

Southwest Network Collaboration

Springs, Seeps and Tinajas Monitoring Protocol: Chihuahuan and Sonoran Desert Networks

SOP #1: Safety for Springs Monitoring

Version 1.00
(September 3, 2018)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #

Acknowledgements

Substantial sections of this Standard Operating Procedure (SOP) are taken from SOP #1 in the Water Quality Vital Signs Monitoring Protocol for Park Units in the Northern Colorado Plateau Network (Sharrow et al. 2007) and the Southwest Network Collaboration Stream Monitoring Protocol (Gwilliam et al. 2017).

Introduction

This SOP describes the safety concerns related to conducting field and laboratory portions of monitoring spring ecosystems in the Chihuahuan and Sonoran Desert networks. This SOP identifies and provides approaches to mitigate hazards associated with springs monitoring.

The safety and health of network staff, contractors, collaborators, and volunteers is a priority for the Chihuahuan and Sonoran Desert networks. At the beginning of each field season, all staff should review the Chihuahuan Desert or Sonoran Desert network safety plan. The networks' safety plans cover topics including accident prevention, field safety, vehicle safety, communications, and responding to an incident. Field crews carry first aid kits and multiple forms of communication (cell phones, satellite phones, satellite beacons/communication devices). All field crew members should know where safety equipment are stored during fieldwork.

Safety always comes first. Because the logistics of field work can require much of the field crew leader's attention, it is the responsibility of everyone in the field to point out safety issues or concerns that otherwise may be overlooked in efforts to complete the field tasks at hand or when distractions occur from problems that may arise. If there is any doubt as to whether or not conditions are safe, sampling should be rescheduled for another day.

Inherent Risks

There are several inherent risks associated with monitoring springs in the Chihuahuan Desert and Sonoran Desert networks:

Travel from network offices to parks and/or between parks involve distances of up to several hundred miles, with travel of highways and secondary roads. Travel occurs under a variety of weather and road conditions.

Accessing springs requires travel on backcountry roads and trails and/or off trail travel. Some sites require overnight backcountry trips and/or hikes of up to three hours. Backcountry roads may become impassible during inclement weather and help in backcountry situations may take hours to overnight.

Springs sampling necessarily occurs in and adjacent to water. Proper personal protective clothing/equipment shall be worn. In addition, care should be taken as springbrook bottoms and adjacent areas may be slippery. Water also attracts wildlife such as bees and bears.

The weather in the Sonoran and Chihuahuan deserts varies significantly by season and sometimes by the day or hour. Snow may occur during the winter and summer temperatures can exceed 110°F. Lightning is common during summer monsoon storms. Although fieldwork schedules try to avoid these conditions, crew members should be prepared for a wide range of conditions.

Some of the water quality reagents are hazardous materials and therefore require proper storage, handling, disposal, and use of personal protective equipment. All chemicals must be stored according to their Material Safety Data Sheet (MSDS).

Safety Training

Training in wilderness first aid and cardiopulmonary resuscitation (CPR) are strongly recommended for all crew members. At least one person, preferably the crew leader, should be currently certified as a wilderness first responder. All crew members must be proficient with the use and etiquette of provided communication devices, including park radios where available. At a minimum, each member will receive training on how to adequately prevent environmental illness and injury, through Operational Leadership training, for example, as well as on-team safety awareness.

References

- Gwilliam, E., C. McIntyre, A. Hubbard, K. Raymond, K. Bonebrake, and L. Palacios. 2017. DRAFT 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.
- Sharrow, D., D. Thoma, K. Wynn, and M. Beer. 2007. Water quality vital signs monitoring for parks units in the Northern Colorado Plateau Network. Unpublished National Park Service report.

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SOP #2: Personnel and Training

Version 1.00
(September 3, 2018)

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Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #

This standard operating procedure (SOP) provides an overview of the qualifications and training needed for personnel conducting field data collection for springs monitoring.

The most essential element for the collection of quality data is well-trained, experienced field crews.

Qualifications and Attributes of Field Staff

Given the variability of springs across Sonoran Desert Network (SODN) & Chihuahuan Desert Network (CHDN) parks, it is necessary to hire highly-skilled technicians with experience collecting water quantity and water quality data, and preferably with some experience with vegetation in the region. The importance of hiring and training well-qualified observers cannot be overemphasized. Field staff must be in good physical condition and able to work safely in small teams and independently.

The crew leader for each network should have experience collecting water quality and water quantity data, including the use and calibration of multiparameter meters.

Additional crew members should have some experience collecting water quality and water quantity samples, identifying plant species, and trouble-shooting equipment.

Training

The crew leader for each network, and/or the Chihuahuan Desert Network physical scientist/ecologist and Sonoran Desert Network aquatic ecologist, will attend the U.S. Geological Survey's course "Field Water-Quality Methods for Ground Water and Surface Water (QW1028TC)" or a similar training course.

All field staff will receive standard network training, including a program overview, administrative responsibilities, safety (see SOP #1), navigation, park etiquette and use of government vehicles. All field staff will be trained by the CHDN physical scientist/ecologist and/or SODN aquatic ecologist in the following topics specific to the springs protocol:

- Purpose and objectives of monitoring
- Water quantity parameters
- Multiparameter meters (pH, temperature, dissolved oxygen, specific conductance, total dissolved solids), their calibration and field operation
- Surface-water sample collection and preparation/handling of sample bottles
- Site characterization
- Site condition, including identification of invasive non-native plants and animals and obligate/wetland plants
- Photo documentation
- Equipment care and decontamination
- Troubleshooting and contingencies
- Data management

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Springs, Seeps and Tinajas Monitoring Protocol: Chihuahuan and Sonoran Desert Networks

SOP #3: Site Characterization

Version 1.00
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Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #

Acknowledgements

The Site Characterization Standard Operating Procedure (SOP) is a modification of the inventory methods developed for the Colorado Plateau (Stevens et al. 2004) and for the Mojave Desert Network (Sada and Pohlman 2006), which was utilized during the inventory of springs in the Chihuahuan and Sonoran Desert networks. Some portions of this SOP were taken from the Northern Colorado Plateau Network (NCPN) seeps and springs monitoring protocol (Weissinger et al. 2017).

Introduction

This Standard Operating Procedure (SOP) describes the methodology for the Site Characterization module which includes documenting information about the sample site and sample extent, site access description, spring type and characterization, site description, vegetation community description, site diagram, GPS locations, and sampling location descriptions in spring ecosystems.

The first two sections of the datasheet are titled Site Visit Information (site information, sample extent and information) are completed on every visit to a spring. The remainder of the site characterization datasheet is completed once every five years, but is updated when necessary. If the system experiences a flood, fire, or other “reset” event, or if the protocol lead directs, all of the Site Characterization data will be recollected. For years when Site Characterization information is not collected, record this fact in the Notes cell of the Sample Extent and Information section of the datasheets, write a “N” in the appropriate cell of the checklist, and draw a diagonal line through the datasheet section that is (are) not collected. During data entry, do not enter these fields (leave them blank). Example datasheets are located in Appendix A (Data are not real and are for example purposes only).

Site Information

During each sampling event, fill in all fields on Site Information (Section 1) as follows:

Site Code: Enter the assigned Site Code as provided. Follow the format of Park Code followed by 3 numbers (e.g., AMIS001). For units in the Chihuahuan Desert Network (CHDN) with springs monitoring, the corresponding park codes are:

AMIS: Amistad National Recreation Area
BIBE: Big Bend National Park
CAVE: Carlsbad Caverns National Park
GUMO: Guadalupe Mountains National Park
WHSA: White Sands National Monument

For units in the Sonoran Desert Network (SODN) with springs monitoring, the corresponding codes are:

CHIR: Chiricahua National Monument
CORO: Coronado National Memorial
FOBO: Fort Bowie National Historic Site
GICL: Gila Cliff Dwellings National Monument
ORPI: Organ Pipe Cactus National Monument
MOCC: Montezuma Castle National Monument, Castle unit
MOWE: Montezuma Castle National Monument, Well unit
SAGE: Saguaro National Park, Tucson Mountain District (east unit)
SAGW: Saguaro National Park, Rincon Mountain District (west unit)
TONT: Tonto National Monument
TUZI: Tuzigoot National Monument

Site Name(s): Enter the Site Name as listed by NPS or as named on a USGS 7.5" topo quad. If there are additional names by which the spring, seep, or tinaja is known, include those as well.

Date: Enter the date in the following format: MM/DD/YYYY (e.g., 02/17/2018)

Crew Lead: Enter the first and last name of the crew lead. Initials or personnel codes (alphanumeric code assigned to each staff member) can be used on subsequent sections of the datasheets.

Field Technicians: Enter the first and last names of all crew members present. Initials or personnel codes can be used on subsequent sections.

Sample Extent and Information

Indicate on Sample Extent and Information (Section) whether or not the site was sampled. Also indicate if the spring was wet or dry. If the site meets the criteria for sampling, indicate the modules (site characterization, site condition, water quality and water quantity) surveyed. Even if the spring is dry, the site characterization and site condition sections can be completed and temperature sensors can still be deployed or retrieved.

If the site is not sampleable, indicate the reason by selecting from the choices and provide a brief description in the notes field. For example: “orifice was inaccessible due to dangerous slope”.

Indicate whether there was precipitation within the past 24 hours.

Indicate whether each orifice associated with the spring is wet or dry. Also indicate which orifices are actively contributing surface water to each sampling location.

In conjunction with the wetted extent measurements, determine the length of the springbrook in meters (up to 100 m) by running a measuring tape down the center of the brook, following bends as best as possible. If the brook is > 100m, estimate the channel length and circle the appropriate category: 100-200m, 200 – 500m, >500m. In the case of intermittent flows within 100m of the orifice, include dry areas of the channel when less than 10m long. If the dry section(s) is greater than 10m, treat the upstream edge of the dry section as the end the brook, and note on the datasheet that flow continues intermittently.

If the Site Characterization sections (Sections 3-9) that follow are not collected on a visit, state this information in the notes cell of the Sample Extent and Information, write a “N” in the appropriate cell of the checklist and draw a diagonal line through the datasheet section(s) that is (are) not collected.

Site Access Description

If a site has been visited previously, review the previous Site Access Description before hiking to the site. Every five years, record the hiking time, hiking distance, route information, safety information and other relevant notes in the Site Access (Section 3) of the datasheet. In other years, if additions or changes are needed, annotate the previous site access description provided in the revisit packet.

Spring Type and Characterization

Use the definitions in Table 1 to determine the spring type and circle the appropriate type on the “Spring Type and Characterization” Section (4) of the datasheet. Only the most common spring types in the Chihuahuan and Sonoran Desert networks are listed on the data form. If you determine that a spring meets a definition below that is not listed on the datasheet, circle Other and write in the appropriate spring type.

Table 1. Definitions of spring types (from Springer and Stevens 2009; tinaja definition added from Bryan 1920, Brown and Johnson 1983, Colbert and Swann 2015).

Spring Type	Definition
Cave	Emergence in a cave in mature to extreme karst with sufficiently large conduits
Exposure	Cave, rock shelter fractures, or sinkholes where an unconfined aquifer is exposed near the land surface
Fountain	Artesian fountain with pressurized CO ₂ in a confined aquifer
Geyser	Explosive flow of hot water from confined aquifer
Gushet	Discrete source flow gushes from a cliff wall of a perched, unconfined aquifer
Hanging garden	Dripping flow emerges usually horizontally along a geologic contact along a cliff wall of a perched, unconfined aquifer
Helocrene	Emerges from low gradient wetlands; often indistinct or multiple sources seeping from shallow, unconfined aquifers

Hillslope	Emerges from confined or unconfined aquifers on a hillslope (30-60° slope); often indistinct or multiple sources
Hypocrene	A buried spring where flow does not reach the surface, typically due to very low discharge and high evaporation or transpiration
Limnocrene	Emergence of confined or unconfined aquifers in pool(s)
Mound	Emerges from a mineralized mound, frequently at magmatic or fault systems
Rheocrene	Flowing spring, emerges into one or more stream channels
Tinaja	(Usually) small pool in rock basin, can be an impoundment in bedrock that is fed by surface flow and/or springflow

Complete the additional information in the as follows:

Channel presence: Indicate whether a stream channel is present.

Channel type: As described in the Northern Colorado Plateau Network Springs Protocol (Weissinger et al. 2017): “The morphology of the channel should be examined (if a channel exists) to determine if it is spring-dominated or surface-flow dominated. If a channel is spring discharge dominated, the channel should be nearly bank full at base-flow conditions of the spring. If the channel is surface-flow dominated, typically the channel is oversized for the base-flow of the spring. Typically there are two bankfull stages for surface-flow dominated channels; a small, incised channel for base-flow condition, and a larger, wider channel for surface-flow dominated conditions.” See Table 2.

Table 2. Definitions of channel types (from Weissinger et al. 2017)

Channel type	Description
Spring discharge dominated	Only one terrace or bankfull channel and channel starts at or near the spring orifice.
Runoff dominated	High terrace or two bankfull channels, one terrace typically higher than a lower, smaller spring-discharge terrace. Channel features are evident upstream of spring flow affected area.
Mixed discharge	Both spring discharge and runoff, two terraces or bankfull channels. Channel features evident upstream of spring-flow affected area, but some channel features are different below orifice because of spring flow.

Number of channels: Record the number of channels present within the first 100m of the primary orifice.

Multiple orifices: Indicate whether there are multiple orifices present within 200m.

Slope: Use a clinometer to measure a representative slope (in **degrees**) of the area around the primary orifice.

Slope variability: From the NCPN Springs Protocol (Weissinger et al. 2017): Indicate the general variability of the slope on the site by choosing one of the following categories: high (3 or more

abrupt changes in slope across site, e.g., a hanging garden with vertical backwall, steep colluvial slope, and low-gradient channel), medium (1-2 changes, e.g., a rheocrene spring with steep banks), low (0 changes, e.g., a wet meadow).

Compass declination: Set and record the declination on the compass to true North (degrees and direction).

Aspect (degrees): Stand with your back facing the orifice and determine the representative aspect of the spring (degrees) and the slope you measured above.

Site Description

If the site was visited previously, a Site Description will be included in the revisit packet for the site. The field crew should review the Site Description before hiking to the site. A new site description and should be completed every five years.

The Site Description should begin at the orifice(s) and work outward. Describe the overall characteristics for these key areas: a) the general landscape setting in which the site is located; b) a description of the orifice; c) the general size of the spring and the extent of the wetted area; d) a description of the channel (if present); e) the general characteristics of the spring such as flow rate, turbidity, the number of plunge pools, abundance and/or presence of macroinvertebrates, dominant substrate and disturbances; and f) notable changes to site compared to data from previous visits.

Changes that should be recorded include, but are not limited to, changes to channel morphology that have occurred due to a bank cave in, erosion, trampling, or a fallen tree which may consequently alter the water course and/or residency time; a significant change in the wetted area (e.g., an increase or decrease; and change in location of the primary orifice.

Vegetation Community Description

If the site was visited previously, a Vegetation Community Description will be included in the revisit packet for the site. The field crew should review the Vegetation Community Description at the site. A new vegetation community description should be completed every five years.

Describe the vegetation community found within 50m of the spring. This should be a systematic description of the vegetation community that characterizes each of three strata beginning with the canopy (> 2 m), then sub-canopy (0.5 – 2m), and finally the field (< 0.5m) height category. The description should focus on the vegetation community that surrounds the spring and characterizes the area that is most clearly influenced by the presence of water. Other details to include should be how the water-dependent community fits into the surrounding area, how the topography of the site influences the community, and other geomorphic observations as they relate to the vegetation community. If names of dominant plants are unknown, include lifeform in description (tree, shrub, forb, grass, vine, etc). The vegetation community description should focus on the dominant community members and should not include an inventory list.

Site Diagram

If the site was visited previously, a Site Diagram will be included in the revisit packet for the site. The field crew should review the site diagram while at the site and determine if any changes can be detected. Annotate the previous diagram as needed (e.g., add a new sample location). A new site diagram should be completed every five years in the Site Diagram (Section 7) of the datasheets.

The site diagram should include a) the direction of magnetic north; b) a scale (estimated); c) prominent landscape and/or geologic features proximate to the site; d) the direction and general course of the channel; e) any areas of disturbance or flow modification; and f) the sampling locations for the location of the water quality measurement(s), the water chemistry measurement(s), and measurements of discharge; g) landscape photo points; h) all orifices (A, B, C...); and i) pools.

GPS Locations

If the site has previously been sampled, a list of known locations and features will be provided in the revisit packet for the site and the existing points will also be in the GPS unit. Review the list and relocate the features using GPS. Create a GPS waypoint if any of following features are missing or if the locations are deemed inaccurate (point is more than 2 times current Horizontal Dilution of Precision (HDOP) away from feature). If the site has not been sampled previously, collect GPS locations for all of the features listed below. Transcribe the coordinates from the GPS locations for the orifice(s), sampling locations and landscape photo points onto Section 8.

Orifices: Include any currently or recently productive orifice or paleo-orifice. The orifice labels (A, B, C, ...) must remain constant over time. Therefore, if a new orifice is found it should be assigned a new letter (instead of renaming all orifices). Orifices can move slightly over time, therefore, locations within 3 m of a previously existing orifice should be considered the same orifice. Use previous photos to help determine if you are looking at a previously-named orifice. During initial monitoring at a spring, Orifice A is generally the point at which groundwater discharges onto the land surface located at the uppermost extent of the springbrook.

Landscape photo points: The locations from which the permanent, landscape photographs are taken (e.g., PP1, PP2).

Sampling locations: Location of discharge, water quality, and/or temperature sensors or pressure transducer.

Using GPS to Map the Features

Use a professional grade GPS receiver (at least one meter resolution). If unavailable, a recreational grade GPS (resolution 3-5meters) is acceptable, especially if GPS data can be post-processed. Set up the GPS unit early on in the survey as it may take some time for the unit to acquire sufficient satellite reception (e.g. in a steep walled canyon), and because the unit will most likely acquire better accuracy if left in a fixed position for an extended period of time. Once a feature has been located, place the GPS unit in the best location to relocate the feature. If the unit cannot acquire sufficient satellite reception while the unit is resting on the ground, hold the unit by hand (elevate the unit if necessary) while standing directly at the desired point. Refrain from roaming about to acquire reception when possible. If the unit will only receive reception at a point away from the feature, make a note in the data form comment section of one's position relative to the feature (bearing and distance to feature).

Below is an overview of the data fields required by the spatial data collection application. Three pieces of information are required when starting to use the spatial data collection application and this information carries through to each point collected:

Unit Code: see list of park/unit codes at start of SOP

Spring Number: The three digit number in the Spring ID. The application will combine the Unit Code and Spring Number into the Spring ID.

Surveyor: The personnel code of the person collecting the data.

The spatial data collection application has separate buttons to collect GPS locations of the sampling locations (discharge, sensor, water quality, water chemistry), orifice(s), and landscape photo points. The required information for each data type is described below:

Sampling Locations: Survey date, location name, and point offset. Notes are optional and are on the 2nd tab.

Orifice(s): Survey date, orifice (e.g., A, B, C), and point offset. Notes are optional and are on the 1st tab.

Landscape Photo Point: Survey date, photo point number, point offset, and description are required for each landscape photo point. For each view from a photo point, the view letter (e.g., A, B, C) bearing and photo description are required.

Recording feature waypoints on datasheets

The coordinates for the orifice(s), landscape photo points and sampling locations should be recorded on in the GPS Locations (Section 8) of the datasheet as a backup to the electronic data.

Observer: Enter the initials of whoever is completing the GPS Locations section.

GPS Unit ID: Units should have identification label on back. If not, record the last 5 digits of the property number.

Feature: Record the feature category for which the coordinates are being reported.

Latitude/UTM N

Longitude/UTM E

PDOP: Position Dilution of Precision. This value rates the three dimensional (horizontal and vertical) precision of the location output based on position of the available satellites. The smaller the number, the more precise.

HDOP: Horizontal Dilution of Precision: This value estimates the horizontal precision of the location output based on the position of the available satellites. The smaller the number, the more precise.

Offsets: If a GPS point cannot be acquired at the feature, collect the point where an adequate signal can be acquired and record the distance (Offset (m)), direction (Offset (°)), and inclination (Offset (°)) from the feature to where the point was collected.

Notes: Note any changes to datum; additional lines or polygons collected; technological difficulties.

Sampling Location Descriptions

If the site was visited previously, a description, photographs, and GPS coordinates of each sampling locations will be included in the revisit packet for each site. Carefully documenting sampling locations (physical locations where discharge, water quality, water chemistry are measured or temperature sensors are placed) allows for trend analysis. If a new sampling location must be established, record the sampling

location number, associated orifice(s), take a photograph, and write a thorough description of the sampling location. If the sampling location is for the temperature sensor placed in a tree or shrub, record the associated orifice as “n/a.” The description should reference any landmarks, distance from orifices, or other defining features.

Equipment

Item	Number needed	Notes
GPS	1	minimum 3m accuracy
Folding ruler	2	
100-m reel tape	1	fiberglass reel tape
Chaining pin	1	striped metal pins

References

- Bryan, K. 1920. Origin of rock tanks and charcos. *American Journal of Science*, s4-50(297), 188-206. doi:10.2475/ajs.s4-50.297.188
- Brown, B. T., and Johnson, R. R. 1983. The distribution of bedrock depressions (tinajas) as sources of surface water in Organ Pipe Cactus National Monument, Arizona. *Journal of the Arizona-Nevada Academy of Science*, 18(2), 61-68.
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- Springer, A. E., and Stevens, L. E. 2009. Spheres of discharge of springs. *Hydrogeology Journal*, 17(1), 83-93. DOI:10.1007/s10040-008-0341-y
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- Stevens, L.E., H. Kloeppel, A.E. Springer, and D.W. Sada. 2004. Terrestrial Springs Ecosystems Inventory Protocols: Task 3 Final Report. NPS Cooperative Agreement Number CA 1200-99-009.
- Weissinger, R., M. Moran, S. Monroe, and H. Thomas. 2017. Springs and seeps monitoring protocol for park units in the Northern Colorado Plateau Network, Version 1.00. Natural Resource Report NPS/NCPN/NRR—2017/1439. National Park Service, Fort Collins, Colorado.

Appendix A - Example of Completed Data Forms

Note that data are not real and are for example purposes only

Spring Monitoring – Site Visit Information (annual)

1 Site Information		Crew Lead: <i>Ever G. Williams</i>
Site Code: <i>DRLC999</i>	Field Technicians: <i>Cheryl McIntyre</i>	
Site Name(s): <i>Example Tinaja</i>		
Date: <i>07/11/2017</i>		

2 Sample Extent and Information				
☒ Sampled	☒ Wet	☐ Dry	☐ Not Sampled (Choose One):	
☒ Site Characterization ☒ Site Condition ☒ Water Quality ☒ Water Quantity			☐ Inaccessible (explain in notes) ☐ Not safe to sample ☐ Potential resource damage too high ☐ Ran out of time ☐ Other (explain in notes)	
Precipitation within last 24 hours? ☐ YES ☒ NO				
Wet/Dry by Orifice (circle): A: <u>wet</u> / dry; B: wet / dry; C: wet / dry; D: wet / dry; E: wet / dry				
Orifice(s) Contributing to Sampling Locations on Sampled on this Visit (list all orifices by letter):				
SL1: <i>A</i>	SL2: <i>n/a</i>	SL3:	SL4:	SL5:
SL6:	SL7:	SL8:	SL9:	SL10:
Channel Length (m): <i>0m</i> (measure up to 100m)				
if >100m, circle one: 100-200m, 200-500m, >500m				
Notes:				

Spring Monitoring – Site Characterization (every 5 years, update as needed)

3 Site Access Description	Observer: CLM Ø1
Drive to east end of Broadway Blvd and park at SODN office. Hike up trail and circle around to tinaja. Hiking time: ~15 min Hiking distance: 1 mile	

4 Spring Type (circle) and Characterization		Observer: CLM Ø1	
Rheocrene	Emerges as flowing streams	Cave	Emerges entirely within cave and not directly connected to surface flow
Limnocrene	Emerges as one or more lentic pools	Exposure	Ground water exposed at surface but doesn't flow
Heleocrene	Emerges in diffuse fashion (marshy, wet meadow) settings.	Gushette	Pour from cliff face
Hillslope	Emerges on 30-60° slope w/ indistinct/multiple source	Hanging gardens	Complex, multi-habitat springs emerge along geologic contacts and seep, drip, or pour onto underlying walls
<u>Tinaja</u>	Small pool in rock basin, impoundment in bedrock	Other	
Channel Present ☐ YES ☒ NO		Slope (degrees): 5	
Channel Type (circle)	Spring discharge dominated <u>Run-off dominated</u> Mixed	Slope variability (circle)	<u>Low</u> Medium High
Number of Channels: 0		Compass declination (degrees & direction): 8E	
Multiple orifices present within 200 m? ☒ YES ☐ NO		Aspect (degrees): 172°	

5 Site Description	Observer: CLM Ø1
Describe the overall ecological community in which the spring is situated. Begin at orifice and work outward, repeat for each individual orifice. Include: a) the general landscape setting in which the site is located, b) a description of the orifice; c) the general size of the spring and the extent of the wetted area; d) a description of the channel (if present); e) the general characteristics of the spring such as flow rate, turbidity, the number of plunge pools, abundance and/or presence of macroinvertebrates, dominant substrate and disturbances; and f) notable changes to site compared to data from previous visits. Located on a south facing slope, example tinaja emerges as a rock pool in a wash. The orifice/main pool is murky and full of algae. The main pool is approximately 12m long by 7m wide. The maximum depth cannot be measured safely. There is not a springbrook present. The flow cannot be measured but the gage measurement is 2.2m. The substrate is dominated by bedrock.	

6 Vegetation Community Description

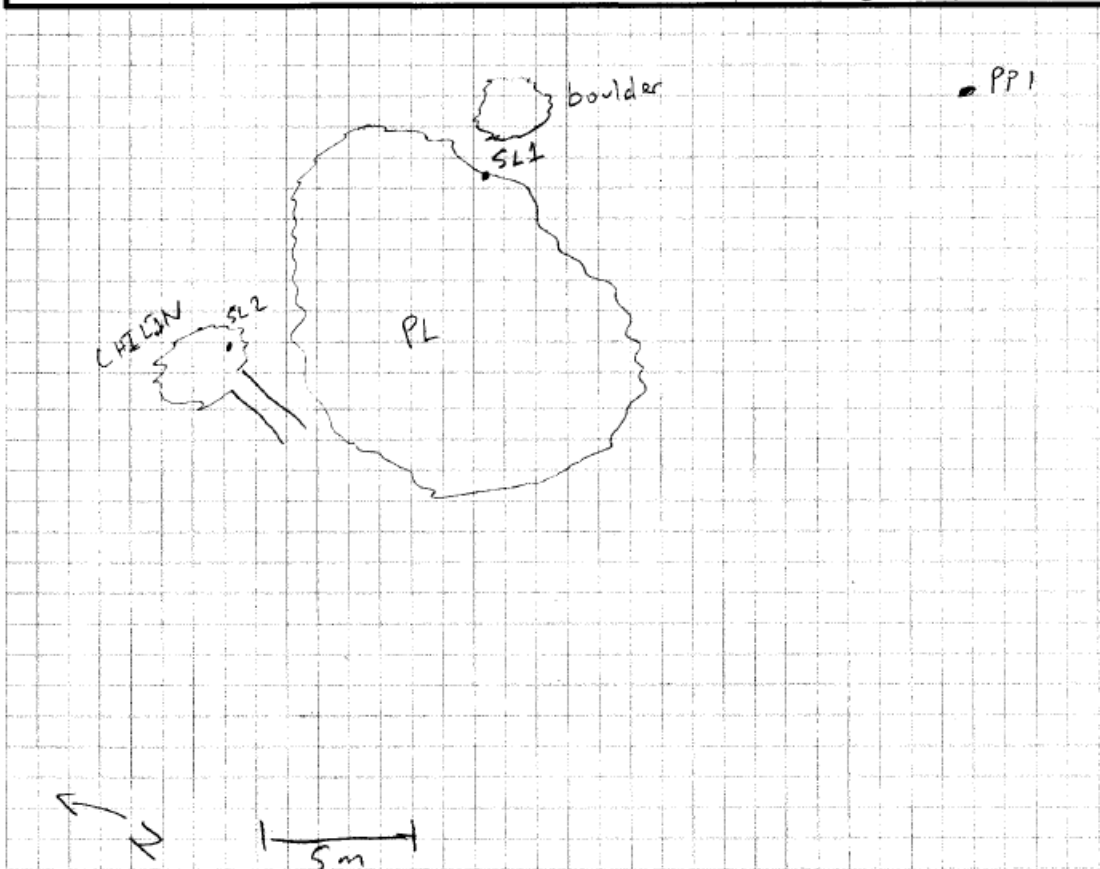
Observer: CLM φ1

Write a systematic description of the vegetation community that describes each of three strata beginning with the canopy (> 2 m), then sub-canopy (0.5 – 2 m), and finally the field (< 0.5 m) height category. The description should focus on the vegetation community that surrounds the spring and characterizes the area that is most clearly influenced by the presence of water. Other details to include should be how the water-dependent community fits into the surrounding area, how the topography of the site influences the community, and other geomorphic observations as they relate to the vegetation community. Do not compile a species list, focus on the dominant members of the community.

The canopy consists of a single CHILIN. The sub-canopy and field are predominately ARIPUR and other grass species. However, the field or sub-canopy are generally > 1 m away from the main pool due to bedrock. Other than the CHILIN, the vegetation is consistent with the surrounding uplands.

7 Site Diagram

Artist: CLM φ1



8 GPS Locations

Record/check the coordinates below for the orifices, the sampling locations, and landscape photo points.

Orifices (OR), Sampling Locations (SL#), Landscape Photo Points (PP1 ...)				Observer: CLMØ1			
Previous pts reviewed for accuracy? ☐ YES ☐ NO				GPS Unit ID: bobcat			
Feature	Latitude/UTM(N)	Longitude/UTM(E)	HDOP	PDOP	Offset (m)	Offset (°)	Offset Inclination
Orifice A	AA.BBBB	- GGG.HHHH	1.7	2.1	-	-	-
SL1	AA.BBBB	- GGG.HHHH	1.7	2.1	-	-	-
SL2	AA.BBBB	- GGG.HHHH	1.7	2.2	-	-	-
PP1	AA.CBBB	- GGG.IHHH	1.8	2.3	-	-	-

9 Sampling Location Descriptions	Observer: CLMØ1
Sampling Location <u>1</u> Associated Orifice(s): A	
Description: Approximately 8m SSE of CHILIM. Adjacent to large boulder with green lichen	

Sampling Location <u>2</u> Associated Orifice(s): n/a
Description: CHILIM (desert willow) adjacent to main pool. Tree is only tree in area

Southwest Network Collaboration

Springs, Seeps and Tinajas Monitoring Protocol: Chihuahuan and Sonoran Desert Networks

SOP #4: Photo Documentation

Version 1.00
(September 3, 2018)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #

Acknowledgements

The Landscape Photo Point section of this SOP are taken from the Southern Colorado Plateau Network's Integrated Riparian Monitoring Protocol for the Southern Colorado Plateau Network of the National Park Service - Part I, SOP #10 (Monroe et al. 2014).

Introduction

This standard operating procedure (SOP) provides step-by-step procedures for photo documentation of spring ecosystems in the Chihuahuan and Sonoran Desert networks. It describes the procedure for taking photographs used for long-term monitoring, retaking historic photographs, pointers for taking photographs, and metadata required for photographs. Additional photographs may be taken at the discretion of the field crew or the network conducting the sampling.

Minimum metadata standards are provided for each network to account for differences across networks. If crews from one network collect data in another network, the minimum metadata standards for the "home" network will be collected. Additional metadata may be collected at the discretion of the network project lead.

Landscape Photo Points

Landscape photo points are permanent locations from which the observer takes one or more landscape photographs of the spring ecosystem to document change. Since these photos will be used to document changes occurring over time, it is important that their locations are described in detail so that they can be relocated in the future. These methods are extracted from Monroe et al. (2014). See Appendix A for example datasheets (data are not real and are for example purposes only) and Appendix B for example photographs.

Establishing Landscape Photo Points

Establish a photo point in a location that will allow a landscape view of the pertinent water, soil and vegetation features to be tracked over time. Photo points should also be established for all survey control points. The selected photo points should provide good visibility of permanent distinctive features in the area and must be easy to relocate, even by first-time surveyors. The photo points should offer the most unobstructed view possible of the features being monitored and possible photo points that may not be suitable in future years due to vegetation growth, erosion, etc. should be avoided. Several photo point locations (numbered 1, 2, 3, etc.), should be established at most monitoring sites from which one or more photos (views) can be taken.

Each photo point should be given a unique number. The photo points are numbered as PP1, PP2, PP3, etc.

Use a GPS unit and spatial data application to identify coordinates for each photo point. Record the coordinates on the GPS Locations section of the datasheet.

Write a brief description of each photo point – Be as detailed as possible and include key site characteristics that are permanent (e.g. rocks, large trees). Be VERY detailed if you cannot collect coordinates with a GPS unit – note any major features, compass bearings, and distances that may help mark the point location on the site map.

Mark the name (e.g. PP1) and location of each photo point on the site map.

Taking Photographs

Ensure that the camera is on the proper settings and that the photo is in landscape orientation. In most cases, the “Automatic” setting is preferred.

Take a photo of the landscape photo point location with a person or an object at the point. This is the point where the observer will stand while taking all subsequent landscape photos from this landscape photo point. It is denoted by an “A” in the view column of the datasheet (**PP1 A** should always be a photo of a person standing at or an object placed on the first photo point at the spring, include other features for future re-location, and will help relocate the photo point in the future).

You can take several views (at different bearings) from the same photo point. Label each of these views using letters (B, C, D...). Be sure to include the areas and features to be monitored over time. Also include in the photo easily identifiable permanent features that can be easily relocated on future visits and allow for duplication of photographs. Whenever possible, try to include features that are unlikely to be impacted by vegetation growth, fire, or flood events. Ridgelines, canyon walls, or large boulders well out of the channel are likely to be visible for long periods of time. Trees or large boulders in the stream may be less permanent but often are the only features available in narrow canyons or dense riparian areas. When using these features as reference points make sure to include a variety of the most recognizable ones in each photo. This will make it more likely that at least one feature can be identified during future visits in order to repeat the same view.

Record the photo file name/number (recorded by the camera) for each photo taken on the Photo Points datasheet (Section 10).

Use a compass to determine the bearing of each photo in degrees and record on the Photo Points datasheet (Section 10).

Revisiting photo points

When you revisit a site, bring the original site visit photos, the most recent set of photos, site maps, and datasheets to aid in finding established photo points and in recreating the view photos. Also use GPS coordinates to help you locate the photo points.

If the photo point is difficult to locate, note this on the datasheet and, if necessary, refine the instructions for locating the photo point.

Stand at the photo point, referring to view A in original site visit photos, or most recent set of photos to locate the photo point.

Use the compass bearing (make sure the compass is set to the same declination as recorded on previous visit datasheets) **and previous view photos to determine proper framing** needed to repeat each view photo from this photo point.

Ensure that the camera is set to the proper settings needed to capture photographs of appropriate quality.

Carefully aim the camera to match framing and perspective of previous view photo. Line up with features such as ridgelines, rocks, and trees in previous view photos to ensure photos match as precisely as possible. Due to differences in cameras and photographers, this may require moving the camera up, down, closer or further away. In some cases (usually due to vegetation growth) the position of the camera may need to be shifted off of the actual photo point or branches moved in order to properly capture the area being monitored.

If the view from the photo point no longer provides an adequate view of the features being monitored, you may need to establish a new photo point.

Use the camera's view screen to review each photo taken to ensure proper focus and exposure have been achieved.

Record the Photo file name/number (recorded by the camera) in the Landscape Photo Points section for each photo taken.

Feature Photos

Feature photos are relatively focused or proximal views of spring orifices and sampling locations. All photos should be in landscape orientation. See Appendix A for example datasheets (data are not real and are for example purposes only) and Appendix B for example photographs. Photos should be taken of the following:

- Spring orifice(s)
- Sampling locations (locations where water quality and water quantity are sampled and where temperature sensors are deployed)

If photographs exist from a previous survey or visit, review photographs and subjects in the revisit packet. Attempt to replicate the composition of the previous photograph(s).

Select a suitable location for taking each photograph. Suitable locations should be easily accessible, relatively flat, and have a clear line of sight of the photo subject. Multiple subjects can be taken from a single location, if appropriate.

Once a suitable location has been selected, determine compass bearing (azimuth) from camera location to subject and record on photo log. After photos have been taken, review the images on the camera to ensure their quality; zooming in on key features. Retake photos as necessary. Complete the Feature Photos section of the datasheet as follows:

Site Code: Enter the alpha-numeric code for the spring site.

Site Name: Enter the Site Name as listed by NPS or as named on a USGS 7.5" topo quad.

Date: Enter the date in the following format: MM/DD/YYYY (e.g., 02/17/2018)

GPS On?: The GPS in the camera should be off. Check Yes or No regarding if the GPS in the camera is on. If the camera used does not have GPS, select No.

Camera ID: Enter the camera name which is being used. Camera name is the last five digits of the number on the property tag.

These fields should be filled out for each photograph taken (see Appendix B for example photos and associated subject, keywords, and comments):

Subject(s): Enter one or more codes that correspond to the subject content (list given at bottom of datasheet and repeated below). If multiple subjects in a photo, separate each subject with a semicolon.

Orifices: Orifice_A, Orifice_B, Orifice_C ...;

Sampling Locations: SL1, SL2, SL3, ...;

Plants: Code (TAMER) or Name (*Tamerix*);

Field Highlights: FH_People – Animal – Plant

Bearing: Enter the true bearing on the compass from your position to the subject. Be sure declination is adjusted properly. Enter these data immediately after taking the photograph while standing at the location from which the photograph was made.

File Name: Enter the numeric file name for each photograph taken. The format is usually in seven digits. Enter the entire seven digit file name for the first photograph taken at a site (e.g. File Name: 101-0807). For all subsequent photographs taken at the same site, only the last four digits need be recorded (e.g. 0808, 0809, 0810,...) unless the initial 3 digits change.

Author Initials: Enter the photographer's initials.

Crew Present: Whenever a person is in the photograph, write "Y" in the crew present box.

Description: Write a short description of each photo; be as detailed as possible and include key site characteristics. Whenever possible the description should include some of the words found in the subject entry as well as others that expand on the photo's overall context. If repeating a photo from previous visit, please indicate by including phrase retake along with year and number/name of previous photograph.

Pointers for Taking Photographs

Take care and adequate time to take the best photos possible. Some photos may be used in formal presentations and reports because of the scenic quality of the site. If the site particularly scenic, take a couple of extra photos without any scale reference or persons in the photograph; thus emphasizing the beauty of the site in its natural setting. Below are some general pointers for taking photographs.

When framing the image, compose the photo so that the subject matter is represented with as wide a view as possible while still capturing focused detail of the subject. For example, while photographing the spring orifice, step back far enough away to show the context (e.g. geology, channel morphology), the vegetation surrounding the orifice, and if warranted, a scale reference.

The sky, if present in shot, should take up no more than 10% of the frame.

Ensure that whatever crew and gear that may be in shot do not block important landmarks of the photograph. Move gear or crew that may be blocking or distracting in the shot. If crew is included in a shot, please include “crew” as a keyword. Respect crew members’ wishes if they wish not to be photographed.

Include a scale, especially for small subjects like animal tracks. If a scale or small ruler is not available, objects of known size such as a quarter or a pen can be used. For larger items, scale reference can also be made by using a 1-meter staff or even a fellow crew member if necessary.

Use lighting and angles to your advantage. At many spring sites, the riparian growth causes much contrast in shadow and light. Experiment with different camera angles and camera settings (manually) to optimize subject matter.

Be aware of what is between you and your subject as most cameras have an AutoFocus setting. With AutoFocus, the camera will seek out the closest object on which to focus (such as a tree branch in the top of the photo frame or a clump of grass in the foreground), resulting in a blurred subject but a sharply focused detail of one tree branch. Reviewing photos while still at the study site allows for option to retake a photograph.

Equipment

Item	Number needed	Notes
GPS	1	minimum 3m accuracy, with data collection application
Compass	1	with declination set
Digital camera	1	

References

Monroe, S., L.P. Thomas, R. Weissner, E.S. Soles, J.R. Norris, A. Snyder, M/L Scott, and E.W. Reynolds. 2014. Draft Integrated Riparian Monitoring Protocol for the Southern Colorado Plateau Network of the National Park Service - Part I: Monitoring hydrology, fluvial geomorphology and vegetation using field-based methods. National Park Service, Flagstaff, Arizona.

Appendix A - Example of Completed Data Forms

Note that data are not real and are for example purposes only.

 Southwest Network Collaboration Chihuahuan & Sonoran Inventory and Monitoring Program	National Park Service U.S. Department of the Interior	
	Proofread by: _____	Scanned by: _____
	Entered by: _____	Verified by: _____
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Site Code <u>DRLC999</u>	Site Name <u>Example Tinaja</u>	Date <u>10/04/2017</u>
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Landscape photo point view checklist:
A - view of photo point itself
B - landscape view from PPx
C ...- additional landscape view(s) from PPx as needed

Spring Monitoring – Site Condition

10 Landscape Photo Points		GPS On? ☐ Yes ☒ No		Camera ID: <u>bobcat</u>	
Photo Point ID (PP1, PP2, ...)	View (A, B, C, ...) <i>A must be of the photo point itself</i>	True North Bearing (°)	File Name	Author Initials	Description
PP1	A	248	101-0739	CLM01	Looking at PP1 from orifice A
PP1	B	73	0740	CLM01	View of orifice A and surrounding vegetation
PP1	C	36	0741	CLM01	View of spring brook

 Southwest Network Collaboration Chihuahuan & Sonoran Inventory and Monitoring Program	National Park Service U.S. Department of the Interior	
	Proofread by: _____	Scanned by: _____
	Entered by: _____	Verified by: _____
	Page 10 of 20	

Site Code _____	Site Name _____	Date _____
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Photograph checklist:
 1) Spring Orifice(s)
 2) Sampling Locations (any used for temp sensors, quantity, quality)

11 Feature Photos		GPS On? ☐ Yes ☒ No		Camera ID: <u>bobcat</u>	
Subject(s) (use list of options below)	True North Bearing (°)	File Name	Author Initials	Crew Present (Y/N)	Description
<u>Orifice_A; SL1</u>	236	101-0734	CLM01	Y	Orifice A, water quality, water temp sensor
<u>SL2</u>	236	0735	CLM01	Y	Water quantity sampling location
<u>SL3</u>	93	0736	CLM01	Y	Air temperature sensor location

Subjects: Orifices: Orifice_A,B,C ...; Sampling Locations: SL#; Plants: Code (XXXXXX) or Name; Field Highlights: FH_People – Animal – Plant

Appendix B - Example Photographs and Datasheet Fields



Figure 1. Example of View A from a landscape photo point showing person standing at PP1.



Figure 2. Example of View B from a landscape photo point showing orifice and surrounding vegetation.



Figure 3. Example of View B from a landscape photo point showing context of spring.



Figure 4. Example of feature photograph showing orifice (Subject = Orifice_A)



Figure 5. Example of feature photograph showing sampling location (Subject = SL1; Crew Present = Y)

Southwest Network Collaboration

Springs, Seeps and Tinajas Monitoring Protocol: Chihuahuan and Sonoran Desert Networks

SOP #5: Site Condition

Version 1.00
(September 3, 2018)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #

Acknowledgements

The disturbance assessment is slightly modified from the inventory methods developed for the Mojave Desert Network (Sada and Pohlman 2006). Don Sada made significant contributions to this document.

Introduction

This Standard Operating Procedure (SOP) describes the methodology for the Site Condition module, with the exception of photo documentation, which is covered SOP #4. The Site Condition module should be completed during every visit, even if the spring is dry. The Site Condition module includes observations of target wildlife species, invasive non-native plants, obligate/facultative wetland plants, and a categorical rating of the level of disturbance in several anthropogenic and natural disturbance categories. The disturbance assessment focuses on the condition and disturbance to vegetation or soils that may affect the condition of the spring and associated habitat (Sada and Pohlman 2006). The disturbance assessment is slightly modified from the inventory methods developed for the Mojave Desert Network (Sada and Pohlman 2006). Example datasheets are located in Appendix A (data are not real and are for example purposes only).

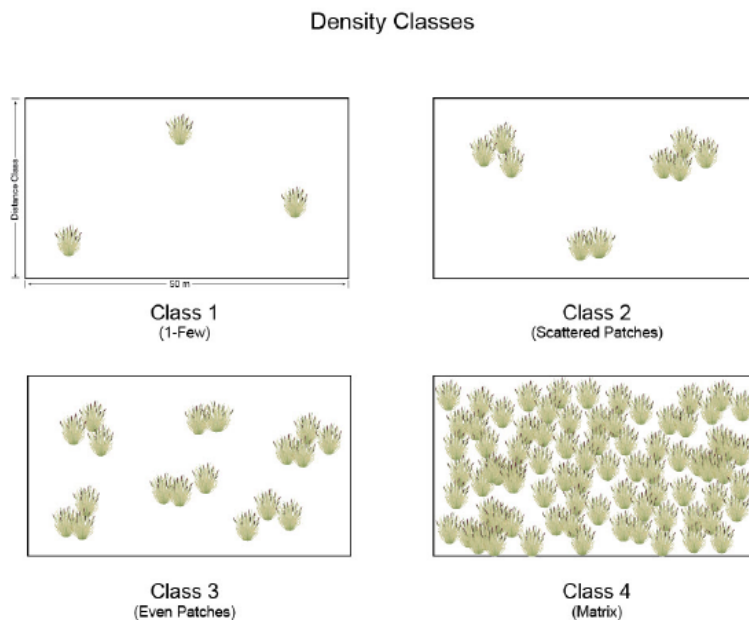
Invasive Non-native Wildlife Observations

Record observations of American bullfrogs (*Rana catesbiana*) or crayfish (*Orconectes* spp.) seen or heard in close proximity to the spring. Record the observation by circling bullfrog or crayfish on the datasheet in the “Invasive Wildlife Observations” in Section 12.

Invasive Non-native Plant Observations

Record all observations for any invasive non-native species present, using the species six digit code (first three letter of genus then first letters of specific epithet) at or near the site in the “Invasive Plant Observations” portion of the datasheet (Section 13). Lists and/or field guides may be available for these species for each park unit. Observers should carry these lists into the field for cross-referencing. For each

species encountered, record its species code and its density class (D1 = 1–5 plants; D2 = scattered patches; D3 = evenly distributed patches; D4 = matrix; – = no data; Folts-Zettner et al. 2016).



Examples of density classes (from Folts-Zettner et al. 2016).

Obligate/facultative Wetland Plants

The Obligate/facultative Wetland Plants (Section 14) contains a list of obligate/facultative wetland plants of interest (Table 1) and is modified from Sada's (2013a, 2013b) list of wetland indicator plants. Check with the network office for a field guide for these plants. Circle the families/genera/species present at the spring. For some families, genera are also listed. In those cases, circle the family (if present) and genera (if present and if possible).

Table 1. Obligate/facultative Wetland Plants of Interest (based on Sada 2013a, Sada 2013b)

Forbs	Sedges/ Rushes	Grasses	Trees/Shrubs
<i>Lemna</i> sp. (floating aquatic)	<i>Carex</i> sp.	<i>Andropogon</i> sp.	<i>Populus</i> sp.
<i>Centarium</i> sp.	<i>Cyperus</i> sp.	<i>Arundo</i> sp.	<i>Salix</i> sp.
<i>Equisetum</i> sp.	<i>Eleocharis</i> sp.	<i>Glyceria striata</i>	<i>Tamarix</i> sp.
<i>Mentha</i> sp.	<i>Fuirena</i> sp.	<i>Polypogon</i> sp.	<i>Platanus</i> sp.
<i>Mimulus</i> sp.	<i>Lipocarpha</i> sp.		
<i>Veronica anagallis</i>	<i>Schoenoplectus</i> sp.	Typhaceae (any sp.)	<i>Baccharis salicifolia</i>
<i>Lobelia</i> sp.	<i>Scirpus</i> sp.		<i>Cephalanthus occidentalis</i>
<i>Helenium</i> sp.			
<i>Phyla</i> sp.	Cyperaceae (any sp.)		
<i>Salicornia</i> sp.	Juncaceae (any sp.)		Ferns
			<i>Adiantum</i> sp.

Condition and Disturbance

Look for evidence of natural and human caused disturbances within 200m of a spring and/or springbrook. Classify disturbance factors on a scale of 1-4, where 1 = undisturbed, 2 = slightly disturbed, 3 = moderately disturbed, and 4 = highly disturbed (Sada and Pohlman 2006). Categories should be assigned for the current state of the site. Mark the level of disturbance as 1-4 next to each disturbance factor in Section 15 section. An example of the datasheet (Section 15) is presented in Appendix A. If other disturbance factors are evident, mark level of disturbance next to “other” and describe it in “Notes” section. If no other disturbance factors are present, mark “1” on the data form next to “other.” General definitions of these categories are (Sada and Pohlman 2006):

“1 = Undisturbed—no evidence of recent or historical factors or activities. Since most springs have been altered by humans, drought, fire, or flood, these types of springs are rare and most undisturbed springs are naturalizing from past disturbances.

2 = Slightly disturbed— little evidence that vegetation or soils have been disturbed. Evidence of past disturbance may be present; however disturbance of vegetation and soils due to the disturbance appears minimal or is no longer evident. Riparian vegetation community appears vigorous.

3 = Moderately disturbed—evidence of recent disturbance to vegetation or soils. Height or distribution of riparian vegetation is reduced. The disturbance could be of relatively low magnitude that covers more than half of the spring ecosystem area or of higher magnitude that covers a small portion of the ecosystem. More than 50% of spring banks are covered by vegetation. Spring brooks contain more than 50% of natural discharge, if they are impounded or dredged, or contain spring boxes that collect water.

4 = Highly disturbed— evidence of significant impact on vegetation and soils across most of the spring ecosystem. Less than 50% of the banks are covered by riparian vegetation. Spring brooks contain less than 50% of natural discharge, if they are impounded or dredged, or contain spring boxes that collect water.”

Description of Disturbance Types and Categories

The following descriptions of disturbance types and categories are meant as guides for determining disturbance severity. Not all conditions may be present and not all criteria need to be met when determining disturbance category.

Anthropogenic Disturbance

Roads and Off-highway Vehicle (OHV) Trails

- 1 Undisturbed — no roads or OHV trails present within 200m of the spring or springbrook.
- 2 Slightly disturbed — road or trail may have been present in the past, but is no longer in use; however, remnants or evidence remains. Riparian vegetation is vigorous and appears to have recovered from the disturbance or is in the process of doing so (e.g. is growing in road or trail).
- 3 Moderately disturbed — road or OHV trail is present, but located on the periphery of the spring ecosystem. Less than 50% of the spring system is affected by fill, compacted soils, or other road/trail-related disturbance. More than 50% of the spring bank has riparian vegetation.

- 4 Highly disturbed — road or OHV trail located within the riparian area. Spring may have been diverted or riparian vegetation removed to accommodate road or trail, or road or trail crosses springbrook. More than 50% of the spring system is affected by fill, compacted soils, or other road/trail-related disturbance. Less than 50% of the spring bank has riparian vegetation.

Hiking Trails – May Be Official or Social

- 1 Undisturbed — no hiking trails within 200m of the spring or springbrook.
- 2 Slightly disturbed — Recreation may be evident, but its impact on riparian or aquatic environments is minimal. Riparian vegetation is vigorous and appears to be either minimally impacted or to have recovered from the disturbance.
- 3 Moderately disturbed — trail is present, but located on the periphery of the spring ecosystem. Less than 50% of the spring system is affected by compacted soils or other trail-related disturbance. More than 50% of the spring bank has riparian vegetation.
- 4 Highly disturbed — trail located in riparian area and/or crosses spring. Spring may have been diverted or riparian vegetation may have been removed to accommodate trail. Less than 50% of the spring bank is covered in riparian vegetation.

Contemporary Human Use

Evidence includes the presence of power lines, or evidence of recreation such as campsites, fire rings, and trash.

- 1 Undisturbed — no evidence of human use.
- 2 Slightly disturbed — evidence of human use is evident; however, spring system vegetation and soils appear unaffected. Power lines are overhead only, and have no apparent effect on spring. May have few small pieces of trash present.
- 3 Moderately disturbed — presence of humans is evident. Large pieces or an abundance of trash is present. Vegetation is trampled or has reduced height and coverage from natural conditions. More than 50% of the spring bank has riparian vegetation.
- 4 Highly disturbed — campsites are large and trashy, and vehicle use is evident, and affect more than half of the spring system.

Historic Human Use

Evidence includes the presence of archaeological or historic artifacts. Historic flow alterations should be recorded under “Flow Modification.”

- 1 Undisturbed — no evidence of historic human use.
- 2 Slightly disturbed — evidence of historic human use is evident; however, spring system vegetation and soils appear unaffected.
- 3 Moderately disturbed — presence of historic humans is evident. Large pieces or an abundance of artifacts is present.
- 4 Highly disturbed — sites are large and affect more than half of the spring system.

Livestock Presence or Use

Evidence includes presence of grazing, trampling, tracks (Figure 1), and scat.

- 1 Undisturbed — no evidence of livestock.
- 2 Slightly disturbed — vegetation shows slight signs of browsing and foraging. Animal footprints and scat are present, but not prominent.
- 3 Moderately disturbed — evidence is common. Vegetation is trampled or has reduced height and coverage from natural conditions. More than 50% of the spring bank has riparian vegetation.
- 4 Highly disturbed — Hoof prints and scat are abundant. Vegetation in more than 50% of the spring system has been trampled or has reduced height or coverage.



Figure 1. Cow hoof prints.

Feral Animal Presence or Use

Evidence includes presence of grazing, trampling, tracks and scat known to be from feral animals.

- 1 Undisturbed — no evidence of feral animals.
- 2 Slightly disturbed — vegetation shows slight signs of browsing and foraging. Animal footprints and scat are present, but not prominent.
- 3 Moderately disturbed — evidence is common. Vegetation is trampled or has reduced height and coverage from natural conditions. More than 50% of the spring bank has riparian vegetation.
- 4 Highly disturbed — Tracks and scat are abundant. Vegetation in more than 50% of the spring system has been trampled or has reduced height or coverage.

Invasive non-native Plant Removal

Evidence includes cut trees, dead plants, or dye from herbicide.

- 1 Undisturbed — no evidence of invasive non-native plant removal.
- 2 Slightly disturbed — vegetation shows slight signs of invasive non-native plant removal/treatment. Signs of treatment are present, but not prominent.
- 3 Moderately disturbed — evidence is common. More than 50% of the spring bank exotic vegetation shows signs of treatment.

- 4 Highly disturbed — Evidence is abundant. Invasive non-native vegetation in more than 50% of the spring system has been treated or removed.

Flow Modification

Historically, water from many springs was dammed or diverted for human use. Consequently, the presence of old pipes, dikes, impoundments, or spring boxes are common sightings. If flow from a spring is currently being dammed or diverted, describe the diversion as thoroughly as possible, and indicate the amount of flow affected. Indicate type of flow medication(s) present in section below.

- 1 Undisturbed — no evidence of other disturbance.
- 2 Slightly disturbed — evidence of historic modification; however, no effect on spring system is apparent now.
- 3 Moderately disturbed — evidence of diversion is present. At least 50% of natural discharge remains within the natural springbrook. Neither the spring nor springbrook has been impounded.
- 4 Highly disturbed — evidence of diversion is present. Less than 50% of natural discharge remains within the natural springbrook. Either the spring or springbrook has been impounded.

Types of Flow Modifications:

- Pipe Diversion (Figure 2)
- Dam Diversion (Figure 2)
- Open trough/tank
- Pumping
- Encasement
- Excavation
- Sealed
- Cracks
- Other



Figure 2. Example of pipe (left) and dam (right) diversions

Other

Describe any other evidence of anthropogenic disturbance in the notes section. Use general categories described in beginning of overall section.

Natural Disturbance

Recent Flooding

Evidence includes an incised channel, a paucity of vegetation, debris located in vegetation or along bank, and scour (clean or bright substrate). The amount and location of debris can provide information on the magnitude of the flood. More debris is deposited during large floods, and the debris may be located higher up on trees or farther away from the spring. Floods are most likely to occur in springs located in the bottoms of gullies.

- 1 Undisturbed — no evidence of flooding.
- 2 Slightly disturbed — evidence of flooding in the distant past may be visible but riparian vegetation is vigorous.
- 3 Moderately disturbed — less than 50% of the vegetation on the springbrook bank affected by flood.
- 4 Highly disturbed — more than 50% of the vegetation on the springbrook bank affected by the flood.

Drying

Springs that dry seasonally have upland vegetation species in the riparian areas frequently and lack obligate wetland species. Plants may also be wilted, dry, stunted, or show other kinds of water stress.

- 1 Undisturbed — no evidence of drying.
- 2 Slightly disturbed — upland species are sparse, but present in riparian area. Riparian vegetation largely appears healthy and vigorous.
- 3 Moderately disturbed — Less than half of the riparian area contains upland species (remainder are wetland species). Riparian plants along the outside perimeter of the spring system are dry or appear water stressed.
- 4 Highly disturbed — spring is dry when sampled, riparian area is dominated by upland species, obligatory wetland plants are absent, more than half of the riparian plants present, including those near the orifice, are dry or appear water stressed.

Fire

Evidence includes burned or scarred tree trunks or soils, soot on rocks.

- 1 Undisturbed — no evidence of fire.
- 2 Slightly disturbed — evidence of fire in the distant past may be visible but riparian vegetation is vigorous.
- 3 Moderately disturbed — more than 50% of the springbrook bank is covered by vegetation. Erosion is minimal. Few dead trees are present.

- 4 Highly disturbed — less than 50% of the spring bank is covered by vegetation. Erosion is evident. Numerous dead trees are present.

Non-Livestock (Wildlife) Use

Wildlife using springs may include deer, elk, bear, javelina, etc. Evidence includes presence of grazing, trampling, rooting, tracks, and scat.

- 1 Undisturbed — no evidence.
- 2 Slightly disturbed — vegetation shows slight signs of browsing and foraging. Animal footprints and scat are present, but not prominent.
- 3 Moderately disturbed — evidence is common. Vegetation is trampled, not rooted, or has reduced height and coverage from natural conditions.
- 4 Highly disturbed — Hoof prints and scat are abundant. Vegetation in more than 50% of the spring system has been trampled or has reduced height or coverage.

Windthrow

Evidence includes uprooted trees.

- 1 Undisturbed — no evidence of windthrow.
- 2 Slightly disturbed — past evidence exists; riparian area appears to have recovered and is healthy and vigorous.
- 3 Moderately disturbed — a few trees are down and less than 50% of the spring system is affected.
- 4 Highly disturbed — numerous trees are down and more than half of the spring system is affected. Erosion is present.

Insect Infestation

Evidence includes dead or defoliated vegetation.

- 1 Undisturbed — no evidence
- 2 Slightly disturbed — past evidence exists; riparian area appears to have recovered and is healthy and vigorous.
- 3 Moderately disturbed — a few trees are dead or have significant defoliation or less than 50% of other plants dead or defoliated. Less than 50% of the spring ecosystem is affected.
- 4 Highly disturbed — numerous trees are dead or have been defoliated or majority of plants dead or defoliated. More than 50% of the spring system is affected.

Beaver Activity

Evidence includes the presence of dams, slides, and characteristically chewed woody plant species.

- 1 Undisturbed — no evidence

- 2 Slightly disturbed — past evidence exists; riparian area appears to have recovered and is healthy and vigorous.
- 3 Moderately disturbed — a few trees show evidence of chewing or a small dam is present. Less than 50% of the spring ecosystem is affected.
- 4 Highly disturbed — numerous trees show evidence of chewing or large dam or slide is present (large relative to the size of the spring). More than half of the spring system is affected.

Other

Describe any other evidence of natural disturbance in the notes section. Use general categories described in beginning of overall section.

Equipment

Item	Number needed	Notes
Invasive non-native plant guide	1	In development
Wetland plant guide	1	In development

References

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Appendix A - Example of Completed Data Forms

Note that data are not real and are for example purposes only

12 Invasive wildlife Observations	Observer: <i>CLM/PI</i>
Circle the species present at the spring. <i>none</i>	
Bullfrog	Crayfish
Comments: (use this field to document details of species observed and indirect invasive wildlife presence/use)	

13 Invasive Plant Observations			Observer: <i>CLM/PI</i>	
Species Code	Density Class		Species Code	Density Class
<i>CYN DAC</i>	<i>D1</i>			
Notes:				

* Density class: D1 = 1-5 plants; D2 = scattered patches; D3 = evenly distributed patches; D4 = matrix

14 Obligate/facultative Wetland Plants			Observer: <i>CLM/PI</i>
Circle the families/genera/species present at the spring. For some families, genera are also listed. In those cases, circle the family (if present) and genera (if present and if possible).			
Forbs	Sedges/ Rushes	Grasses	Trees/Shrubs
<i>Lemna</i> sp. (floating aquatic)	<i>Carex</i> sp.	<i>Andropogon</i> sp.	<i>Populus</i> sp.
<i>Centarium</i> sp.	<i>Cyperus</i> sp.	<i>Arundo</i> sp.	<i>Salix</i> sp.
<i>Equisetum</i> sp.	<i>Eleocharis</i> sp.	<i>Glyceria striata</i>	<i>Tamarix</i> sp.
<i>Mentha</i> sp.	<i>Fuirena</i> sp.	<i>Polypogon</i> sp.	<i>Platanus</i> sp.
<i>Mimulus</i> sp.	<i>Lipocarpa</i> sp.		
<i>Veronica anagallis</i>	<i>Schenoplectus</i> sp.	Typhaceae (any sp.)	<i>Baccharis salicifolia</i>
<i>Lobelia</i> sp.	<i>Scirpus</i> sp.		<i>Cephalanthus occidentalis</i>
<i>Helenium</i> sp.			
<i>Phyla</i> sp.	Cyperaceae (any sp.)		
<i>Salicornia</i> sp.	Juncaceae (any sp.)		
			Ferns
			<i>Adiantum</i> sp.

15 Condition and Disturbance		Observer: <i>CLM/PI</i>
Examine 200m around spring and/or brook for anthropogenic and natural disturbances and assign severity class 1-4:		
1 = Undisturbed (no evidence of recent or historical disturbance) 2 = Slightly Disturbed (little evidence that veg/soils disturbed recently. Riparian community vigorous.) 3 = Moderately Disturbed (low magnitude over >1/2 of spring ecosystem OR higher magnitude over small portion. 4 = Highly Disturbed (significant impact on veg & soils across most of the spring ecosystem.		
Anthropogenic Disturbance Categories	1 - 4	Natural Disturbance Categories
Roads/OHV trails	1	Recent flooding
Hiking trails	3	Drying
Contemporary human use	3	Fire
Historic human use	1	Non-livestock (wildlife) use
Livestock (trampling, grazing, droppings)	1	Windthrow
Feral animals (manure, trailing, trampling)	1	Insect infestation
Exotic plant removal (cut trees, herbicide)	1	Beaver activity
Flow Modification	3	Other (describe in notes section)
Other (describe in notes section)	1	
Notes:		

Southwest Network Collaboration

Springs, Seeps and Tinajas Monitoring Protocol: Chihuahuan and Sonoran Desert Networks

SOP #6: Water Quality

Version 1.00
(September 3, 2018)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #

Acknowledgements

Geoff Moret of the Mojave Desert Network made significant contributions to this document.

Introduction

This Standard Operating Procedure (SOP) describes the methodology for collecting water quality data in spring ecosystems.

Water quality measurements will be conducted to meet standards set by the National Park Service's Water Resources Division (WRD) and state agencies within the two networks, which set standards for calibrating multiparameter meters. The calibration procedure described in this SOP meets WRD standards. Networks may choose to alter calibration frequency at the discretion of the protocol lead, to meet state and other relevant regulations. The protocols must be followed to collect credible data that could be used to detect long-term changes in water quality or be defended in court.

Water quality should be measured immediately after arrival at the site, before the water at the orifice is disturbed. To the extent possible, measurements should be taken at the same time of day on repeat visits. Example datasheets are located in Appendix A (data are not real and are for example purposes only).

Collecting Water Chemistry Samples

Water Samples Analyzed with the Spectrophotometer

Water should be collected from the same sampling locations as the core water quality measurements (collected with the multiparameter meter). Only a single bottle is collected per sampling location. In the case where multiple multiparameter measurements are collected, the bottle sample should be collected at the surface of deep springs and in the middle of wide springs.

1. Prior to departing for a spring, sample bottles should be cleaned and rinsed 3x with deionized (DI) water.
2. Rinse the bottle with water from the spring a minimum of 3 times by collecting water in the bottle, loosely capping the bottle, shaking it vigorously, then pouring out the contents. Contents should be poured downstream from the collection site to minimize disturbance of the water, substrate, or detritus at the collection site.
3. When collecting the water sample, take care not to introduce silt, sediment, organic matter, or other material into the sample.
 - a. If water is sparse, difficult to access, or very susceptible to disturbance by moving sediment, use a syringe and hose system that has been rinsed 3x with DI water to collect the sample.
 - b. Refer to the appropriate task instruction (TI) for the measurements being taken to determine whether any special precautions or treatment of the water sample is required.
 - c. Refer to the appropriate TI for the measurements being taken to verify volume of water to be collected.
4. Label the bottle with tape and a permanent marker.
5. Record the contributing orifice(s), bottle ID, and whether there was soil contact (if any part of bottle came into contact with the substrate) during the sample collection in the Water Chemistry Sample section of the datasheet (Section 17). An example data form is located in Appendix A.
6. Make detailed documentation of where the measurements are taken, either at an existing or new Sampling Location on the Sampling Location datasheet (Section 9) following the guidance in SOP #3 (Site Characterization).
7. Keep water in a dark, cool (if possible) location until it can be processed.
8. Process as appropriate upon return from the field for the day (see Water Quality Analysis using the YSI Spectrophotometer TI) and record data in the Water Chemistry Analysis section of the datasheets (Section 17b). Water chemistry analyses for springs monitoring are alkalinity, chloride, magnesium, sulfate, potassium, and calcium.

Water Samples Analyzed with the Turbidimeter

The water sample for turbidity is a subsample of the photometer sample. Process as appropriate upon return from the field and record data in the Turbidity section of the datasheets (Section 18) (see Water Quality Analysis using the HACH® 2100 Q Turbidimeter SOP/TI).

Water Samples Analyzed at a Certified Laboratory

The collection and labeling procedures for water samples sent to a certified laboratory for analysis is the same as that described above, unless the sample needs to be preserved with a buffering solution or other chemical. In this case, follow instructions provided by the lab. Samples should still be taken at or near the orifice, and care should be taken not to introduce silt or other contaminants into the sample. If the laboratory provides a pre-washed bottle, rinsing is generally not necessary, unless described by the laboratory procedures.

Blank and control samples should be collected for each series of samples collected within a management area. A blank sample is a bottle of DI (appropriate DI-type for the tests) that is given to the laboratory to verify results and methodology, and it provides additional insight into cleanliness of equipment, awareness of operator error, and problems with field kits. A control sample is a solution of known concentration that is submitted to the laboratory as a field sample. This sample is analyzed to verify laboratory results. Generally, a minimum of 10% control or blank samples should be sent to the lab during a field season.

Chain of Custody (COC)

A COC form must be maintained to track samples collected in the field and sent to a laboratory for analysis. The following procedures should be employed for the COC:

1. A COC must accompany all samples accepted into the laboratory. Upon delivery, a laboratory number must be assigned to each sample. This number must be recorded on the COC and cross-referenced to each individual sample.
2. When all samples on the COC are accounted for, then the individual delivering the samples must sign the “Released by” portion of COC form and the laboratory personnel must sign the “Received by” portion of the COC form. The original COC form must be retained at the laboratory, and a copy retained by the project supervisor.
3. Samples and COCs must be kept in a safe repository until processing is complete. The COC must also be maintained for any samples sent for verification or quality assurance. A copy of each COC must also be maintained in permanent laboratory records.
4. Samples should be released from the laboratory only when the COC is completed properly and samples are ready for release.

Collecting Core Water Quality Parameters

Calibration of Multiparameter Meters

Multiparameter meters and optical dissolved oxygen instruments (when available) will be calibrated prior to departure for each field tour and a minimum of **once per day**, prior to the sampling event. Where possible, the calibration will take place at each site, immediately before data collection. However, in most cases, calibration will occur prior to departing for the day. Specific instructions for calibrating particular multiparameter meters and optical dissolved oxygen instruments are provided in the TI. Pre-sampling calibration information will be recorded in the calibration data form.

Dissolved Oxygen (DO)—One-point DO calibrations are accomplished by partially sealing (one turn) the sensor container (a specially manufactured jar or a port built into the instrument) or by using the storage sleeve (optical) with water saturated-air (e.g., 100% DO saturation). If a container is not available, the sensor can be wrapped in a water-saturated towel. Several minutes should be allowed to elapse before the calibration is performed to allow the air to equilibrate with the water. If a transparent container is used, it should be protected from direct sunlight to prevent temperature increases. In order to calibrate the DO sensor, either the air pressure (measured by the instrument itself or with a hand-held barometer) or the elevation (read from a topographic map) must be entered.

Conductivity—A one-point calibration is conducted, using 1,413 $\mu\text{S}/\text{cm}$ conductivity standard. The calibration is followed by a check using 447 $\mu\text{S}/\text{cm}$ or 200 $\mu\text{S}/\text{cm}$ conductivity standards. Meters should be rinsed with de-ionized (DI) water and conductivity solution prior to performing the calibration.

pH—A two-point calibration with pH 7 and pH 10 buffers is appropriate for most arid-land springs. A pH 4 buffer may be added, if necessary.

Temperature—Temperature sensors will be checked prior to each field tour by comparing them to a separate NIST-traceable thermometer. If the temperature sensor does not meet standards ($\pm 0.5^{\circ}\text{C}$), the temperature probe must be replaced.

Field Data Collection

Water temperature, DO, pH, specific conductivity, and total dissolved solids will be collected using a multiparameter meter and an optical dissolved oxygen instrument (if available). Instructions for using and calibrating the instruments are provided in equipment specific (TI).

1. Prior to entering the field each day, ensure meter/instrument has good batteries and is in working order. Conduct pre-sampling calibration as outlined in above and described in detail in TI.
2. Record Meter ID and Observer in the Water Quality (Section 16). An example data form is located in Appendix A.
3. Place the meter as close to the orifice as possible in a suitable sampling location. The meter should be placed at the same sampling locations as where the water chemistry samples are collected. Ensure that the meter is covered entirely by water. Minor excavation at the orifice may be conducted to accommodate the meter. Make sure to wait until any disturbed sediment settles before sampling.
4. Make detailed documentation of where the measurements are taken, either at an existing or new Sampling Location on the Sampling Location (Section 9) datasheet following the guidance in SOP #3 (Site Characterization).
5. Take measurements as described in the TI appropriate for the meter in use.
 - a. In springs where the source is a spring box, measurements should be collected in the spring box. For all spring boxes, three measurements should be taken to prevent the inclusion of outlier data.
 - b. In rheocrene springs without spring boxes that are **at least 1 m wide at the sampling location** (near the spring source), three measurements should be made across the springbrook at 25%, 50%, and 75% of the wetted width. The measurements should be made at mid-water column depth. All parameters should be recorded for each measurement. Record the 25%, 50%, and 75% wetted width measurements in the sample 1, 2, and 3 columns on the datasheet, respectively.
 - c. In limnocrene springs without spring boxes, depth profiles of core parameters should be collected (if depth is > 0.3 m). The total depth of the pool should be measured, if it is possible to do so safely and without causing significant disturbance. Measurements are made near the surface, at 1/3 of the total depth, at 2/3 of the total depth, and near the bottom. Record the 1/3, 2/3, and near bottom measurements in the sample 1, 2, and 3 columns on the datasheet, respectively.
6. Record the sampling location, time of day, temperature ($^{\circ}\text{C}$), DO (% and mg/L), specific conductivity ($\mu\text{S}/\text{cm}$), total dissolved solids (TDS; mg/L), pH, and contributing orifice(s) in the Water Quality section of the datasheet (Section 16). Circle to indicate if location of measurement

is in full sun, partial sun, or shade at the time of the sample. Make any additional notes on the datasheet. An example data form is located in Appendix A.

7. If problems with the meter are suspected, collect three readings to prevent the inclusion of outlier data.
8. If multiple orifices are present, measurements should be taken at each orifice.

Post-calibration Check of Multiparameter Meters

The purpose of the post-calibration check is to ensure that the instrument held calibration during sampling. You must compare the post-calibration values to the expected value for each standard. If the post-calibration values fall outside the error limits for any of the parameters (Table 1), then the data do not pass QA and cannot be reported. Post-calibration check information will be recorded in the calibration data form.

Do not use the calibration menu for the post-calibration check. As this is a check of the readings against expected values, simply take the readings for each standard, using the following steps:

1. Rinse probes thoroughly with DI water.
2. Fill the calibration cup with the appropriate standard and record the measurements for all standards, following the TI for rinsing between standards (1413 and 447 for conductivity, 7 and 10 for pH).
3. Post-calibrate for DO by repeating steps 1, 2, and 5 of section 4.1.3 of the TI. Again, do not actually calibrate any parameter at this time.
4. Record values in the post-calibration section of the data form.
5. Determine whether the instrument passed the post calibration using Table 2.

Table 2. Acceptable errors for pre- and post-calibration of multiparameter meter.

Parameter	Error Limit
DO	± 6 % saturation
pH	± 0.2 S.U.
Specific Conductivity	± 3% >200; 5% ≤200

Equipment

Item	Number needed	Notes
Multiparameter meter	1	An additional stand-alone meter for dissolved oxygen may also be needed
Calibration solutions	4	pH 7 and 10, conductivity 1413 and 447 or 200 µS/cm
Deionized water	1	

Item	Number needed	Notes
Calibration cup	1	
Flow cup	1	
Protective sleeve	1	
Spectrophotometer	1	
Reagent tablets	5	
Turbidimeter	0 or 1	SODN uses turbidimeter, CHDN does not.
Sample bottles	1 min.	More bottles may be required if collecting samples for laboratory analyses

Appendix A - Example of Completed Data Forms

Note that data are not real and are for example purposes only

Spring Monitoring – Water Quality

16 Water Quality		Meter ID: 606		Observer: CLM 01	
•Rheocrene springs $\geq 1\text{m}$ wide (no springboxes): measure at 25%, 50%, and 75% of wetted width, all at mid-water column depth. •Source is a springbox: Repeat measurements 3 times and collect in the springbox. •Limnocrene springs > 0.3 m deep (no springboxes): Measure total depth of the pool, and take measurements near the surface, at 1/3 of the total depth, at 2/3 of the total depth, and near the bottom.					
Sample	#1	#2	#3	#4	
Sampling Location	1				
Width/depth for special cases	surface				
Time (24 hr)	1030				
Temp (°C)	14.8				
DO (%)	57.8				
DO (mg/L)	5.85				
SPC ($\mu\text{S}/\text{cm}$)	461.5				
TDS (mg/L)	8.17				
pH	7.6				
Sunlight	Shade Partial Sun	Shade Partial Sun	Shade Partial Sun	Shade Partial Sun	
Quality Issue?	O YES ☒ NO	O YES O NO	O YES O NO	O YES O NO	
Sampling/Quality Notes					
Additional Notes: Could only safely sample surface					

17a Water Chemistry Sample		Observer: <i>CLM/DI</i>	
<i>*Remember that water quality and water chemistry samples should be collected at the same locations*</i>			
Sample	#1	#2	#3
Sampling Location	<i>1</i>		
Width/depth for special cases	<i>surface</i>		
Time (24 hr)	<i>1040</i>		
Bottle ID	<i>Newt</i>		
Soil Contact?	☐ YES ☒ NO	☐ YES ☐ NO	☐ YES ☐ NO
Sampling/Quality Notes			
Additional Notes: <i>could only safely sample surface</i>			

17b Water Chemistry Analysis		Spectrophotometer ID: <i>CHDV</i>		Observer: <i>CLM/DI</i>	
All measurements in mg/L					
Sample ID-Bottle ID	<i>Newt</i>				
Processed Time (24 hr)	<i>1620</i>				
	Value	Dilution Factor	Value	Dilution Factor	Value
Alkalinity Test #002 0-500 mg/L (undiluted)	CaCO ₃	<i>275</i>	<i>1</i>		
Chloride Test #051 0-500 mg/L (undiluted)	Cl	<i>11</i>	<i>1</i>		
Magnesium Test #021 0-100 mg/L (undiluted)	Mg	<i>32</i>	<i>1</i>		
Sulphate Test #032 0-200 mg/L (undiluted)	SO ₄	<i>92</i>	<i>1</i>		
Calcium Test #060 0-500 mg/L (undiluted)	Ca	<i>104</i>	<i>1</i>		
Potassium Test #030 0-12.0 mg/L (undiluted)	K	<i>4</i>	<i>1</i>		
If the photometer indicates the sample is above the test range (">>") will be displayed, dilute the sample and repeat the test. If the test result is below the detection limit of the photometer, "<<" will be displayed. In this case, record -3333 on the data form (for non-detect).					
Notes:					

18 Turbidity				Observer: <i>CLMBI</i>		Sensor ID: <i>SODN3</i>	
All measurements in NTU							
Calibration		Bottle ID: <i>george</i>		Bottle ID:		Bottle ID:	
		Time: <i>1045</i>		Time:		Time:	
20 NTU	<i>19.3</i>	Sample 1	<i>5.37</i>	Sample 1		Sample 1	
100 NTU	<i>97.0</i>	Sample 2	<i>4.68</i>	Sample 2		Sample 2	
800 NTU	<i>774</i>	Sample 3	<i>4.69</i>	Sample 3		Sample 3	
10 NTU	<i>10.1</i>	Mean		Mean		Mean	
		St Dev		St Dev		St Dev	
Notes:							

Southwest Network Collaboration

Springs, Seeps and Tinajas Monitoring Protocol: Chihuahuan and Sonoran Desert Networks

SOP #7: Water Quantity

Version 1.00
(September 3, 2018)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #

This Standard Operating Procedure (SOP) describes the methodology for collecting water quantity data in spring ecosystems. The water quantity module has three components: discharge, wetted extent, and persistence. Example datasheets are located in Appendix A (data are not real and are for example purposes only).

Discharge - Volumetric Procedure

The volumetric procedure should be used in springbrooks that are too small to use a flow meter (e.g., depth < 0.1m or width < 1.2m). such as in is most springs in Chihuahuan Desert Network (CHDN) and Sonoran Desert Network (SODN). The volumetric procedure involves measuring the time required for a spring's discharge to fill a container of known volume. Discharge is calculated in the database by dividing the container's volume by the time needed to fill it and scaling based on the percent of flow captured. This procedure requires two persons to complete; one to collect water in the container and another to time the measurement.

1. Select location for measurement. Ideally, the location should be close to the primary orifice and all water is concentrated or funneled into one area small enough to be captured in a container. If multiple orifices are present, measure discharge at each orifice to determine discharge of the entire site. If measurement of each orifice is not possible, choose a sample location below the orifices that contribute the majority of the flow. When resampling a site, measurements should be conducted at a previously-established sampling location (refer to GPS points, photos, and descriptions of sampling locations in the revisit packet to re-locate the measurement location).

Weirs, flumes, PVC, and other “funneling” devices may be used to funnel water into one location for measurement. Rocks and other debris may also be used as impoundments to funnel water. Be creative, but mindful of your impact on the spring. Any impoundments or alterations must be removed when measurement is complete.

2. On the Discharge – Volumetric datasheet (Section 19), circle which orifice you are measuring. Also record the time that measurements begin and end.
3. Select a container (Ziplock bag, graduated cylinder, bucket, etc.) that is sufficiently large to hold all the water that flows for 10 or more seconds. Timed intervals are usually accurate within 1 second, consequently, times less than 10 seconds should be avoided by using a larger container. Times less than 5 seconds are not permitted.
4. Collect water in the appropriate container for the agreed upon duration. When the time is up, measure the volume captured with a graduated cylinder (to nearest 5 mL). This requires two persons to complete; one to collect water in the container and another to time the measurement.
5. Record collection duration and volume on datasheet (Section 19) (example in Appendix A).
6. Collect measurements at same location five times.
 - a. Measured volumes should be within 5% of each other. If this standard is not met, the measurements should be repeated.
7. On the datasheet (Section 19), record percentage of flow captured, container type and size.
8. Make detailed documentation of where the measurements are taken, either at an existing or new Sampling Location on the Sampling Location datasheet following the guidance in SOP #3 (Site Characterization).
9. Remove any impoundments or alterations.

Wetted Extent

Springs with Standing Water

For springs with standing water (e.g., limnocrenes, heleocrenes, or some tinajas), three or five length and width measurements (in meters) are taken to determine the pooled water area (Figure 1). Three length (width) measurements are taken when the spring is less than 30m wide (long), and five length (width) measurements are taken when the spring is greater than 30m wide (long). Measurements should be spaced equidistantly across the pool. Length (parallel to flow) and width (perpendicular to flow) measurements should be taken at a perpendicular angle. Measurements may be taken using any method, such as using tape measures (most common) or electronic survey equipment, such as a total station. If the wetted edge is not obvious (e.g., when substrate is soft or spongy), press your fingers into the substrate. If water pools into the depression, you have not reached the wetted edge. Exclude dry areas if multiple channels, islands (raised areas supporting vegetation of any size), bedrock, or large boulders (> 1m on intermediate access) or other obstructions (>1m) are present. For example, a damp spot on bedrock would be excluded as the wetted width. Rocks on the surface of the channel that stick up above the water surface are included in the measurement. Record the measurement method, length, width, and depth measurements (to nearest 0.5cm), and any notes in the Wetted Extent (Limnocrene) (Section 20a) of the datasheet. Depth measurements are taken at the intersection of the width/length lines along the middle transect only (Figure 1).

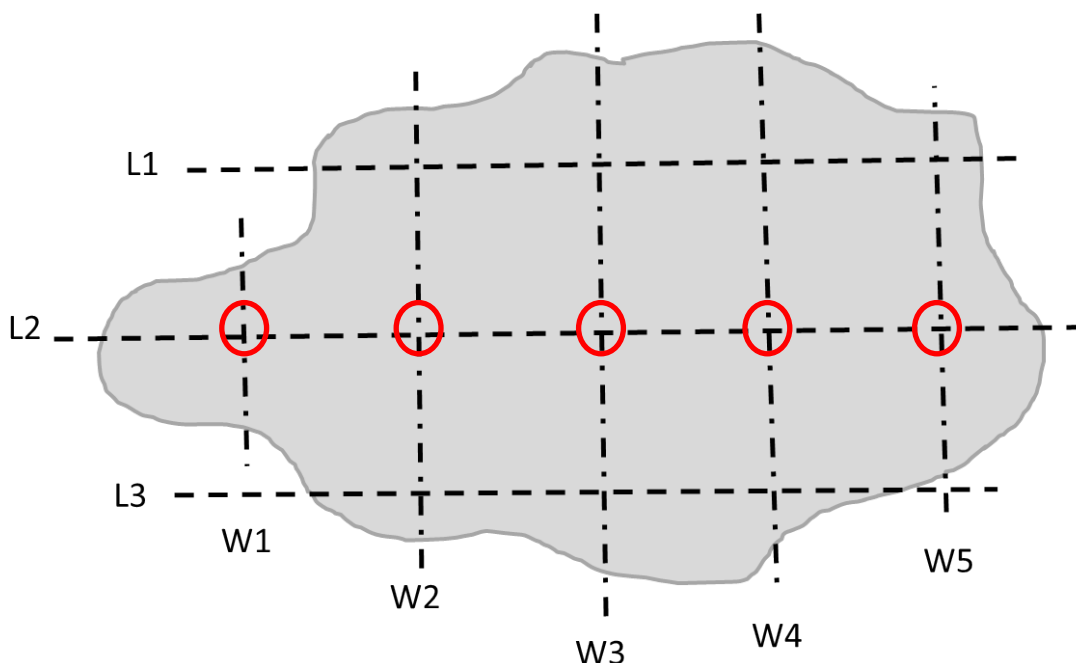


Figure 1. Example of measuring wetted extent of springs with standing water (limnocrene, heleoecrene). In this example, because the longest length is greater than 30m, 5 width measurements are necessary. As the widest width is less than 30m, then only 3 length measurements are necessary. Red circles indicate the locations of depth measurements.

Springs with Flowing Water

For springs with flowing water (i.e., rheocrenes, or some tinajas), measurements for wetted extent and depth are focused on the first 100m of the **main** springbrook. Determine the length of the main springbrook in meters by running a measuring tape down the center of the brook, following bends as best as possible. In the case of intermittent flows within 100m of the orifice, include dry areas of channel when less than 10m long. If the dry section is greater than 10m, treat the upstream edge of the dry section as the end the brook, and note on the data sheet that flows continue intermittently. If possible, estimate the extent of the intermittent flow, and include in the notes section of the data form. Record the brook length included in sample on the Wetted Extent & Substrate (Rheocrene) datasheet (Section 20b).

The number of wetted-width measurements to be sampled depends on the springbrook length (Table 1). If the brook length is ≤ 30 m, wetted width measurements are taken at 10 equally-spaced locations along the length of the springbrook, starting 1m downstream of the orifice. If the brook length is >30 m and ≤ 50 m, measurements are taken at 15 equally-spaced locations, starting 1m downstream of the orifice. If the brook length is >50 m, wetted width measurements are taken at 20 equally-spaced locations, starting 1m downstream of the orifice. For brooks > 100 m, 20 equally-spaced locations are concentrated in the first 100 m, starting 1m downstream of the orifice. To find the distance between sampling locations, divide the brook length by the appropriate number of samples. For brooks >100 m, the sampling interval is 5m. For brooks <10 m, subtract 1m from the brook length and then divide by 10 to get the sampling interval. Record the distance between sampling locations as Transect Interval on the datasheet. The first sampling location is always 1m downstream of the orifice. Using the sampling interval, transects are then allocated along the tape used to measure length of the brook at equidistance from each other.

In the case of multiple springbrooks that merge downstream, only record wetted extent for the main spring brook.

Table 1. Spring brook length, total number of transects, and transects on which depth is measured.

Spring Brook Length	# Transects	Transects for Depth Measurements	
		Odd Numbers	1, 3, 5, 7, 9
≤30m	10	Odd Numbers	1, 3, 5, 7, 9
>30m to ≤ 50m	15	Every 3 rd	1, 4, 7, 10, 13
>50m	20	Every 4 th	1, 5, 9, 13, 17

Measuring Wetted Width

The wetted width is a linear measurement taken perpendicular to direction of the channel. At each transect, measure and record the distance (to nearest 0.5cm) from point to point where water exists above the surface of the ground. If overhanging banks occur, measure to where the water extends beneath the bank. If multiple channels, measure each channel separately (using the same measurement interval) until the channels merge. Exclude the dry areas in the measurement if the channel is braided, or if islands (raised areas supporting vegetation), bedrock, or large boulders (>1,024mm) are present. For example, if a measurement occurred across an island, the width would be the sum of the wetted sections on either side of the island and a damp spot on bedrock would not be included as the wetted width. Rocks on the surface of the channel that stick up above the water surface are not excluded from the measurement. If the wetted edge is not obvious (e.g., when substrate is soft or spongy), press your fingers into the substrate. If water pools into the depression, you have not reached the wetted edge.

Measuring Depth, Detritus and Substrate

Five of the wetted width transects are used to establish transects along which water depth will be measured at three equally-spaced locations (Table 1):

- When 10 locations are measured for wetted width, depth measurements will be taken on odd numbered locations (transect 1, 3, 5, etc).
- When 15 transects are measured, depth will be measured at every third location.
- When 20 transects are measured, depth will be measured at every fourth location.

Along each transect, water depth is measured in three locations if wetted width is > 10cm (Figure 2) or in one location if wetted width is • 10cm. Where the wetted width of the springbrook is • 10cm, sample in the middle of the transect by dividing the wetted width by 2. To determine depth measurement locations where wetted width is >10cm, divide the wetted width measurement by three. The result is the sampling increment. Take the left measurement at one-half the increment width from the left bank, take the middle measurement in the middle of the wetted width, and the right measurement at one-half the increment distance from the right bank. For example, if the wetted width is 3m, the measurement increment is 1m. Measurements will be taken at 0.5, 1.5, and 2.5m from the left bank. Dry areas excluded from the wetted width measurement should also be excluded from depth measurement by measuring increment only along

wetted portion of brook. Right and left bank are defined by your right-hand and left-hand side when looking downstream/away from the orifice.

Measure water depth (to nearest 0.5cm) from the top of the substrate to the water's surface. If the measurement location lands on a rock that projects above the water, either move the rock (if can be done safely) or move the measurement to one side of the rock. In either case, record the substrate as that protruding rock.

Record the size of the substrate (in mm) directly beneath the ruler used to measure water depth. If the particle is not embedded, pick up the particle and see which opening it fits through on a gravelometer (Table 2). Record the opening size on the data sheet. 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 (or can estimate). If you encounter bedrock, record the substrate size as 4096mm. If you encounter silt, record the substrate size as 0.06mm. If you encounter sand, record the substrate as 2mm.

Record the depth of detritus in millimeters. Detritus is dead particulate organic matter that has settled onto the streambed. Living algae is not detritus. To conduct the detritus depth measurement, insert the measuring instrument in the detritus layer until the instrument touches the channel bottom (e.g. at the point in which resistance occurs). Do not insert the instrument into to mud or silt layer below the detritus; doing so can result in an inaccurate measurement. If detritus is not present, record zero for the detritus depth in the appropriate cell.

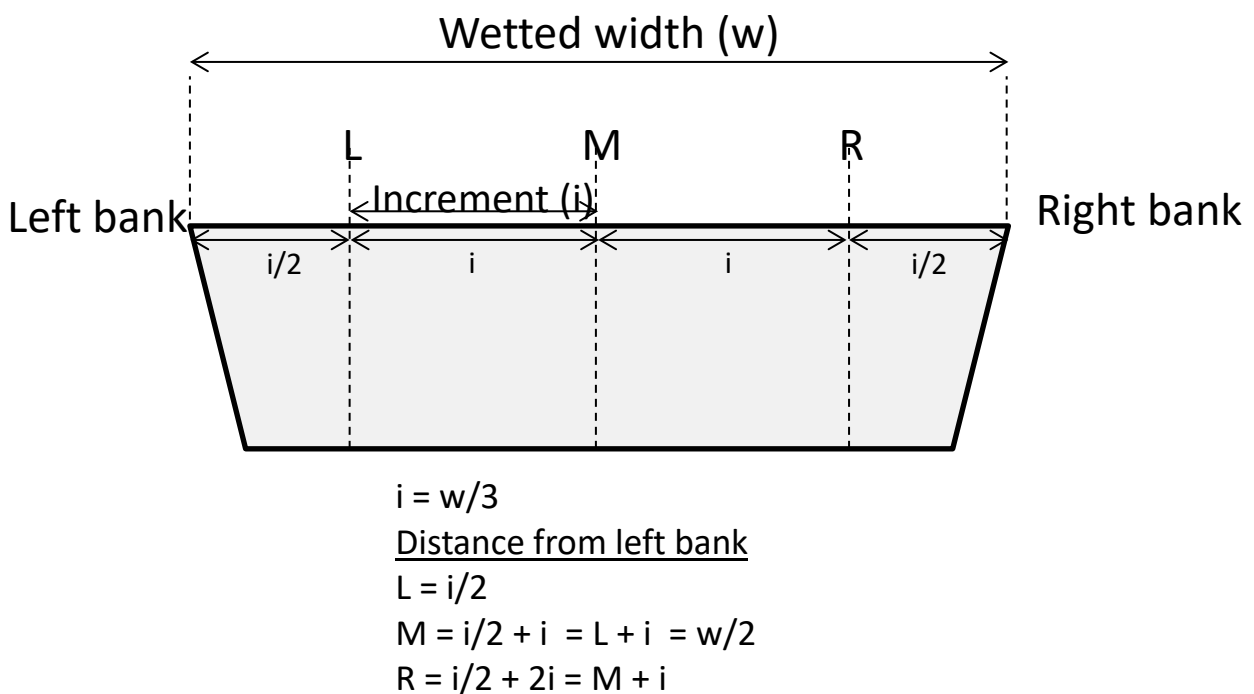


Figure 2. Calculating left, middle, and right sampling locations based on the wetted width.

Table 2. Wolman pebble count size classes using Gravelometer (modified from Harrelson et al. 1994).

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	$4096 < X$

Springs without Weasurable Water Depth

In the case of springs that consist of wet spots on rock or soil or have laminar flow, measure width and length of the wetted area as described for springs with standing water. The number of length or width measurements may be reduced at very small springs, such that the minimum distance between length or width measurements is 10cm.

Persistence Sensor Deployment/Retrieval

The persistence of springs is measured continuously using an electronic data recorder such as a temperature sensor, humidity sensor or a pressure transducer. The device will be deployed and affixed in each spring near the orifice, and data will be retrieved each time a spring is sampled. The devices used by CHDN and SODN are Onset HOBO® Pendants that measure temperature. Detailed instructions on how to use the Pendants can be found in Task Instruction CHDN_TI_Persistence_v300.

As much as possible, prepare sensor for deployment while in office or at basecamp. See specific instructions in appropriate TI.

Initial Installation of Temperature Sensors

Two sensors will be placed at each spring site – one in the water and one in the “air” at a nearby location. A minimum of one sensor will be placed in each spring. Placement of the sensor should not occur until after all other site data have been collected. The purpose of the temperature sensor is to record the presence/absence of surface water over the course of the year. Therefore, the sensor should be deployed at the point that is the last to dry up as discharge decreases, which is generally the lowest point in the source area. It may or may not be possible to identify this point in the field, particularly if the springs are visited when they are completely dry or in the case of multiple orifices. Additionally, the sensor must be placed in a location where it is well anchored. The location can be changed on subsequent visits. However, changing a sensor’s location makes it impossible to compare future data to previously-collected data, so

the original location should be kept unless it is completely inappropriate (e.g., not in the spring). Before placing the sensor, be sure to record the serial number in the Sensor ID field on the datasheet.

Once the location for deployment has been selected, every effort should be made to secure the sensor in place so as to avoid translocation and potential loss during rain events. Again, do not begin this until all other data have been collected. The sensor itself must be underwater, in the appropriate housing, and should be flat on the surface of substrate. If it is not possible to pound a bolt into the substrate (e.g. if the substrate is bedrock or the installation of the bolt is not permitted for fear of disturbing cultural resources), then another method should be used to secure the sensor such as tying the sensor to a nearby tree or large rock that is upstream.

On the Sensor Deployment/Retrieval datasheet (Section 21) indicate “Deployed,” “Water” and record the time. Record the temperature of the water at the time of deployment using a multiparameter meter or NIST thermometer. Follow the instructions below for documenting the Sampling Location used for sensor deployment.

An additional sensor shall be placed near the primary orifice, outside of the water. This “air” sensor provides baseline data at the site that is necessary for interpreting the data from the submerged sensor, especially as water levels drop in the spring. The sensor should be inside the appropriate housing and hung using cable in a shady location, preferably on the north side of an object. If hanging from vegetation, keep the cable loose so as not to interfere with growth. An air sensor should be treated and recorded in the same manner that a water sensor is.

Retrieval and Reinstallation

Once all other data have been collected at the site, the sensor deployed during the previous visit should be located at the spring. If found out of place ($> 2x$ HDOP (Horizontal Dilution of Precision)), mark the location of retrieval using a GPS unit and record the location coordinates on the datasheet. Then remove the sensor and record the Sensor ID, the time of the retrieval, and condition of the sensor (e.g., dry, underwater, buried in sediment, covered in algae) on the data sheet. If the unit is not located, make note of it on the data sheet and record any observations that could prove useful, such as evidence of flood or tampering.

Secure the sensor for transport out of field and note the time that the sensor was retrieved. Follow the appropriate TI for downloading the sensor and replacing the sensor’s battery.

Deploy a new sensor in the same location where initially deployed to be able to compare data between sample periods. If the existing location is deemed unsuitable (i.e. does not capture most persistent water, changes in spring morphology, etc.), a new location may be selected. However, changing a sensor’s location makes it impossible to compare future data to previously-collected data, so the original location should be kept unless it is completely inappropriate (e.g., not in the spring). Treat as a new deployment detailed above.

Documentation of Sampling Locations

Make detailed documentation of where the measurements are taken, either at an existing or new Sampling Location on the Sampling Location datasheet following the guidance in SOP #3 (Site Characterization).

Equipment

Item	Number needed	Notes
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Item	Number needed	Notes
Graduated plastic cylinder	1	10mL increments
Plastic bags	2	1-2 gallons
Stopwatch	1	shows 0.01 seconds
Weir, flume	0-1	depends on site
Folding ruler	2	metric
100-m reel tape	1	
Chaining pins	2	
Waders	1	as needed
Personal flotation device	1	as needed
Anti-static bag	1	
Temperature sensors	2	
Sensor housings	2	
Kevlar string	2m	
Wire rope clips	4	

References

Harrelson, C.C., Rawlins, C.L., Potyondy, J.P. 1994. Stream channel reference sites: An illustrated guide to field technique. Gen. Tech. Rep. RM-GTR-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Appendix A - Example of Completed Data Forms

Note that data are not real and are for example purposes only

Spring Monitoring – Water Quantity

19 Discharge – Volumetric						Observer: <i>CLMØ1</i>	
Measurable (circle): ☐ YES ☐ NO				Start Time:		End Time:	
Sample ID	A		B		C		D
Sampling Location	1						
Sample*	Time (sec)	Volume (ml)	Time (sec)	Volume (ml)	Time (sec)	Volume (ml)	Time (sec)
#1	10	975					
#2	10	980					
#3	10	965					
#4	10	985					
#5	10	990					
Est. % flow captured	90%						
Container Type/Size	1 gallon 2ptoe						
Notes							

20a Wetted Extent (Limnocrene/Heleocrene)		Observer: <i>CLMØ1</i>	
Length 1 (cm): 457	Width 1 (cm): 271	Depth 1 (cm): 113	
Length 2 (cm): 973	Width 2 (cm): 473	Depth 2 (cm): 121	
Length 3 (cm): 1207	Width 3 (cm): 503	Depth 3 (cm): unknown	
Length 4 (cm): 1003	Width 4 (cm): 373	Depth 4 (cm): 152	
Length 5 (cm): 912	Width 5 (cm): 211	Depth 5 (cm): 73	
All measurements should be to the nearest 0.5cm			
Measurement method (circle) <u>Ruler</u> Tape GPS Estimate Other			
Notes:			

20b Wetted Extent & Substrate (Rheocrene)										Observer(s): CLM Ø1				
Starting orifice:				Included Brook Length (L): 2.5 m				Transect Interval: 2.5 m						
Transect	L ≤ 30 m (10 Transects)	> 30 m L ≤ 50 m (15 Transects)	L > 50 m (20 Transects)	Wetted Width (to nearest 0.5 cm)	Depth (to nearest 0.5 cm)			Detritus (to nearest mm)			Substrate (to nearest mm)			
					L	M	R	L	M	R	L	M	R	
1	1.0	1.0	1.0	120	1	2	1	Ø	Ø	Ø	0.06	0.06	0.06	
2	3.5			73										
3	6			88	0.5	1	2	3	7	2	4	16	7	
4	8.5			40										
5	11			30	4	1	1	Ø	Ø	Ø	16	16	4096	
6	13.5			52.5										
7	16			31	1	1.5	1	Ø	3	2	4	2	16	
8	18.5			30.5										
9	21			8.5		1			1			2		
10	23.5			12										
11	25													

21 Sensor Deployment/Retrieval					Observer: CLMØ1	
Sensor ID (serial #)	10809197	10809190	10675054	10809185		
	☐ Deployed ☒ Retrieved ☐ Air ☐ Water	☐ Deployed ☒ Retrieved ☐ Air ☒ Water	☒ Deployed ☐ Retrieved ☒ Air ☐ Water	☒ Deployed ☐ Retrieved ☐ Air ☒ Water		
Time (24hr)	1430	1440	1430	1440		
T _{water} (°C)		18.4		18.4		
Deployed in Same Location?	☒ Yes ☐ No	☒ Yes ☐ No	☒ Yes ☐ No	☒ Yes ☐ No		
Sampling Location	2	1	2	1		
Notes						

Southwest Network Collaboration

Springs, Seeps and Tinajas Monitoring Protocol: Chihuahuan and Sonoran Desert Networks

SOP #8: Cleaning and Decontamination of Field Equipment

Version 1.00
(September 3, 2018)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #

Acknowledgements

This SOP is modified from the cleaning and decontamination methods described in the Southwest Network Collaboration Stream Monitoring Protocol (Gwilliam et al. 2017) and includes methods from Colorado Park and Wildlife (2015), Phillot et al. (2010), U.S. Fish and Wildlife Service (2005), and Van Rooij et al. (2017).

Introduction

This Standard Operating Procedure (SOP) describes how to properly decontaminate used sampling equipment. Sampling equipment must be decontaminated between **sites** (individual springs, seeps, or tinajas) to prevent cross contamination. Care should also be taken to avoid moving contaminants upstream in connected systems; to avoid having to decontaminate between connected sites, sample from upstream to downstream, not vice versa. These procedures are appropriate for decontamination 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. 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. Bleach, Tec-quat 128, and HCl are skin and eye irritants. 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. See product-specific safety data sheets.

Cleaning Procedure for Personal Items

Prior to departing an isolated spring sites, items that have gotten wet (e.g., boot soles, waders) should be rinsed in water from the spring to remove mud, vegetation, and all other material. This should be done in a manner that disrupts the site the least. Decontaminate wet items (or areas of items) with the disinfection solution as described below.

For items that have not gotten wet, use a stiff-bristled brush to remove debris and seeds. Inspect gear for seeds and debris.

Cleaning Procedure for Sampling Equipment

Non-electronic, Immersible Sampling Equipment

1. Prior to departing a site, rinse sampling equipment with water from the spring to remove mud and vegetation from equipment. Take care to minimally disturb the site. If possible, allow equipment to dry before departing site.
2. Remove gross contamination.
 - a. Use tap or deionized water and a scrub brush. 1% Liquinox can be used to clean stubborn dirt.
 - b. If available, hot water is generally more effective than cold water
3. Spray clean-surfaced sampling equipment with 1% solution of sodium hypochlorite or .0008% solution of Tec-quat 128 (or other quaternary ammonium compound 128 containing DDAC, didecyl dimethyl ammonium chloride as active ingredient). See Appendix A for how to mix these solutions.
 - a. Use scrub brush if helpful
 - b. Repeat if necessary
 - c. Bleach solution must remain on equipment for a minimum of 5 minutes; Tec-quat 128 solution must remain on equipment for a minimum of 10 minutes
4. Rinse equipment well, preferably with deionized water
5. Let air dry on a clean surface. If the equipment is needed for further sampling as soon as possible, then clean paper towels may be used to dry off the equipment.
6. Store equipment in a clean location after it has fully dried

Electronic, Non-immersible, or Fragile Sampling Equipment

1. Prior to departing a site, rinse sampling equipment that can get wet with water from the spring to remove mud and vegetation from equipment. Take care to minimally disturb the site. If possible, allow equipment to dry before departing site.
2. Refer to operating manuals for specific decontamination and cleaning instructions.
3. For instruments without specific decontamination procedure, follow the general decontamination guidelines below.

- a. YSI probes can be cleaned with a bleach solution. Check if the equipment can be cleaned using Liquinox, which is non-corrosive and designed for delicate equipment. Be sure to rinse off all cleaning solutions with tap water immediately following cleaning. Do not use DI water.
- b. Wipe off dirt using paper towels moistened with deionized water (or tap water for YSI probes), taking care to avoid getting electronics wet.
- c. Use kimwipes or cotton swabs for delicate instruments, such as pH and Dissolved Oxygen (DO) probes, to avoid potential damage.
- d. If pieces of the equipment that are immersible are easily removed, then those pieces may be cleaned following the steps listed above.
- e. Let air dry on a clean surface
- f. Store equipment in a clean location after it has fully dried.

Calcified Sampling Equipment

1. Refer to operating manuals for specific decontamination and cleaning instructions.
2. Soak in 5% HCl to remove calcium from non-reactive surfaces such as plastic Hobo loggers and housings and glass vials.
3. Use a plastic scrub brush if necessary to remove large debris.
4. Rinse equipment well, preferably with deionized water
5. Clean following previously outlined decontamination steps.

Disposal

All solutions degrade over time; therefore it is best to mix up only what you will need for the day. Mixed solutions left at the end of a tour should be brought back to the lab and disposed of in a sanitary sewer system. Water used to rinse equipment may be discarded on the ground (preferably bare ground).

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.**

Bleach

Bleach solution can be poured down a sanitary sewer system. **Do not pour bleach or bleach solution directly into any waterway.** Water used to rinse bleached equipment may be poured on the ground (preferably bare ground) away from waterways. UV light breaks down bleach into salt and oxygen.

Hydrochloric Acid

Dispose of used HCl according to local and state guidelines for acid disposal.

Tec-quat 128

Diluted Tec-quat solution (8% or 0.0008%) can be poured down a sanitary sewer system. Quaternary ammonium compounds become tightly bound to organic matter in soils and sediments and are degraded by aerobic bacteria, so small amounts of solution may be disposed of on the ground in the field. Water used to rinse treated equipment may be poured on the ground (preferably bare ground) away from waterways.

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. Make sure to clearly label all containers!

Equipment

Item	Number needed	Notes
Stiff bristled brush	1	Carry to each site
Sprayer	1	
Protective eyewear	1	
Gloves	6	
Liquinox	1	
Bleach	1	
Tec-quat 128	1	
Deionized water	1	
Kimwipes	1	
Paper towel Roll	1	
Hydrochloric Acid	1	

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Appendix A – Dilution Aids and Disinfection Notes

Household Bleach-to make 1% sodium hypochlorite solution

For 5.25% bleach – dilution ratio is 1 part bleach to 4 parts water. 200 mL bleach to 800 mL water (or 757 mL bleach to 1 gallon water)

For 6% bleach – dilution ratio is 1 part bleach to 5 parts water. 175 mL bleach to 83 mL water (or 662 mL bleach to 0.83 gallon water)

For 8.25% bleach – dilution ratio is 1 part bleach to 7 parts water. 127 mL bleach to 87 mL water (or 481 mL bleach to 0.87 gallon water)

Tec-quat 128

Prepare an 8% solution = 8 mL Tec-quat in 100 mL water beforehand.

Mix 1 mL of prepared 8% solution and add to 1000 mL water to make a .0008% solution.

Liquinox

Prepare a 1% solution = 1.25 oz Liquinox to 1gal water or 10 ml Liquinox to 1 liter water

Liquinox is NOT a disinfectant, but it is better than using water only, IF the instrument can be cleaned with Liquinox.

Additional Notes

Bleach is basically the same as sodium hypochlorite—but not when you calculate dilutions. Confusion can arise because what is labeled 100 percent bleach is only three to six percent sodium hypochlorite (READ THE LABEL!). In other words, if a lab protocol calls for 1 percent sodium hypochlorite, use 20 percent bleach.

Bleach solution degrades over time and is more unstable in its diluted form. If you plan to use a bleach solution over the span of a week for repeated disinfection, mix it at a 1:4 ratio (20 percent bleach) to make it last.

Bleach is corrosive. Rinse metal instruments well after disinfecting or use another disinfectant.

Do not mix bleach and Tec-quat 128! This will create toxic gases.

Amistad National Recreation Area has not yet documented invasive zebra and quagga mussels in the lake; should these species appear, higher concentrations of disinfectant will be required on equipment used at Amistad.

Southwest Network Collaboration

Springs, Seeps and Tinajas Monitoring Protocol: Chihuahuan and Sonoran Desert Networks

SOP #9: Data Management

Version 1.00
(September 3, 2018)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #

This standard operating procedure (SOP) describes the procedures for managing and maintaining data collected by the springs monitoring protocol for the Sonoran Desert Network (SODN) and Chihuahuan Desert Network (CHDN). The SOP was developed in accordance with strategies and guidance for data processing and quality assurance/quality control (QA/QC) specified in the CHDN (Richie 2009) and SODN data management plans (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 Springs 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 datasheets, (2) entering data directly into the project database on the field computer(s), (3) using GPS handheld devices to collect spatial data, and (4) downloading data from various water quality and quantity data loggers. (Field Crew)

Paper Field Datasheets

1. Record data neatly and legibly on the datasheet 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 datasheet or sampling location, review each datasheet 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 datasheets for that day. If corrections are required, incorrect values may be erased and corrected on the datasheet. Initial and date the “proofread by” space on each datasheet. 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 datasheet, 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 datasheets 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.
6. 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)

7. Review the test dataset. (Protocol leader/ Data Management Staff)
8. If the data meet overall project quality requirements, continue data collection. (Field Crew)
9. 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)
10. 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)
11. Regularly enter the data into the project database according to the instructions in the Springs Monitoring Database User Guide. If at all possible, do not wait until the end of the field season to begin entering data from datasheets 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 datasheet 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 or TIs 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 (Temperature) Data Collection

1. Follow appropriate networks' instructions in order to properly setup and download data from persistence (temperature) 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 Datasheets

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 datasheets. 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 datasheets. 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 Datasheets

Scanned datasheets 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 datasheet, 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

2. 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 datasheet containing spatial coordinates. (Field Crew/Field Crew Leader)
3. Certify all spatial datasets by completing a “Project Data Certification” form. (Protocol or Field Crew Leader)
4. 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.

Certification of 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 section 3 in the SODN QA/QC Procedures for Tabular Data Management Guidance Document or, for CHDN, the Field Data Workflow and QA/QC Procedures SOP for further details.) (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 CHDN physical scientist/ecologist and SODN aquatic ecologist are 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 (SODN) or ReportsAndOther (CHDN) 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 database. 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)

NPStoret Database

After the certification process is complete, add new water quality and quantity data collected during the field season through the NPStoret Application (Data Manager/Assistant Data Manager) OR submit the entire seasonal database to NPStoret staff for uploading to the database. (Data Manager/Assistant Data Manager)

Network Protocol Products

Web Sites

The SODN and CHDN Internet sites automatically query the IRMA Data Store Application and display links to the springs monitoring 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)

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 (SODN) or P:\ drive (CHDN), which ones to transfer to the master project file on the S:\ drive (SODN) or A:\ drive (CHDN), (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 (SODN) or A:\ drive (CHDN). (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 CHDN data backup procedures, see the CHDN Data Backup Procedures SOP. For SODN 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, Protocol 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 datasheets are not altered. Field datasheets 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 datasheets; file a copy of the report with the copied datasheets. (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 (SODN) or corresponding folder on the A:\ drive (CHDN). (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>.
- Richie, J. T. 2009. Data management plan for the Chihuahuan Desert Network. Natural Resource Report NPS/CHDN/NRR—2009/096. National Park Service, Fort Collins, Colorado.

Guidance documents, global operating procedures (GOPs), and forms mentioned in this SOP are stored on the respective network servers.

Southwest Network Collaboration

Springs, Seeps and Tinajas Monitoring Protocol: Chihuahuan and Sonoran Desert Networks

SOP #10: Revising the Protocol Narrative and SOPs

Version 1.00
(September 3, 2018)

Revision History Log

Previous Version #	Revision date	Author	Changes made	Reason for change	New Version #

This standard operating procedure (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 Control and Versioning for SWNC Documents. 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.

To ensure the use of the most current the protocol narrative, appendixes, SOPs, and datasheets; please go to P:\Monitoring\Springs\ (CHDN) or V:\Springs\ (SODN).

Master Version Table

Protocol Version	Date of Change	Narrative	SOP #1	SOP #2	SOP #3	SOP #4	SOP #5	SOP #6	SOP #7	SOP #8	SOP #9	SOP #10
1		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00