

Springs Monitoring Protocol Implementation Plan for Park Units in the Southern Colorado Plateau Network

Standard Operating Procedure (SOP) # 2

Sampling Overview and Equipment Needed

Version SCPN_Springs_SOP2_20180930

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP is adopted from the Northern Colorado Plateau Network's SOP #2 Sampling Overview and Equipment Needed, Version 1.00 (June 2016) in eissinger, 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.

This SOP describes which SOPs are used under various sampling scenarios and provides equipment lists for all activities.

Sampling Overview

The Southern Colorado Plateau Network's (SCPN) springs monitoring program is designed to be completed by at least two individuals of differing expertise – a hydrologic technician and a biological technician specializing in vegetation – at differing intervals. Both should be present for site establishments, if possible. Hydrologic revisits occur monthly from March through November. Vegetation revisits occur once per growing season. Relevant SOPs for each field activity are documented in Table 1.

Table 1. SOPs needed for each type of field visit.

SOP	Site Establishment	Hydrologic Revisit	Vegetation Revisit
SCPN Field Safety	X	X	X
3 – Site Characterization	X		
4 – Site Map and Vegetation Characterization	X		X
5 – Hydrologic Monitoring	X*	X	
6 – Site Condition	X		X
7 – Hanging Gardens	X**		X**

8 – Surveying	X	X	
9 – Groundwater Wells	X	X	
10 – Decontamination	X	X	

* at sites with flow or stage monitoring

** at hanging gardens

Equipment

Table 2. Safety and general equipment needed for all springs sampling.

Item	Number needed	Description	Notes
Safety Equipment			
First aid kit	1		content list in SCPN Field Safety Plan
Personal safety beacon/InReach	1		For use in field
Satellite phone	1		For use in camp
Satellite phone charger	1		
InReach/Personal Locator Beacon	1		InReach or Digital Radio
Digital Radio	1		InReach or Digital Radio
SCPN Field Safety Plan	1		
SCPN Medical Information Form	1 per person		found in SCPN Field Safety Plan
Personal Safety Equipment - <i>provided by observers</i>			
Insect repellent			
Sunscreen			
Water bottles			
Sunhat or baseball hat			
Appropriate footwear and clothing			
General Equipment			
Digital camera	1	Small handheld	
Extra battery for digital camera	1		
Permit	2 per vehicle		one on vehicle dashboard, one with crew
Topographic Maps	1		access site
Sketch Map	1 per site		relocate monitoring locations on site
Printed photos	Variable		relocate and duplicate monitoring locations
Data sheets	variable		at least 25% on rite-in-the-rain paper
SOPs	Relevant set		

Item	Number needed	Description	Notes
Clipboard	1	lightweight with interior storage	
Field notebook	1	small, Rite-in-the-Rain®	field notes
Pencils	3-5		
Group Camping Equipment – Necessary for all field work that requires car camping			
Stove	1-2		Include spare, if available
Propane	1-2		Ideally full containers
Kitchen box	1	Includes pots, pans, plates, bowls, silverware	
Tarp / rain shelter	1		If available. For tarp, bring ropes necessary to put it up.
Roll-a-table	1		If available when the crew is not camping in a campground
Water jugs	min. 1 gal/person/day		
Tent repair	1	Tent tape and zipper wax	
Duct tape	1		
Backpacking Equipment – Necessary for backpacking			
Water filters (hand pump)	2	MSR Sweetwater	
Bucket	1		For settling water
Alum	1	Spice used to help settle particles out of water	
Water bladders	2		For water storage
Backpacking stoves	2		One that attaches to canister fuel bottle; one that attaches refillable fuel bottle
Fuel	various	White gas for refillable fuel bottle or canister fuel bottles	Bring extra
Lighters	2		For stoves
Cook set	2		Includes pots of various sizes
Trowel/shovel	1		
Wag bags	1/person/day		Use if camping in main basecamp
Spare tent	1		If available. Works out well to store extra equipment and use as back-up.

Table 3. Equipment needed for SOP #3 - site characterization.

Item	Number needed	Description	Notes
GPS	1	Trimble GeoXM or more accurate	

Item	Number needed	Description	Notes
GPS car charger	1		
Compass	1	with declination setting	set declination, take orifice bearing
Clinometer	1		measure slope
100-m reel tape	1	fiberglass reel tapes	measure spring outflow
Rangefinder	1	short-range	alternate for measuring spring outflow
Chaining pins	2	striped metal pins	secure reel tape
Solar pathfinder	1	Dome, tripod, and sunpath diagram	Use 37-43° latitude diagram

Table 4. Equipment needed for SOP #4 – site map and vegetation characterization

Item	Number needed	Description	Notes
Graph paper	1	4 squares per inch	draw map
Rangefinder	1	short-range	measure spring dimensions
Spring species list	1	species previously recorded at site	
Hand lens	1		
2-gallon resealable plastic bags	min. 2	2- gallon or larger	collect plants
Masking tape	1		label plant collections
Permanent marker	1		label plant collections
Trowel	1	small garden tool	extract specimen roots
Plant press	1	field press with card, blotter, and paper	store plant collections for identification
Relevant floras and park species lists		various by park	

Table 5. Equipment needed for well installation and hydrologic monitoring.

Item	Number needed	Description	Notes
Below Ground Hydrologic Installation, driven steel well - SOP #5 <i>*Equipment needed for transect setup during well installation is listed in Table 1.</i>			
Well points	3	1.25" I.D. x 3' length, 60 Gauze (Campbell)	
Galvanized pipe	min. 36 ft.	1.25" x 4' lengths, threaded on both ends	for riparian wells
Screened riser	1	1.25" I.D. x 2.5' length 60 Gauze well point (Campbell) without point, threaded	for instream well
Fence post driver	1	large diameter, heavy-weight	drive in wells

Drive caps	4	1.25" I.D.	
Drive couplings	12	1.25" I.D.	
Sacrifice pipe	3	1.25" x 8" length, threaded on both ends	
Teflon tape	3 rolls		protect threads while installing pipe
Ear protection	3	ear-muff style	safety
Padded gloves	3 sets		safety
Bubble level	1		level pipe during installation
Shovel	1		prepare hole for well
Rope	1	min. 15 ft.	guide casing during installation
Bentonite pellets	6 shovels worth		seal space around riparian well
Bucket	1	5-gallon	add water to purge well
Peristaltic pump	1	Geotech Geopump 2	purge well
Flexible tubing	min. 25 ft.	Masterflex	used with peristaltic pump
Metal file	1		file a notch in top of well for water level measurements
Cordless power drill	1		vent well
Drill bit	2	1/8" split point	vent well
Drill bit	1	1/4"	drill cap for eyebolt
Threaded cap	1 per well	1.25"	
Eyebolt	1 per well	1/4"	
1/4" nut	1 per casing		keep eyebolt in place
1/4" washers	2 per casing		keep eyebolt in place
1/4" stopper nut	1 per casing		keep eyebolt in place
Below Ground Hydrologic Installation, augered PVC well - SOP #5			
<i>*Equipment needed for transect setup during well installation is listed in Table 1.</i>			
Ratcheting soil auger with extensions	min. 20 ft.		augering well hole
Auger buckets	2	2.75 or 3.25", regular and mud-clay	augering well hole
PVC solid riser pipe	min. 30 ft.	1.5 or 2", 10' lengths, threaded on both ends	for riparian wells
PVC screened pipe	min. 5 ft.	1.5 or 2", 5' or 10' lengths, threaded	for riparian wells
PVC slip-thread couplings	2	1.5 or 2"	for caps if needed
PVC primer	1 can		prime any glued joints
PVC glue	1 can		glued joints
Flexible gloves	2 pair		handle PVC glue
Rags	3		clean-up
Teflon tape	3 rolls		lubricate threads

Bubble level	1		plumb well pipe
Shovel	1		replace soil cuttings
“Clean” sand	min. 50 lbs.		pack well screen annulus
Bentonite pellets	10 lbs.		seal well annulus
Bucket	1		purge well
Inertial hand pump	1	semi-rigid tubing (HDPE) with footvalve (Waterra)	purge well
Tubing for hand pump	30 ft.		
Metal file	1		MP notch in top well lip
Cordless drill	1		vent well; drill caps
Drill bit	2	1/8” split point	vent well
Drill bit	1	¼”	drill cap for eyebolt
Post pounder and/or 3–8 lb. sledgehammer	1		drive protection pipe
Galvanized pipe	5–8 ft.	1”	
Wood block	1		drive protection well
Hacksaw	1	metal blade	cut PVC or protector pipe
Locking well plug	1	1.5 – 2”	if locked well is desirable
Threaded cap	1-2 per well	1.5 or 2”	Top and bottom caps
Slip cap	1 per well	1.5 or 2”	Bottom cap if screened section is unthreaded
Eyebolt	1 per well	¼”	
¼” nut	1 per casing		keep eyebolt in place
¼” washers	2 per casing		keep eyebolt in place
¼” stopper nut	1 per casing		keep eyebolt in place
Tape-down Pipe Installation– SOP #5			
Galvanized pipe	1	1”, 6–8 ft.	tape-down pipe
Sledge hammer	1		drive in pipe
Level	1		plumb pipe
Hacksaw	1		notch MP on pipe
All Hydrologic Installations			
Pressure transducer	1 per installation	non-vented (Solinst)	records water stage
Barometric pressure logger	1 per reach	Solinst Barologger	records atmospheric pressure
Kevlar rope or line	min. 45 ft.	1/8” braided or kite line (U.S. Rope & Cable)	install pressure transducers
Knife or scissors	1		cut Kevlar rope
Eye bolt	1 per casing	1/4” x 2” threaded	install pressure transducers
Nut	1 per casing	¼”	keep eyebolt in place
Washers	2 per casing	¼”	keep eyebolt in place
Stopper nut	1 per casing	¼”	keep eyebolt in place
Carabiner	1 per casing	2”	attach Kevlar rope to eyebolt

Ring Terminals	2 per casing		connect Kevlar rope to eyebolt carabiner and pressure transducer
Crimping tool or pliers	1		clamp ring terminals to Kevlar rope
Hydrological monitoring (<i>all visits</i>) - SOP #5 <i>Necessary for all visits unless noted with an R = re-visit.</i>			
Pipe wrenches	2		tighten fittings, open and close wells
Cheater bars	R – 2		assist with opening rusted well caps
Plumber's grease	R – 1		grease well threads
Water level meter	1	Solinst	measure depth to water in wells
Flow measuring equipment	1	Current meter, 10-m transect tape, 2 chaining pins	measure stream flow > 1 cfs
		Flume, level, trowel	measure stream flow 0.25 – 1 cfs
		Weir, level, trowel	measure stream flow <0.25 cfs
Inertial lift pump	1	semi-rigid tubing (HDPE) with footvalve (Waterra)	remove fine sediments
Folding ruler	1		measure to ground surface
PDA and interface cable	R – 1	Solinst Leveloader and cable specific to the PDA	download pressure transducer and barometric logger data
Field laptop and cable	1	with Solinst software and optical interface USB cable is specific to pressure transducer /barometric logger	download pressure transducer and barometric logger data; reprogram instruments
Camera download interface	1		Download stage gage card
Batteries	6-12	per camera requirements	replacements for stage gage camera
Laptop access card	1	DOI Access Card	log in to laptop

Item	Number needed	Description	Notes
Water quantity			
Flow instrument	0-1	Baski flume, weir plates, etc.	see SCPN site descriptions for specific needs
Hammer, duct tape, etc	0-1	As needed for weir plate setup	
Calibrated large plastic container	1-2	approximately 4000 ml	volumetric flow container, calibration fluid container in pack
Calibrated small plastic container	1-2	approximately 250-500 ml	volumetric flow container; capture water at shallow sites for water quality measurement
Bucket	0-1	Variable	capture channelized flow
Graduated plastic cylinder	0-1	1 L, marked in 10 ml increments	measure timed captures
Plastic bags	0-2	1-2 gallon-sized with no holes	capture channelized flow
Trowel or small shovel	0-1	small garden tool	build earthen dam for volumetric measurement; seal around flow instrument
Plumber's putty	0-1	orange-sized chunk, some sites.	funnel flow on bedrock for volumetric measurement
Retracting steel ruler	0-1	≥2 m long, marked in 0.1 cm increments	record pool stage
Folding ruler	0-1	any increments	verify that pool behind flow measurement structure is stable
Stopwatch	0-1	To 0.01 seconds	timed flow measurements
Voice recorder	0-1	small, with spare batteries	Increase accuracy of timed flow measurements on solo visits
Waders or sandals	0-1	appropriate for season	standing in water if required by site
Waterproof gloves	0-1 pair	seasonal need	protect hands from cold water
Poison ivy gear	variable	clothing, gloves, soap	prevent infection at relevant sites
Water quality			
Thermometer	1	Celsius, NIST traceable	water and air temperatures
Water quality meter	1	Variable	at minimum pH and specific conductance
Calibration solutions	3	pH 7.01 and 10.01; conductivity 1413 mhos	in small field bottles
Small beakers or cups	2	About 50-mL	calibration of water quality meter
Batteries	variable	Variable	for water quality meter
Small mesh bag	1		store calibration solutions

Table 6. Equipment needed for SOP #7 – hanging gardens.

Item	Number needed	Description	Notes
Rare plant descriptions	1		target species
Spring species list	1	species previously recorded at site	

Table 7. Equipment needed for SOP #8 – Surveying

Item	Number needed	Description	Notes
Springs Surveying with Total Station - SOP #8, surveying <i>Necessary for all visits unless noted with an I = initial survey or R = re-visit.</i> *Equipment needed for transect setup is listed in Table 1.			
Total station with 6 batteries	1		make sure batteries are fully charged before leaving; includes tribrach
Charger for total station	1		Including power cord; use when electricity is available
Hand-held weather unit	1		Highgear brand, WeatherPort model. Used for calibrating temperature & pressure in total station. Stored in total station case.
Datalogger with Survey Pro software	1		make sure batteries are fully charged before leaving
Charger for datalogger	1		use when electricity is available
Datalogger holder	1	Folding metal holder	attaches to tripod leg
Battery/Generator	1	12-volt battery with inverter or Goal Zero Yeti Generator	charging equipment in the backcountry
Solar panel	1		charging equipment in the backcountry
Tripod	2	1 wooden and 1 metal with screw-mount adjustable legs	to mount total station, includes spare & carrying cases
Prism poles	3	identical	includes attached levels and both flat foot and a point on the end
Prism poles extenders	3	orange & white stripe sections	good for visibility in thick vegetation
Leveling rod	3	identical, telescoping to 5 m	with adapters to mount prisms
Levels for leveling rods	3		need to attach to rods before surveying
Bipods	2		used to turn a prism pole into a free-standing tripod

Item	Number needed	Description	Notes
Prisms	4	identical	for rods and backsight, includes spare & padded cases for each prism
10-m engineer's tape or rolling metric tape (>5 m)	4		measure instrument and rod heights; one for each person, includes spare
Tool pouch	1		holds equipment for survey lead
Survey notebook	1		
Ear piece with microphone	1	compatible with radios	for person running total station
Survey umbrella	1		
Umbrella stand	1	separate tripod to support the umbrella	
Rebar	I - min. 12, R – 4	3/8" diameter cut in 0.5 m lengths	permanent survey markers
Survey rebar caps	I - 12	1 1/2" pre-stamped with NCPN and dot in center	label rebar and cover top for safety
Permanent bedrock marker for horizontal bedrock	I – 1 per control point	5" piece of 1/2"-diameter threaded rod	Cut with hacksaw or other saw borrowed from maintenance
Permanent bedrock marker for vertical wall	I – 1 per control point	7" piece of 1/2"-diameter threaded rod	have maintenance grind down the threads on one side, so the pointed foot of the prism pole can be placed there without threads in the way
Hammer drill with extra batteries	I – 1		drill rock for permanent bedrock markers
Concrete drill bit	I – min. 1	1/2"-diameter	used with hammer drill
Small, flexible hose	I – 1	small diameter tube or straw that fits in 1/2" drill hole	blow sediment out of drilled hole
Small broom	I – 1		brush away sediment from drilled hole
Small baggie of concrete mix	I – 1	Quikrete brand	fasten metal rod to bedrock for permanent marker; pass mix through 2 mm sieve first to get larger rocks out
Small paper cup, plastic spoon, and water	I – min. 1 set per bedrock marker		mix concrete
Straw with spoon end	I – min. 1 per bedrock marker	slushie straw	put concrete slurry into and around threaded rod
Screwdriver, pliers, and allen wrench set	1 each		attach prisms, tighten rods, troubleshoot equipment
Flagging	4 rolls	brightly colored	mark locations
GPS	2	survey grade with horizontal accuracy < 0.1 m	includes spare

Item	Number needed	Description	Notes
Field notes from previous survey			Includes files to be uploaded to datalogger and reference photos for survey control
Reference geomorphology photos	R -2	reference photos taken during survey control establishment	
Total station & Survey Pro manuals	1 each		
Pipe wrenches	2		use to tighten fittings, open and close wells; only needed for reaches with wells
Cheater bars	R - 2		assist with opening rusted well caps; only needed for reaches with wells
Personal floatation device	2-3		safety gear for surveying the thalweg or deeper channel cross-sections
Dry Suit	1-2		optional safety gear for surveying the thalweg or deeper channel cross-sections in colder weather
Springs Surveying - SOP #8, RTK equipment Necessary for all visits unless noted with an I = initial survey or R = re-visit. *Equipment needed for transect setup is listed in Table 1.			
RTK base	1		In yellow Pelican case including Trimble R6 receiver, 2 batteries, 1 antennae, 1 tribrach with optical plummet, 1 extender, 1 battery charging cradle, 1 charging power cord, 1 tape measure. Make sure batteries are fully charged before leaving
Base Battery	1		Small yellow jug Trimble battery. Make sure batteries are fully charged before leaving.
Container of cords	1		3 cords for RTK base (2 black, 1 yellow). 1 black cord for RTK rover.
Tripod	2		For base radio. In orange canvas cases.
Base Radio	1		In yellow Pelican case, including cord to connect to base and battery
Base Radio antennae	1		35 Watt high-powered radio antennae
Base Radio battery	1		Usually a motorcycle or car battery

Item	Number needed	Description	Notes
RTK rover	1		In yellow Pelican case, including Trimble R6 receiver, 2 batteries, 1 antennae, 1 battery charging cradle, 1 charging power cord
Seco carbon rod	1		For rover. Comes with quick-release attachment for receiver and flat topo boot
Data collector	1		Trimble TSC 3 with all the necessary files uploaded before leaving
Data collector holder	1		Attaching to rod. Two pieces.
Data collector charger	1		Power cord
Survey rebar caps	I - 12	1 1/2" pre-stamped with NCPN and dot in center	label rebar and cover top for safety
Stamp kit	1		Label rebar caps
Sledgehammer	1		Placing rebar
Screwdriver, pliers, and allen wrench set	1 each		attach prisms, tighten rods, troubleshoot equipment
10-m engineer's tape or rolling metric tape (>5m)	1 per surveyor + 2 spares		measure instrument and rod heights
Survey notebook	1		
Field notes from previous survey			Includes files to be uploaded to data collector
Reference geomorphology photos	R - 2	reference photos taken during survey control establishment	
Generator	1	Honda EU1000i	Used to recharge batteries
Gas & oil for generator	one 5 gallon + enough oil		
Chisel	1		Marking control points in rocks
White marker	1		Marking control points in rocks

Table 8. Equipment needed for SOP #9 – Groundwater Wells

Ratcheting soil auger with extensions	min. 20 ft.		augering well hole
Auger buckets	2	2.75 or 3.25", regular and mud-clay	augering well hole

PVC solid riser pipe	min. 30 ft.	1.5 or 2," 10' lengths, threaded on both ends	for riparian wells
PVC screened pipe	min. 5 ft.	1.5 or 2", 5' or 10' lengths, threaded	for riparian wells
PVC slip-thread couplings	2	1.5 or 2"	for caps if needed
PVC primer	1 can		prime any glued joints
PVC glue	1 can		glued joints
Flexible gloves	2 pair		handle PVC glue
Rags	3		clean-up
Teflon tape	3 rolls		lubricate threads
Bubble level	1		plumb well pipe
Shovel	1		replace soil cuttings
"Clean" sand	min. 50 lbs.		pack well screen annulus
Bentonite pellets	10 lbs.		seal well annulus
Bucket	1		purge well
Inertial hand pump	1	semi-rigid tubing (HDPE) with footvalve (Waterra)	purge well
Tubing for hand pump	30 ft.		
Metal file	1		MP notch in top well lip
Cordless drill	1		vent well; drill caps
Drill bit	2	1/8" split point	vent well
Drill bit	1	¼"	drill cap for eyebolt
Post pounder and/or 3–8 lb. sledgehammer	1		drive protection pipe
Galvanized pipe	5–8 ft.	1"	
Wood block	1		drive protection well
Hacksaw	1	metal blade	cut PVC or protector pipe
Locking well plug	1	1.5 – 2"	if locked well is desirable
Threaded cap	1-2 per well	1.5 or 2"	Top and bottom caps
Slip cap	1 per well	1.5 or 2"	Bottom cap if screened section is unthreaded
Eyebolt	1 per well	¼"	
¼" nut	1 per casing		keep eyebolt in place
¼" washers	2 per casing		keep eyebolt in place
¼" stopper nut	1 per casing		keep eyebolt in place

Item	Number needed	Description	Notes
Pump Sprayer	1	2- gallon herbicide pump sprayer	decontaminate equipment and personal items
Protective eyewear	1		use while mixing Quat solution
Quaternary ammonium	Pre-diluted	Quat128	decontaminate equipment and personal items

Item	Number needed	Description	Notes
Quat-Chek test paper	1		test dilution of decontamination solution
Scouring brush	1		decontaminate equipment and personal items
Rubber gloves	6		protect hands during decontamination

Table 8. Equipment needed for SOP #10 – decontamination

Item	Number needed	Description	Notes
Pump Sprayer	1	2- gallon herbicide pump sprayer	decontaminate equipment and personal items
Protective eyewear	1		use while mixing Quat solution
Quaternary ammonium	Pre-diluted	Quat128	decontaminate equipment and personal items
Quat-Chek test paper	1		test dilution of decontamination solution
Scouring brush	1		decontaminate equipment and personal items
Rubber gloves	6		protect hands during decontamination