17/2010	Raymond	Added text	Missing info	0.001
0.001	10/31/2012	Raymond	Changed calibration info	To USGS standards	0.002
0.002	11/12/2014	Raymond and Palacios	Added Pre-mobilization	QAQC change	0.003
0.002	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This global standardized operating procedure gives step-by-step instructions for how to use a recording water quality probe (YSI Multimeter) to collect core water quality samples.

1. Premobilization of equipment in the office

Premobilization occurs one to two weeks in the office before taking equipment into the field at the start of each quarterly sampling period. The purpose is to make sure equipment is functioning properly and that calibration solutions remain uncontaminated. Use data sheet: Pre-mobilization of core parameter equipment.

1.1 Check pH sensor via 2 point method (7.0 and 10.0)

- 1.1.1 Inspect the pH sensor. Check for damage and rinse any precipitate off the sensor with water.
- 1.1.2 Rinse the pH sensor, thermometer and calibration cup with pH 7. Discard the buffer into a waste container. Repeat twice more for a total of three rinses.
- 1.1.3 Begin calibration by pouring fresh pH 7 buffer into the calibration cup and submerging the pH sensor. Swirl the calibration cup gently to remove any air bubbles around the pH sensor.
- 1.1.4 Record the theoretical pH value, buffer lot number, and expiration data.

- 1.1.5 When pH reading stabilizes, record the temperature and pH value. Click calibration and record the temperature, pH value and millivolts reading. Discard the pH 7 buffer into the waste container.
- 1.1.6 Repeat steps 1.2.2 – 1.2.5 using pH 10.
- 1.1.7 The pH sensor is in acceptable condition if it calibrates correctly, and if the sensor reads between millivolts between -50 and 50 in pH7 and between -130 and -230 in pH10. Replace pH sensor if the conditions above are not met.

1.2 Check temperature sensor

- 1.1.1. Fill containing $\frac{3}{4}$ with tap water. Place a NIST thermometer and conductivity/temperature sensor in the container and allow both to stabilize. Record both temperature readings on the datasheet.
- 1.1.2. Ensure the conductivity/temp sensor reading is within 1°C of the NIST thermometer reading. If not, the conductivity/temp sensor may need to be replaced.

1.3 Check specific conductivity sensor

- 1.3.1 Inspect conductivity /temperature. Check for damage and rinse any precipitate off the sensor with water.
- 1.3.2 Rinse the conductivity sensor and calibration cup three times with the 1413 $\mu\text{S}/\text{cm}$ conductivity standard. Each time discard the standard in a waste container.
- 1.3.3 Begin calibration by pouring fresh 1413 $\mu\text{S}/\text{cm}$ conductivity standard into the calibration cup and submerging the conductivity standard. Swirl the calibration cup to expel air bubbles trapped in the sensor.
- 1.3.4 Record specific conductivity value, buffer lot number, and expiration date
- 1.3.5 When the specific conductance reading stabilizes, record temperature and specific conductance reading. Click calibrate, and record temperature and specific conductance reading. Discard the 1413 $\mu\text{S}/\text{cm}$ standard in the waste container.
- 1.3.6 The conductivity sensor is in acceptable condition if it calibrates correctly

1.4 Check dissolved oxygen sensor

- 1.4.1 Replace the dissolved oxygen membrane.
- 1.4.2 Add 0.5 cm layer of water to the calibration cup, this will ensure 100-percent humidity.
- 1.4.3 Screw the calibration cup onto the sensor loosely, allowing for ventilation.
- 1.4.4 Allow the sensor to stabilize, which may take 10 minutes. Record temperature, barometric pressure, dissolved oxygen %, and dissolved oxygen mg/L. Click calibrate and record barometric pressure, dissolved oxygen %, and dissolved oxygen mg/L.
- 1.4.5 The dissolved oxygen sensor is acceptable if it stabilizes and the calibrated percent oxygen reading is between 75-95%.

2. Calibrating the sensors in the field

Calibrate the water quality sensors on site prior to sampling as per the equipment manual located at [V:\Global_SOPs\Water_Quality](#). Use datasheet: quarterly sampling to record the calibration

2.1. Calibrate the pH sensor via 2 point method (7.0 and 10.0)

- 2.1.1. Bring the pH buffers, calibration cup and sensor to the temperature of the sample. Allow the buffer 7 and 10 bottles to equilibrate to the temperature of the stream water by placing in a mesh bag in the stream channel.
- 2.1.2. Inspect the pH sensor. Check for damage and rinse any precipitate off the sensor with water.
- 2.1.3. Rinse the pH sensor, thermometer and calibration cup with pH 7. Discard the buffer into a waste container. Repeat twice more for a total of three rinses.
- 2.1.4. Begin calibration by pouring fresh pH 7 buffer into the calibration cup and submerging the pH sensor. Swirl the calibration cup gently to remove any air bubbles around the pH sensor.
- 2.1.5. Note the temperature of the buffer and determine the theoretical pH value of the buffer from temperature-correction tables. Adjust the meter reading to the theoretical pH value.
- 2.1.6. When pH reading stabilizes, record the temperature and pH value. Click calibration and record the temperature, and pH value. Discard the pH 7 buffer into the waste container.
- 2.1.7. Repeat steps 2.1.2 – 2.1.6 using pH 10 buffer.

2.2. Calibrate the conductivity sensor using specific conductance

- 2.2.1. Choose two conductivity standards that will bracket the expected conductivity of the sample (200 and 1413 $\mu\text{S}/\text{cm}$).
- 2.2.2. Bring the conductivity standards, calibration cup and sensor to the temperature of the sample. Allow the two conductivity standards to equilibrate with the stream water by placing in a mesh bag in the stream channel.
- 2.2.3. Rinse the conductivity sensor and calibration cup three times with the 1413 $\mu\text{S}/\text{cm}$ conductivity standard. Each time discard the standard in a waste container.
- 2.2.4. Begin calibration by pouring fresh 1413 $\mu\text{S}/\text{cm}$ conductivity standard into the calibration cup and submerging the conductivity standard. Swirl the calibration cup to expel air bubbles trapped in the sensor.
- 2.2.5. When the specific conductance reading stabilizes, record temperature and specific conductance reading. Click calibrate, and record temperature and specific conductance reading. Discard the 1413 $\mu\text{S}/\text{cm}$ standard in the waste container.
- 2.2.6. Repeat steps 2.2.2 – 2.2.5 with the second standard, 200 $\mu\text{S}/\text{cm}$, but do not calibrate. The purpose for measuring a second standard is to check instrument calibration over a range of standards. If the difference from the standard value should not exceed 5%.

2.3. Calibrate the dissolved oxygen probe using the 100 percent saturation method

- 2.3.1. Check the dissolved oxygen sensor membrane for bubbles or tears if applicable, replace if necessary.
- 2.3.2. Add 0.5 cm layer of water to the calibration cup, this will ensure 100-percent humidity.
- 2.3.3. Screw the calibration cup onto the sensor loosely, allowing for ventilation.

- 2.3.4. Allow the sensor to stabilize, which may take 10 minutes. Record temperature, barometric pressure, dissolved oxygen %, and dissolved oxygen mg/L. Click calibrate and record barometric pressure, dissolved oxygen %, and dissolved oxygen mg/L.

3. Choosing location for water quality core parameter sampling

- 3.1. Sample within the index reach.
- 3.2. In a riffle or other area with sufficient flow.
- 3.3. Upstream of any other activities in the stream.
- 3.4. Replace calibration cup with flow cup.
- 3.5. Place probe on channel floor in area free of obstacles.

4. Water quality sampling

4.1. Continuous sampling in the index reach

- 4.1.1. Take calibration cup off probe
- 4.1.2. Inspect probes and ensure that they are clean and the DO cap is intact
- 4.1.3. Screw on flow cup
- 4.1.4. Put probes in water to begin equilibrating
- 4.1.5. Turn probe on
- 4.1.6. Ensure that date and time are correct
- 4.1.7. Start logging is highlighted, select by pressing enter.
- 4.1.8. Ensure logging is set on 1 minute intervals. Change if necessary by highlighting and pressing enter to select. Re-enter the correct 00:01:00 interval.
- 4.1.9. Highlight “site” and click enter to select. Choose from site list or add a new site as necessary. Press enter to select.
- 4.1.10. Highlight “folder” and press enter. Select add new and title the folder UNITMMDD (example: GICL1022). Press enter again select.
- 4.1.11. Highlight “Start Now!” and press enter to start logging.
- 4.1.12. Leave in water for approximately five minutes before and after bottle sampling occurs.

4.2. Taking discrete water quality measurements

- 4.2.1. If continuous sampling is not possible take a discrete sample.
- 4.2.2. Allow probe to equilibrate in the stream for 10 minutes.
- 4.2.3. Before recording measurements make sure the readings are stable
- 4.2.4. Record a single reading for pH, specific conductance, dissolved oxygen and temperature. The time of sampling should coincide with the collection of bottle samples.

References

Equipment manual located at [V:\Global_SOPs\Water_Quality](#).
Collecting Water Quality Core Parameter Data with YSI ProPlus

Equipment list for field

Equipment	Quantity	Pre-trip	Post-trip
YSI 650 MDS handheld	1	Pack	Clean
pH calibration buffer	Bottle of 4, 7, 10	Pack	Refill
Conductivity buffer	Bottle of 200 and 1413 $\mu\text{S}/\text{cm}$	Pack	Refill
Calibration cup	1	Pack	Clean
Flow cup	1	Pack	Clean
Protective sleeve	1	Pack	Clean
C Batteries	1	Pack	Restock
Dissolved oxygen probe membranes	3	Pack	Restock
Dissolved Oxygen probe solution	1 bottle	Pack	Restock
carrying cases	2	Ensure integrity	Clean
32 oz bottle of deionized water	1 bottle	Pack	Restock
clipboard with SOPs, datasheets, notebook and pen	2	Pack	Restock
Cleaning supplies	1	Pack	Restock
Backup Hanna probe	1	Pack	Clean

2002. YSI Environmental Operations Manual, YSI Incorporated, Yellow Springs, Ohio.

Sprouse, T., Emanuel, R., Storrer, S., 2003. Water Quality Monitoring Program for High-Priority Water Bodies in the Sonoran Desert Network. In: Kunkle, S., Hawkins, P. (Eds.), National Park Service, U.S. Department of the Interior Sonoran Desert Network, Tucson, AZ.

[NPS Literature Cited Guidelines](#)

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #20: Water Quality Bottle Sampling

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
None	01/02/2009	Gwilliam	Versioned correctly, made minor edits	Needed to complete SOP	0.002
0.002	02/22/2011	Raymond			0.003
0.003	03/28/2014	Palacios	Edits; added appendix	Updates needed	0.004
0.002	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

Water quality is a critical measure of the chemical and biological properties of aquatic systems. Aquatic ecosystems depend on the maintenance of particular water quality conditions in order to sustain life-supporting biochemical processes in plant and animal communities. Aquatic ecosystems are influenced by inputs of metals, nutrients, toxins, soil erosion, fire ash, sewage effluent, and biomass.

This SOP covers the step-by-step process for collecting water samples to be analyzed at an outside laboratory for the following components: alkalinity, primary nutrients, biological condition, and pollutant metals.

- Bottle sampling occurs concurrently with sampling of core water quality parameters. Refer to the appropriate SOPs.
- Sample delivery to the laboratory is constrained by the lab's operating hours, the distance from the field sampling location to the lab, and the requested analysis with the minimum hold time. Plan bottle sampling delivery options prior to actually sampling.

1. Obtaining sample bottles

- 1.1. Order sample bottles from the laboratory three or more weeks in advance of the start of the field trip. Refer to Appendix for which bottles/analyses to request. Lab May also

provide sample labels, sample chain of custody forms, shipping labels, and shipping stickers.

- 1.2. Pick up bottles at laboratory or have them shipped to the office. The lab will typically provide a cooler for storage/transportation.
- 1.3. There are standard limits on sample hold time that a laboratory adheres to, principally for compliance purposes (not relevant to SODN) that are related to the decay time of the particular substance being analyzed. If the hold time is exceeded the lab will still complete the analysis but will flag the value.

2. Labeling sampling bottles

- 2.1. Bottles from the lab should already include labels for the test being performed and preservative (i.e. HNO_3). Fill out remaining information using a waterproof pen.
- 2.2. Attach labels to bottle. Wear gloves as preservative (acids) may have leaked out and be present on the surface of the bottle.
- 2.3. Write “Field Filtered” on the bottles which will test for dissolved metals and dissolved Nitrate-Nitrite if the lab did not include this on the label.

3. Filling out chain of custody form according to lab specifications

- 3.1. Lab may print out pre-filled COCs upon request.

4. Collecting bottle samples

- 4.1. Choose a sampling location.
 - 4.1.1. The sample site should be within the index reach, in a riffle or other area of sufficient flow.
 - 4.1.2. Do not disturb the substrate upstream of the sampling location prior to sampling
- 4.2. Place tarp on ground or truck bed to create a clean workspace.
- 4.3. Put on disposable, powderless gloves. If gloves become contaminated, dispose of gloves and put on a new pair.
- 4.4. Rinse sampling vessel, funnel and tubing in the water to be sampled three (3) times by completely submerging it and swirling water in it. This should remove loosely adhering contaminants.
- 4.5. Fill sampling vessel and replace cap immediately to reduce entrainment of atmospheric gases.
- 4.6. Use the vessel to directly fill the bottles that do not need to be field filtered. Periodically shake the sampling vessel to resuspend particles
 - 4.6.1. Only touch the outside of the bottles. Do not touch the lip of the bottles and keep cap open only when necessary.
- 4.7. Attach a funnel to a $45\mu\text{m}$ filter. Electrical tape and tubing may be used to prevent leaks. Rinse filter by filling the funnel with sample water and allowing the water to flow for 20 seconds.
- 4.8. Use the funnel to fill the remaining two bottles that require filtration. If the filter becomes clogged, resulting in slow flow or no flow, discard the clogged filter and put on a new filter. Allow sample water to rinse the new filter for 20 seconds before you resume filling sample bottles.

- 4.9. Add the date and time that the sample was collected from the stream to the bottle labels and the chain of custody. Each bottle should have the same sample date and time.
- 4.10. Place bottles on ice in cooler. The samples must be delivered at 4°C or lower.
- 4.11. Transport samples to lab or FedEx location within specified delivery time (see delivery considerations). Present cooler and Chain of Custody form to lab personnel.

5. Quality Assurance Quality Control

- 5.1. **Field Blanks-** A field blank sample is processed twice a year to identify, quantify, and document bias and variability in data resulting from handling of samples by field personnel.
 - 5.1.1. Label bottles, referring to Section 2. Label sampling bottles with FDBL for field blank instead of park code.
 - 5.1.2. Fill bottles according to Section 4; however, instead of rinse and sampling river water, use certified inorganic-grade blank water. Maintain the certification.
- 5.2. **Duplicate Sample-** A duplicate sample is processed twice a year to identify, quantify and document bias and variability in all parts of the sampling and analysis systems
 - 5.2.1. Label bottles, referring to Section 2. Label sampling bottles with DUPL for duplicate instead of park code.
 - 5.2.2. Fill bottles according to Section 4.
 - 5.2.3. Record sample location on the pink chain of custody copy.
- 5.3. **Replicate Sample-** A concurrent replicate sample is collected once a year and is submitted to a different lab for identical analysis to identify variability among laboratory procedures.
 - 5.3.1. Label bottles, referring to Section 2. Label sampling bottles with REPL for duplicate instead of park code.
 - 5.3.2. Fill bottles according to Section 4.
 - 5.3.3. Record sample location on the pink chain of custody copy.

Equipment List

Equipment	Quantity	Pre-Trip Procedure	Post-Trip Procedure
Lab approved bottles	1 set	Obtain from lab	Drop off at lab
Cooler	1	Obtain from Lab	Drop off at lab
Zip-loc bags	2	Put in cooler	Drop off at Lab
Ice	Enough	--	Obtain immediately after sampling
Decanter	1	Pack	Clean
Gloves	Several	Pack	Restock
Filters	2	Pack	Restock
Tubing	1	Pack	Clean
Electrical tape	1 roll	Pack	Restock
Tarp	1	Pack	Clean
Core water quality monitoring equipment		See relevant SOP	

Recommended reading

U.S. Geological Survey, 2006, Collection of water samples (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4, September, <http://pubs.water.usgs.gov/twri9A4/>.

Appendix

Analyte list for Fall, Winter and Spring sampling

Evan Gwilliam (520) 403-3055; Kara Raymond (520) 343-8670 FY 2013

Parameter	Method
Alkalinity as CaCO ₃	SM2320B
Chloride	300.0
Conductance, Specific @25C	SM2510B
Fluoride	SM4500 F, C
Hardness as CaCO ₃	SM2340B CALC
Mercury, dissolved	245.1
Mercury, total	245.1
Nitrate as N, dissolved	300.0
Nitrogen, total Kjeldahl	SM4500 Norg C
Sulfate	300.0
TDS Residue on evap. @ 180°C, water, filtered	SM2540C
TDS calculated	CALC
TDS (ratio - measured/calculated)	CALC
ICP Metals with digestion Total Metals Method 200.7	200.7
Calcium	Mineral
Magnesium	Mineral
Potassium	Mineral
Sodium	Mineral
Aluminum	Metal
Antimony	Metal
Arsenic	Metal
Barium	Metal
Beryllium	Metal
Boron	Metal
Cadmium	Metal
Chromium	Metal
Copper	Metal
Iron	Metal
Lead	Metal
Manganese	Metal
Molybdenum	Metal
Nickel	Metal
Selenium	Metal

Parameter	Method
Silver	Metal
Thallium	Metal
Uranium	Metal
Zinc	Metal

Analyte list for Additional Summer sampling

Analyte	Method
(+/-)11-nor-9-carboxy-delta-THC	EPA 1694
2,4,5-T	Reg. 8 Lab
2,4,5-TP	Reg. 8 Lab
2,4-D	Reg. 8 Lab
3-Hydroxycarbofuran	Reg. 8 Lab
Acebutolol	EPA 1694
Acetochlor	Reg. 8 Lab
Acetochlor OA	Reg. 8 Lab
Alachlor	Reg. 8 Lab
Alachlor OA	Reg. 8 Lab
Albuterol	EPA 1694
Aldicarb	Reg. 8 Lab
Aldicarb sulfone	Reg. 8 Lab
Aldicarb sulfoxide	Reg. 8 Lab
Alprazolam	EPA 1694
Amitriptyline	EPA 1694
Amitriptyline (+/-)-E-10-hydroxylated	EPA 1694
Atenolol	EPA 1694
Atraton	Reg. 8 Lab
Atrazine	EPA 1694
Atrazine	Reg. 8 Lab
Atrazine de-ethyl	Reg. 8 Lab
Atrazine de-isopropyl	Reg. 8 Lab
Azoxystrobin	Reg. 8 Lab
Bentazon	Reg. 8 Lab
Benzoylecgonine	EPA 1694
Benzphetamine	EPA 1694
Bezafibrate	EPA 1694
Bromacil	Reg. 8 Lab
Brombuterol	EPA 1694
Bromoxynil	Reg. 8 Lab
Bupropion	EPA 1694
Butabarbital	EPA 1694
Butachlor ESA	Reg. 8 Lab

Analyte	Method
Butalbital	EPA 1694
Caffeine	EPA 1694
Cannabidiol	EPA 1694
Cannabinol	EPA 1694
Carbamazepine	EPA 1694
Carbaryl	Reg. 8 Lab
Carbofuran	Reg. 8 Lab
Chloramphenicol	EPA 1694
Chlordiazepoxide	EPA 1694
Chlorimuron ethyl	Reg. 8 Lab
Chlorpheniramine	EPA 1694
Cimetidine	EPA 1694
Clenbuterol	EPA 1694
Clobazam	EPA 1694
Clonazepam	EPA 1694
Clonidine	EPA 1694
Cocaethylene	EPA 1694
Cocaine	EPA 1694
Codeine	EPA 1694
Cyanazine	Reg. 8 Lab
Dacthal monoacid	Reg. 8 Lab
DEET	EPA 1694
Diazepam	EPA 1694
Diazinon	Reg. 8 Lab
Dichloroprop	Reg. 8 Lab
Diclofenac	EPA 1694
Diltiazem	EPA 1694
Dimethachlor	Reg. 8 Lab
Dimethenamid	Reg. 8 Lab
Dimethenamid ESA	Reg. 8 Lab
Diphenhydramine	EPA 1694
Disulfoton sulfone	Reg. 8 Lab
Diuron	Reg. 8 Lab
Diuron Metabolite	Reg. 8 Lab
EPTC	Reg. 8 Lab
Ethoprop	Reg. 8 Lab
Famotidine	EPA 1694
Fenbendazole	EPA 1694
Fenbufen	EPA 1694
Fentanyl	EPA 1694

Analyte	Method
Fipronil	Reg. 8 Lab
Fipronil sulfide	Reg. 8 Lab
Flunitrazepam	EPA 1694
Fluoxetine	EPA 1694
Flurazepam	EPA 1694
Furosemide	EPA 1694
Gemfibrozil	EPA 1694
Glyburide	EPA 1694
Hexazinone	Reg. 8 Lab
Hydrocodone	EPA 1694
Hydromorphone	EPA 1694
Ibuprofen	EPA 1694
Imazaquin	Reg. 8 Lab
Imazethapyr	Reg. 8 Lab
Imidacloprid	Reg. 8 Lab
Levorphanol	EPA 1694
Linuron	Reg. 8 Lab
Loratadine	EPA 1694
Lorazepam	EPA 1694
Malathion	Reg. 8 Lab
MCPP	Reg. 8 Lab
MDEA	EPA 1694
MDMA	EPA 1694
Meperidine	EPA 1694
Mephobarbital	EPA 1694
Metalaxyl	Reg. 8 Lab
Methaqualone	EPA 1694
Methiocarb	Reg. 8 Lab
Methomyl	Reg. 8 Lab
Methyprylon	EPA 1694
Metolachlor	Reg. 8 Lab
Metolachlor ESA	Reg. 8 Lab
Metoprolol	EPA 1694
Metribuzin	Reg. 8 Lab
m-Hydroxybenzoylecgonine	EPA 1694
Monuron	Reg. 8 Lab
Morphine	EPA 1694
Naproxen	EPA 1694
n-Butylparaben	EPA 1694
Neburon	Reg. 8 Lab

Analyte	Method
Nifedipine	EPA 1694
Nifedipine oxidized	EPA 1694
Norfentanyl	EPA 1694
Norverapamil	EPA 1694
Omeprazole	EPA 1694
Oryzalin	Reg. 8 Lab
Oxamyl	Reg. 8 Lab
Oxycodone	EPA 1694
Oxymorphone	EPA 1694
Paroxetine	EPA 1694
Pentazocine	EPA 1694
Phenmetrazine	EPA 1694
Phenobarbital	EPA 1694
Phenytoin	EPA 1694
Pindolol	EPA 1694
Prazepam	EPA 1694
Progesterone	EPA 1694
Prometon	Reg. 8 Lab
Propachlor	Reg. 8 Lab
Propachlor ESA	Reg. 8 Lab
Propachlor OA	Reg. 8 Lab
Propazine	Reg. 8 Lab
Propiconazole	Reg. 8 Lab
Propoxur	Reg. 8 Lab
Propranolol	EPA 1694
Secobarbital	EPA 1694
Sildenafil	EPA 1694
Simazine	Reg. 8 Lab
Simvastatin	EPA 1694
Sotalol	EPA 1694
Sulfamethazine	EPA 1694
Sulfamethoxazole	EPA 1694
Sulfometuron methyl	Reg. 8 Lab
Sumatriptan	EPA 1694
Talbutal	EPA 1694
Tebuconazole	Reg. 8 Lab
Tebuthiuron	Reg. 8 Lab
Temazepam	EPA 1694
Terbuthylazine	Reg. 8 Lab
Testosterone	EPA 1694

Analyte	Method
THC	EPA 1694
Thebaine	EPA 1694
Thiabendazole	EPA 1694
Thiamethoxam	Reg. 8 Lab
Tramadol	EPA 1694
Trazodone	EPA 1694
Triamterene	EPA 1694
Triazolam	EPA 1694
Triclocarban	EPA 1694
Triclopyr	Reg. 8 Lab
Triclosan	EPA 1694
Trimethoprim	EPA 1694
Tylosin	EPA 1694
Venlafaxine	EPA 1694
Verapamil	EPA 1694
Warfarin	EPA 1694

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #21: Turbidity

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
None	01/05/2011	Raymond	Added text	No SOP existed	0.001
0.001	11/12/2014	Raymond and Palacios	Calibration edit	Calibration update	0.002
0.002	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This Water Quality Monitoring Standard Operating Procedure (SOP) describes sample collection and analysis of turbidity.

The SODN and SOPN Stream Monitoring Program currently uses the HACH® 2100 Q Turbidimeter.

1. Calibration

Calibrate the Turbidimeter before reading any samples

- 1.1 Clean each calibration standards with silicone oil and lint-free cloth. Shake each calibration standard to suspend and evenly distribute particles.
- 1.2 Calibrate according to equipment manual.
 - 1.2.1 Hach 2100Q calibration uses 20, 100 and 800 NTU standards.
- 1.3 Record readings
- 1.4 Check with 10 NTU. The reading should be between 9.0 and 11.0 NTU. If it is not, repeat calibration.

2. Collecting and running the turbidity sample

- 2.1. Collect sample from undisturbed (i.e., no one has walked upstream of sample point), flowing water near thalweg in index reach – turbidity can be included in a concurrent collection of bottle samples (SOP20 – Bottle Sampling)
- 2.2. Stand downstream of decanter (i.e., facing upstream).
- 2.3. Rinse decanter three times with stream water.
- 2.4. Fill decanter with water.
- 2.5. Carefully pour water sample into 3 empty cells to the neck – shake decanter between filling cells to distribute particles.
- 2.6. Process as soon as possible
- 2.7. Clean and insert the first sample cell into turbidimeter
- 2.8. Record value on bacteria and turbidity datasheet.
- 2.9. Repeat with other two sample cells and record values.

Equipment list

Equipment	Quantity	Pre-trip	Post-trip
HACH® 2100P Turbidimeter	1	Pack	Store
Soft lint-free cloth	1	Pack	Store
Silicone oil	1	Pack	Restock
Empty cells	3	Pack	Clean
Secondary Standards	3 (0-10, 0-100, 0-1000 NTU)	Pack	Store
AA batteries	4	Pack	Restock

References

- Turbidity from USGS National Field Manual for the Collection of Water-Quality Data (TWRI Book 9)
- HACH® 2100P Turbidimeter Manual

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #22: Fecal Indicator Sampling and Analysis

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
None	01/02/2009	Gwilliam	Added text	No SOP existed	0.001
0.001	11/09/2010	Raymond	Added info	Added test, deleted into	0.002
0.002	03/28/2014	Palacios	Added into	Reflect color change in quanti-tray procedure	0.003
0.002	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This Water Quality Monitoring Standard Operating Procedure (SOP) describes sample collection, handling and processing for the enumeration of Fecal Indicator Bacteria in natural waters including coliform, *Escherichia coli* and enterococci. This SOP is located at V:\Streams\Protocols\Narratives_and_SOPs.

The SODN and SOPN Stream Monitoring Program use IDEXX Quanti-tray[®]/2000 and water microbiology test kits, Colisure[®] and Enterolert[™]. The IDEXX system uses the most probable number method.

1. File quality assurance certificates

- 1.1. Ensure that quality assurance certificates have been obtained for all reagent and sample bottles
- 1.2. When new Colilert[®] reagents are purchased, download certificates of quality from the IDEXX website: <http://www.idexx.com/water/certificates/index.jsp>
- 1.3. Save in the SODN server at: V:\Streams\Products\QUALITY CONTROL CERTIFICATES

2. Collecting samples

- 2.1. Label bottles with site name, date of collection, and time of collection
- 2.2. Use the collection decanter used during bottle sampling (SOP04).

- 2.3. Collect sample from undisturbed (i.e., no one has walked upstream of sample point), flowing water near thalweg in index reach.
- 2.4. Stand downstream of decanter (i.e., facing upstream)
- 2.5. Rinse decanter three times with stream water
- 2.6. Fill decanter with water
- 2.7. Carefully pour water sample into plastic sample bottles filling to 100ml line
- 2.8. Transport samples to be processed
 - 2.8.1. If time between sampling and processing is more than an hour, place samples on ice

3. Processing samples

- 3.1. Prepare analysis by turning laminator and incubator on. Wait until both units have reached operational temperature (green light appears on laminator, incubator is 35°C).
- 3.2. Pour one Colilert® reagent capsule into each three containers, tighten cap securely and vigorously shake until the entire reagent is dissolved.
- 3.3. Label each Quanti-tray®/2000 plate with date, location and start time of incubation taking care to not puncture the tray.
- 3.4. Pour each sample into a Quanti-tray®/2000 and run through sealer using the rubber insert (Figure 1)
- 3.5. Use a thermometer to ensure that sample is ~25°C before incubation
- 3.6. Place sealed trays in incubator for 24–28 hours
- 3.7. Record date and time of sample collection and sample incubation on the datasheet

Quantification

Step 1.

Add reagent to sample.



Step 2.

Pour into Quanti-Tray®/2000 (counts from 1-2,419).



Step 3.

Seal in [Quanti-Tray® Sealer](#) and place in incubator for 24 hours.



Step 4.

Quanti-Tray / 2000-read results:

- Yellow wells = total coliforms
- Yellow and Fluorescent wells = *E. coli*



Figure 1. Photo instructions of the use of Quanti-tray®/2000 and Colisure® reagent

4. Analyzing bacterial samples

- 4.1. Remove all Quanti-tray®/2000 from incubator after 24 hours
- 4.2. For Total Coliforms, count and record the number of large and small wells that have a positive reaction under ambient light, represented by a yellow color.
 - 4.2.1. If the color of any well is not clear, incubate tray further up to 28 hours maximum.
 - 4.2.2. Colilert® wells that remains clear at 28 hours is negative for coliforms
- 4.3. For *E. coli* and use a blacklight in a dark room to count and record the number of large and small wells that have a positive reaction, represented as fluorescence under ultra violet light.
- 4.4. Use these values to look up MPN, 95% confidence lower limit and 95% confidence upper limit values for both Total Coliforms and *E.coli* using the IDEXX MPN Generator 3.2 located at V:\Streams\Data_Nonspatial\Raw_Data.
- 4.5. Fill out the data sheet
 - 4.5.1. Record date and time of analysis
 - 4.5.2. Record number of large and small well positive for coliforms and *E.coli*
 - 4.5.3. Look up most probable number and 95% confidence intervals from IDEXX MPN Generator.

Equipment list

Equipment	Quantity	Pre-trip	Post-trip
Datasheet	1	Pack	Restock
Quanti-Tray [®] laminater and power cord	1	Pack	Store
Portable incubator and cord	1	Pack	Store
Sealed 120ml plastic sample bottles/w sodium thiosulfate	3	Pack	Restock
Quanti-Tray [®] /2000	3	Pack	Restock
Colilert reagent packets	3	Pack	Restock
Gloves	Several	Pack	Restock
Decanter	1	Pack	Clean
Cooler	1	Pack	Store
Blacklight	1	Pack	Store

References

How to Use Quanti-Tray 2000 Video, located at
http://www.idexx.com/view/xhtml/en_us/water/quant-tray.jsf#How-To---FAQs
Fecal Indicator Bacteria from USGS National Field Manual for the Collection of Water-Quality Data (TWRI Book 9)
Colilert[®] Procedure

Acknowledgement

A large portion of this SOP was taken from the *Sampling Analysis Plan and Quality Assurance Project Plan for Monitoring the Santa Cruz River at Tumacacori Historical Park*, and from the Northern Colorado Plateau Network Water quality protocol SOP #11 for Fecal Bacteria Indicators.

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #23: Daily Data Management

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
001	02/24/2011	Raymond	Change text and edited	Updating	0.002
002	11/24/2014	Palacios	Added database section	Missing	0.003
0.002	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This document outlines the specific daily data management tasks for all data collected in the field for this protocol. This includes tabular data, spatial data and photographs. File naming conventions and storage locations are SODN specific.

1. Compile data sheets

- 1.1. Verify all datasheets complete and initial then proofread.
- 1.2. Copy datasheets, initial them copied.
- 1.3. Place originals data sheets into an archive manila folder labeled "Streams_WY##_UNIT_ Q#". Store in fire safe.
- 1.4. Place copies into a manila folder labeled " Streams_WY##_UNIT_ Q#". Store in a separate place than originals.
- 1.5. Make two copies of any relevant notes made in notebooks, store one with originals and one with the copies.
- 1.6. Enter data immediately into database

2. Managing water quality probe data

- 2.1. Connect water quality probe to computer and download probe data.
- 2.2. Download data in CSV file format and save file in
V:\Streams\Data_Nonspatial\Raw_Data\Network\WY##_UNIT\QUARTER
- 2.3. Rename to UNIT_YYYYMMDD_probe (i.e. MOWE_20101018_probe)
- 2.4. Print two copies of the report, file one with the original data sheets and the other with the copies.

- 2.5. Once probe data have been downloaded successfully, erase data from water quality probe.

3. Managing discharge data

- 3.1. Connect current meter to computer and download discharge data.
- 3.2. Rename the file UNIT_YYYYMMDD_discharge (i.e. MOWE_20101018_discharge)
- 3.3. Save file in V:\Streams\Data_Nonspatial\Raw_Data\Network\WY##\UNIT\QUARTER
- 3.4. Create a PDF of the discharge report.
- 3.5. Print two copies of the report, file one with the original data sheets and the other with the copies
- 3.6. Once discharge data have been downloaded successfully, erase data from current meter.

4. Managing bacteria and turbidity data

- 4.1. Determine MPN/100ml, 95% Confidence interval lower limit and upper limit for bacteria samples. Record values on data sheet.
- 4.2. Record all values on bacteria and turbidity data sheet
- 4.3. Enter data into excel file, named UNIT_YYYYMMDD_OtherWQ. Template is located at V:\Streams\Data_Nonspatial\Raw_Data\Network\WY## and should be moved to a new appropriate folder at the beginning of each new WY.
- 4.4. Save file in V:\Streams\Data_Nonspatial\Raw_Data\Network\WY##\UNIT\QUARTER

5. Managing lab bottle data

- 5.1. Save PDF report and excel file from lab in
V:\Streams\Data_Nonspatial\Raw_Data\Network\WY##\UNIT\SEASON
- 5.2. Rename the file UNIT_YYYYMMDD_bottles
- 5.3. Print two copies of the report, file one with the original data sheets and the other with the copies
- 5.4. Upload lab data into the data base using import tool
 - 5.4.1. Create text file with six columns: Analyte, Result, DL, RL, Units, Method Name
 - 5.4.2. Under result change all ND to -3333.
 - 5.4.3. Add Dis before Analyte name for Method EPA 200.7-Diss. (i.e. Aluminum becomes Dis Aluminum).
 - 5.4.4. After importing check that all line have been imported
 - 5.4.5. Make sure that all Analyte names correspond to a name in the Analyte drop down list. If an Analyte does not match any in the pick list, change it to the name in the pick list that represents the same analyte.

6. Managing data for database

- 6.1. Create a new event group at the new water year.
- 6.2. Click enter stream data from the switchboard and select the correct park code and user from the pop-up.
- 6.3. Click on any other date from the park and select “access data” to open a new entry form.
- 6.4. Enter data from: datasheets, water quality probe, discharge, and e. coli into database corresponding tables.
- 6.5. Transform bottle data and upload into database.

7. Managing photos

- 7.1. Transfer data photos en masse to V:\Streams\Photographs\Data\Unit\
- 7.2. Label each photo individually according to this scheme:
“PARK_XS_DIR_YYYYMMDD_description (ex. a, b, c)”, where XS is the cross section designation (A through K), DIR is the abbreviated direction in which the photo was taken (e.g., “L2R” is left to right bank, D2U is down to upstream), and description is an optional distinguishing letter (use a,b,c if there are more than one photos) or other term. Examples: GICL_D_L2R_20090101c.jpg; MOCC_K_U2D_20080505.jpg.
- 7.3. All none data photos can be transferred to V:\Streams\Photographs\General. Label folder UNIT_YYYYMMDD (i.e. GICL_20060605).

8. Transferring spatial data

- 8.1. Transfer point files: to V:\Stream\Data Spatial\Raw\Unit\
- 8.2. In Arc Toolbox, use the Define Projection command to identify proper projection for each spatial data file.
- 8.3. In ArcCatalog, navigate to folder from 1.3.1.
- 8.4. Follow SODN naming convention: Select each file and verify name is in proper format "PARK_TYPE_YYYYMMDD", where TYPE might be “macros,” “ww” (wetted width), “xs” (cross-section), “rebar”, or “survey.” Examples: GICL_ww_20090101.shp; TUMM_macros_20050101.shp.
- 8.5. Geography and Table Validation: Chose preview tab in large right window of ArcCatalog interface; within lower drop down box, chose either geography or table to view those portions of the shapefile. Use the ‘geography’ to check that geography looks accurate. Use the ‘table’ preview to check that the file has been correctly and fully attributed. If necessary utilize the editor toolbar to make any changes (see editing spatial files).

9. Editing spatial files

- 9.1. In ArcMap, use the “add data” tool to open the files needing edits. Click “start editing” on the Editing toolbar. Chose proper file to edit; check the editing target on the toolbar if you have multiple field data files loaded into your project for editing.
- 9.2. Make changes to attributes or delete extra points etc and then chose “save edits” using the editor drop down menu on the editor tool bar. When all edits to all files are complete, choose “stop editing” on the same drop down menu of the editor tool bar.

10. Quarterly sampling QA/QC

- 10.1. QA/QC quarterly data once data for all sites has been entered into the database.
- 10.2. Refer to SOXXXXQA/QC. (V:\Global_SOPs\Data_Management_GOPS)

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #24: Continuous Water Quality Station Mount Installation

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
None	11/26/2012	Raymond	Added text	No SOP existed	0.001
0.002	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This SOP provides step-by step instructions for choosing a location, installing and surveying a station mount for deployment of a logging multi-parameter probe to collect continuous water quality data.

1. Choosing the deployment location

- 1.1. Within the index reach as close to index point as possible
- 1.2. In the vicinity of a gage
- 1.3. A location where water is flowing, not a pool or eddy
- 1.4. Not in a depositional zone or a erosional zone
- 1.5. Water must flow past the water quality meter during base, bankfull and low flows
- 1.6. Once site is selected work with park compliance officer to ensure all compliance requirements are met.

2. Install the water quality station mount

The type of water quality station mount is dependent on the baseflow level, substrate type and bank morphology. The station mount should be a semi-permanent installation; however, channel characteristics may require a moveable structure.

- 2.1. *Bedrock or boulder mount*- provide a stable anchor for instillation of a mount. Ideally the location is smooth and roughly 90°.
 - 2.1.1. Use a 3ft galvanized metal or PVC pipe for the water quality meter housing.

- 2.1.2. Drill numerous holes in the bottom of the pipe to allow water to flow past the meter.
 - 2.1.3. Attach the pipe at two or more locations using two ½” bolts on either side. Use at least 4 threaded bolts.
 - 2.1.4. Drill >5” deep holes into the bedrock using ½” mason bit in a hammerdrill.
 - 2.1.5. Use a cement epoxy to secure the bolts in the holes.
 - 2.1.6. Secure the pipe to the bolts using metals plates with holes for the bolts, fender washers, hexagon nuts, and locking nuts.
 - 2.1.7. Secure an eyelet screw to the pipe cap with a carabiner to hang the water quality meter.
- 2.2 *Bank mount*- where bedrock or a large boulder are not present, the station mount can be embedded in the bank. This works well in 3-5ft banks with fine substrate.
- 2.2.1 Use an 8ft galvanized metal pipe for the water quality housing.
 - 2.2.2 Drill numerous holes in the bottom 2ft of the pipe to allow water to flow past the meter.
 - 2.2.3 Dig a trench in the bank 6”. The trench should be at an angle so that the top of the pipe sticks out of the top of the bank and the bottom is of the pipe, where the meter sits exits the bank into the stream.
 - 2.2.4 Nestle the pipe into 10ft, ¼” angle iron. There should be 2ft of the angle iron at the bottom by itself. Secure the pipe to the angle iron using hose clamps.
 - 2.2.5 Lay the angle iron with the pipe in the trench. Use a sledge hammer to hammer the 2ft bottom of the angle iron into the stream bottom.
 - 2.2.6 Use 3- 5ft rebar staples to secure the angle iron and pipe to the bank.
 - 2.2.7 Cover the trench with the excavated soil.
 - 2.2.8 Secure an eyelet screw to the pipe cap with a Teflon rope or wire with carabiners so that the meter can be deployed and retrieved.
- 2.3. *Attachment to installed equipment*- Station mounts for other water quality equipment may already be present.
- 2.3.1. Use a galvanized or PVC pipe of an appropriate size for the location.
 - 2.3.2. Drill numerous holes in the bottom 2ft of the pipe to allow water to flow past the meter.
 - 2.3.3. Attach the pipe to the mounts for the other equipment using hose clamps.
- 2.4. *Anchor*- This is the best solution for channels that are prone to constant flow or low water levels. This is a moveable mount.
- 2.4.1. Use a 3ft galvanized metal or PVC pipe for the water quality meter housing.
 - 2.4.2. Drill numerous holes in the bottom of the pipe to allow water to flow past the meter.
 - 2.4.3. Attach the pipe to a cinder block or steel Using hose clamps
 - 2.4.4. Place a relatively deep location in the stream.
 - 2.4.5. Secure using 5ft rebar staples.

- 2.4.6. Use cable to secure the anchor to a tree.

3. Survey the barometer on the meter

Surveying allows the depth readings to be related to nearby gages.

- 3.1. Survey frequency
 - 3.1.1. Survey in the barometer elevation on the water quality after the station mount is installed.
 - 3.1.2. Resurvey the barometer anytime the station mount is moved or the level of the water quality meter is adjusted.
- 3.2. Benchmark
 - 3.2.1. Use a permanent NGS or other agency benchmark when possible
 - 3.2.2. If there is not a benchmark nearby, use a local benchmark

Colilert^{*}



06-12999-08

IDEXX

For Technical Support, please call:

North/South America: 1 207 556 4496/1 800 321 0207

Europe: 00800 4339 9111

UK: +44 (0) 1638 676800

China: +86 21 61279528

Japan: 03 5301 6800

Australia: 1300 443 399

IDEXX

IDEXX Laboratories, Inc., One IDEXX Drive, Westbrook, Maine 04092 USA

idexx.com/water

Colilert* Test Kit

Introduction

Colilert* simultaneously detects total coliforms and *E. coli* in water. It is based on IDEXX's proprietary Defined Substrate Technology*. When total coliforms metabolize Colilert's DST* nutrient-indicator, ONPG, the sample turns yellow. When *E. coli* metabolize Colilert's DST* nutrient-indicator, MUG, the sample also fluoresces. Colilert can simultaneously detect these bacteria at 1 cfu/100 mL within 24 hours even with as many as 2 million heterotrophic bacteria per 100 mL present.

Storage

Store at 2–30°C away from light.

Presence/Absence (P/A) Procedure

1. Add contents of one pack to a 100 mL sample in a sterile, transparent, nonfluorescing vessel.
2. Cap vessel and shake.
3. Incubate at 35±0.5°C for 24 hours.
4. Read results according to Result Interpretation table below.

Quanti-Tray* Enumeration Procedure

1. Add contents of one pack to a 100 mL water sample in a sterile vessel.
2. Cap vessel and shake until dissolved.
3. Pour sample/reagent mixture into a Quanti-Tray* or Quanti-Tray*/2000 and seal in an IDEXX Quanti-Tray* Sealer.
4. Place the sealed tray in a 35±0.5°C incubator for 24 hours.
5. Read results according to the Result Interpretation table below. Count the number of positive wells and refer to the MPN table provided with the trays to obtain a Most Probable Number.

Result Interpretation

Appearance	Result
Less yellow than the comparator ¹	Negative for total coliforms and <i>E. coli</i>
Yellow equal to or greater than the comparator	Positive for total coliforms
Yellow and fluorescence equal to or greater than the comparator	Positive for <i>E. coli</i>

- Look for fluorescence with a 6-watt, 365-nm UV light within 5 inches of the sample in a dark environment. Face light away from your eyes and towards the sample.
- Colilert results are to be read after 24 hours of incubation.
- However, if the results are ambiguous to the analyst based on the initial reading, incubate up to an additional four hours (but not to exceed 28 hours total) to allow the color and/or fluorescence to intensify.
- Positives for both total coliforms and *E. coli* observed before 24 hours and negatives observed after 28 hours are also valid.
- In addition, laboratories may incubate samples for additional time (up to 28 hours total) for their convenience.

Procedural Notes

- This insert may not reflect your local regulations. For compliance testing, be sure to follow appropriate regulatory procedures. For example, samples run in other countries are incubated at 36±2°C for 24–28 hours.
- Colilert can be run in any multiple tube format. *Standard Methods for the Examination of Water and Wastewater*² MPN tables should be used to find Most Probable Numbers (MPNs).
- If a water sample has some background color, compare inoculated Colilert sample to a control blank of the same water sample.
- If sample dilutions are made, multiply the MPN value by the dilution factor to obtain the proper quantitative result.
- Use only sterile, nonbuffered, oxidant-free water for dilutions.
- Colilert is a primary water test. Colilert performance characteristics do not apply to samples altered by any pre-enrichment or concentration.
- In samples with excessive chlorine, a blue flash may be seen when adding Colilert. If this is seen, consider sample invalid and discontinue testing.
- Aseptic technique should always be followed when using Colilert. Dispose of in accordance with Good Laboratory Practices.

Quality Control Procedures

1. One of the following quality control procedures is recommended for each lot of Colilert:
 - A. IDEXX-QC Coliform and *E.coli*³: *Escherichia coli*, *Klebsiella variicola*⁴, and *Pseudomonas aeruginosa*
 - B. Quanti-Cult[®]: *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*.
 - C. Fill three sterile vessels with 100 mL of sterile nonbuffered oxidant-free water and inoculate with a sterile loop of ATCC⁵ strains, *Escherichia coli* ATCC 25922/WDCM 00013 or ATCC 11775/WDCM 00090, *Klebsiella variicola*⁴ ATCC 31488/WDCM 00206 and *Pseudomonas aeruginosa* ATCC 10145/WDCM 00024 or ATCC 27853.
2. Follow the P/A Procedure or Quanti-Tray Enumeration Procedure above.
3. Results should match the Result Interpretation table above.

NOTE: IDEXX internal quality control testing is performed in accordance with ISO 11133:2014. Quality Control Certificates are available at idexx.com/water.



1. IDEXX P/A Comparator, catalog #WP104; Quanti-Tray Comparator #WQTC, or Quanti-Tray/2000 Comparator #WQT2KC
2. Eaton, AD, Clesceri, LS, Greenberg, AE, Rice, EN. *Standard Methods for the Examination of Water and Wastewater*. American Public Health Association, 2005. Washington, DC.
3. IDEXX-QC Coliform and *E. coli*—IDEXX Catalog #UN3373-WQC-TCEC
4. Quanti-Cult cultures—IDEXX catalog # WKIT-1001
5. American Type Culture Collection 1-800-638-6597 atcc.org
†. *Klebsiella pneumoniae* (ATCC 31488/WDCM 00206) has been renamed to *Klebsiella variicola*.
*Colilert, Defined Substrate Technology, DST and Quanti-Tray are trademarks or registered trademarks of IDEXX Laboratories, Inc. or its affiliates in the United States and/or other countries. Quanti-Cult is a trademark or registered trademark of Remel Inc.
Patent information: idexx.com/patents.
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Kit d'analyse Colilert*

Introduction

Colilert® permet la détection simultanée des coliformes totaux et *E. coli* dans l'eau. Ce test est basé sur la technologie propriétaire Defined Substrate Technology® (DST®) d>IDEXX. Lorsque les coliformes totaux métabolisent ONPG, le substrat chromogène-indicateur de Colilert, le prélèvement vire au jaune. Lorsque l'échantillon est positif, le réactif MUG contenu dans Colilert est métabolisé par les *E. coli* et génère une fluorescence. Colilert peut détecter simultanément ces bactéries à 1 cfu/100 ml en 24 heures, même en présence de bactéries hétérotrophes d'une concentration de 2 millions par 100 ml.

Conditions de Conservation

Conserver entre 2–30°C à l'abri de la lumière.

Procédure de Présence/Absence (P/A)

- Ajouter le contenu d'un sachet dans un prélèvement de 100 ml placé dans un récipient stérile, transparent et non fluorescent.
- Fermer le récipient et agiter.
- Incuber à 35 ± 0,5°C pendant les 24 heures qui suivent.
- Interpréter les résultats en se référant au tableau d'interprétation des résultats ci-dessous.

Quanti-Tray® Procédure de numération

- Ajouter le contenu d'un sachet dans un prélèvement de 100 ml d'eau placé dans un récipient stérile.
- Fermer le récipient et agiter jusqu'à dissolution.
- Verser le mélange prélèvement/réactif dans un Quanti-Tray® ou un Quanti-Tray®/2000 et fermer hermétiquement dans un IDEXX Quanti-Tray® Sealer.
- Placer le plateau hermétiquement fermé dans un incubateur à 35 ± 0,5°C pendant 24 heures.
- Interpréter les résultats en se référant au tableau d'interprétation des résultats ci-dessous.
Compter le nombre de puits positifs et se référer au tableau MPN fourni avec les plateaux pour obtenir le Chiffre le plus probable (MPN).

Interprétation des Résultats

Aspect	Résultat
Moins jaune que le comparateur¹	Négatif pour les coliformes totaux et <i>E. coli</i>
Aussi jaune ou plus jaune que le comparateur	Positif pour les coliformes totaux
Couleur jaune et fluorescence égales ou supérieures au comparateur	Positif pour <i>E. coli</i>

- Évaluer la fluorescence avec une ampoule UV de 6 watts et 365 nm placée à 13 cm du prélèvement dans l'obscurité. Orienter la lumière vers le prélèvement, dans la direction opposée à celle des yeux de l'opérateur.
- Les résultats du test Colilert doivent être lus après 24 heures d'incubation.
- Toutefois, si les résultats de la première lecture sont ambigus pour l'analyste, incuber jusqu'à quatre heures supplémentaires (sans dépasser 28 heures au total) pour laisser la couleur et/ou la fluorescence s'intensifier.
- Les résultats positifs en coliformes et *E. coli* observés avant 24 heures et les résultats négatifs observés après 28 heures sont également valables.
- En outre, les laboratoires peuvent incuber des échantillons pendant une durée plus longue (jusqu'à 28 heures en tout) par souci de commodité.

Remarques Concernant la Procédure

- Cette notice peut différer des réglementations en vigueur dans votre pays. Pour tout test de conformité, suivre les procédures réglementaires appropriées. Par exemple, l'incubation des échantillons dans certains pays est réalisée à 36 ± 2°C pendant 24 à 28 heures.
- Colilert peut être effectué en format de tubes multiples. Utiliser des méthodes standards et les tableaux MPN pour le contrôle des eaux et eaux usées² afin de déterminer les Chiffres les Plus Probables (MPN).
- Si un prélèvement d'eau présente une couleur de fond, comparer le prélèvement inoculé avec Colilert à un contrôle neutre du même prélèvement d'eau.
- Si les prélèvements sont dilués, multiplier la valeur MPN par le facteur de dilution pour obtenir le résultat quantitatif correct.
- Utiliser uniquement de l'eau stérile, non tamponnée et sans oxydant pour les dilutions.
- Colilert est avant tout un test pour eau. Les caractéristiques de performance de Colilert ne s'appliquent pas aux prélèvements altérés par tout enrichissement préalable ou toute concentration.
- Avec les prélèvements présentant un excédent de chlore, il peut se produire une rapide lueur bleuâtre lors de l'ajout de Colilert. Si tel est le cas, le prélèvement n'est pas valide et il faut cesser le test.
- Utiliser systématiquement des techniques aseptiques dans l'emploi de Colilert. Mettre au rebut conformément aux Bonnes pratiques de laboratoire.

Procédures de contrôle de qualité

- L'une des procédures de contrôle qualité suivantes est recommandée pour chaque lot de Colilert:
 - IDEXX-QC³ pour les Coliformes et *E. coli*: *Escherichia coli*, *Klebsiella variicola*⁴ et *Pseudomonas aeruginosa*.
 - Quanti-Cult⁵ *Escherichia coli*, *Klebsiella pneumoniae* et *Pseudomonas aeruginosa*.
 - Remplir trois récipients stériles avec 100 ml d'eau stérile, non tamponnée et sans oxydant puis inoculer les récipients avec une anse stérile avec des souches ATCC⁶, *Escherichia coli* ATCC 25922/ WDCM 00013 ou ATCC 11775/ WDCM 00090, *Klebsiella variicola*⁴ ATCC 31488/ WDCM 00206 et *Pseudomonas aeruginosa* ATCC 10145/ WDCM 00024 ou ATCC 27853.
- Suivre la procédure P/A ou la procédure de numération Quanti-Tray ci-dessus.
- Les résultats doivent correspondre aux résultats du tableau d'interprétation ci-dessus.

REMARQUE: les tests de contrôle qualité internes d>IDEXX sont effectués conformément à la norme ISO 11133:2014. Les certificats de contrôle qualité sont disponibles à l'adresse idexx.fr/water.

1. Comparateur P/A IDEXX, réf. n° WP104 ; Comparateur Quanti-Tray n° WQTC ou Quanti-Tray/2000 Comparateur n° WQ2K2C.
2. Eaton, AD, Clesceri, LS, Greenberg, AE, Rice, EN. *Standard Methods for the Examination of Water and Wastewater* (Méthodes traditionnelles d'analyses de l'eau et des eaux usées), American Public Health Association, 2005. Washington, DC.
3. Coliforme et *E. coli* d>IDEXX-QC - Catalogue IDEXX n° UN3373-WQC-TCEC
4. Cultures Quanti-Cult - IDEXX réf. n° WKIT-1001
5. American Type Culture Collection 1-800-638-6597 atcc.org
6. *Klebsiella pneumoniae* (ATCC 31488 / WDCM 00206) a été renommé *Klebsiella variicola*.

* Colilert, Defined Substrate Technology, DST et Quanti-Tray sont des marques de fabrique ou des marques déposées d>IDEXX Laboratories, Inc. ou ses filiales aux États-Unis et/ou dans d'autres pays. Quanti-Cult est une marque de fabrique ou des marques déposée de Remel Inc.

Information sur les brevets: idexx.com/patents.

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Kit di analisi Colilert*

Introduzione

Colilert* rileva simultaneamente i coliformi totali e l'*E. coli* nell'acqua. Si basa su una tecnologia di substrato definito (DST* o Defined Substrate Technology) di cui IDEXX* e' proprietaria del brevetto. Quando i coliformi totali metabolizzano l'indicatore di nutrienti del Colilert, ONPG, il campione diventa giallo. Quando l'*E.coli* metabolizza il nutriente-indicatore MUG, il campione presenta anche fluorescenza. Il Colilert è in grado di rilevare simultaneamente questi batteri in concentrazioni di 1 cfu/100 ml entro 24 ore anche se sono presenti addirittura 2 milioni di batteri eterotrofici per 100 ml.

Conservazione

Conservare a 2–30°C lontano dalla luce.

Procedura Relativa a Presenza/Assenza (P/A)

- Unire il contenuto di un pacchetto ad un campione da 100 ml in un a provetta sterile, trasparente e non fluorescente.
- Incappucciare la provetta ed agitarla.
- Incubare a 35±0,5°C per 24 ore.
- Leggere i risultati secondo la tabella di Interpretazione dei risultati qui sotto.

Procedura di Enumerazione Quanti-Tray*

- Unire il contenuto di un pacchetto ad un campione di acqua da 100 ml in una provetta sterile.
- Chiudere la provetta e agitarla fino a dissoluzione.
- Versare la miscela campione/reagente in un vassoietto Quanti-Tray* o Quanti-Tray*/2000 e sigillarlo in un IDEXX Quanti-Tray* Sealer.
- Mettere il vassoietto sigillato in un'incubatrice a 35°C±0,5°C per 24 ore.
- Leggere i risultati secondo la tabella di Interpretazione dei risultati qui sotto.
Contare il numero di pozzetti positivi e consultare la tabella MPN fornita insieme ai vassoietti per ottenere il numero più probabile.

Interpretazione dei Risultati

Aspetto	Risultato
Meno giallo rispetto al colore di confronto¹	Negativo per coliformi totali ed <i>E. coli</i>
Giallo uguale o più intenso rispetto al colore di confronto	Positivo per coliformi totali
Giallo e fluorescenza uguali o più intensi rispetto al colore di confronto	Positivo per <i>E. coli</i>

- Individuare la fluorescenza con una luce a raggi ultravioletti da 6 watt, 365 nm, entro circa 13 cm dal campione, in ambiente buio. Dirigere la luce verso il campione, in direzione opposta ai propri occhi.
- I risultati di Colilert devono essere letti dopo 24 ore di incubazione.
- Tuttavia, se i risultati sono ambigui per l'analista sulla base della lettura iniziale, incubare fino a quattro ore in più (non superando tuttavia 28 ore in totale) in modo da consentire l'intensificarsi del colore e/o della fluorescenza.
- Sono validi anche i positivi sia per i coliformi totali sia per *E. coli* osservati prima di 24 ore e i negativi osservati dopo 28 ore.
- Inoltre, i laboratori possono incubare i campioni per un periodo aggiuntivo (fino a 28 ore in totale) per loro comodità.

Note Sulla Procedura

- Questo inserto informativo potrebbe non riflettere le normative locali. Per i test sulla conformità, assicurarsi di seguire le procedure normative corrispondenti. Ad esempio, i campioni trattati in altri Paesi vengono incubati a 36±2°C per 24–28 ore.
- Il Colilert si può eseguire in qualsiasi formato a provetta multipla. I metodi standard per l'esame delle tabelle MPN dell'acqua e delle acque di scarico² vanno usati per ottenere i Numeri Più Probabili (MPN).
- Se un campione di acqua dovesse presentare della colorazione di sfondo, confrontare il campione Colilert inoculato con controllo vuoto dello stesso campione di acqua.
- Se il prodotto viene diluito, moltiplicare il valore MPN per il fattore di diluizione per ottenere la quantità giusta.
- Per le diluizioni usare solo acqua sterile, non tamponata, priva di ossidanti.
- Il Colilert è un test primario per l'acqua. Le caratteristiche di prestazione del Colilert non sono applicabili a campioni alterati da qualsiasi pre-arricchimento o da concentrazione.
- In campioni con cloro eccessivo, quando si aggiunge il Colilert si potrebbe vedere un lampo azzurro. In questo caso, considerare il campione non valido e interrompere l'analisi.
- Quando si usa il Colilert va sempre seguita la tecnica asettica. Eliminare secondo le buone pratiche di laboratorio.

Procedure di Controllo della Qualità

- Per ciascun lotto di Colilert si consiglia una delle seguenti procedure di controllo della qualità:
 - Coliformi ed *E.coli*³ IDEXX-QC: *Escherichia coli*, *Klebsiella variicola*⁴ e *Pseudomonas aeruginosa*.
 - Quant-i-Cult** *Escherichia coli*, *Klebsiella pneumoniae* e *Pseudomonas aeruginosa*.
 - Riempire tre contenitori sterili con 100 ml di acqua sterile non tamponata e senza ossidanti e inoculare con un'ansa sterile di ceppi ATCC⁵, *Escherichia coli* ATCC 25922/ WDCM 00013 o ATCC 11775/ WDCM 00090, *Klebsiella variicola*⁴ ATCC 31488/ WDCM 00206 e *Pseudomonas aeruginosa* ATCC 10145/ WDCM 00024 o ATCC 27853.
- Seguire la procedura P/A o la procedura di enumerazione Quanti-Tray descritte sopra.
- I risultati devono corrispondere a quelli della tabella di Interpretazione dei risultati indicata sopra.

NOTA: i test di controllo di qualità interni IDEXX sono condotti in conformità con ISO 11133:2014. I certificati di controllo qualità sono disponibili sul sito idexx.it/water.



1. Comparatore P/A IDEXX, codice di catalogo WP104; Comparatore Quanti-Tray N. WOTC o Quanti-Tray/2000 Comparatore N. WOT2KC
2. Eaton, AD, Clesceri, LS, Greenberg, AE, Rice, EN. *Standard Methods for the Examination of Water and Wastewater*. American Public Health Association, 2005. Washington, DC.
3. Coliformi ed *E.coli* IDEXX-QC - Catalogo IDEXX N. UN3373-WQC-TCEC
4. Colture Quant-i-Cult N. di catalogo IDEXX WKIT-1001
5. American Type Culture Collection 1-800-638-6597
⁴. *Klebsiella pneumoniae* (ATCC 31488 / WDCM 00206) è stato rinominato in *Klebsiella variicola*

*Colilert, Defined Substrate Technology, DST e Quanti-Tray sono marchi di proprietà di, e/o registrati da, IDEXX Laboratories, Inc. o di suoi associate e protetti negli Stati Uniti e/o in altri paesi.
Quant-i-Cult è un marchio di proprietà di, e/o registrato da, Remel Inc.
Informazioni sui brevetti: idexx.com/patents.

Colilert* Testkit

Einführung

Colilert* ist zum gleichzeitigen Nachweis von Gesamtcoliformen und *E. coli* im Wasser bestimmt. Es basiert auf der gesetzlich geschützten Defined Substrate Technology* (DST*) von IDEXX. Wenn die Gesamtcoliformen den Nährstoff-Indikator ONPG von Colilert metabolisieren, verfärbt sich die Probe gelb. Wenn *E. coli* den Nährstoffindikator MUG verstoffwechselt, fluoresziert die Probe. Colilert kann diese Bakterien gleichzeitig im Bereich von 1 CFU/100 ml innerhalb von 24 Stunden nachweisen, selbst wenn 2 Mio. heterotrophe Bakterien pro 100 ml vorhanden sind.

Lagerung

Bei 2–30°C und nicht im Licht lagern.

Presence/Absence (P/A) Test

- Den Inhalt einer Packung zu einer 100 ml Probe in einem sterilen, transparenten, nicht fluoreszierenden Gefäß hinzugeben.
- Das Gefäß verschließen und schütteln.
- Für den verbleibenden 24-Stunden-Zeitraum bei 35 ± 0,5°C inkubieren.
- Die Ergebnisse gemäß der nachstehenden Ergebnisauswerte-Tabelle ablesen.

Quanti-Tray* Auszähl-Methode

- Den Inhalt einer Packung zu einer 100 ml Wasserprobe in einem sterilen Gefäß hinzugeben.
- Das Gefäß verschließen und so lange schütteln, bis der Inhalt aufgelöst ist.
- Die aus Probe und Reagenz bestehende Mischung in ein Quanti-Tray oder Quanti-Tray/2000 gießen und in einem IDEXX Quanti-Tray Sealer fest verschließen.
- Das verschlossene Tray 24 Stunden in einen Inkubator im Temperaturbereich von 35 ± 0,5°C inkubieren.
- Die Ergebnisse anhand der nachstehenden Ergebnisauswerte-Tabelle ablesen. Die Anzahl der positiven Vertiefungen zählen und die wahrscheinlichste Zahl (MPN; Most Probable Number) anhand der MPN-Tabelle, die den Trays beiliegt, ermitteln.

Ergebnisauswertung

Aussehen der Probe	Mögliche Ergebnisse
Geringere Gelbfärbung als der Comparator ¹	Negativ für Gesamtcoliforme und <i>E. coli</i>
Gleiche oder stärkere Gelbfärbung als der Comparator	Positiv für Gesamtcoliforme
Gelbfärbung und Fluoreszenz gleich oder stärker als die des Comparators	Positiv für <i>E. coli</i>

- Prüfung auf Fluoreszenz mit einer 6-Watt, 365 nm UV-Lampe aus einem Abstand von 13 cm in einer dunklen Umgebung. Dabei die Lampe nur auf die Probe, nicht auf die Augen, richten.
- Colilert-Ergebnisse sollten nach einer Inkubationszeit von 24 Stunden abgelesen werden.
- Wenn die Ergebnisse jedoch nach der ersten Ablesung nicht eindeutig sind, nochmals bis zu vier Stunden (insgesamt jedoch nicht länger als 28 Stunden) inkubieren, um die Intensivierung der Farbe und/oder Fluoreszenz zu ermöglichen.
- Positive Ergebnisse für Gesamtcoliforme und *E. coli*, die vor Ablauf von 24 Stunden und negative Ergebnisse, die nach Ablauf von 28 Stunden beobachtet werden, sind ebenfalls gültig.
- Darüber hinaus können Labors die Proben aus praktischen Gründen auch länger (insgesamt bis zu 28 Stunden) inkubieren.

Verfahrenshinweise

- Diese Packungsbeilage entspricht unter Umständen nicht Ihren örtlichen Bestimmungen. Bei Konformitätsprüfungen unbedingt die entsprechenden aufsichtsbehördlichen Verfahren anwenden. In anderen Ländern werden zum Beispiel zu untersuchende Proben 24–28 Stunden bei 36 ± 2°C inkubiert.
- Das Colilert Verfahren kann in jedem Multiple-Tube-Format durchgeführt werden. Zur Ermittlung der MPNs (wahrscheinlichste Zahlen) sollten MPN-Tabellen für Standardverfahren zur Untersuchung von Wasser und Abwasser² verwendet werden.
- Wenn eine Wasserprobe etwas Hintergrundfarbe aufweist, ist die inokulierte Colilert Probe mit einer Kontrollprobe derselben Wasserprobe zu vergleichen.
- Bei Probenverdünnungen den MPN-Wert mit dem Verdünnungsfaktor multiplizieren, um das korrekte quantitative Ergebnis zu erhalten.
- Nur steriles, nicht gepuffertes, keine Oxidantien enthaltendes Wasser zur Verdünnung verwenden.
- Colilert ist ein primärer Wassertest. Die Leistungsmerkmale von Colilert gelten nicht für Proben, die durch Voranreicherung oder Konzentration modifiziert wurden.
- In Proben mit übermäßigem Chlorgehalt wird bei der Zugabe von Colilert u.U. ein blaues Aufleuchten beobachtet. In diesem Fall ist die Probe als ungültig zu betrachten und der Test abzubrechen.
- Bei der Verwendung von Colilert ist ein aseptisches Vorgehen vorgeschrieben. Entsorgung gemäß Standard-Laborpraktiken.

Qualitätskontrollverfahren

- Eines der folgenden Qualitätskontrollverfahren wird für jede Colilert-Charge empfohlen:
 - IDEXX-QC Coliforme und *E. coli* ³: *Escherichia coli*, *Klebsiella variicola*⁴ und *Pseudomonas aeruginosa*.
 - Quanti-Cult*⁵ *Escherichia coli*, *Klebsiella pneumoniae* und *Pseudomonas aeruginosa*.
 - Drei sterile Gefäße mit 100 ml sterilem, ungepuffertem, oxidationsfreiem Wasser füllen und mit einer sterilen Öse ATCC⁵-Stämme, *Escherichia coli* ATCC 25922/ WDCM 00013 oder ATCC 11775/ WDCM 00090, *Klebsiella variicola*⁴ ATCC 31488/ WDCM 00206 und *Pseudomonas aeruginosa* ATCC 10145/ WDCM 00024 oder ATCC 27853 inokulieren.
- Das oben beschriebene P/A-Verfahren oder das Quanti-Tray Auszählverfahren befolgen.
- Die Ergebnisse sollten mit der Ergebnisauswerte-Tabelle oben übereinstimmen.

HINWEIS: Die internen Qualitätskontrollprüfungen von IDEXX werden im Einklang mit ISO 11133:2014 durchgeführt. Qualitätskontrollzertifikate sind unter idexx.de/water erhältlich.

1. IDEXX P/A Comparator, Best.-Nr. WP104; Quanti-Tray Comparator WOTC oder Quanti-Tray/2000 Comparator WOT2KC
2. Eaton, AD, Clesceri, LS, Greenberg, AE, Rice, EN. *Standard Methods for the Examination of Water and Wastewater* (Standardverfahren für die Wasser- und Abwasseruntersuchung). American Public Health Association, 2005. Washington, DC, USA.
3. IDEXX-QC Coliform und *E. coli* - IDEXX Bestellnr. UN3373-WOC-TCEC
4. Quanti-Cult Kulturen - IDEXX Best.-Nr. WKIT-1001
5. American Type Culture Collection 1-800-638-6597
4. *Klebsiella pneumoniae* (ATCC 31488 / WDCM 00206) wurde *Klebsiella variicola* umbenannt

* Colilert, Defined Substrate Technology, DST und Quanti-Tray sind Schutzmarken oder eingetragene Schutzmarken von IDEXX Laboratories, Inc. oder eines Tochterunternehmens von IDEXX in den Vereinigten Staaten und/oder anderen Ländern. Quanti-Cult ist ein Schutzmarken oder eine eingetragene Schutzmarken von Remel Inc.

Patentinformation: idexx.com/patents.

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Kit de análisis Colilert*

Introducción

Colilert® detecta simultáneamente los coliformes totales y *E. coli* en el agua. Se basa en Defined Substrate Technology® (Tecnología de sustrato definido [DST®]), patentada por IDEXX. Cuando los coliformes totales metabolizan el indicador ONPG de nutrientes de Colilert, la muestra toma una coloración amarilla. Cuando *E. coli* metaboliza el indicador MUG de nutrientes de Colilert, la muestra además fluoresce. Colilert puede detectar simultáneamente estas bacterias a una concentración de 1 ufc/100 ml dentro de las 24 horas, hasta en presencia de 2 millones de bacterias heterótrofas por cada 100 ml.

Almacenamiento

Almacenar a temperatura de 2–30°C, alejado de la luz.

Procedimiento de Presencia/Ausencia (P/A)

- Añadir el contenido de una dosis a una muestra de 100 ml en un recipiente estéril transparente, no fluorescente.
- Tapar y agitar el recipiente.
- Incubar a 35±0,5°C durante 24 horas.
- Leer los resultados de acuerdo con el cuadro de interpretación de resultados, más abajo.

Procedimiento de Enumeración Quanti-Tray®

- Añadir el contenido de un paquete a una muestra de 100 ml de agua, en un recipiente estéril.
- Tapar y agitar el recipiente hasta disolver.
- Verter la mezcla de muestra/reactivo en una Quanti-Tray® o una Quanti-Tray®/2000 y sellar en un IDEXX Quanti-Tray® Sealer.
- Colocar la bandeja sellada en una incubadora a 35±0,5°C durante 24 horas.
- Leer los resultados de acuerdo con el cuadro de interpretación de resultados, más abajo. Contar el número de pocillos positivos y referirse al cuadro NMP proporcionado con las bandejas para obtener el número más probable.

Interpretación de resultados

Aspecto	Resultado
Menos amarillo que el comparador ¹	Negativo para coliformes totales y <i>E. coli</i>
Amarillo igual o mayor que el del comparador	Positivo para coliformes totales
Amarillo y fluorescencia iguales o mayores que los del comparador	Positivo para <i>E. coli</i>

- Buscar fluorescencia usando una luz UV de 6 vatios, 365 nm a distancia de unas 5 pulgadas (13 cm) de la muestra, en un entorno oscuro. Apuntar el haz de luz en dirección contraria a los ojos y hacia la muestra.
- Los resultados de Colilert se deben leer a las 24 horas de incubación.
- Es posible *prolongar* el tiempo de lectura 4 horas mas, hasta las 28 horas, para que en raro pero posible caso de duda el color o la fluorescencia se intensifiquen.
- Los resultados positivos para coliformes totales y *E. coli* antes de las 24 horas y negativos tras 28 horas también son válidos.
- Asimismo, los laboratorios pueden incubar muestras (hasta 28 horas en total) si lo desean, para mayor comodidad.

Notas sobre el procedimiento

- Este prospecto tal vez no refleje sus reglamentaciones locales. Para probar el cumplimiento, asegurarse de seguir los procedimientos reglamentarios apropiados. Por ejemplo, las muestras realizadas en otros países se incuban a 36±2°C durante 24 a 28 horas.
- Colilert puede procesarse en cualquier formato de múltiples tubos. Deben usarse los Standard Methods for Examination of Water y las tablas NMP de aguas residuales² para encontrar los números más probables (NMP).
- Si la muestra de agua tiene un cierto color de fondo, comparar la muestra inoculada de Colilert con un blanco testigo de la misma muestra de agua.
- Si se hacen diluciones de muestra, multiplicar el valor NMP por el factor de dilución para obtener el resultado cuantitativo apropiado.
- Usar solamente agua estéril, no tamponada, libre de oxidantes, para efectuar las diluciones.
- Colilert es una prueba primordialmente del agua. Las características de rendimiento de Colilert no se aplican a muestras alteradas por enriquecimiento o concentración previos.
- En el caso de muestras con un exceso de cloro, tal vez se observe un destello azul al añadir Colilert. Si se observa, considerar que la muestra no es válida y suspender la prueba.
- Siempre debe utilizarse una técnica aséptica cuando se use Colilert. Desechar en cumplimiento con las Buenas Prácticas de Laboratorio.

Procedimientos de control de calidad

- Se recomienda uno de los siguientes procedimientos de control de calidad para cada lote de Colilert:
 - A. IDEXX-QC Coliform and *E.coli*®: *Escherichia coli*, *Klebsiella variicola*³ y *Pseudomonas aeruginosa*.
 - B. Quanti-Cult® *Escherichia coli*, *Klebsiella pneumoniae* y *Pseudomonas aeruginosa*.
 - C. Llene tres recipientes estériles con 100 ml de agua estéril, libre de oxidantes, no tamponada e inocule con un asa estéril de cepas ATCC®: *Escherichia coli* ATCC 25922/ WDCM 00013 o ATCC 11775/ WDCM 00090, *Klebsiella variicola*⁴ ATCC 31488/ WDCM 00206 y *Pseudomonas aeruginosa* ATCC 10145/ WDCM 00024 o ATCC 27853.
- Seguir el procedimiento P/A o el procedimiento de enumeración Quanti-Tray mencionado anteriormente.
- Los resultados deben corresponder a los del Cuadro de Interpretación de resultados, más arriba.

NOTA: Las pruebas de control de calidad interna de IDEXX se realizan según ISO 11133:2014. Los certificados de control de calidad se encuentran disponibles en idexx.es/water.



1. IDEXX, Comparador P/A, N° de catálogo WP104; Comparador Quanti-Tray N° WQTC o Quanti-Tray/2000 Comparador N° WQ2KC
2. Eaton, AD, Clesceri, LS, Greenberg, AE, Rice, EN. *Standard Methods for the Examination of Water & Wastewater*, (Métodos estándares para el análisis del agua y las aguas residuales). American Public Health Association, (Asociación Americana de Salud Pública), 2005. Washington, D. C.
3. IDEXX-QC Coliform and *E. coli* — IDEXX Catalog #UN3373-WQC-TCEC
4. Cultivos Quanti-Cult — N° de catálogo IDEXX WKIT-1001
5. American Type Culture Collection 1-800-638-6597
6. *Klebsiella pneumoniae* (ATCC 31488 / 00206 WDCM) se ha renombrado como *Klebsiella variicola*
* Colilert, Defined Substrate Technology, DST y Quanti-Tray son marcas o marcas registradas de IDEXX Laboratories, Inc. o sus filiales en los Estados Unidos de América y/o en otros países. Quanti-Cult es una marca o una marca registrada de Remel Inc.
Información sobre la patente: idexx.com/patents.
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Colilert* (コリラート) 検査キット

はじめに

Colilert®はIDEXXが知的財産権を持つDefined Substrate Technology® (DST®) (特定酵素基質法)を用いて、水中の大腸菌群と大腸菌を同時に検出します。大腸菌群が、コリラートに含まれる栄養指標のONPGを代謝することにより、検水は黄色に変色します。さらに、大腸菌がもう1つの栄養指標であるMUGを代謝すると、検水は蛍光を呈します。コリラートは、100mL当たり最大200万個の従属栄養細菌の存在下においても、24時間以内に1cfu/100mLの感度で対象細菌を検出することができます。

保管

直射日光を避け、2〜30℃で保管してください。

定性検査手順手順

- スナップパック1つの中身を、滅菌済みの透明な蛍光を発しない容器に入った100mLの検水に加えてください。
- 容器の蓋を締め、振ってください。
- 36±1℃で、24時間培養してください。
- 以下の結果判定表に従って、結果判定してください。



Quanti-Tray® 定量検査手順

- スナップパック1つの中身を、滅菌済み容器に入った100mLの検水に加えてください。
- 容器の蓋を閉め溶けるまで静かに振ってください。
- Quanti-Tray/2000に検水/コリラート混合液を注ぎ、シーラーで密封してください。
- 密封されたトレイを36±1℃で24時間培養してください。
- 以下の結果判定表に従って、結果を判定してください。陽性ウェルの数を数え、専用MPN表を参照して、最確数を求めてください。

結果判定

培養液の状態	結果
比色管*より薄い黄色 ¹	大腸菌群および大腸菌陰性
比色管*と同等か、またはそれより濃い黄色	大腸菌群陽性
比色管*と同等か、またはそれより濃い黄色および蛍光	大腸菌陽性

- 暗所で6W・365nmのUVランプから13cm以内に検水を置き、判定してください。光は目に向けないようにし、検水に向けてください。
- コリラートの結果は培養開始から24時間後に判定してください。
- 但し、初回の判定において結果があいまいな場合には、さらに最長4時間（総時間数が28時間を超えないように）培養を継続し、再判定を行ってください。
- 24時間以内に大腸菌群および大腸菌が共に陽性となった場合、または28時間以降も共に陰性であった場合、これらの判定は有効です。
- また、検査の便宜上、検水の培養時間を延長（総培養時間28時間まで）することも可能です。

操作上の注意

- 本説明書の内容は該当する地域の法律・条例に適合していない場合があります。法律・条例に準拠した検査を行うために、必ず適切な規制手順に従ってください。例えば、他の国で検査を行う際は、36±2℃で24〜28時間培養する必要があります。
- コリラートは、5本法などの最確数法でも実施できます。最確数は最確数表(MPN表)を使用して求めてください。
- 検水に何らかの着色がある場合、同じ検水を用いたブランクと比較してください。
- 検水を希釈した場合、MPN値に希釈倍数を掛けて、適切な定量結果を求めてください。
- 希釈には、緩衝液や酸化物質の入っていない、滅菌された水だけを使用してください。
- コリラートは、水の一次検査です。コリラートの性能特性として、増菌培地で培養または濃縮によって変質した検水に使用できません。
- 塩素を過剰に含む検水では、コリラートを加えると、青色を呈することがあります。この場合、検査は無効ですので検査を中止してください。
- コリラートを使用する際は、常に無菌操作を行ってください。結果判定後の検水と容器はGLPIに従って、廃棄してください。

品質管理手順

- コリラートを使用する場合、ロット毎に次の品質管理手順のいずれかを行うことをお勧めします。
 - IDEXX-QC大腸菌群および大腸菌³: 大腸菌、*Klebsiella variicola*⁴、*Pseudomonas aeruginosa* (緑膿菌)
 - Quanti-Cult⁵: *Escherichia coli* (大腸菌)、*Klebsiella pneumoniae* (肺炎桿菌)、*Pseudomonas aeruginosa* (緑膿菌)
 - 滅菌容器3本に、それぞれ緩衝剤や酸化剤の入っていない滅菌水100 mLを入れ、大腸菌ATCC 25922/WDCM 00013またはATCC 11775/WDCM 00090、*Klebsiella variicola*⁴ ATCC 31488/WDCM 00206、および *Pseudomonas aeruginosa* ATCC 10145/ WDCM 00024または27853 ATCC⁶菌株を、滅菌ループを用いて接種してください。
- 上記の定性検査手順またはQuanti-Tray定量検査手順に従ってください。
- 結果が上の結果判定表と一致することを確認してください。

注: IDEXXの社内品質管理検査は、ISO 11133:2014に準拠して行われます。成績証明証 (品質管理認証) は idexx.co.jp/water にて利用可能です。

1. IDEXX P/A 比色管、カタログ # WP104、または Quanti-Tray/2000比色トレイ # W072KC

2. Eaton, AD, Clesceri, LS, Greenberg, AE, Rice, EN. *Standard Methods for the Examination of Water and Wastewater*. American Public Health Association, 2005. Washington, DC.

3. IDEXX-QC大腸菌群および大腸菌- IDEXX カタログ番号UN3373-WQC-TCEC

4. Quanti-Cult - IDEXX カタログ # WKIT-1001

5. American Type Culture Collection 1-800-638-6597

6. *Klebsiella pneumoniae* (ATCC 31488/WDCM 00206) は*Klebsiella variicola*へと菌種名の変更が行われました。

* Colilert Defined Substrate Technology, DST、およびQuanti-Trayは、米国および他国のIDEXX Laboratories, Inc. またはその関連会社の、商標または登録商標です。

Quanti-Cult は、Remel Inc. の商標です。

特許情報 : idexx.com/patents

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IDEXX Water Quality Control Laboratory is accredited to ISO/IEC 17025:2005

Reference for Water Discharge- SonTek Flow Tracker

Version 1.00

The reference document provides step by step instructions for using the SonTek Flowtracker to take discharge in wadeable streams, following SOP#07.

Operating manuals for SonTek Flowtracker are located at [V:\Global_SOPs\Water_Discharge\Flowtracker](V:\Global_SOPs\Water_Discharge\Flowtracker).

SonTek Flowtracker Procedure

Setup Flowtracker

- Turn on Flowtracker
- Verify the date and time displayed are correct (keep in Arizona Mountain Standard Time)
- 'Enter' for Main Menu
- In '2 System Functions', check battery power under '5 Battery Data', if battery power is less than 60%, switch batteries before starting.
- In Main Menu Press '3 Start Data Run'
- Enter 'Name' using park code followed by date mmdd (i.e. MOWE1018) and press '9 Accept Name'
- Enter 'Operator' (your last name) and press '9 Accept Name'
- Follow screen instructions to run the automatic quality check test
- If test fails, clean the sensor, then try again, if test passes, press 'Enter'

Input starting edge information

- Press 8 ('QC Menu') to enter water height from gauge if available.
- Press 4 ('LEW/REW') to reflect your starting edge (LEW is river left).
- Enter the tagline distance of the water's edge using 'Set Location'.
- Enter the water depth at the water's edge (usually '0') using Set Depth.
- Press 2 ('Next Station') to continue.

Taking a measurement (repeat at each station)

- Place pole at next observation point location
- Press 'Set Location' to enter tagline location
- Check water depth on pole and press 'Set Depth' to enter depth location
- Move the top setting wading rod to reflect depth, which automatically puts the probe at the 0.6 depth.
- Verify that the pole is level and perpendicular to tagline
- Press 'Measure' and hold Flowtracker still for 40 seconds

Taking a measurement when depth is >1.5ft

- Press 9 ('Method') to switch from 0.6 depth method to 0.2 and 0.8 Method
- The screen will prompt you first for either the 0.2 or the 0.8 depth
- For the 0.2 depth move the top setting wading rod to reflect twice the actual depth and press 'Measure'
- For the 0.8 depth move the top setting wading rod to reflect half the actual depth and press 'Measure'

Accept/Reject Measurement

- If QC flags occur, you will be notified.
- Large SNR Variation –move obstacles or move a few tenths of a foot away and retry.
- High angle- consider if measured angle is realistic and repeat measurement if necessary.
- Bad Boundary QC- move obstacles or move a few tenths of a foot away and retry.
- High %Q- add more stations.
- To repeat a measurement, 'Reject' the previous measurement and you will be returned to the station measurement screen; reenter location and depth and try again
- If there are no flags or you do not want to repeat a measurement, press 1 ('Accept')

After final measurement

- When you have completed all measurements, press – ('End Section')
- You will be asked to review any QC flags and sections that have >10% of total discharge.
- To add another measurement station use the standard method, if you are skipping around you will be asked to verify location.
- Confirm 'End Section'
- Press 8 ('QC Menu') to enter water height from gauge if available
- Enter tagline location and depth (usually '0')
- Press 'Calculate Discharge'
- After viewing summary results press '0' to exit to the Main Menu to the main menu, which saves the data.
- Turn off Flowtracker.

Downloading Flowtracker data in office

- Create folder under correct water year for park_date_discharge (i.e. MOWE_20101018_discharge)
- Connect Flowtracker to computer and open SonTek FlowTracker software
- Click "Connect to a Flowtracker" on left panel
- Select Serial port
- Click "Recorder" icon on left panel
- Select files and destination folder, and click ok
- Once files have been downloaded successfully, click "Format" to erase ALL data on storage card.

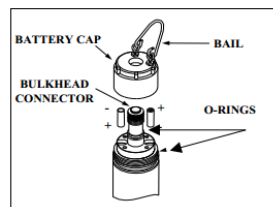
- Change name of downloaded file to full descriptive name, including date.

How to use a Sonde

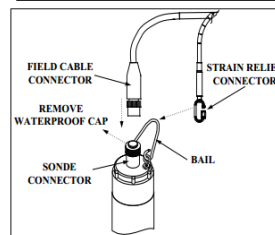
Before Data Collection:

1. Initial Setup

- a. Place 4 completely charged AA batteries into the probe



- b. Connect probe to monitor and turn on.



2. Calibrate to pH

- a. Rinse probes with the pH 7 buffer (yellow) - Pour a small amount of buffer into the plastic storage tube (fill about 1"), screw into place and tilt back and forth. Dump the solution and repeat two more times.
- b. Fill tube with pH 7 buffer so that the pH probe (light grey with glass bulb on end) is immersed.
- c. On monitor 650 main menu, navigate to "Sonde Run" and record temperature
- d. Press "esc" to return to main menu. Monitor will say "disconnecting"
- e. On main menu, navigate to: "Sonde Menu" > "Calibrate" > "Ise1 pH" > "2 point"
- f. Use the pH table included with the buffer and current temperature to input the pH
- g. Wait for the pH on the screen to remain stable or within a couple hundredths variation
- h. Record the theoretical pH, Buffer lot No, Expiration date of buffer, temperature and reading
- i. Select "calibrate" by pressing enter.
- j. Record the new temperature and pH.
- k. Select "continue" by pressing enter again
- l. Rinse the probe 3 times with the pH 10 (blue) buffer and repeat steps b-k
- m. After calibrating, the monitor will return to the pH calibration menu. Press "esc" to return to the calibrate menu

3. Calibrate the specific conductance

- a. Rinse probe with the specific conductance 1.413 mS/cm buffer three times.

- b. Fill tube with the buffer so that the specific conductance probe (light grey with protruding end) is completely immersed past the hole on the side – probe can be turned upside down to use less buffer solution.
- c. On calibrate menu, navigate to: “conductivity” > “spCond”
- d. The SpCond of 1.413 should already be inputted. Verify and press “enter”
- e. Wait for the SpCond on the screen to remain stable or within a couple hundredths variation
- f. Record the mS/cm, Buffer lot No, Expiration date of buffer, temperature and reading
- g. Select “calibrate” by pressing enter.
- h. Record the new temperature and mS/cm.
- i. Select “continue” by pressing enter again
- j. After calibrating, the monitor will return to the “Cond calibration” menu. Press “esc” to return to the calibrate menu
- k. Press “esc” three more times to disconnect device.
- l. Rinse tube with the specific conductance 200 mS/cm buffer three times.
- m. Select “Sonde run” from the main menu
- n. Record the mS/cm, Buffer lot No, Expiration date of buffer, temperature and reading.

4. Calibrate the Dissolved Oxygen

- a. Rinse probes with water and place a small amount at bottom of tube (a few mm). Screw tube on one turn so that the bottom of the probe is not touching the water – DO NOT fully screw on.
- b. On main menu, navigate to: “Sonde Menu” > “Calibrate” > “optic-T dissolved oxy” > “ODOSat %” > “1 point”
- c. The barometric pressure should already be inputted. Verify and press “enter”
- d. Wait for the ODO% on the screen to remain stable or within a couple hundredths variation
- e. Record the ODO%, Buffer lot No, Expiration date of buffer, temperature and reading
- f. Select “calibrate” by pressing enter.
- g. Record the new temperature and ODO%. (ODO % should range from 80-90%. If this is not the case, press “esc” and begin calibration again.)
- h. Select “continue” by pressing enter again.
- i. Press “esc” three times to return to the main menu (not the 650 main menu)

5. Verify Deployment Settings

- a. On the main menu, navigate to “run” > “unattended sample”
- b. Select “stop logging” and “yes” to stop logging

```
-----Unattended setup-----
1-Interval=00:15:00
2-Start date=07/17/96
3-Start time=18:00:00
4-Duration days=365
5-File=
6-Site=
7-Bat volts: 11.6
8-Bat life 25.1 days
9-Free mem 41.3 days
A-1st sample in 8.10 minutes
B-View params to log
C-Start logging
```

- c. Verify the interval is “00:15:00” and the date and time are correct
- d. Navigate to “file” and press enter to enter a new file name. Press enter again to finish.
- e. Navigate to “site” and enter the correct site name. Press enter again to finish
- f. Verify that the new batteries have enough life to support logging – should be approximately thirty days with new batteries.
- g. Verify that the first sample will occur shortly after probe will be placed in the water.
- h. Select “start logging” and “yes” to begin logging

6. Verify Logging status

- a. Press “esc” to return to the main menu
- b. Navigate to “status” and verify that Logging is Active. Press “esc” to disconnect probe.
- c. Place probe in water and begin data collection.

After Data Collection:

7. Upload data

- a. Connect probe to monitor.
- b. Navigate to “file” > “sonde menu” > “file” > “quick upload” > “PC6000” and upload
- c. “esc” out to “650 main menu”

8. Fouling check

- a. Place probe in water.
- b. Select “sonde run” and record temp, specific conductance, DO %, DO (mg/l) and pH.
- c. Take probe out and clean with water and q-tips to remove silt and debris. To clean the pH probe, fluff a q-tip and gently clean around bulb to prevent breakage. Use a bottle brush to clean the inside of the specific conductivity probe. Use a q-tip to wipe of debris from the optic oxygen sensor.
- d. Place probe back in water.
- e. Record temperature, specific conductance, DO %, DO (mg/l) and pH.
- f. Press “esc” to return to the 650 main menu

9. Calibrate for pH, specific conductance and dissolved oxygen drift

- a. Follow calibration steps 2-4 and record in the drift section of the data sheet
- b. Press “esc” (once more after step 4h) to return to the 650 main menu

10. Final Reading

- a. Place casing on probes and return to water
- b. Select “sonde run”
- c. Record temperature, specific conductance, DO %, DO (mg/l) and pH.
- d. Press “esc” to disconnect

Reference for Collecting Water Quality Core Parameters with YSI ProPlus

Version 0.001 DRAFT

The reference document provides step by step instructions for using the YSI ProPlus to take water quality core parameters, following SOP#X.

Operating manuals for the YSI ProPlus are located at
[V:\Global_SOPs\Water_Quality\YSI_ProPlus_Sonde](V:\Global_SOPs\Water_Quality\YSI_ProPlus_Sonde).

YSI ProPlus Calibration

- Calibrate probe directly before use. Place calibration fluid in mesh bag and place in stream water to bring calibration solution to stream water temp.

pH probe calibration

- Use a small amount of the pH 7 calibration standard (yellow colored) to rinse the probe and storage cup (the plastic cup that screws onto the probe).
- Fill the calibration cup 2/3 of the way with the pH 7 calibration standard.
- Carefully immerse the sensor end of the probe module into the solution.
- Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.
- Screw the storage cup on the threaded end of the probe module and tighten.
- Press **Power** to display the run screen.
- Press **Cal** to go to the calibration screen
- Use arrow keys to highlight **ISE1 (pH)** and press **Enter**. The pH Calibration screen is displayed.
- Use the arrow keys to highlight **Calibration value** and press **Enter**.
- On the Calibration Standard Value screen enter the correct value for the calibration stand you are using, 7.00 and on the second point 10.00.
- Highlight **Enter** and press **Enter** to return to the pH Calibration screen.
- Allow at least one minute for temperature equilibration before proceeding. The current value of pH will change with time as it stabilizes.
- Observe the pH actual reading. When the reading shows no significant change for approximately 30 seconds, highlight **Accept Calibration** and press **Enter**.
- Repeat steps 10-13 using the 10.00 pH calibration standard (blue colored).
- When finished with the 2-point calibration, press **Cal** to finish.
- Press **Cal** again.
- Rinse the probe module and sensors in tap or purified water and dry.

Conductivity probe calibration

- Use a small amount of the 1,413 $\mu\text{S}/\text{cm}$ calibration standard (clear colored) to rinse the probe and storage cup.
- Fill the calibration cup 2/3 of the way with the 1,413 $\mu\text{S}/\text{cm}$ calibration standard.
- Carefully immerse the sensor end of the probe module into the solution.
- Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.
- Screw the storage cup on the threaded end of the probe module and tighten.
- **Note:** The calibration standard should cover both the metal end of the probe and the circular indentation halfway up the sensor.
- Press **Cal** to go to the calibration screen
- Use arrow keys to highlight **Conductivity** and press **Enter**.
- Highlight **Sp. Conductance** and press **Enter**.
- Highlight **SPC-uS/cm** and press **Enter**. The Specific Conductance Calibration screen is displayed
- Use the arrow keys to highlight **Calibration value [x.xx]** and press **Enter**.
- Use the keypad to enter the calibration value of the standard being used, 1,413 $\mu\text{S}/\text{cm}$.
- Highlight **Enter** and press **Enter** to return to the Conductivity Calibration screen.
- Allow at least one minute for temperature equilibration before proceeding. The current value of specific conductance will change with time as it stabilizes.
- Observe the Specific Conductance actual reading. When the reading shows no significant change for approximately 30 seconds, highlight **Accept Calibration** and press **Enter**.
- Press **Cal** to finish.
- Press **Cal** again.
- Rinse the probe module and sensors in tap or purified water and dry.

Dissolved oxygen probe calibration

- Wet sponge in storage cup. If sponge is missing, place a small amount of clean water (1/8 inch) in the storage cup.
- Place the probe module into the storage cup.
- **NOTE:** Make sure the DO and temperature probes are **not** immersed in water.
- Screw the cup onto the probe, but only engage only 1 or 2 threads of the storage cup to ensure the DO sensor is vented to the atmosphere.
- Highlight **Barometer** and press **Enter** to adjust it if needed.
- Allow approximately ten minutes for the air in the storage cup to become water saturated and for the temperature to equilibrate before proceeding. The DO current value of all enabled sensors will appear on the screen and will change with time as it stabilizes.

- Observe the reading under DO %. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
- Press **Cal** to finish.
- Press **Cal** again.

Collection of Water Quality Core Parameters

- The YSI should be used while discharge is being taken

Setup

- Take calibration cup off probe
- Inspect probes and ensure that they are clean and the DO cap is intact
- Screw on flow cup
- Choose location in index reach with flowing water
- Put probes in water to begin equilibrating
- Turn YSI ProPlus on
- Ensure that date and time are correct
- Press the system button
- Highlight **Logging** and press **Enter**.
- Ensure that **Logging** is set on **Continuous Mode** with 15 sec intervals.
- Press **ESC** to return to run screen
- Highlight **Start Logging** and press **Enter**
- Highlight **Site** and press **Enter**
- Highlight correct park code and press **Enter**
- Highlight **Folder** and press **Enter**.
- Highlight **Add new...** and press **Enter**
- Enter name of file with parkmdd (i.e. MOCA1018)
- Highlight **Enter** and press **Enter**.
- Highlight **Start Now!** and press **Enter**.
- Allow the YSI to log data for at least 30 minutes.
- When you are finished highlight **Stop Logging** and press **Enter**.

View data

- Press **Folder**.
- Highlight **Folder List** and press **Enter**.
- Highlight folder of interest and press **Enter**.

Download data

- Connect the Communications Saddle to the back of the Pro Plus instrument and use the USB cable to connect the saddle to the USB port on the PC.
- Open Data Manager on the PC and turn on the Pro Plus.
- Under the **Select Instrument** heading, highlight on the correct instrument.

- Click the **Retrieve Instrument Data** tab and check **Data, GLP, Site List, Configuration** or **Select All** options to retrieve data and click **Start**.
- After the file transfer is complete, the data is available for viewing, printing, and exporting from Data Manger.
- Click the **View Saved File / Data** tab.
- Under **Select File Type**, highlight **Data**
- Under **Select Parameters** check **Barometer, Specific Conductance, Dissolved Oxygen, pH_1, Temperature** and **TDS**.
- Under **Setup** chose **Folder** you would like to view.
- Click **View Data**.
- On View PC Data screen, click **Export**.
- Export data as both a csv and txt file.
- Data should be saved in V:\Streams\Data_Nonspatial\Raw_Data under correct network, correct water year, and correct sampling event.
- Save both files with the name park_code_date_probe (i.e. MOCA_20100624_probe)

Delete data

- Once all data has been saved, delete data on the YSI
- Turn on YSI ProPlus
- Press **File**.
- Highlight **Delete Data** and press **Enter**.
- Highlight **Folder** and press **Enter**.
- Highlight correct folder and press **Enter**.
- Highlight **Delete Data** and press **Enter**.
- Highlight **Yes** and press **Enter**.

Downloading Data

- Connect the Communications Saddle to the back of the Pro Plus instrument and use the USB cable to connect the saddle to the USB port on the PC.
- Open Data Manager on the PC (V:\Streams\Resources\YSI Data Manager) and turn on the Pro Plus.
- Under the **Select Instrument** heading, highlight on the correct instrument.
- Click the **Retrieve Instrument Data** tab and check **Data, GLP, Site List, Configuration** or **Select All** options to retrieve data and click **Start**.
- After the file transfer is complete, the data is available for viewing, printing, and exporting from Data Manger.
- Click the **View Saved File / Data** tab.
- Under **Select File Type**, highlight **Data**
- Under **Select Parameters** check **Barometer, Specific Conductance, Dissolved Oxygen, pH_1, Temperature** and **TDS**.

- Under **Setup** chose **Folder** you would like to view.
- Click **View Data**.
- On View PC Data screen, click **Export**.
- Export data as both a csv and txt file.
- Select destination folder
- Save both files with the name park code_date_probe (i.e. MOCA_20100624_probe)

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #25: Macroinvertebrate Collection

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
0.10 (also named 1.0)	06/06/2007	D. Backer	Major Revisions	New field methods based on 2006 data & field review	0.20 (also called 1.1)
0.20 (also called 1.1)	07/12/2007	D. Backer	New SOP Template	Standard Formatting and modified procedures	0.21 (also called 1.2)
0.21	02/04/2008	J Balmat	Revised SOP template	Formatting only	0.22
0.22	09/2008	E. Gwilliam	Major revision	Removed and updated methods	0.004
0.004	10/2008	Gwilliam	Changed version # and made some minor changes to methods and text	Targeted riffles dropped from methods, integration of phys char into other SOP's	
0.004	04/2010	Gwilliam	Modified sampling locations	Added targeted riffles	0.005
0.005	03/2012	Raymond	Major revision	Removed and updated methods	0.006
		Palacios	Minor Edits		
0.002	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This Standard Operating Procedure explains the procedure for collecting quantitative and qualitative aquatic macroinvertebrate samples, labeling samples for lab processing, and completing the data sheet. It is adapted from Brasher et al. 2011.

The sampling methods used in this protocol are compatible with NAWQA (Moulton et al. 2002) and EMAP (Peck et al. 2006, Section 10) protocols for sampling macroinvertebrates. The invertebrate collection methods described here are intended to be comparable to the protocols being used by the Arizona, New Mexico, Oklahoma, Texas and Colorado agencies. See table 2-1 of Gwilliam et al. 2017.

Do not collect macroinvertebrate samples when the following conditions occur: bankfull flows within 4 weeks prior to the sample date; reach is greater than 50% bedrock; reach is ephemeral or intermittently flowing; or flow is too deep or fast ($> .5\text{m}$ & 50 cfs.) to safely wade.

In several SODN units there may be threats to human health if there is contact with the water. The SODN program will provide workers with adequate PPE and training to mitigate this threat. If the threat cannot be mitigated, the project manager may halt sampling.

1. Overview of Collection and Sampling Methods

- 1.1. Samples will be collected from twelve kick samples distributed across riffle habitat units (preferably three or four) in the sample reach (riffle quantitative sample).
- 1.2. Samples will be collected from all habitat unit types in sample reach (multi-habitat qualitative sample).
- 1.3. Physical characteristic data will be collected from each sampled riffle.

2. Mapping the Index Reach

- 2.1. Walk the entire index reach and map the location and relative size on grid paper. Stream habitats should be recorded as marsh/backwater, pool, glide, run, riffle, rapid, cascade or other. Attribute a number to each habitat, representing its place in the index reach, e.g., the first run you in the index reach is Run1, and the second run in the index reach is Run2, no matter how many other habitats are present between the two runs.
- 2.2. For the riffle quantitative sample identify 3-5 locations in riffle habitat across all available riffle habitat with similar physical characteristics: depth, velocity, substrate size and substrate embeddedness.
- 2.3. For the multi-habitat qualitative sample use the map to determine the amount of time each habitat should be sampled.
 - 2.3.1. Estimate the percent of total area that each habitat type occupies on your map. Calculate the number of minutes that will be spent on each habitat type. For example, if run habitat covers 30% of the index reach, then 30% of the 60 minutes, 18 minutes, should be spent sampling the areas with run habitat.
 - 2.3.2. Based on the sampling time calculated for each habitat type, assign a sampling duration to each individual habitat proportionate to its size.

3. Collecting the Riffle Quantitative Sample

Sampling will take place at 8-12 quadrats (0.09m^2) from 3-5 riffle unit. All quadrat samples will be combined into a single composite sample. The ideal is to collect three quadrat samples from four riffle units. Do not collect more than 3 samples from a single riffle unit. A minimum of 8 quadrats (a sampling area of 0.74m^2) is necessary to collect a riffle quantitative sample.

- 3.1. At each riffle unit identified during the mapping of the index reach, select sampling locations.

- 3.1.1. Exclude "margin" habitats by constraining the potential sampling area. Margin habitats are edges, along the channel margins or upstream or downstream edges of the riffle macrohabitat. Define a core area for each targeted riffle as the central portion, visually estimating a "buffer" strip between the core area and the marginal habitat.
- 3.1.2. At each riffle to be sampled, visually layout a 9 equal cell grid (3 x 3 cell) as the core area. The grid will vary in size because of the width of the channel and length of the riffle. Assign each cell a position as shown in Figure 1.

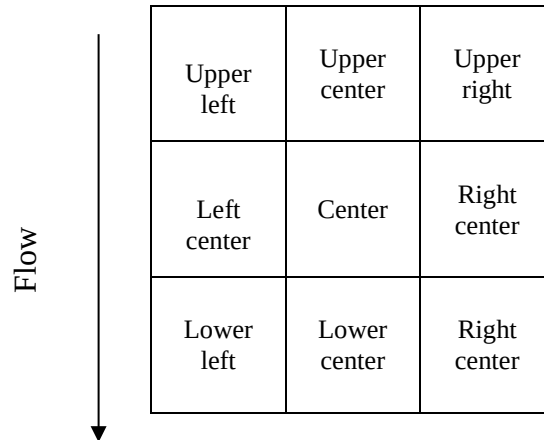


Figure 1. Layout of quadrats for sampling targeted riffles.

- 3.1.3. At each riffle to be sampled, randomly select 3 cell locations to collect a sample. If only 2 samples are being collected from a targeted riffle, randomly select 2 cell locations for sampling.
- 3.2. Begin sampling at the most downstream riffle unit. Sample units as they are encountered to minimize in stream disturbance.
- 3.3. Collect the kick sample in the center of the selected cell as described in Section 5 above. If a cell is located in water that is too deep or otherwise unsafe to wade, do not attempt to sample that location. Instead choose another cell, or sample a different riffle unit.
- 3.4. If there is too little water to collect the sample with the kick net, randomly pick up 10 rocks from the riffle and pick and wash the organisms off them into a bucket which is half full of water.
- 3.5. Retrieve the macroinvertebrates from the sample as outlined in Section 6.
- 3.6. Label the inside and the outside of the collection bottle with "National Park Service", "Sonoran Desert Network", Stream ID, Sample ID ("Riffle" or "Multi-habitat"), Date, and Sample Number
 - 3.6.1. Outer labels can be printed before tour using the macro label template.
 - 3.6.2. Inner labels should be written in pencil on a small square of write in the rain paper. The label can be placed on top of the sample.
 - 3.6.3. If multiple containers are necessary for an individual sample, indicate by ascending letters following the sample number. (ex: #6A, #6B, #6C)
 - 3.6.4. Full Label Example:
National Park Service - Sonoran Desert Network

Stream ID: GICL-West Fork Gila River
Sample ID: Riffle (NM Protocol)
Date: 10/05/2012 Sample#: 6A

4. Collecting the Multi-Habitat Qualitative Sample

- 4.1. Start sampling at the most downstream habitat in the index reach. Using a kick-net, sample the habitat for the number of minutes that you calculated. Sample all micro habitats within the larger habitat area. If a microhabitat is located in water that is too deep or otherwise unsafe to wade, do not attempt to sample that location.
 - 4.1.1. Collect kick-nets samples as described in Section 5.
 - 4.1.2. Sweep the kick-net through submerged and overhanging vegetation.
 - 4.1.3. Sweep net along the submerged portion of the banks
 - 4.1.4. Pick up woody debris and wash in the net, dislodging macroinvertebrates.
 - 4.1.5. Sweep net through the surface of the water and water column.
- 4.2. Remove macroinvertebrates from the net as necessary as described in Section 6. Do not include time taken to remove macroinvertebrates from the net in the sampling time. The 60 minutes only accounts for active sampling time.
- 4.3. Repeat this process at each habitat until sampling has been completed through the whole index reach over a period of 60 minutes.
- 4.4. Retrieve the macroinvertebrates from the sample as outlined above beginning at Section 7.
- 4.5. Label the inside and the outside of the collection bottle as noted in Section 3.6.4.

5. Collecting Kick-Net Samples

- 5.1. With the net opening facing upstream, position the net quickly and securely on the stream bottom to eliminate gaps under the frame. Avoid large rocks that prevent the sampler from sitting properly on the stream bottom. Avoid stepping in front of the net or having another disturbance upstream (within 10 – 20 meters). Avoid flow areas where current will pass over the top of the D net frame.
- 5.2. Holding the net in position on the substrate, visually define a square quadrat directly in front of the net opening that is 1ft wide and 1ft long. The area is to be approximately 0.09 m² (1 ft²).
- 5.3. While holding the net, check the quadrat for heavy organisms, such as mussels and snails. Remove these organisms from the substrate by hand and place them into the bucket.
- 5.4. For samples located within dense beds of long, filamentous aquatic vegetation (e.g., algae or moss), kicking within the quadrat may not be sufficient to dislodge organisms in the vegetation. Usually these types of vegetation are lying flat against the substrate due to current. Use a knife or scissors to remove only the vegetation that lies within the quadrat (i.e., not entire strands that are rooted within the quadrat) and place it into the bucket or sample container.
- 5.5. Set timer for one minute. Use this minute to sample the substrate still within the quadrat.
 - 5.5.1. Remove any loose rocks or other larger substrate particles, golf-ball sized or larger, that are over halfway within the quadrat. Use just your hands to dislodge

organisms that may be clinging to the rocks (Figure 2). Use forceps if necessary. **NOTE:** If there is a threat to human health through contact with stream water, workers should assess if wearing PPE can make removing substrate particles is safe, i.e., limits contact with water. If it is not possible, do not remove particles, and just kick material into the D-net.



Figure 2. Rocks within the sample quadrat are removed and checked for macroinvertebrates prior to using the kick net method.

- 5.5.2. Keep holding the net handle securely in position and vigorously kick the substrate (Figure 3). Attempt to disturb the sediment, not kick it into the sample net. If there is no current, slowly move upstream within the quadrat, dragging the net on the bottom.
- 5.6. Remove the net from the water with a quick upstream motion to wash the organisms to the bottom of the net. Immerse the net in the stream several times to remove fine sediments and to concentrate organisms at the end of the net. Avoid letting any water or material enter the net opening.



Figure 3. The kick net method involves dislodging macroinvertebrates upstream of the net by vigorously stomping in the channel substrate, the current areas them into the net.

6. Retrieving the Macroinvertebrates from the Sample

- 6.1. To remove specimens from the net, invert the net into a plastic bucket which has been half filled with stream water. With the net raised above the water but the frame resting over the bucket, invert the net portion, depositing contents into the bucket. Using water in the bucket, gently splash the inside of the net to dislodge any material and organisms. Make sure all the contents remain in the bucket. Next, turn the handle and frame over so the inverted net is facing upward. Use hands, toothbrush, and/or forceps (if necessary) to gently remove any organisms that are stuck in the net. Free any vertebrates that may have been caught.
- 6.2. Do not discard any of the sample that may contain organisms not visible to the eye. Place the debris, fine sediment or algae that may contain the organisms into the sample collection bottle.
- 6.3. Place any large objects (such as rocks, sticks, and leaves) that will fit, carefully into the collection bottle—do not attempt to remove invertebrates off of any object that will fit into the collection bottle. If any objects are in the net or bucket that will not fit into the collection bottle, carefully inspect the large objects (such as rocks, sticks, and leaves) and carefully wash any organisms found off of the objects and into the bucket before discarding the object.
 - 6.3.1. To dislodge organisms on rocks 1) gently brushing the rock surfaces underwater with your fingers, 2) use forceps, or 3) holding the rock over the sieve and spray the rock surfaces with alcohol to facilitate removing the macroinvertebrates. Capture the alcohol runoff under the sieve in a container and place specimens into the sample collection bottle. After the alcohol rinse, gently brush the rock surfaces underwater with your fingers. When all of the organisms are removed from the rock, discard the rock.
- 6.4. Slowly pour water from the bucket containing water and the sample through a 500µm sieve into a second bucket. Swirl bucket to dislodge sediment and organisms (Figure 4). If the sieve becomes clogged with fine sediment, gently tap on the bottom of the screen to dislodge the sediment; the water should filter out more quickly. Do not fill the sieve to the top or let the water overflow the rim of the sieve. Let the water in the sieve filter out before adding more water to it.



Figure 4. Transferring water to collect sample in sieve.

- 6.5. Repeat this process 5 times. Inspect the remaining contents/sediment in the bucket to insure all organisms have been removed from the sediment.
- 6.6. Fill the collection bottle $\frac{1}{4}$ full with ethanol (95%) or isopropyl alcohol (99%). More alcohol will be added during processing.
- 6.7. Starting with the largest organisms (they will take longer to intoxicate), transfer the contents of the sieve into the collection bottle (Figure 5). It is extremely important not to crush or damage the organisms; therefore, be GENTLE. From algae laden samples, gently squeeze the material to remove excess water. You can also use forceps to pick up individual organisms or roll a toothbrush on the side to lightly pick up the material. You may have to dip the forceps or toothbrush into the alcohol to remove the organism.



Figure 5. Extracting macroinvertebrates from sieve.



Figure 6. Keep sample wet while sorting.

- 6.8. To help gather the contents in the sieve, you can partially immerse the sieve into the bucket of water and wash the contents to one side of the sieve. It is important that the invertebrates do not dry out (it also makes them easier to collect when they are moving) therefore periodically immerse the sieve in stream water but not over the rim (Figure 6).
- 6.9. Thoroughly rinse the net before proceeding to the next sampling location.

7. Characterizing Quantitative Riffle Sample Locations

Four parameters are measured at each riffle sampled for the quantitative macroinvertebrate sample.

- 7.1. Record the number of quadrat samples taken from each riffle unit.
- 7.2. Measure the intermediate axis of 30 pebbles using a gravelometer, following the Wolman Pebble Count Method at each sampled riffle, 3-5.
- 7.3. Measure water velocity at each location where a riffle quadrat sample was taken, 8-12.
- 7.4. Measure depth at each location where a riffle quadrat sample was taken, 8-12.
- 7.5. Estimate embeddedness to the nearest 10 percent at each sampled riffle, 3-5.

8. Processing the Sample

- 8.1. Completely fill the sample bottles with 95% ethanol (preferable) or 99% isopropyl alcohol (no headspace) so that the final concentration of solution is between 75 and 90%. It is very important that sufficient alcohol be used, or the organisms will not be properly preserved.
- 8.2. Label the inside and outside of samples properly as described in section 3.6 and 4.5.
 - 8.2.1. If a sample requires more than one jar, the jars should be labeled with the sample number followed by consecutive letters, e.g., 1a, 1b, 1c etc.
 - 8.2.2. Attach the completed label to the jar and cover it with a strip of clear tape. Using “rite-in-rain” paper and pencil, place a label with the same information inside the bottle.
- 8.3. Seal the jar with duct tape.

Notes on preservation:

Ethanol is a potent enough fixative for most applications and is much safer to deal with. Careful attention must be paid to the final concentration of alcohol in the sample. Too high a concentration will cause the invertebrates to dehydrate and become brittle, and therefore make them very difficult for our macroinvertebrate taxonomists to identify. If the alcohol concentration is too low, the samples will not be adequately preserved and cause your invertebrates to decompose in their containers. For long term storage we recommend a solution of 70-80% ethanol. Since the water entrained in the sample usually dilutes the alcohol considerably, we recommend using a 95% ethanol solution in the field.

Adjust the amount of alcohol to the matrix of the sample. A good rule of thumb is a 1:1 ratio of preservative to sample material. If the sample is large and just barely fits in the jar, you are better off splitting it into separate containers to allow adequate preservation.

Invertebrates die and decompose remarkably fast, so don't delay preserving them. If for some reason you are unable to use preservative in the field, put the samples on ice, out of direct sunlight, and preserve them as soon as possible. You may find that isopropyl alcohol (rubbing alcohol) is more readily obtainable. Isopropyl is a good alternative to pure ethanol, but make sure you get the technical grade (99%). Denatured alcohol is also available but is a less attractive

alternative as it often contains toxic additives to that could cause the macroinvertebrates to become more difficult to identify.

Check carrier regulations before shipping a Class 3 (Flammable Liquid) Hazardous Material. If HazMat shipping is not possible, call the lab to make overnight shipping arrangements.

Equipment List

Equipment	Quantity	Post-Trip Procedure
D-Net	1	Clean
500 μ m Sieve	2	Clean
Bucket (12qt square preferred)	1	Clean
Bucket (16 qt square preferred)	1	Clean
1 Liter Wide Mouth Nalgene Jars	3 per site	Send samples to lab
500 mL Wide Mouth Nalgene Jars	4 per site	Send samples to lab
Forceps	3	Clean
Alcohol	3L per site	Restock
Rite-in-the-Rain paper	2	Restock
Clear tape	1 roll	Restock
Duct tape	1 roll	Restock
Stopwatch	1	Store
Gravelometer	1	Clean
Flow meter	1	Clean
Folding ruler	1	Clean
Macroinvertebrate field sheets	1 set per site	Restock

References

Brasher, A. M. D., C. M. Albano, R. N. Close, M. L. Freeman, C. L. Lauver, S. A. Monroe, S. E. Stumpf, A. E. C. Snyder, and L. P. Thomas. 2011. Aquatic macroinvertebrate monitoring protocol for the Southern Colorado Plateau Network. Natural Resource Report NPS/SCPN/NRR—2011/460. National Park Service, Fort Collins, Colorado.

Moulton, S. R., J. G. Kennen, R. M. Goldstein, and J. A. Hambrook. 2002. Revised protocols for sampling algal, invertebrate, and fish communities as part of the National Water Quality Assessment. USGS OFR 02-150. U.S. Geological Survey, Reston, Virginia. 87 pp.

Peck, D.V., J.M. Lazorchak, and D.J. Klemm (editors). 2003. Environmental Monitoring and Assessment Program -Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams. EPA/XXX/X-XX/XXXX. U.S. Environmental Protection Agency, Washington, D.C.

[NPS Literature Cited Guidelines](#)

How to Send Samples

1. Fix samples with 95% ethanol in the field.
2. Label samples inside and outside.
 - a. Internal labels: Pencil on waterproof paper (such as “Rite-in-the-Rain”). Do NOT use pen.
 - b. External labels: Pencil on paper or masking tape works well for outside labels.
 - c. Information: Both internal and external labels should, at a minimum, include information about the location of the sample and the date of sampling.
 - d. Jar Numbers: Place a consecutive sample number on the lid of each jar, samples requiring more than one jar should be labeled as 1 of 2, 2 of 2 OR 1a, 1b, 1c, etc.. We will composite multiple jars (Jar 1 of 2 and Jar 2 of 2) into a single sample in the laboratory.
3. Record complete information on where, when, and how the samples were collected.
 - a. Submit information to our lab via the online tool:
<http://usu.edu/buglab/sampleProcessing/sampleSubmission/>
 - b. The minimum information recommended is:
 - i. Site Name (specifying distances from tributaries, landmarks, cities, etc)
 - ii. GPS coordinates (Latitude/Longitude or UTM format)
 - iii. County/State
 - iv. Sampling date
 - v. Sampling device (Surber, Kicknet, etc.)
 - vi. Habitat sampled (riffle, pool, etc.)
 - vii. Total area sampled in square meters or square feet
 - c. Additional physical and chemical data collection are encouraged in the field, but do not need to be provided during sample submission unless additional reporting has been arranged prior.
4. To prepare for shipping, follow the guidelines for Class 3 (Flammable Liquid) Hazardous Materials according to your chosen carrier’s guidelines. General guidelines are as follows:
 - a. Make sure the lids are on tightly. To be careful, you may wrap duct tape around the lids.
 - b. Place individual samples in ziploc baggies or other secondary sealed containers lined with absorbent material (such as paper towels) for support, cushion, and to absorb any leaks.
 - c. Place data sheets, including forms generated in the online submission, and any other paper documentation in a separate zip-lock plastic bag.
 - d. As specified by your carrier, mark package as Hazardous Material and fill out a Shipping Declaration for Dangerous Goods form to accompany the package (keep a copy for your records).
 - e. If HazMat shipping is not an option for your institution, please contact us concerning options for overnight shipping in water.
 - f. Ship samples, data sheets, and any additional information concerning the samples to:
BLM/USU National Aquatic Monitoring Center (Buglab)
Department of Watershed Sciences
Utah State University
5210 Old Main Hill
Logan, UT 84322-5210.
5. Upon receipt of your samples we will notify you via email.

Sonoran Desert and Southern Plains Network

Streams Monitoring Protocol

SOP #26: Habitat Characterization

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
1.0	03/06/2012	Raymond	minor	Reflect field methods	0.004
0.002	10/13/2017	Many	Formatting	Preparation for publishing protocol	1.00

This Standard Operating Procedure explains the procedure for measuring the physical characteristics of streams as part of stream monitoring conducted by the Sonoran Institute. Much of the text and diagrams is based on the manual “Environmental Monitoring and Assessment Monitoring Program Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams” (Peck et al. 2003).

1. Overview of Sampling Methods

- 1.1. Four measures of physical habitat and supplementary descriptive information are collected within the sampling reach.
- 1.2. Data collection begins at the bottom of the reach and proceeds upstream.
- 1.3. Sampling for all measures occurs at each of the 11 cross-section transects (A through K).

2. Channel Classification/water Column Description

- 2.1. Channel classification/water column descriptions are made at each of the 11 cross-section transects (A through K).
- 2.2. Choose a single dominant description for **flow class** within an imaginary 10m wide belt transect centered over the cross section and the full width of the channel using the descriptions in Table 1.

Table 1 Flow class categories and descriptions (Peck et al. 2003)

Dry Channel	No water in the channel;
Pool	Still water, low velocity, smooth, gassy surface, usually deep compares to other parts of the channel;
Glide	Water moving slowly, with a smooth, unbroken surface, low turbulence;
Run	Refers to segments of streams where there is moderate velocity water, but non-turbulent conditions which do not break the surface tension of the water and do not produce whitewater.
Riffle	Refers to the portions of streams where moderate velocities and substrate roughness produce moderately turbulent conditions which break the surface tension of the water and may produce whitewater. Riffle (EMAP)water moving, with small ripples, waves and eddies, waves not breaking, surface tension not broken, sound is “babbling,” “gurgling”
Rapid	Water movement rapid and turbulent, surface with intermittent whitewater with breaking waves, sound is continuous rushing, but not as loud as a cascade
Cascade	Water movement rapid and very turbulent over steep channel bottom, most of the water surface is broken in short, irregular plunges, mostly whitewater, sound is roaring
Falls	Free falling water over a vertical or near vertical drop into plunge, water turbulent and white over high falls, sound is from splash to roar
Marsh	Backwater area

- 2.3. Choose a single dominant description for **erosion class** within an imaginary 10m wide belt transect centered over the cross section and the full width of the channel. Options for erosion class are erosional (E) and depositional (D).
- 2.4. Choose a single dominant description for **water color** within an imaginary 10m wide belt transect centered over the cross section and the full width of the channel. Water color options include clear, brown, blue-green, green, etc.
- 2.5. Choose a single dominant description for **water mixing** within an imaginary 10m wide belt transect centered over the cross section and the full width of the channel. Water mixing options include well-mixed, stratified, poorly mixed, unknown, etc.

3. Densiometer Canopy Cover Measurements

- 3.1. Canopy cover is measured at 6 locations at each of the 11 cross-section transects within a sampling reach using a modified convex spherical densitometer (Model B). The densitometer must be marked with tape exactly as shown in Figure 1 to limit the number of square grid intersections to 17 (Peck et al. 2003). Densiometer readings can range from 0 (no canopy cover) to 17 (full canopy cover within the range of view).

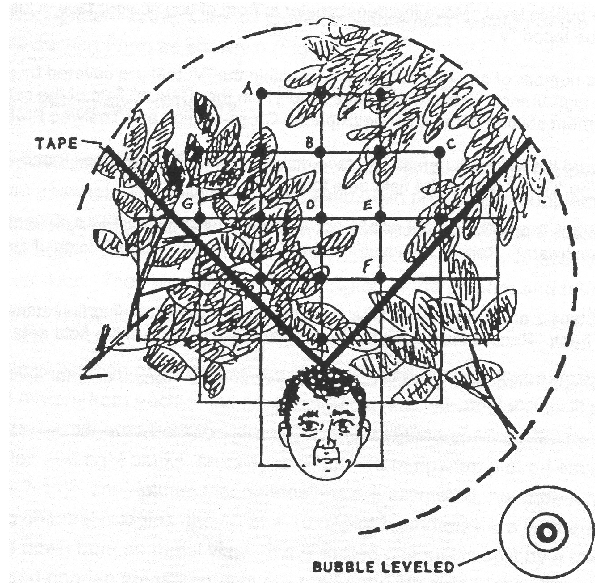


Figure 1. Proper positioning of the densitometer is indicated by the bubble level and having the observer's head at the base of the "V." Canopy measurements are indicated by the number of grid intersections that are covered by vegetation or branches (Peck et al. 2003).

- 3.2. At each cross-section transect a total of six measurements are taken: four at mid channel, and one each on either side of the channel: at mid-channel take the four measurements: facing upstream (Center Up), downstream (Center Down), facing the left bank (Center Left) and facing the right bank (Center Right); at each side of the channel, take measurements 1 m from the bank, facing toward the bank (Left Bank and Right Bank).
- 3.3. Hold the densitometer 0.3 m (1 ft) above the surface of the stream.
- 3.4. Make sure the densitometer is level using the bubble level.
- 3.5. Move the densitometer in front of you so your face is just below the apex of the taped "V" (see Figure 1).
- 3.6. Count the number of grid intersection points within the "V" that are covered by a tree, a leaf, or a high branch.
- 3.7. Record the value (0 to 17) in the appropriate place on the datasheet.

4. General Observations

- 4.1. General observations are made at each of the 11 cross-section transects (A through K) and as you traverse the sampling reach.
- 4.2. Conduct a visual assessment noting any:
 - 4.2.1. Films on the surface of the water
 - 4.2.2. Foams or bubbles on the surface of the water
 - 4.2.3. Decaying vegetation or other organic matter in or near the water
 - 4.2.4. Algae growth or "scum" on the surface of the water (note the percentage of surface covered)
 - 4.2.5. Dead fish or other aquatic organisms in or near the water
 - 4.2.6. Signs of life in the water such as macroinvertebrates, fish or amphibians
 - 4.2.7. Unusual deposits on the shore or emergent vegetation

- 4.2.8. Evidence of sediment deposition from a recent storm, streambank erosion, signs of high sediment/turbidity deposition along the channel, or debris from recent storms
- 4.3. Conduct an olfactory assessment noting any:
 - 4.3.1. Smells of rotting vegetation or animal matter;
 - 4.3.2. Acrid or bitter smells;
 - 4.3.3. Sour (sulfurous or “rotten egg”) smells;
 - 4.3.4. Smells associated with chlorine (“smells similar to a swimming pool”);
 - 4.3.5. Smells associated with urine, ammonia, or vinegar;
 - 4.3.6. Moldy or musty smells;
 - 4.3.7. Motor oil, gasoline, diesel or other “chemical” odors;
 - 4.3.8. Any “almond-like” smells;
 - 4.3.9. Other unusual or particularly strong odors.
- 4.4. Conduct a recreation assessment noting any:
 - 4.4.1. Recent recreational use of the floodplain. Note type of recreation.
 - 4.4.2. Note any animals (cows, horses, dogs, etc.) in the area

5. Substrate Classification

- 5.1. Substrate classification observations are made at each of the 11 cross-section transects (A through K) as you traverse the sampling reach.
- 5.2. For each of the following categories, record the percentage of the total streambed area (10m belt transect centered along cross-section) so that the sum equals 100 percent.
 - 5.2.1. Bedrock; $4096 < x$
 - 5.2.2. Boulders; $256 < x \leq 4096$
 - 5.2.3. Cobble; $64 < x \leq 256$
 - 5.2.4. Gravel; $2 < x \leq 64$
 - 5.2.5. Sand; $0.06 < x \leq 2$
 - 5.2.6. Silt/Clay, $x < 0.06$
 - 5.2.7. Concrete
 - 5.2.8. Other (describe)

6. Aquatic Habitat Observations

- 6.1. Aquatic habitat observations are made at each of the 11 cross-section transects (A through K) as you traverse the sampling reach.
- 6.2. For each of the following categories, record the percentage class of the total streambed area (10m belt transect centered along cross-section). Classes are 0= Absent; 1= Sparse (1-9%); 2= Moderate (11-40%); 3= Heavy (41-75%); 4= Very Heavy (76-100%)
 - 6.2.1. Filamentous algae.
 - 6.2.2. Macrophytes. Macrophytes are aquatic plants, growing in or near water that are emergent, submergent, or floating.
 - 6.2.3. Large woody debris with diameter $> 0.3\text{m}$.
 - 6.2.4. Small woody debris with diameter $< 0.3\text{m}$.
 - 6.2.5. Live trees and roots (those in the channel or roots on the bank and exposed).

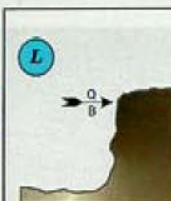
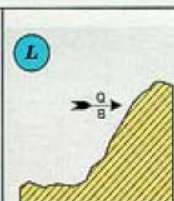
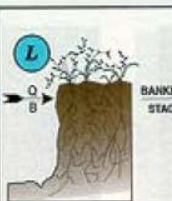
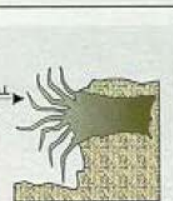
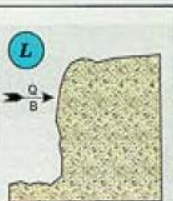
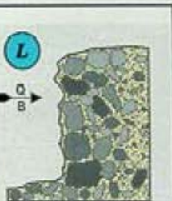
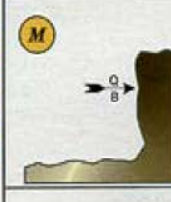
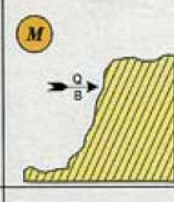
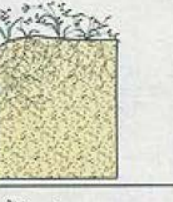
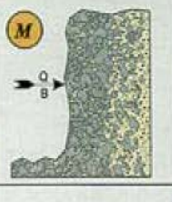
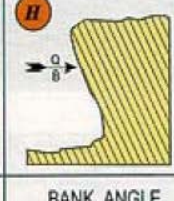
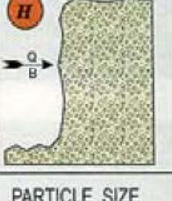
- 6.2.6. Overhanging vegetation that is within 1m of the surface of the water.
- 6.2.7. Undercut banks. Record the percent of the bank that has undercut banks.
- 6.2.8. Boulders (between 25-400cm).
- 6.2.9. Any artificial structures.

7. Channel Profile

- 7.1. Aquatic habitat observations are made at each of the 11 cross-section transects (A through K).
- 7.2. Stretch a measuring tape taught across the wetted width at each sampling location, perpendicular to the flow. Record the wetted width on the datasheet to the nearest 0.1m.
- 7.3. Probe along the measuring tape with a folding ruler. Record the maximum depth on the datasheet to the nearest 0.05m.

8. Bank Erodibility Hazard Index

- 8.1. Bank erodibility metric observations are made at each of the 11 segment cross-sections (1 through 11).
- 8.2. For each of the following categories, rate the erosion potential as low, moderate or high. Refer to the Bank Erodibility Hazard Index chart to determine erosional potential.

BANK EROSION POTENTIAL	LOW MODERATE HIGH						
							
							
				BANK HEIGHT vs BANKFULL DEPTH	BANK ANGLE	DENSITY of ROOTS BANK SURFACE PROTECTION % of TOTAL BANK HEIGHT WITH ROOTS	SOIL STRATIFICATION

- 8.2.1. Ratio of bank height to bankfull height. A ratio of 1.0-1.19 is low, 1.2-2.0 is moderate, and greater than 2.0 is high.
- 8.2.2. Bank angle. An angle of 0-60 degrees is low, 61-80 is moderate, and greater than 80 is high.

- 8.2.3. Density of roots, percent of total bank height with roots. A percent of 100-55 is low, 54-30 is moderate and 29-0 is high.
- 8.2.4. Soil stratification. No stratification is low, few stratifications below bankfull are moderate, and many stratified layers at bankfull height are high.
- 8.2.5. Particle size. A dominance of bedrock, boulders or cobble is low, gravel is moderate and sand is high.

9. Photographs

- 9.1. Four photographs are taken at each of the 11 cross-section transects (A through K).
 - 9.1.1. Standing upstream and looking downstream (up to down).
 - 9.1.2. Standing on the left bank and looking across to the right bank (left to right).
 - 9.1.3. Standing downstream and looking upstream (down to up).
 - 9.1.4. Standing on the right bank and looking across to the left bank (right to left).
- 9.2. Record the order in which the pictures are taken on the datasheet. Note any differences of the position of where photos taken from due to obstructions.
- 9.3. All photographs should be landscape-oriented with the measuring tape in view.
 - 9.3.1. For the up and down photographs, allow for a wide enough frame to capture both transect endpoints with the tape crossing the center of the frame.



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- 9.3.2. Bank photographs should be have the tape endpoint in the center of the frame.
 - 9.3.2.1. Attempt to capture the 10m belt on either side of the tape. In small streams, stand on the bank to capture the opposing side. In large streams, you may stand closer to the center to narrow the frame to capture only the 10m belt.



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9.4. Additional photographs may be taken to document important features. Note any additional photographs on the datasheet.

Equipment List

Equipment	Quantity
Datasheets	1
pencils	many
1 convex spherical canopy densiometer, Model B	1
50+ foot measuring tape, marked in feet tenths	1
Folding ruler marked in feet-tenths	1
Digital camera	1
GPS with pre-loaded transects	1

References

Peck, D.V., J.M. Lazorchak, and D.J. Klemm (editors). 2003. Environmental Monitoring and Assessment Program -Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams. EPA/XXX/X-XX/XXXX. U.S. Environmental Protection Agency, Washington, D.C.

**Sonoran Desert and Southern Plains Network
Stream Monitoring Protocol**

SOP #27: Determining Status of Fish in Perennial Streams

Version 1.00
(October 13, 2017)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #
None	10/13/2017	Gwilliam	New SOP	New	1

SODN and SOPN currently works with state game and fish agencies to determine the status of fish in or near perennial streams in park units. In WY16 the stream monitoring program is working with the state of Arizona and other partners on the Santa Cruz River near Tumacácori NHP.

Workers should familiarize themselves with the references

In the future the SOP will be modified to accommodate new techniques for harvesting data from other sources and partners, and collecting field data.

It cannot be emphasized enough that the safety of workers is paramount. Before any sampling event all safety procedures should be revisited and discussed. This includes proper training on operation of the electrofishing equipment, waders, wearing suitable PFD. Any training should be up-to-date.

Overview of Methods

The methods used on the Santa Cruz River are electrofishing and seining modified from Barbour et al. 1999, Bonar 2009 and Zale et al. 2013. The Stream Monitoring Protocol currently seeks to work with partners that have received training and can maintain the electrofishing gear used in this technique.

The goal is to determine what taxa of fish are found in or near the Index reach in each park unit. Working with partners like the Arizona Fish and Game Department, and other federal and state agencies

Sampling Location

Fish sampling should occur in the Index Reach, typically 150 m of stream; see SOP 25 for description of the Index Reach establishment. When the sampling occurs on a stream reach outside of NPS administered boundary, it may not be possible to implement methods described in SOP 25, due to logistical, legal and administrative restraints.

In this case, as a minimum, spatial data should be collected, including the location of the start and end of the sampling reach.

Habitat data (SOP 26) and water quality data (see SOP19) should also be collected during the fish sampling

Data management

The total time shocking should be recorded before and after each electrofishing event. The fish taxa should be identified, and the number of each taxa should be recorded.

The results should be summarized in a fish/unit effort statistic.

The data from sampling should be placed into the Streams Database and follow data management methodologies described in SOP 5 and in the data management section of the Streams Protocol (Gwilliam et al 2017).

Citations

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Bonar, S. 2009. Standard Methods for Sampling North American Fishes. American Fisheries Society, Bethesda, MD.

Gwilliam, E., C. McIntyre, A. Hubbard, K. Raymond, K. Bonebrake, and L. Palacios. 2017. Streams monitoring protocol for the Sonoran Desert and Southern Plains networks: Version 1.0. Natural Resource Report NPS/SODN/NRR—2017/XXX. National Park Service, Fort Collins, Colorado.

Zale, A.V., Parrish, D.L., T.M. Sutton (Eds.). 2013. Fishery Techniques, 3rd Ed. American Fisheries Society, Bethesda, MD.