WATER QUALITY PROGRAM

STANDARD OPERATING PROCEDURES

FOR WATER QUALITY SAMPLING

Revision IV

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WATER QUALITY PROGRAM DESCRIPTION

This document provides direction and instruction on standard operating procedures (SOP) for field water quality sampling for the Water Quality Program (WQP).

The WQP standards and monitoring section routinely monitors a network of South Dakota rivers and streams called the Water Quality Monitoring (WQM) network. In addition, the standards and monitoring team may collect water samples during Use Attainability Analyses (UAAs), fish kill investigations, complaint investigations, and special short-term monitoring projects. The surface water discharge permit team may also collect water quality samples during routine facility inspections, compliance sampling, and complaint investigations.

Environmental data collected by the WQP may be used to determine 1) trends in water quality, 2) support of beneficial uses and water quality standards, 3) compliance with permit conditions, and/or 4) causes/sources of pollution. More information regarding WQP sampling activities is available in the Quality Assurance Project Plan for the Water Quality Program (WQP QAPP).

PRE-SAMPLING PROCEDURES

WQP personnel conduct sampling work to meet a variety of goals/purposes. All sampling work requires pre-planning. During the planning stage, the scope of sampling to be performed is modified for the purpose of obtaining data necessary for meeting a specific and desired goal or purpose. Pre-planning procedures common to all sampling include the following:

1. Identify the objectives for sampling;
2. Review any existing data for the site/waterbody to be sampled;
3. Identify additional data requirements, including types of samples/characteristics and sampling frequency;
4. Examine maps and diagrams of the area/waterbody to be sampled;
5. Make a list of proposed sampling sites;
6. Check the operation of all required sampling equipment;
7. Load all required sampling equipment and obtain all required sample bottles, forms, documents, field books, and apps;
    a. Sample bottles may be obtained from the laboratory that will do the analysis.

b. Deionized (DI) and "Polished" water may be obtained from the laboratory that will do the analysis.

8. Notify all stakeholders (as necessary), including landowners, businesses, and city, state, federal, or tribal agencies;
9. Procure permission to access private property;
10. Perform reconnaissance (as necessary) of the proposed sampling sites and the general area/waterbody to be sampled;
11. Determine if the plan for sampling requires revision; and
12. Proceed with sampling activities.

DOCUMENTATION AND REPORTING

A. Documentation

Field recordkeeping activities are required. Recordkeeping is accomplished using the Survey123 App, a field notebook and/or pre-printed project forms. It is recommended that all field notebooks and pre-preprinted project forms be waterproof. A standard format for field notebook recordkeeping is not required. All field records should include the following:

1. Survey123 App/Field notebook

a. Date and time;

b. Station ID (unique identification);

c. Station location (street number, avenue number, driving directions, WQM number, or GPS location);

d. Types of meters being used;

e. Meter calibration readings into Survey123 App. If Survey123 App isn't working enter data in a field notebook so it can be recorded into the App later.

f. Comments regarding any meter maintenance, damage or difficulty in operation or calibration;

g. Weather conditions that could impact water quality (high wind, rainfall and runoff, temperature);

h. Velocity or discharge measurements (if flow measurements are taken);

i. The following field measurements are recorded for every sample site based on equipment used (if a measurement is not recorded, the rational should be documented):

i. water temperature;

ii. pH;

iii. specific conductance; and

iv. dissolved oxygen.

j. Fish size, length, species, number and photo voucher for iNaturalist (if fish are collected);

k. Method of fish collection (sampling equipment used, time and date set, length of stream segment, etc.);

l. Method of biological sample collection (net type, sampling equipment type, depth, etc.);

m. Upstream and downstream photos. Discuss and identify all photographs;

n. Document site conditions/visual observations (riparian vegetation, bank and stream bottom, stream incision and definition, water appearance, flow, public access);

o. Document the name of any individual encountered during sampling and summarize the conversation along with any pertinent information.

2. Pre-printed project sheets

a. Completely fill out all applicable “blanks” on any pre-printed project forms;

b. Information discussed in section (1. Survey123 App/Field notebook) should be gathered for each project as needed.

3. Laboratory sheets

A DANR Water Quality Data Sheet (see WQP QAPP) must be completely filled out and submitted with all laboratory samples. This provides the laboratory with information about the water sample and directs the laboratory on which analyses are requested.

4. Bottle labels

All bottles must be labeled prior to sample collection. At a minimum, the label must include the station identification, sample date, sample time, and bottle identification (Bottle “A”). The bottle will get wet, so ensure that bottle labels and marking pen are water resistant so the label stays affixed and the ink does not run.

B. Reporting

Data collected as a result of sampling is recorded in the following ways:

1. Recorded in appropriate database, hardcopies or electronic copies of data are also maintained;
2. Recorded in reports;
3. Hard copies or electronic hardcopies filed.

INSTRUMENT/EQUIPMENT CALIBRATION, CARE, AND OPERATION

Each field instrument must be inspected prior to use, calibrated, and operated according to manufacturer specifications. If problems with any field instrument are encountered, the user should consult the manufacturer's manual, the project manager, and/or call the manufacturer. Calibrations and instrument observations must be recorded in the calibration log book or Survey123 App prior to field use.

General calibration procedures and necessary instrument inspections are presented below:

A. Multimeter – YSI Proplus/ProQuatro

Record each step of calibration in the Survey 123 App under Probe Calibration. Always calibrate the multimeter in the following order, Specific Conductance, pH, ORP (if needed), and DO. The meter should always stay connected to the probe bulkhead. Use fresh calibration solutions with each calibration. Keep the meter from extremes in temperature such as freezing and extreme heat (do not leave in your vehicle) YSI Proplus User Manual can be found at: 605596-ysi-proplus-user-manual-revd.pdf YSI ProQuatro User Manual at: 606962-ProQuatro-User-Manual-English.pdf

To Begin Calibration

1. Turn the meter on using the green button located on the bottom right.of keypad (may have to hold button in for a few seconds).

Specific Conductance Calibration

1. Press the Cal key.
2. Arrow down to highlight Conductivity and press enter. A second menu will offer the option of calibrating Specific Conductance, Conductivity, or Salinity. Specific Conductance is highlighted so press enter. Another sub-menu will require you to select the calibration units. Microsiemens per centimeter or uS/cm is the unit needed and is already highlighted so press enter.

3. Triple rinse meter probes using conductivity standard in the calibration cup.
4. Fill the calibration cup approximately ¾ full of conductivity standard. When the meter is placed in the calibration cup it needs to be full. This ensures the conductivity probe is completely submerged in conductivity standard.
5. Allow temperature to stabilize.
6. Enter the calibration solution value by highlighting Calibration Value, pressing enter, and then using the alpha/numeric keypad to enter the known value. Once you have entered the value of the calibration standard, highlight <<ENTER>> and press enter.
7. Wait for the readings to stabilize, highlight Accept Calibration and press enter to calibrate.
8. To get Cell constant, press the File button and then scroll down to View GLP and press enter. You may need to scroll down a couple lines to see it.

pH Calibration

1. Triple rinse meter probes using pH 7 buffer solution in the calibration cup.
2. Press the Cal key.
3. Arrow down to highlight ISE1 (pH) and press enter. Auto-buffer recognition will determine which buffer the sensor is in (always start with the lowest pH buffer).
4. Fill the calibration cup approximately half full of pH 7 buffer.
5. Insert probe into the pH 7 solution, making sure the pH sensors glass bulb is submerged. Allow temperature to stabilize.
6. The YSI should automatically recognize the buffer value and display it at the top of the screen. The pH solution should include a chart of solution values per temperature. Confirm the automatic value is correct from this chart. If not correct enter the pH buffer value by highlighting Calibration Value, pressing enter, and then using the alpha/numeric keypad to enter the known value. Once you have entered the value of the calibration standard, highlight <<ENTER>> and press enter.
7. Wait for the pH and pH mV readings to stabilize (this can take a few minutes). When readings stabilize, highlight Accept Calibration and press enter to calibrate.
8. Triple rinse meter probes using pH 10 buffer solution in the calibration cup.
9. Fill the calibration cup approximately half full of pH 10 buffer.
10. Insert probe into the pH 10 solution, making sure the pH sensors glass bulb is submerged. Allow temperature to stabilize.

11. The YSI should automatically recognize the buffer value and display it at the top of the screen. The pH solution should include a chart of solution values per temperature. Confirm the automatic value is correct from this chart. If the values are different enter the pH buffer value from the chart by highlighting Calibration Value, pressing enter, and then using the alpha/numeric keypad to enter the known value. Once you have entered the value of the calibration standard, highlight <<ENTER>> and press enter.
12. Wait for the pH and pH mV readings to stabilize (as pH probe starts to age this can take a few minutes). When readings stabilize, press Cal to complete the calibration.

ORP Calibration

1. Triple rinse meter probes using ORP calibration solution in the calibration cup.
2. Fill the calibration cup so that the ORP sensor tip is submerged in solution.
3. The ORP solution should include a chart of solution values per temperature. Enter the correct ORP mV value from the chart by highlighting Calibration Value, pressing enter, and then using the alpha/numeric keypad to enter the known value. Once you have entered the value of the calibration standard, highlight <<ENTER>> and press enter.
4. Wait for the readings to stabilize and then press enter to accept the calibration.

DO Calibration

1. Triple rinse meter probes using water in the calibration cup.
2. Place a small amount of water (1/8 inch) in the calibration cup and loosely screw it on the probe. Having the calibration cup only barely screwed on ensures atmospheric venting. Do not submerge DO and temperature sensors in water.
3. Press the Cal key.
4. DO is highlighted so press enter. A second menu will offer different units, the option highlighted DO% is the one needed so press enter. The galvanic DO sensor does not require a warm-up time.
5. Verify the barometric pressure and salinity displayed are accurate. Salinity should be 0.00 ppt and if not rinse the probes and calibration chamber again. Once DO and temperature stabilize, highlight Accept Calibration and press enter.
5. Calibration is complete.

Taking a Measurement

After calibrating all parameters, the YSI meter is now ready for use. To take a water quality measurement:

1. Log One Sample is already highlighted after calibration or when you turn on the meter.
2. Screw on the weighted probe guard to protect them from damage. Place into the water to be sampled. Be careful not to place in mud and that the flow of water is sufficient to overcome oxygen consumption by the DO probe (swirl the probe in the water if flow is inadequate).
3. Allow the meter sufficient time to stabilize. You may electronically record the measurements by pressing "ENTER" once bringing up a submenu and then pressing "ENTER" a second time. This will store the measurement in a data file in the YSI Proplus. Record the measurements in the field logbook, datasheet, or Survey123 App. If a water quality sample is also being submitted, record the measurement information on the lab sheet.

B. Flow meter – SonTek FlowTracker

This flow meter is used to calculate stream flow or discharge. This meter uses sonar to detect water velocity. The operator inputs the location (on the tape line) and depth so the unit may calculate discharge. For best results and to reduce errors, select an area of the stream with minimal water turbulence and minimal underwater obstacles (rocks, algae, plants). A slow moving segment of the stream with a flat bottom is ideal. Take care not to disturb sediment on the bottom of the stream bed as this will cause sonar errors. Refer to Figure 1. SonTek/YSI FlowTracker Handheld ADV Technical Manual (uvm.edu)

1. Attach the sonar probe to the wading rod and tighten the set screw.
2. Set up a tape line. While standing in the water facing downstream, the "right bank" is on your right side. This is the side where you will start.
3. On the right bank, use a stake to place the start of the tape line. Stake the tape line high enough up the bank so that the tape does not get swept by the stream and place in soil secure enough so that the line may be taunt.
4. Cross the stream to the left bank allowing tape to reel out. Secure the end of the tape line to the left bank with a stake. Note the measurement of the tapeline at the edge of the left bank. Subtract the measurement of the starting edge on the right bank to determine the stream width. It is ideal to measure 10 to 20 stations

(locations) at equal intervals so that no more than 10% of stream discharge is represented at any one stream location. This may not be possible on very narrow streams. At a minimum, measurements may be made every 3 inches. For example, the tape line measures 6.5 feet at the right bank shore and 32 feet at the left bank shore. Subtracting 6.5 from 32 results in a stream width of 25.5 feet. In order to prevent greater than 10% stream discharge in any one stream location, at least 10 stations should be the measured. 25.5 feet divided by 10 stations would result in increments of 2.5 feet. However to prevent greater than 10% discharge in any one station measurement, increments of 1.5 or 2 feet may be more appropriate. Determine the station intervals based on stream width.

5. Turn on the FlowTracker meter. The startup screen will appear.
6. Press the “ENTER” button. The Main Menu will display.
7. Press the “3” button to start the data run. This will take you to the data file name screen.
8. Press the “1” button to input the station name (StationID if it fits). Input a unique name. The name can only be 8 characters maximum, so you may need to abbreviate. Press the “ENTER” button once the name is input.
9. Press the “9” button to accept the name.
10. Press the “9” button again to start the data run. At this time the display message will read “Press QC Menu at any time for Gauge data Enter to continue.” Press “ENTER.”
11. The Automatic QC Test will appear. A QC test must be conducted once each day that the flow meter is used. Press “1” to run test or “2” to skip the test. If running the test, a message will display to “Put probe in moving water away from any underwater objects. Press enter to start.” Following those instructions, place the probe/wading rod in the water so that the direction of the flowing water is perpendicular to the direction of the sonar. Make sure there are no underwater objects such as plants, rocks, or debris. Hold the probe/wading rod still and upright. Press the “ENTER” button. The meter will begin a self-diagnostic QC test. Only proceed if the QC test passes.
12. The Starting Edge screen will appear. At the right bank, locate the measurement on the tapeline of the edge of the water. Press the blue “Set Location” button and use the numeric keys to enter the measurement of the tapeline at the edge of the water.

13. Press the gray “Next Station” button. This will take you to Station 1 – which correlates with the location on the tape line. The location of Station 1 may need to be adjusted based on the stream width. The first station (Station 1) and the last station measured on the left bank must be half the interval of the rest of the stations. This is to accommodate for slope of the stream from the stream edge to the first and last station. To adjust the location of Station 1, Press the blue “Set Location” button and manually enter the appropriate location. Go to that location on the tape line.

14. Press the blue “Set Depth” button and use the numeric keys to enter the depth of the water based on the stream depth measurement on the wading rod at Station 1.

15. Holding the meter still and upright, press the blue “Measure” button. The meter will begin taking measurements or “pings.” If there are any errors, correct the source of the error if possible and repeat the measurement. It may take several attempts per station. Press “1” to accept the measurement or “2” to repeat the measurement.

16. Once you accept the measurement, the meter will go to Station 2 and so forth. At each station, you must verify you are at the appropriate location on the tape line and enter the appropriate depth based on the measurement on the wading rod.

17. After the last station has been recorded, press the gray “End Section” button. The screen will display a prompt to press “End Section” again to end the section. The Ending Edge screen will display. Press the blue “Set Location” button and key in the corresponding location of the left edge on the tapeline.

18. Press the gray “Calculate Disch.” button. The screen will display a prompt to press the Calculate Discharge button again to confirm. Press the “Calculate Disch.” button again.

19. The meter will display information. Press the “Enter” button to continue viewing data. Press the “0” button to exit. Important: After viewing the data, you must press the “0” button to exit in order for your data to be saved.

20. Record the flow discharge measurement in cubic feet per second in Survey123 app, field logbook, or pre-printed data sheet.

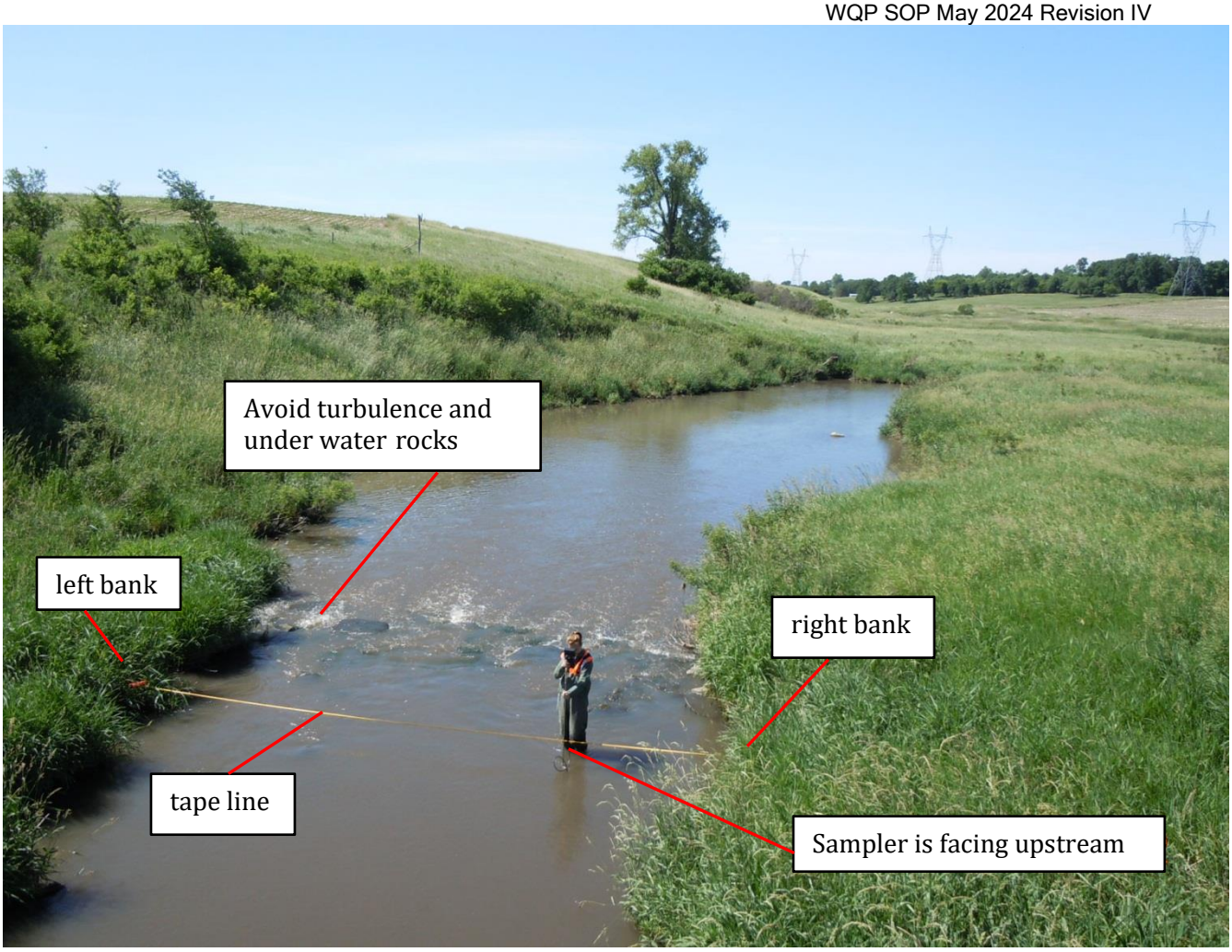


Figure 1. Taking a flow measurement with SonTek FlowTracker.

LABORATORY SHEETS AND CHAIN-OF-CUSTODY

The majority of samples collected for ambient monitoring, fish kills, complaints, and other sampling projects do not need complete custody documentation. However, under certain conditions, such as compliance investigations, DANR must be able to prove that any analytical data offered into evidence accurately represent environmental conditions existing at the time of sample collection. Due to the evidentiary nature of such samples, possession must be traceable from the time the samples are collected until they are introduced as evidence in legal proceedings. It must be clearly demonstrated that none of the involved samples could have been tampered with during collection, transfer, storage, or analysis. DANR chain-of-custody protocols and procedures are described below.

Documentation

To maintain and document sample possession, the following chain-of-custody procedures are followed:

1. Sample Custody - A sample is under custody under one of the following conditions:

    a. It is in your direct possession (you are holding it).
    b. It is in your direct line-of-sight after being in your possession (you can see it).
    c. It was in your possession; you locked it up or placed it in a sealed container to prevent tampering (no one can access the sample without leaving evidence of access, e.g. seal broken, tape removed, etc.).
    d. It is in a designated, secure area (typical evidence holding area).

Field Custody

1. The project officer will advise laboratory personnel that a sample requiring chain-of-custody will be collected and will specify the approximate date and time that it will arrive at the laboratory. In instances where date and time are not known in advance of a field trip, the laboratory should be notified as soon as possible about the arrival of such samples.
2. The samples must be collected in accordance with required and established methods set forth in this SOP, the Quality Assurance Project Plan (SWQ QAPP), and 40 CFR Part 136 (or other applicable section).

Transfer of Custody

1. To establish the documentation necessary to trace sample possession, chain-of-custody record (refer to DANR WQP QAPP) must be filled out on the SD DANR Water Quality Data Sheet and accompany each set of samples. The record should accompany the water quality data form and the samples to the laboratory. This record tracks sample custody transfers between the sampler and laboratory analysts. At a minimum, the record should contain:

    a. The StationID or sample identification;
    b. The signature of the collector and witnesses when present;
    c. The date and time of collection; place and address of collection;
    d. Substances sampled;

e. Signatures of persons involved in the chain of possession; and inclusive dates of possession.

All chemical water samples collected using this SOP utilize the DANR Water Quality Data Sheet (commonly referred to as the lab sheet) or Fish Flesh Chain of Custody (refer to SD DANR WQP QAPP for these forms) as the laboratory data sheet and chain-of-custody document. When properly signed by all affected personnel, the SDDANR Water Quality Data Sheet and Fish Flesh forms comply with chain of custody requirements.

2. Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis. The samples for each shipping container shall be placed in the large plastic bags provided by the laboratory.
3. If samples are split with a source or government agency, it will be noted in the remarks section of the Chain-of-Custody Record. The note should indicate with whom the samples are being split and be signed by both the sampler and recipient.
4. Each transfer of sample custody must be documented on the Chain-of-Custody Record.
5. The Chain-of-Custody Record identifying its contents will accompany all shipments. The original record will accompany the shipment, and the project officer will retain a copy and place it in the project file.
6. The laboratory should have assigned laboratory custodians who are responsible for overseeing the reception of all controlled custody samples.
7. When the samples are not in the immediate possession of the individual having official custody, they must be kept in a locked enclosure.
8. After the laboratory has completed the sample analysis, the Water Quality Data form and the Chain-of-Custody record will be returned to the appropriate program. These items will be kept on file for at least five years. Access to the Chain-of-Custody file is limited to program personnel.

Delivery or Shipment of Samples

Samples must be packed in coolers on loose ice for shipment or delivery to the laboratory. You must include appropriate paperwork. Make sure the container does not leak and all shipping or delivery labels are legible. Generally, samples need to be chilled to less than 6^{o} Celsius. Make sure there is adequate ice in the cooler to keep samples chilled during transit.

1. Completely fill out a DANR Water Quality Data Sheet (see WQP QAPP) for each sample station.

2. If the samples are being shipped or sent with the courier, place all sample containers in a large plastic bag. Add loose ice to the bag and tie closed. Place the bag inside the shipping cooler.
3. Make sure that all DANR Water Quality Data Sheets are filled out completely. Protect the documents from getting wet by placing them in a plastic bag and putting them in the shipping cooler.
4. Securely seal the cooler with packing tape.
5. Shipping coolers are shipped via mail (USPS, FedEx, etc.), delivered by the courier, or delivered by the sampler to the appropriate laboratory.

QUALITY ASSURANCE

General Information and Handling Procedures

This section is supplemental to quality activities and requirements outlined in the WQP QAPP. Refer to the WQP QAPP for specific information on data quality objectives, quality activities, and corrective actions.

1. If several locations are to be sampled during one sample run, which includes both clean and polluted sites, sampling should progress from the clean areas to the polluted areas. This lessens the chance of unintentional contamination of cleaner samples through the use of contaminated sampling equipment (waders, meters).
2. Sampling equipment (meters, graduated cylinders, field bottles, etc.) should be triple rinsed with water from the waterbody being sampled prior to collecting the water sample.
3. The sample container and preservation must be appropriate to the sampled parameter. See figures 3, 5, and 6.
4. A regular schedule of calibration of field instrumentation must be followed. The field instrument calibration frequency is outlined in the WQP QAPP. The calibration process is necessary to ensure that the instrument is working properly and within the range of acceptance as determined by the manufacturer. All instrumentation used in field activities must be calibrated prior to field use and as often as necessary thereafter, according to manufacturer instructions. All calibrations must be recorded in the meter's calibration logbook.
5. In those instances where field equipment cannot be calibrated or is not functioning properly, the sampler will attempt to repair the affected equipment in the field. For field meters that are assigned to individuals, such as regional staff, that person is responsible for the maintenance and repair of their own equipment. For field meters that are not assigned to individuals and are available for general use, the WQP designated sampler is responsible for maintenance and repair. The WQP designated sampler is also responsible for ordering parts or service for all WQP field equipment. The WQP designated sampler is identified in the WQP QAPP.
6. All WQP field equipment will be examined for maintenance/repair recommendations and checked for proper operation by the WQP designated sampler; this information is recorded in a calibration logbook or the Survey 123 app. Any necessary maintenance will be performed immediately to assure instrumentation is in operating condition prior to the next use.

LABORATORY ANALYTICAL METHODS

Per Surface Water Quality Standards, tests or analytical procedures to determine conformity with surface water quality standards will be made in accordance with methods approved in 40 CFR Part 136. It is the responsibility of the project officer to specify and ensure that the laboratory uses approved analytical methods listed in 40 CFR Part 136 for all SWQP water quality samples.

SAMPLE CONTAINERS, PRESERVATION AND HOLDING TIMES

Appropriate sample containers, preservation techniques, and holding times for water quality samples are listed in 40 CFR Part 136. It is the responsibility of the project officer to ensure that the appropriate sample containers and preservation techniques are used during sample collection. It is the responsibility of the laboratory manager to ensure that the water quality sample is analyzed within the appropriate holding time. However, the project officer should verify that the holding time was met as a part of standard quality control practices (see SWQ/ QAPP).

In addition to sample container, preservation, and holding time information, 40 CFR Part 136 places additional requirements on some tests in the form of footnotes. These footnotes are important and are a required step in achieving meaningful results.

Figure 2 displays common test parameter suites used by the SWQP and FPP, and the appropriate container type, preservation requirement, and maximum holding time for the parameter with the shortest holding time in that bottle. For individual parameter holding times, refer to 40 CFR 146. As appropriate, footnotes are included and their action described at the bottom of the table.

Figure 2. Sample Parameter Suites and Information

Bottle	Size & Material		Preservative	Parameters	Holding Time[4]
A	DOH	1000 mL HDPE	Cool to 6°C	Alkalinity, total solids, TSS, volatile solids, TDS, BOD, CBOD, CO_3,Hardness, K, lab pH, lab conductivity, nitrate, chloride, fluoride, HCO_3, SO_4	48 hours
	Midco	1000 mL polypropylene			
B	DOH	1000 mL HDPE	2 mL H_2SO_4 pH <2 Cool to 6°C	Ammonia, Nitrite+Nitrate, TKN, Total P, COD	28 days
	Midco	500 mL polypropylene			
C	DOH	100 mL sterilized polystyrene	Na_2SO_3 if chlorinated Cool to 6°C	Fecal coliform, *E coli*, total coliform, enterococci, fecal PFG	6 hours[1]
	Midco	100 mL sterilized polystyrene			
D	DOH	100 mL polystyrene	Field filter 0.25 mL H_2SO_4 pH <2 Cool to 6°C	Dissolved P, dissolved inorganic nitrogen	28 days
	Midco	250 mL polypropylene			
Metals – Dissolved	DOH	100 mL polystyrene	Field filter 0.25 mL HNO_3 pH <2 Cool to 6°C	Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Cu, Hg, Pb, Mg, Mn, Ni, Se, Ag, Na, Ti, U, Vn, Zn, Fe, Mo, fluoride, K, Cl, silica	28 days
	Midco	250 mL polypropylene			
Metals – Total Recov	DOH	100 mL polystyrene	0.25 mL HNO_3 pH <2 Cool to 6°C	Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Cu, Hg, Pb, Mg, Mn, Ni, Se, Ag, Na, Ti, U, Vn, Zn, Fe, Mo	28 days
	Midco	250 mL polypropylene			
Oil & Grease	all	1000 mL amber glass	2 mL HCl pH <2 Cool to 6°C	Oil & Grease	28 days
R	all	1 gal cubitainer polypropylene	Cool to 6°C	Radium-226, radium-228	6 months
CN	DOH	250 mL polypropylene	NaOH pH>10 Cool to 6°C	Total cyanide, WAD cyanide *Mitigate interferences as described in 40 CFR136	48 hours[2]
	Midco	150 mL brown polypropylene			
H	all	1000 mL amber glass	Cool to 6°C	TPH – diesel, caffeine	14 days[3]
V	DOH	40 mL amber glass vial	Cool to 6°C	VOC, TOC, DOC (lab filtered & preserved within 48 hours), TPH -gasoline	14 days[3]
	Midco	120 mL amber glass			

If you need to sample for an analyte that is not on this list – contact the laboratory for bottle, preservation, and holding time information.

[1]The holding time for bottle C parameters is 6 hours for compliance samples. Noncompliance samples must be analyzed within 24 hours of collection. [2]The maximum holding time for total and WAD cyanide is 14 days as long as all interferences have been mitigated as described in 40 CFR 136. If interferences are unknown the maximum holding time is 6 hours. 40 CFR 136 may be viewed at http://www.ecfr.gov. [3]The holding time for bottles H and V is 14 days from the time of collection to laboratory extraction. [4]Maximum holding time is based on the analyte with the shortest hold time.

DECONTAMINATION OF SAMPLE CONTAINERS AND SAMPLING EQUIPMENT

The laboratory will provide new, clean containers or decontaminate previously used sample containers. Sample container decontamination by the laboratory involves detergent washing, rinsing with dilute chromic acid and final rinsing with laboratory-grade distilled water. Decontamination of sampling equipment (probes and instruments) will be accomplished by triple rinsing with the calibration or distilled, tap, or blank water as appropriate by field personnel.

Field personnel do not need to triple rinse clean bottles supplied by the laboratory. However, when a field sampler uses a field bottle to collect a sample then transports it to another container, the field bottle must be triple rinsed with the water being sampled prior to filling.

PROCEDURES FOR SURFACE WATER SAMPLING

A. Field Observations

Record all field observations of conditions at the sampling sites that could influence the water quality of the collected sample. These observations are recorded on pre-printed project sheets, field log book, or Survey 123 app. Examples of observations recorded under COMMENTS could include: “cloudy, heavy recent rainfall, windy, cattle grazing near sampling site, dense emergent aquatic vegetation present at sampling site, etc.”

In addition to comments, specific observations should be recorded on the field data sheets as follows:

Flow-	Record in cubic feet per second (CFS)
Specific Conductance-	Record in umhos/cm
Dissolved Oxygen-	Record in milligrams per Liter (mg/L)
Field pH-	Record in standard units (su)
Water Temperature-	Record in degrees Celsius
Secchi-	Record in meters
ORP-	Record in millivolts

B. Field Analyses

Calibrate all instruments prior to field use as described in Section 4.0. Record all field analysis data on pre-printed project sheets, field logbook, or Survey 123 App.

1. DO, pH, ORP, specific conductance, and temperature
    a. If water is static, provide stirring by gently swishing the probe back and forth.

b. Allow sufficient time for the probe to stabilize.
c. Record data in the field logbook, pre-printed project sheet, or Survey 123 App.

2. Secchi Depth

a. Lower the Secchi disk with calibrated rope into the waterbody from the shaded side of the boat.
b. Drop the Secchi down until it is no longer visible.
c. Bring the Secchi up until you can just barely make out the cross pattern.
d. Record the depth of the Secchi Disk in meters.

Repeat the above procedure and average the two readings for the final Secchi depth reading.

3. Flow (SonTek)

a. Calibrate and operate the meter using methods found in Section 4.0 of this manual.
b. Record the stream discharge in cubic feet per second.

C. Sample Collection

The types of samples collected during sampling activities depend on the parameters that are necessary for the project. Sample parameters must be determined prior to conducting sampling activities. This will ensure that samples are adequately collected, handled, preserved, and that the sampling will address the project objectives. Figure 3 displays the parameter groupings, preservation requirements, and bottle type and size information used by the WQP. Figures 4 and 5 are depictions of bottle information and preservation requirements. Figure 4 is a depiction of the disposable filters used to field filter water samples.

In the event a sample needs to be collected and the necessary information is not contained in Figure 2, refer to 40 CFR 136 or other appropriate chapter for approved methods and information.

When collecting a water sample from a river, stream, lake, or wetland, follow these basic principles:

1. Use the appropriate sample bottle as directed in Figure 2. Affix a waterproof label that contains the station identification, sample date, and bottle identification.
2. If sampling a wadable waterbody, wade into the waterbody to collect the sample. It is acceptable to use a dip rid from the bank, bridge it or bucket from a bridge to collect a sample if it is unsafe to wade into the waterbody or for other safety reasons. Do not endanger yourself by

wading into a waterbody with unsafe conditions (ice jams, high flows, etc.). Wade into the thalweg or deepest part of the channel to collect the sample.

3. If sampling a non-wadeable waterbody, access the waterbody by boat, boat dock, or by wading along the shore if possible.

4. Face upstream or into the flow when collecting a sample. Remove the bottle lid and submerge the bottle beneath the surface of the water taking care not to disturb the bottom sediment. It is imperative that surface debris or bottom sediment do not enter the bottle. After filling the bottle, secure the bottle lid. Preserve according to Figure 2 and place in a cooler of loose ice (even during winter months).

5. If the bottle is pre-preserved, do not overfill the bottle or rinse the bottle prior to filling.

6. If using a field bottle to collect a sample that will be field filtered, like dissolved metals, make sure you triple rinse the field bottle with water from the waterbody being sampled before filling the bottle.

7. For samples that require field filtering, use 45 micron non-cellulosic disposable filters. See Figure 3 below. Attach the tube from the hand vacuum pump to the vacuum port on the disposable filter. Remove the filter lid to the filter apparatus and pour an appropriate amount of water into the top of the filter apparatus. Pump the hand vacuum to create negative pressure in the filter apparatus. This will result in water being vacuumed through the 45 micron filter into the receiving bottle. Field filtering must be done on site within 15 minutes of sample collection. If the time cannot be met, note it on the lab sheet.

8. Preserve the sample as directed in Figure 2 immediately after sample collection and chemical preservation. If you are unfamiliar with the buffer capacity of the water being sampled (feedlot waste, point source discharges, mining wastewater, etc., may be highly buffered), make sure you verify the pH with pH paper to make sure enough preservative has been added. Place all samples in a cooler with loose ice immediately.

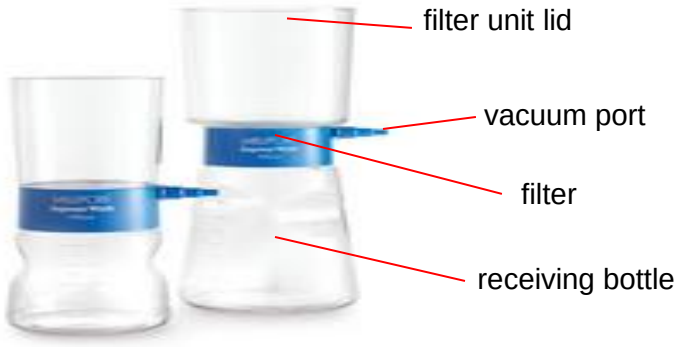


Figure 3. Disposable Filter Apparatus

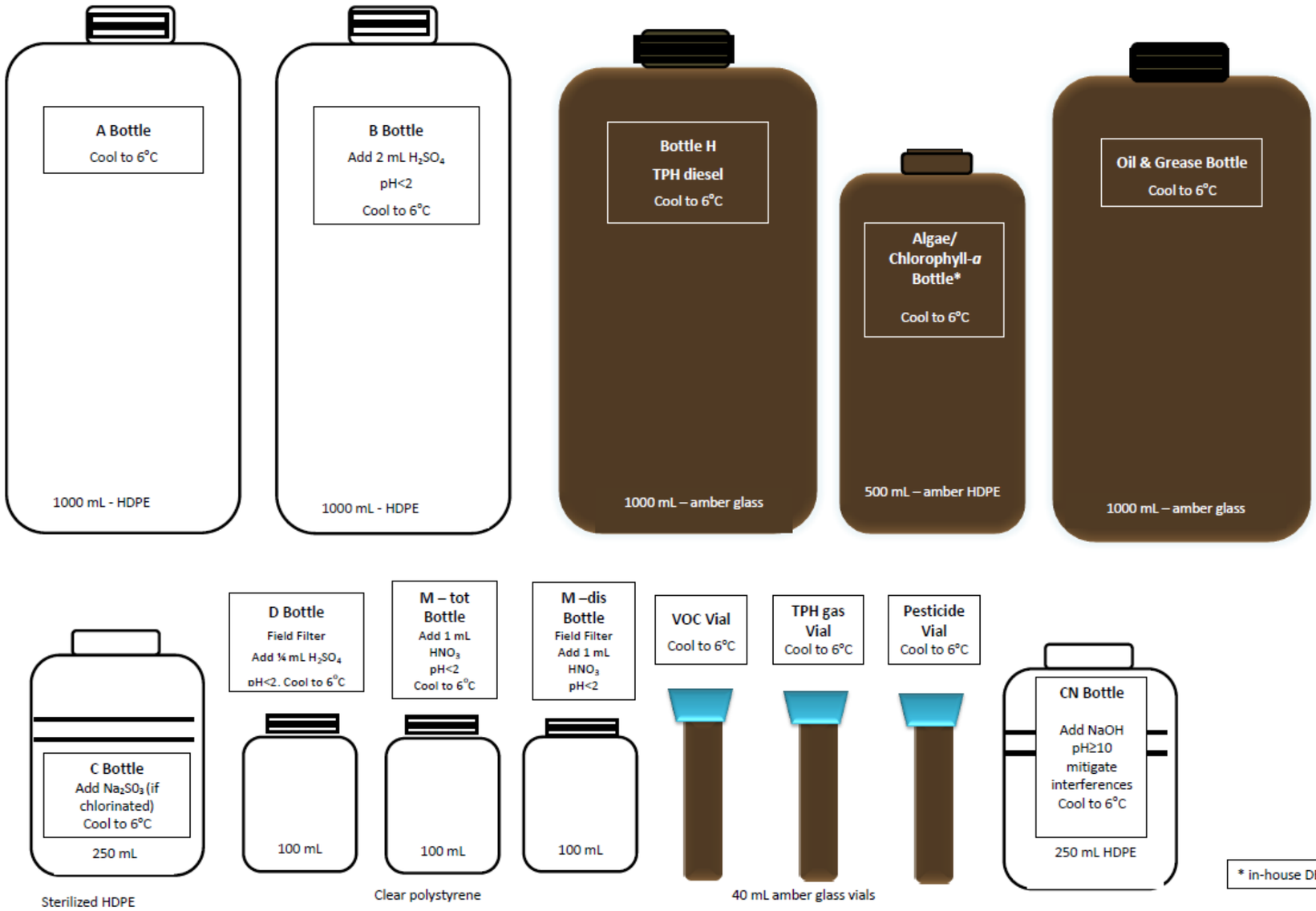
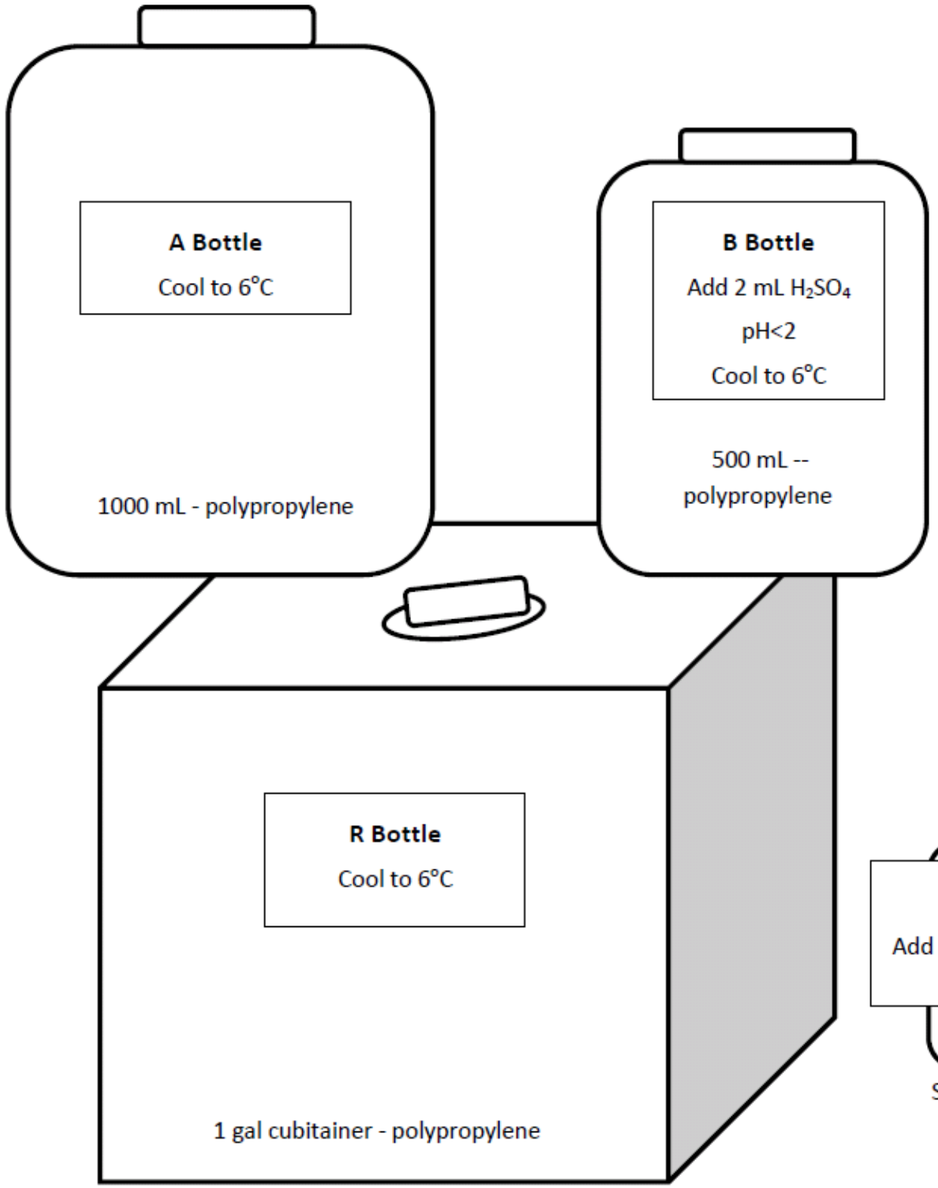
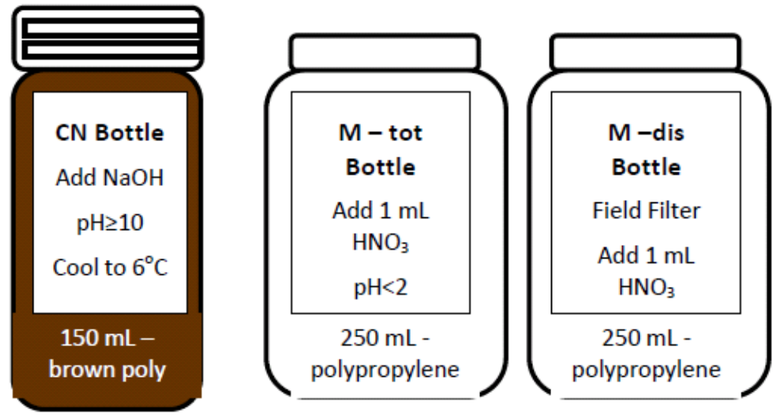
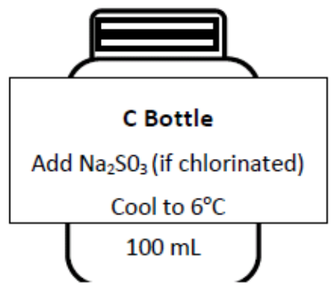
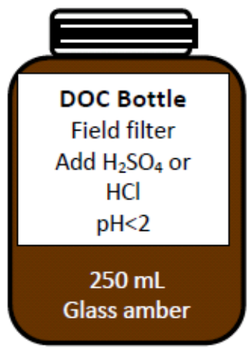


Figure 4. Sample Bottles for DOH laboratory.









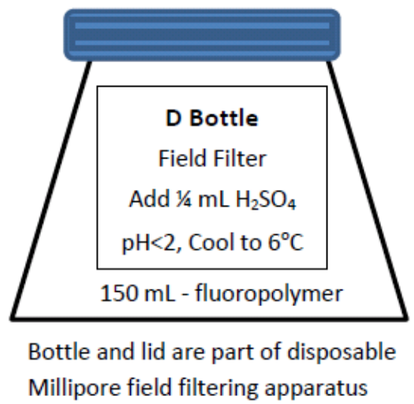


Figure 5. Sample Bottles for Midcontinent laboratory

1. Grab Sampling

Collecting a Sample

Be careful not to contaminate the inside of the lid or mouth of the bottle with your fingers or introduce other sources of contamination.

a. The "A" bottle –one liter bottle

i. Position the open end of the bottle towards the current flow and away from the hand of the collector.

ii. Grasp the bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum. The sampling depth should be 6 inches to 1 foot below the water surface, if possible.

iii. Tip the bottle slightly upward to allow air to escape and the bottle to fill.

iv. The "A" sample bottle should be filled to the neck of the bottle and capped immediately.

v. Place sample container in a cooler on loose ice (6°C), no preservative is required for bottle “A.”

vi. Mail or deliver the “A” bottle to the laboratory.

b. The "B" bottle –one liter bottle

Follow collection procedures for filling bottle “A” to fill bottle "B." Preserve the sample using the following procedure below.

i. After the sample has been collected, **preserve this sample with 2 mL of concentrated sulfuric acid (H_2SO_4)** to lower the pH of the sample below 2 standard units. As necessary, use pH paper to verify the pH has been lowered to <2.

ii. After H_2SO_4 has been added, the sample bottle is inverted several times to ensure mixing of the preservative throughout the sample.

iii. Place sample container in a cooler on loose ice (6°C) for shipment or delivery to the laboratory.

c. The “C” bottle -250 mL or 100 mL bacteriological sample

The 250 mL bottle is used when the sample requires more than one bacteriological analysis. If the sample only requires one bacteriological analysis, the 100 mL bottle may be used.

i. The "C" bottle **should not be rinsed** with sampling site water.

ii. Position the open end of the bottle towards the current flow and away from the hand of the collector.

iii. Grasp the bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum.

iv. The sampling depth should be 6 inches to 1 foot below the water surface if possible. If it is not possible, the

sample depth may be less, but the sampler should avoid surface debris and bottom sediment.

v. Tip the bottle slightly upward to allow air to escape and the bottle to fill. On the initial plunge, the "C" sample bottle should be filled completely. Immediately after obtaining the sample, pour off any excess sample water from the container until the sample volume is 250 mL or 100 mL and cap.

vi. If the sample bottle is not filled at least to the designated mark on the sampling bottle, discard the sample and sample bottle and repeat the process with a new "C" bottle. **DO NOT re-immerse the original bottle to add more sample volume**.

vii. Place sample container in a cooler on ice (6° C); **no preservative is required for bottle "C."**

viii. For compliance samples, bacteriological samples need to arrive at the laboratory within 6 hours after collection and processed within 2 hours. For all other types of samples the holding time is increased to 24 hours.

d. The "CN" bottle – 250 mL or 150 mL

i. Fill the bottle as directed for the "A" bottle.

ii. To preserve, add 1 to 3 pellets of sodium hydroxide (NaOH). Swirl the bottle until the pellets have dissolved.

iii. Using pH paper, verify the pH is greater than 10 but less than 12. If the pH is less than 10, add more pellets. If the pH is greater than 12, discard the sample and collect a new sample.

iv. Cap the bottle and place in a cooler with loose ice.

v. Mail or deliver the "CN" bottle to the laboratory.

e. The "H" bottle – amber glass liter

i. Fill the bottle as directed for the "A" bottle.

ii. The "H" bottle does not require any preservative.

iii. Cap the bottle and place in a cooler on loose ice.

iv. Mail or deliver the "H" bottle to the laboratory.

v. If being used for caffeine sampling, the sampler must abstain from all forms of caffeine for 24 hours prior to sampling. Ensure your hands are clean and make sure you do not contaminate the inside of the bottle or lid.

f. The "Oil and Grease" bottle – amber glass liter

i. Fill the bottle as directed for the "A" bottle.

ii. Preserve the bottle by adding 2 mL of 50% hydrochloric acid (HCl). Using pH paper, verify the resulting pH is less than 2.

iii. Place the acidified "Oil and Grease" bottle into a cooler on loose ice.

iv. Mail or deliver the “Oil and Grease” bottle to the laboratory.

g. The “V” or “pesticide” bottle – 40 mL amber glass vial or 250 mL amber glass

The ‘V” bottle is a 40 mL amber glass vial. It comes from the laboratory pre-preserved with ascorbic acid and hydrochloric acid. Do not rinse the vial. Do not use a marker to write on the vial – use a pencil or preprinted labels and allow the ink to fully cure before opening the vial (due to risk of VOC contamination from marker). Do not allow contamination (even airborne) from organic compounds such as vehicle exhaust or cleaning compounds. Do not allow the bottle cap, bottle threads, or inside of bottle to be touched or contaminated. For VOC analysis, the laboratory will also send 2 trip blanks. Do not open these trip blanks. They must accompany the vials at all times, including return to the laboratory. For pesticide analysis, trip blanks will not be included. ***For DOC samples are lab filtered & preserved within 48 hours.

i. Open the vial and completely submerge to fill. Underwater, tip the vial vertically so that it will completely fill and create a convex meniscus.
ii. Gently tap the vial to dislodge any air bubbles.
iii. Cap the vial and invert to mix preservative and visually verify there are no air bubbles.
iv. The glass vials can easily break. Pack the vials in the packing material supplied by the laboratory or wrap each vial in bubble wrap. Securely place the vials in a cooler of loose ice and ship or deliver the vials to the laboratory.

h. The “R” bottle – 1 gal/4L cubitainer

The cubitainer must be expanded before filling. Do not blow into or place fingers inside the cubitainer. To expand, partially unscrew the lid to allow air to enter the cubitainer and gently pull at the seams.

i. Fill the cubitainer as directed for the “A” bottle.
ii. If you are unable to submerge the cubitainer without disturbing bottom sediment, use the “field” bottle to collect the sample and pour the water into the cubitainer.
iii. The “R” bottle is the only sample bottle that will be filtered and preserved by the laboratory. This is due to the large volume of filtered water that is required and the general difficulty in filtering that amount of water from “R” bottle sites.
iv. Cap the “R” bottle and place in a cooler on loose ice.
v. Mail or deliver the “R” bottle to the laboratory.

i. **The "Metals-Tot Recov bottle" – 100 mL or 250 mL**

i. Fill the bottle as directed for the "A" bottle.
ii. Preserve the bottle by adding 0.25 to 1 mL of concentrated Nitric Acid (HNO_3) based on bottle size. As needed, use pH paper to verify the resulting pH is less than 2.
iii. Place the acidified "Metals-Tot Recov" bottle into a cooler on loose ice.
iv. Mail or deliver the bottle to the laboratory.

j. **Collection of the "field bottle" - one liter bottle**

If collecting dissolved phosphorus and/or dissolved metals water to be filtered, the sample can be collected in a one-liter polypropylene "field" bottle. Thoroughly triple rinse the field bottle with water from the waterbody being sampled then follow steps 1(a)(i)-(iv).

k. **The "D" bottle -100 mL plastic bottle**

Water to be filtered for this sample comes from the field bottle. Procedure for field filtration and preservation of the total dissolved phosphorus sample are described below.

i. Assemble the disposable filters by attaching the filter unit to the receiving bottle. Attach the hand pump hose to the vacuum port.
ii. Pour approximately 120-150 mL of water from the field bottle into the filter unit and cap with the filter lid.
iii. Use the electric vacuum pump or hand pump to create a vacuum in the filter unit. This will cause water to be filtered through the 45 micron filter and accumulate in the lower receiving bottle.
iv. After 100 mL has been filtered, unscrew the receiving bottle. This water may be transferred to the 100 mL "D" bottle (if going to the DOH lab) or it may remain in the receiving bottle (if going to Energy).
v. Add 0.25 mL of concentrated H_2SO_4. As needed, verify the pH with pH paper to ensure the pH is <2.
vi. Place the acidified bottle into a cooler on loose ice.
vii. Mail or deliver the bottle to the laboratory.

l. **The "Metals- Dissolved" bottle -100 mL or 250 mL plastic bottle**

Follow collection procedures for filtering and filling bottle "D" to fill bottle "F." Preserve the sample using the following procedure below.

i. 0.25 mL of concentrated Nitric Acid (HNO_3). As needed, use pH paper to verify the resulting pH is less than 2.

ii. Place the acidified "Metals-Dissolved" bottle into a cooler on loose ice. Mail or deliver the bottle to the laboratory.

m. **"Caffeine" bottle – 1000 mL amber glass with Teflon lid**

Caffeine sampling is conducted to provide information which may correlate contamination with human waste from septic leachate. **NOTE: Sampler must abstain from ingesting caffeine for 24 hours prior to sampling to minimize contamination due to low caffeine detection limits.**

i. Fill the bottle as directed for the "A" bottle taking care not to touch the inside of the lid, the threads of the bottle, or the inside of the bottle.
ii. If residual chlorine is present, add 80 mg of sodium thiosulfate per liter of water collected.
iii. Cap the sample and store in a cooler on loose ice.
iv. If the sample cannot be analyzed by the laboratory within 48 hours, freeze the sample to increase holding time to 7 days.
v. Mail or deliver the bottle to the laboratory.

n. **"Algae/Chlorophyll *a*" bottle – 500 mL amber plastic**

Algae or chlorophyll *a* are samples that may be collected during a complaint or fish kill to provide information on the water quality. These samples may be analyzed internally or contracted with an outside laboratory.

i. Fill the bottle as directed for the "A" bottle.
ii. Cap the sample and store in a cooler on loose ice.
iii. Ship or deliver the sample to the laboratory or SDDANR personnel.

2. Composite Sampling

Collecting a Sample

The sampling plan or project manager will determine which samples are to be composite samples. Unless specified, most samples will be grab samples.

a. Triple rinse a plastic graduated cylinder with sample site water.
b. Collect a sample in a rinsed Van Dorn sampler or other sampling device.
c. Calculate the amount of water needed from each sub-sample. Divide the size of your container (milliliters), by the number of sampling sites to be composited.

Example: Compositing three sites and placing them in the "A" bottle (1,000 mL).

1000 mL/ 3 = 333 mL

d. Pour the previously calculated amount (i.e. 333 mL) from one sub-sample into the graduated cylinder.
e. Pour the water from the graduated cylinder into each sample bottle.
f. Repeat procedures “a” through “e” on the remaining sub-sample sites.
g. Preserve each bottle following the procedures from the Grab sampling section.

1.0 South Dakota Hydrologic Duration Assessment Method

February 2023

WQP SOP May 2024 Revision IV Duration Assessment Method

Contents

Introduction

Purpose of this document is to describe field data collection methods used for waterbodies that require a Use Attainability Assessment (UAA). This methodology is centered around use of the mobile data collection platform Survey123. Data collection applications have been developed for recording landowner interviews and field data. Expectations for site visits establishes minimum data requirements for site visits. It is not necessary to complete data collection in a specific order, however it may be beneficial to complete recreational indicators at the end of a site visit.

Expectations for UAA site visits

1. On the UAA Enterprise App – collect these at every site even if there is no water.
    a. Location
    b. Site information
    c. Human Use
    d. Geomorphology
    e. Biology
    f. Photos of the Hydrologic Feature
2. Landowner surveys:
    a. Whenever someone stops to visit, request some information from them
    b. Whenever you reach out to a landowner for permission, request the information
3. Meter readings should be collected whenever there is enough water to submerse the sensor, flowing or ponded.
4. If there is enough water for the multiprobe, there is enough water to attempt fish collection.
5. All fish species need to be photographed and added to INaturalist
    a. Try to take photos of distinguishing characteristics (like chin barbels on bullheads)
    b. Use the Photarium for small fish to be able to see fin structures
    c. Take more than one photo
6. Other aquatic species encountered
    a. Always document presence of mussels
        i. At least 2 photos of each one
        ii. Live species side view and view of umbo
        iii. Shells – inside and outside of shell, and umbo
    b. Always document crayfish
        i. Females any photo
        ii. Males, at least one close-up of the pleopods.
    c. Lower priority, snap an INAT photo when convenient
        i. Amphibians and reptiles
        ii. Vertebrates/invertebrates
        iii. Aquatic plants – optional
7. Discharge measurements
    a. Whenever the flow is greater than about 1 CFS.
    b. But less than flood stage (deeper than about waist deep, rapid water, any major river)
8. Segments with individual site scores in excess of 30 (group of similar UAA sites on a stream) should be prioritized for a full 2N assessment that includes full habitat measures and an in depth fish and macroinvertebrate assessment.

Hydrologic Cycles

Highly variable streamflow conditions including extended wet and dry cycles are normal conditions for prairie streams. The high variability and low runoff from prairie streams results in a higher proportion of intermittent to perennial streams than is found in forested biomes (Dodds, et al. 2004). Data collection during abnormally wet or dry periods may lead to inaccurate assessments of flow duration.

Wet and dry conditions may be assessed using a drought index that assimilates rainfall, snowpack, and streamflow data into a big picture (Hayes, Alvord and Lowery 2007). Indices such as the Standardized Precipitation Index (SPI), Palmer Drought Severity Index (PDSI), or Palmer Z index as well as others may all provide useful assessments of conditions (NOAA 2020). The limitation with using these indexes is that they are only available after data collection is complete. These indices should be used as confirmation of conditions when suspect observations are encountered or as a verification tool incorporated during data analysis.

Data accuracy and usability may be improved by avoiding regionally extreme conditions during field visits. To accomplish this, current stream flow condition should be evaluated prior to completing fieldwork. Regional flow conditions at the nearest downstream gauge as well as the geographically closest gauge should both be evaluated in the Current Streamflow page on the USGS WaterWatch website (USGS 2020). The Current Streamflow page has near real-time discharge data ranked against historical flows providing seasonally adjusted long-term hydrologic rankings. When rankings fall outside the 10^{th} or 90^{th} percentiles, assessments should be discontinued. Suspect evaluations should be verified with a precipitation index or resampling during a different flow condition. Accumulating data over an extended period of time covering a variety of hydrologic conditions should result in data progressing or regressing to the mean and settling around an average.

Further data improvements may be attained by close observation of weather immediately prior and during field visits. The high plains weather during the growing season is characterized by small yet intense thunderstorms that may generate locally heavy rainfall. Many of the indicators are sensitive to rainfall and high flows may obscure them preventing an accurate assessment. Avoiding data collection during or within 48 hours after significant rainfall events will help mitigate these extremes.

Recreation

Recreational activities that occur in, on, or along water bodies are important factors in assigning beneficial uses. Frequently, field crews first interactions with a waterbody come through landowner contacts when seeking permission. This initial contact should include an attempt to collect the landowner survey data.
In addition to surveys, site visits should include a search for any signs of recreation. When walking within the reach of permitted access, riparian areas should be inspected for noticeable indicators in the soil, surrounding grass, under bridges or other structures, and in tree canopies (i.e. fishing lines in trees hooked in branches). Any observed indicators or active occurrences of recreation in the area should be marked in its appropriate section. Indicators are grouped into three categories; area use, contact use, and immersion use.

Landowner Survey

Landowner and operator surveys provide direct input from the public as to how a water body is being used. Limited access to private property adjoining a water body may result in field crews' inability to observe some indicators. Recreational activities that occur intermittently or seasonally may not leave sufficient evidence to note their occurrence. Local knowledge is a critical component to understanding how people are interacting with and using a water body.
Surveys should be conducted in the field whenever possible. Field crews frequently interact with local residents at sampling locations providing an opportunity to collect data. Surveys may also be conducted via phone interview or by mail when requesting permission to cross private lands. A data collection application has been developed for Survey123 and all data will be entered into this application. The survey questions are listed in Appendix B.

Area Use Indicators

Area use indicators are signs of human activity within proximity to a water body. They may not confirm recreation and in cases of exclusionary fencing and signage may indicate that recreation is prohibited. The indicator list consists of frequently encountered signs of human use and are documented as either present or absent. Other signs of human use not included in the list should be documented in the comments of a site visit.

- **Fire rings**- Can be indicated by rocks or loose debris arranged in a circle for containing a fire. Usually contain remnants of burn wood and/or trash. Presence of fire rings can indicate recent or past use of the area for fishing, cooking, or camping.
- **Cut or bunt wood** – Indicated by burn piles or associated with fire rings. Wooded plants along the channel area may show signs of being cut for collection.
- **No trespassing signs** – Signs posted by landowners along the fence line or in view from the site. No trespassing signs indicate that public use of the site is not allowed, and recreation use is unlikely.

- **Fencing (limits access)** - Any form of fencing that limits access to the water. Can be of various types with some being attached to a bridge at the site while others are strung over the stream along a property line.
- **Graffiti** – Typically found on bridges or other structures, such as gaging stations, located along the stream corridor. One or two markings can indicate that the site is rarely used. Several or more markings can indicate frequent use of the site.
- **Public access signs** – Signs generally issued by the state or local municipalities to indicate that the area is open for public use such as public hunting, public park, and fishing access signs.
- **Human trails** – Indented or bare paths in the foliage along streams that indicate humans have recently or frequently traveled on foot or by vehicle in near the site.
- **Logs turned on ends for sitting** – Cut or broken logs arranged in a way that indicates the area is used for long periods of time. May be accompanied by fishing indicators or arranged around fire rings.
- **Rocks arranged for sitting** – Rocks from the surrounding area gathered in a line, circle or other formation that indicates the site is used by people for long periods of time. May be accompanied by fishing indicators or fire rings.
- **Public parking or indications vehicles park frequently** – Paved, gravel, or bare spots on the side of the road or along stream corridor that indicate the vehicles frequently park at the sight. Can be designated by public parking signs or turnouts along the roadside. Indicate the area is used regularly for recreation activities.
- **Developed public facilities such as bathrooms, picnic shelters, parks, or camping areas** – Public recreation or use facilities. Structures constructed for regular use by the public. Indicate the area is open for public use.
- **Discarded items** – Wrappers, paper, cardboard boxes, cans, or any other forms of solid waste that indicate the area is frequently used by humans.
- **None Observed** – Confirmation that after searching, none of the indicators were observed.

Limited Contact Use Indicators

Indicators in the limited contact portion of the list are those associated with recreational activities that will result in human contact with the water but do not typically result in full body immersion. The indicators listed are those most frequently encountered. Each site visit should verify their presence or absence. Other observations of recreation use not included in the list should be documented within the site visit comments.

- **Fishing equipment** – Bait, lures, fishing line, tackle boxes, or fishing nets. Lures and line can often be found in the water, along the shore, or in trees near the site. Indicate that the site is used for catching fish for sport or consumption.
- **Fishing sticks** – Branches that have been driven into the ground for propping up fishing poles. An indication that fishing occurs at the site.
- **Furbearer traps** – Furbearing mammals such as raccoons, beaver, mink, muskrat, and otter are frequently found around aquatic habitats. Trapping these species typically involves setting traps in and along the edges of water bodies. This is an indicator that humans may have contact with the water at the site.

- **Shotgun shell casings** – Expended shotgun shells lying in water or around the site area. Indicate that the area has been used by humans for hunting which may result in limited contact with the water.
- **Waterfowl blinds –** Structures used for hunting waterfowl that simulate wetland or stream foliage. Waterfowl blinds indicate the area is used for waterfowl hunting.
- **Minnow traps** – Cylindrical cages with conical openings which are placed in streams for capturing minnows. Can be strung or chained from bridges.
- **Boot prints in the mud** – Impressions of boots in the mud generally along the shoreline or trailing to water bodies.
- **Boat ramps** – Ramps made of wood, asphalt, or concrete for placing boats into water bodies. Boat ramps can be private or public access.
- **None observed** - Confirmation that after searching, none of the indicators were observed.

Immersion Use Indicators

Immersion use indicators are associated with recreation that normally results in full body immersion in the water. Site visits should confirm the presence or absence of each indicator and document any other signs of immersion recreation in the visit comments.

- **Rope Swings** – Ropes strung from tree branches for individuals to swing into streams and other water bodies.
- **Water Slides** – Any structure or device placed on a bank that can be used by individuals for sliding into waterbodies. Can be a formed slide or plastic tarps.
- **Swimming Platforms** – Piers or docks that individuals can use for getting and out of a waterbody.
- **Barefoot footprints in the mud –** Footprints of bare human feet in the soil near a body of water. This indicates that individuals may fully immerse in the water.
- **Beach facilities** – Areas maintained for beach access and structures such as bathrooms or showers intended for use by individuals using the beach area.
- **None Observed –** Confirmation that after searching, none of the indicators were observed.

Field Data Collection

Site Location

Using the Avenza Mapping Application (Avenza Maps 2021), verify the current location has a station and that it matches the pinned map in the Survey 123 application. If the locations correspond, enter the station ID into the Survey 123 application (ESRI 2021) and proceed with the assessment. If no stationID exists for the current location, a new ID may be created by using a combination of both the UAA drainage and a road number. An example would be for the Miller UAA, a new station might be named Miller361 to signify the drainage crossed 361st Avenue. Additional modifiers of “A”, “B”, “C”, etc may be added for stream segments that cross the same road in multiple locations.

Site Information

General data and first impressions of a site should be entered into the site information tab of the application. The waterbody type can be selected from the drop-down list: Lake, Wetland, Ditch, River/Stream, Linear wetland, or draw with no channel features. The site hydrology is selected from the following list: flowing, ponded, saturated, dry, frozen over, frozen to bottom.

Dominant land uses immediately surrounding the site should be selected from this list, pasture, hay land, housing, wastewater lagoon, railroad, public hunting, non-ag, cropland, commercial, forested, park, cemetery, or other. If the “other” land use is selected, the land use should be entered into the comments section immediately following the land use entries. This section should also be used to document any other relevant observation that is not adequately captured by the application.

Water chemistry

Measurements of dissolved oxygen, pH, specific conductance, water temp, and oxidation reduction potential (ORP) may be used to distinguish differences in habitat types. Wetland systems may be expected to have low DO and high ORP while a coldwater fishery should have lower temperatures and higher DO. This data will be collected with a properly calibrated field meter according to program procedures (SDDENR 2016) at every site where water depth is adequate to submerse the instrument. Results will be recorded in the relevant sections of the field application.

Physical measurements of the stream including average and maximum width and depth as well as the discharge volume will be collected at all sites. Average and maximum depths will be recorded for both lentic and lotic systems. Average and maximum widths will be limited to lotic systems and should be left blank for sites that are dry or not flowing.

Recreational uses may be impaired by elevated bacteria concentrations. Collection of *E. coli* samples at stations assigned the use of limited contact recreation but without the immersion recreation use will increase baseline knowledge at these locations. These samples will normally be collected on the last day of a trip to facilitate delivery to the laboratory within the parameters 24 hour holding time.

Complete water chemistry should be collected on investigations in new systems to establish baseline water chemistry. Parameters measured should include total suspended solids, total dissolved solids, biological oxygen demand, hardness, chloride, sulfate, ammonia, nitrates, total Kjeldahl nitrogen, total phosphorus, and *E. coli*.

Fish collection

The presence of fish and species composition at a site are important indicators of the waterbody's permanence and habitat type. Provided access to the stream corridor is both safe and permitted, fish collection will be attempted at all sites not already classified as a fishery. All pools, regardless of size should be checked for aquatic life. Microhabitats such as the small pool in Figure 1 can provide refuge in intermittent streams. The intent of the fish survey is primarily to document fish presence and secondarily species composition. It is not intended to address a catch per unit effort or document full community structure.

Primary stream collection methods will consist of electrofishing available habitats. Site efforts will vary depending on the available habitats and access to private lands. When adequate access exists, reach lengths up to 100 meters should be assessed. Although electrofishing is the primary means of fish collection, other methods may be used including seine, gill, and fyke nets, fish found dead or observed swimming. At inaccessible locations, environmental DNA samples should be gathered.

At certain sites, it may not be possible to collect fish using traditional methods. In these instances, an EDNA (Environmental DNA) test should be administered. EDNA is organismal DNA that can be found in the environment and originates from cellular material shed by organisms into aquatic or terrestrial environments (USGS 2021). By utilizing EDNA kits, the presence of fish and other aquatic organisms can be ascertained as either present or not present and in many cases the species composition can be determined as well. Collection procedures should follow those recommended for the sample kit in use.

Specimens will be identified to the species level. The field application is designed to accept either individual or groups of a single species of fish. Specimens of a species may be grouped by length to create a single entry of similar sized individuals. A species such as fathead minnows might be entered into a sing group of specimens ranging from 60mm-80mm in length. The same site may have common carp ranging from 70mm-120mm and a second group of common carp ranging from 250mm-350mm. Voucher photographs of the identifying characteristics of each species should be recorded and uploaded to the programs I-Naturalist account (iNaturalist 2021).

Figure 1. Green Sunfish in Microhabitat

In addition to fish, other aquatic organisms found at the sites should be photographed and submitted to I-Naturalist. Of particular interest are freshwater mussels. Live specimens should be photographed and returned to the water; shells photographed onsite may be retained as vouchers for positive identification. As a lower priority, amphibians, reptiles, crayfish, and aquatic insects may all be documented when photos are easily captured.

Stream Duration and Assessment Method

Long term continuous hydrologic data is the preferred data set to aid in beneficial use determinations. This data is unavailable for most stream segments which necessitates a method for estimating flow frequency which can be completed with a finite number of visits. Methods for the delineation of ephemeral, intermittent, and perennial streams have been developed in other regions of the country. South Dakota (SD) reviewed protocols developed for North Carolina (NC) (NC Department of Water Quality 2010), New Mexico (NM) (State of New Mexico 2011), and the Pacific Northwest (Nadeau 2015). The NC and NM methods used similar approaches of quantifying observations while the Pacific Northwest method was more qualitative and utilized a decision tree in its determination. Many of the indicators used in the quantitative methods could be adapted for use in South Dakota streams.

The quantitative methods employed a suite of independently scored indicators. The sum of the indicators may then be related to flow frequency. Although the total points possible varied between the methods, they each found that as scores increased a transition from ephemeral to intermittent and then intermittent to perennial occurred.

Specific indicators varied between the methods due to differences in geology and climate. Initially, all indicators from both methods were included for evaluation on South Dakota waters. A desk exercise using photos and maps from well-known sites statewide revealed that several method specific indicators used in the other methods had no correlation to the ephemeral- perennial gradient. Those were removed from further consideration. The sinuosity of the channel metric was used in both the NC and NM methods. The desktop evaluation found that sinuosity did not differentiate between dry draws and flowing streams, likely due to the extremely low gradient of the landscape in many parts of South Dakota. This represents the only metric that was common amongst the other regional methods which was not selected to use in SD.

Scoring

The assessment is divided into two broad categories. Nine of the indicators are related to waterbody geomorphology and are a function of the water's interaction with the landscape. The remaining eight indicators are biological and are dependent on flow frequency and duration for their presence and prevalence. Each indicator has a set of scores associated with its presence or density in the reach. Most indicators are scored based on their relative abundance in the reach. Strong implies that it is abundant and clearly visible throughout the reach. Moderate indicates a relative decrease in frequency from strong and weak suggests the indicator was present but very poorly represented. The absence of an indicator will result in a low score. Exceptions to the scoring for upland plant and rooted vegetation measures are discussed further in their respective sections. Indicators that bear importance in any density or concentration are scored as either present or absent.

Scores vary between the indicators according to the weight the indicator carries in perennial flow determination. Unionid mussels are sensitive species only associated with the continuous presence of water, therefore their presence carries greater weight than the presence of macroinvertebrates which may be found in highly intermittent to ephemeral waters.

Some indicators such as stream order and filamentous algae are scored as either present or absent, while others such as channel continuity and bankfull features may receive a range of scores depending on how prevalent the feature is found within the reach. If a feature is entirely absent, it will typically score 0 while a feature that is clearly visible and prevalent throughout the reach will score 3. Guidance for the application of intermediate values is further discussed within each indicator.

The level of emphasis (reflected by the total possible score for an indicator) placed on each indicator varied between the North Carolina and New Mexico methods. Scores associated with stream geomorphology were left largely unchanged for the SD method while several of those associated with the biological community were adjusted. Much of the biological community in Great Plains systems contain a mixture of unique endemics and opportunist cosmopolitans (Fritz, Johnson and Walters 2006). Macroinvertebrates may be found recolonizing within a week after a major disturbance (Fritz and Dodds 1997) such as a flood or drought. Stream fishes of the Great Plains are highly adapted to harsh conditions and migrate to areas of water, reproduce quickly, and withstand poor water quality in isolated pools (Matthews 1987). The maximum values for some of the biological indicators were adjusted to better reflect the communities of the northern plains. Details regarding score adjustments are included in each of the specific indicator discussions.

Stream duration assessment methods were developed for lotic systems. Low gradient prairie landscapes common in eastern South Dakota creates a continuum of systems ranging from traditional streams to linear wetlands more accurately described as lentic. Applying the assessment method to both lotic and lentic systems eliminated the need for field staff to apply subjective determinations of waterbody type. Most indicators may be assessed a full range of scores in both lotic and lentic systems. A few indicators such as the presence of water will only have limited applicability for lentic waters but are comparable amongst other lentic systems.

Geomorphology

Presence of Water

Is flowing water present within the reach?

The basis of these assessments is to determine relative flow frequency in an assessment reach. Consequently, the presence of water during a field visit is an important indicator. This indicator is the most sensitive to hydrologic cycles and recent weather conditions. Following the guidelines established in the hydrologic cycle section for both seasonal and recent weather are essential for accurate data. Scores for this indicator range from 3 points for the strong presence of flowing water to 0 for systems that are entirely dry.

Reaches that have flowing water evident such as is visible in Figure 2 should be scored strong. Channels that have water present throughout most of the reach, but flow is absent or difficult to observe should be scored moderate. After flow ceases and only small remnant pools remain such as are visible in Figure 3, should receive a weak score. When assessing lentic systems such as wetlands, scores for this indicator may only vary between weak and absent.

Strong - Flow is evident throughout the sample reach (3 points)

Moderate - Water is present in most of the channel, but flow is difficult or impossible to observe(2 points)

Weak – Most of the channel is dry, water is pooled in scour holes (1 point)

Absent - No water present anywhere (0 points).

Figure 2. Strong Presence of Water: This stream has clearly evident flow.

Figure 3. Weak Presence of Water: This stream only has a small pool of water in the scour hole below the culvert.

Continuity of Channel

Is the channel bed and bank clearly defined throughout the entire reach?

A channel is a landform that conveys water and sediment between banks. Banks are relatively narrow zones that have steeper gradients than adjacent hillslopes and the transverse slope of the channel bed (Dietrich and Dunne 1993). The bed of a stream is defined as the physical confine which flowing water would normally cover. The channel bed will frequently be defined by a sharp increase in slope at the bank which will be reduced above the bank. Vegetation may be absent from a channel bottom or composed entirely of obligate wetland plants. Substrates are frequently much coarser in the channel bottom than on the banks or surrounding uplands. This indicator will become less obvious and fragmented in upstream reaches that are ephemeral.

Scoring for this indicator ranges from 3 when the channel is well developed and continuous such as in Figure 4. As the feature becomes more fragmented and difficult to observe, lower scores are assigned. Figure 5 depicts a stream where there are some bed and bank features along the scour hole but they are not visible further downstream. Lentic systems may receive a full range of scores for this indicator. Permanent features such as lakes form a clearly visible shoreline shape while temporary wetlands may not have a defined bed and bank shape.

Strong - A well-developed channel with continuous and distinct bed and bank features are present throughout the reach(3 points).

Moderate – Some channel bed and bank features are present, or features are interrupted (2 points).

Weak - Few bed and bank features are present or difficult to locate and frequently interrupted (1 point).

Absent - Bed and bank features are absent (0 points).

Figure 4. Strong Continuity of Channel: This channel has variation in sediment particle size, vegetation, and slope are all clearly evident along the edges that define the entire flow path.

Figure 5. Weak Continuity of Channel: A stream edge is visible at the margins of the scour hole, but the features are absent further downstream.

Channel Feature Sequence

Does the channel have both riffles and pools with clearly defined transitions between them?
Riffles and pools are important stream features that provide unique habitats essential for a diverse biological community. A stream with continuous flow will form a series of habitat features. Riffles are shallow areas characterized by more rapidly flowing water and larger sediment particle size than the rest of the streambed. Pools are deeper areas characterized by slow moving water and smaller sediment particle size.

Upstream, the transitions between these features becomes less distinct and frequently evolves into a single feature. In the low gradient plains east of the Missouri River, headwater areas most generally terminate in wetland areas that are most like pools. Steeper gradient systems in the Black Hills and portions of western South Dakota often terminate in reaches that have steeper slopes and may resemble riffles. Scores for this indicator range from 3 when both features are present, and transitions are frequent throughout the reach such as in Figure 6. Note that flowing water need not be present to identify these features as is the case with the first example. A single pool habitat such as is visible in Figure 7 should be assessed with a 0 score. Lentic systems will typically only receive a score of 0 for this indicator.

Strong – Stream has multiple clearly distinct features present with obvious transitions (3 points).

Moderate – Riffles and pools are present, but transitions are difficult to observe (2 points).

Weak – One type of feature dominates the system with only small breaks between (1 point).

Absent – Waterbody consists of a single unbroken feature (0 points).

Figure 6. Strong Channel Sequence: This stream has a clear sequence of dry riffles and wet pools that alternate frequently. The absence of flow during this visit would not affect the score of this indicator.

Figure 7. Absent Channel Sequence: This stream appears to be a continuous channel of relatively uniform depth.

Sediment Particle Size

Are the sediment particle sizes sorted and coarser in the stream channel than on the surrounding uplands?

Perennial streams flow with enough frequency and velocity to create or cut a channel through the soil profile. This flow removes the finest components from the channel and leaves behind sediment particles that are on average larger than those found on the surrounding landscape. The remaining particles are sorted leaving the largest in riffles and the finer components in pooled areas. Most assessments use a form of the Wolman pebble count (Wolman 1954, Leopold 1970, Kondolf and Li 1992) to determine particle size distributions. This indicator may be adequately assessed by first determining if a channel is present and incised through the soil profile. If a channel is present, each of the feature's present should be sampled (riffles, pools, or both).

The presence of riffles and pools in a channel with substrates sorted into different sizes should be assessed as strong. Figure 8. Strong Sediment Particle Size: There is a channel clearly cut through the landscape and stream substrates are more coarse than those visible in the upper left of the image on the unvegetated upland and sediments sizes are sorted. shows strong substrate sorting and should be given 3 points in the scoring matrix. An intermittent stream may be incised through the soil profile and exhibit a clearly defined bed, but sediment sizes may be like those in the uplands or unsorted in the streambed. Ephemeral systems may be expected to have no incision through the soil profile and similar sediment found within the channel as is represented in the soils of the surrounding uplands. Lentic systems may receive a full range of scores for this indicator.

Strong –There is a clear distribution of various sized substrates in the channel including fine sediment in the pools and large particles like gravel and cobble in riffles/runs (3 points).

Moderate –Particle size differs somewhat between the stream substrate and adjacent land. Some coarse sediment is present in the streambed in a continuous layer (2 points).

Weak – Few coarse sediments are present in the streambed. Particle size are similar throughout the reach and differ little from the adjacent land (1 point).

Absent – No channel is evident, little or no coarse sediment is present. There is no difference in particle size between the stream and surrounding uplands (0 points).

Figure 8. Strong Sediment Particle Size: There is a channel clearly cut through the landscape and stream substrates are more coarse than those visible in the upper left of the image on the unvegetated upland and sediments sizes are sorted.

Figure 9. Weak Sediment Particle Size: Substrates in the foreground appear to be fine, the channel is present but poorly developed, the presence of cattails along the thalweg suggests that fine sediments are present along the entire reach and no riffles or beds of larger aggregate have formed.

Presence of "Mucky" soils

Are high organic carbon sediments present?

"Mucky" is a USDA texture modifier for mineral soils. The content of organic carbon is at least 5 percent and ranges to as high as 18 percent (United States Department of Agriculture, Natural Resouces Conservation Service 2010). Hydric soils are formed under conditions of saturation during the growing season and develop anaerobic conditions in the upper portions of the horizon (USDA Natrual Resources Conservation Service 2020). Anaerobic conditions are a key difference from terrestrial soils which are typically aerobic. The absence of oxygen produces characteristics, especially differences in soil color and texture that are uniquely different from aerobic, terrestrial soils. A consequence of anaerobic soil conditions is slowed decomposition of organic matter with the result being enrichment of wetland soil with organic matter, especially compared to terrestrial soils (Craft 2016). Properties associated with these soils include high organic matter content and colors characterized by low value and chroma (dark and dull).

This indicator is not intended to be an intensive determination of wetland soils. These deposits are frequently unconsolidated and when fully saturated become soft and difficult to move through. It will frequently be associated with emergent wetland vegetation and pooled systems that are lentic for at least a portion of each year. Use of an Alpha-alpha-Dipyridyl solution may aid in confirmation of the presence of ferrous iron in soils, which is indicative of reducing conditions and the possibility of aquic conditions. Spraying the solution on freshly exposed soil material will develop a bright pink color if ferrous iron is present. The positive reaction indicates the soil is reduced and anaerobic at the time of application (USDA 1998).

In some situations, this indicator may be present in isolated pools adjacent to lotic systems. Evaluations of those instances should consider the dominance of the indicator in comparison to the entire reach. All hydrologic features may receive a range of integer scores from 0 – 3; dependent on the relative presence of mucky substrates.

Strong – Soft dark organics are the dominate substrate (3 points).
Moderate – A majority of the substrates are composed of dark organics (2 points).
Weak – Some soft dark organics present but not dominant (1 point)
Absent – Little or no organics substrates are observed (0 points)

Presence of Odors

Are odors associated with wetlands such as hydrogen sulfide, methane, or others observed?
Wetland soils differ from terrestrial soils in that they are anaerobic. In saturated wetland soils, oxygen typically does not diffuse more than a few millimeters below the water table and reduced compounds and trace gases (N_2O, H_2S, CH_4) produced from anaerobic metabolic pathways can accumulate at high concentrations (Schlesinger and Bernhardt 2013). Their presence are a strong indicator of anaerobic conditions associated with near permanent saturation.
Emissions of these greenhouse gasses may be observed through smell or visible bubbling. This indicator is recorded as either present or absent for all hydrologic features. The associated scores for absence and presence are 0 and 3, respectively.

Present – Wetland gasses and odors observed (3 points).
Absent – No wetland gasses or odors observed (0 points).

Presence of Bankfull Features

Are bankfull features clearly evident and at generally similar elevations providing a consistent indication of the bankfull depth?

Bankfull features are those that are most commonly associated with an annual peak flow recurrence also referred to as the channel forming flow. Many of the features evaluated as individual indicators are also used to identify bankfull. Features that may be used to identify the bankfull depth include an active floodplain, variable particle size as you move up the bank, breaks in the bank slope, changes in vegetation, depositional features, small benches along the stream, staining on rocks/culverts/bridges, or undercut banks. These features when viewed in concert should occur at a single elevation along the stream corridor which is then referred to as the bankfull depth.

A perennial stream may be expected to have most if not all these features and most of them will typically occur at a uniform elevation and should receive a high score of 3. Moving upstream, these features will become less obvious, inconsistent in elevation, or entirely absent. Fewer indicators and greater uncertainty in the bankfull depth should be reflected by a lower score for this indicator. Lentic systems may receive a full range of scores when these indicators are used to evaluate the high-water mark for the feature.

Strong – Multiple features are distinctly visible and there is a clear indication of the bankfull (3 points).
Moderate – Features present but questionable or inconsistent making determination difficult (2 points).
Weak – Features difficult to distinguish and determining accurate bankfull depth impossible (1 point).
Absent – No indicators were observed (0 points).

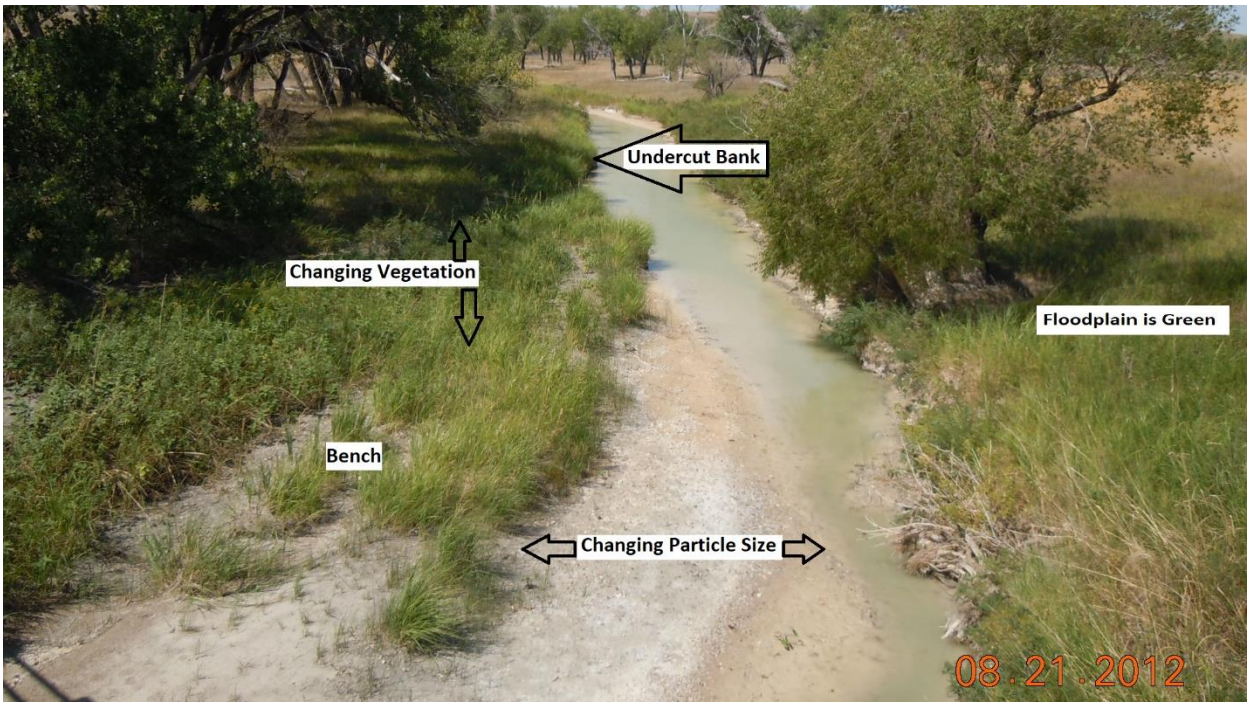


Figure 10. Bankfull Features Strong: Stream with several bankfull indicators evident at similar elevations. Top of the bench is a similar height to the undercut bank downstream, sediment particles change from top of bench to bottom of stream channel, and the vegetation on the bench is different than that above the undercut bank. The active floodplain is evident at a slightly higher elevation indicated by the green vegetation contrasted by the brown dry upland grass surrounding it.

Figure 11. Bankfull Features Weak: A channel appears to be washed through the rocks and incision of the high bank is evident downstream. Some features are arguably present but difficult to distinguish and not at similar elevations.

Depositional Features

Are there alluvial depositional features present throughout the stream reach?

Rivers and streams move sediments and organic material downstream that may accumulate in the streambed, along its margins, or within the floodplain. At the initiation of concentrated flow, organic material and soils have not yet accumulated in the water column. As flow continues down-slope, it begins to first accumulate organic debris such as grasses, leaves, and crop residue. Further down-channel, as enough flow and duration persist to remove all organic debris from the flow path, the stream will begin to erode the underlying sediments shaping a primary channel. Once the water column has accumulated organic debris and sediments, they may be deposited along the stream margins or in places where water velocity is reduced.

Perennial systems with sufficient silt and sand loads will create deposits in the form of bars and benches along the margin such as are visible in Figure 12 should be assessed a value of 3. Similarly, higher gradient systems consisting of cobbles and gravels that have been sorted into variable size classes should also receive a score of 3. Ephemeral to intermittent systems lacking sufficient sediments to form depositional features but carrying adequate amounts of organic matter to leave visible accumulations such as those in Figure 13 may be assessed a lower value. Linear wetland systems may not have visible point bars or organic debris accumulated along the margins. Soft sediments encountered in these systems should be considered depositional features. Lentic systems by default are depositional features and should be scored strong for this indicator.

Strong – Alluvial depositional features such as bars or benches are well developed, or fine organics are found throughout the reach (3 points).
Moderate – Depositional features are present but not consistent throughout the reach (2 points).
Weak – A single depositional feature is noted such as an organic debris line or sediment on plants or debris (1 point).
Absent – No depositional features observed (0 points).

Figure 12. Strong Depositional Features: Multiple point bars and benches are visible all along this reach.

Figure 13. Weak Depositional Feature: No sediment deposits are apparent in this stream, but organic debris has accumulated on the fence.

Stream Order

Is the channel being evaluated classified as third order or greater in NHDplus.

A simple method for classifying the relative size of a stream is to use its Strahler Stream Order. A streams order is determined by the order of its tributaries. When two streams of different order merge, they maintain the higher order. When two streams of equal order merge, they downstream segment becomes one order higher. A first order stream has no tributaries. At the point two first order streams merge, they become a second order stream. A second order stream remains a second order stream until it merges with a stream of equal or higher value.

Lower order streams are more frequently ephemeral in nature and higher order streams are more frequently perennial in nature. Stream order is included in NHDplus (United States Geological Survey 2017) for all streams in South Dakota. Other state methods in more moist climates used a break between first and second order. The semi-arid landscape in much of South Dakota results in large drainage areas that produce flow on an infrequent basis. An example of this would be the Bad River, which is a sixth order stream that flows less than 60% of the time based on USGS gauge data and would be classified as an intermittent. Many of the biological metrics under development in the state used third and fourth order streams as the target population for intermittent to perennial wadable streams. Maintaining consistency with those efforts, streams 3rd order and above will be scored higher than 2nd or 1st order streams. Lentic systems will be assessed as less then 3rd order and receive 0 points for this indicator.

Yes – The reach is at least third order in NHDplus (3 points).
No – The reach is second order or less in NHDplus or a Lentic system (0 points).

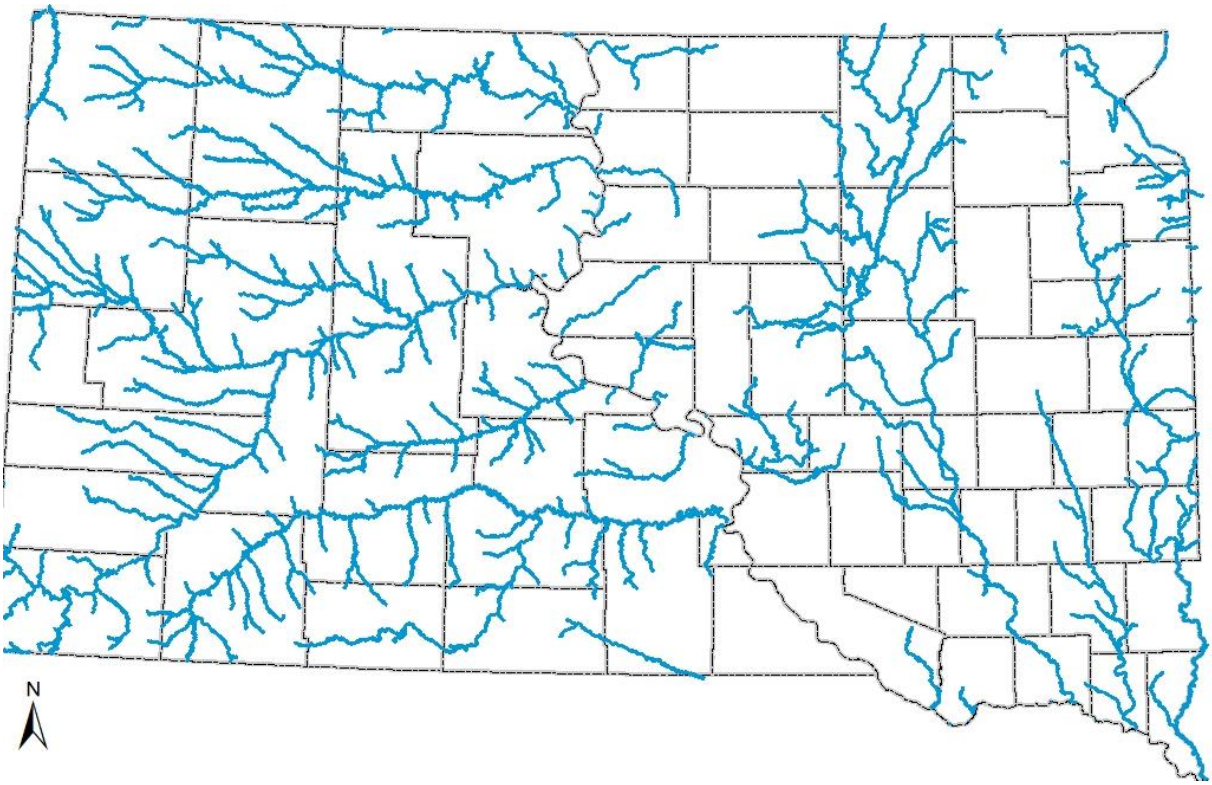


Figure 14. South Dakota stream channels classified third order or higher in NHDplus.

Biology

Aquatic Plants

Is the stream channel or corridor dominated by Obligate Wetland (OBL) plants?

Obligate and facultative wetland plants are good indicators of persistent wet conditions. Their presence frequently indicates a groundwater connection or saturation due to regular inundation from surface flows. Evaluations of the plant species can be conducted from right of ways and make a good surrogate for evaluating the potential presence of hydric soils.

Evaluations should consider both the channel bottom and the active floodplain along the stream corridor. Obligate wetland (OBL) plants occur almost always under natural conditions in wetlands with a frequency of 99%. Facultative Wetland (FACW) plants usually occur in wetlands but occasionally are found in non-wetlands (frequency of 67-99%). The US Army Corps of Engineers maintains the list of national wetland plant indicators (Lichvar, et al. 2012). There are many species of hydrophytic plants that are classified as OBL plants. Some of the most commonly observed along South Dakota waterways include cattails, rushes, and sedges. All hydrologic features may receive a full range of scores for this indicator.

Strong – OBL dominate the stream corridor (3 points).
Moderate - Corridor is broken by beds of OBL or FACW vegetation (2 points).
Weak - Few OBL or FACW are observed along the stream corridor (1 point).
Absent - No OBL or FACW plants observed (0 points).

Figure 15. Strong presence of Aquatic Plants and Hydric Soils: This stream has a small channel and the surrounding flood prone area is dominated by OBL wetland plants suggesting the presence of hydric soils and a potential for a groundwater connection.

Figure 16. Weak Presence of Aquatic Plants: Some OBL plants are present in the scour hole in the ditch but upland vegetation dominates the stream corridor further downstream in the pasture.

Rooted Upland Plants in the Streambed

Are upland plants present in the streambed?

Upland plants are susceptible to the erosional forces of stream flow and sensitive to the low oxygen conditions found in hydric soils. These factors act to remove and deter upland vegetation development in intermittent and perennial streams. Stream flow intensity and duration in ephemeral channels is often inadequate to remove upland vegetation. This allows upland pants to establish and dominate the plant community in the flow path.

The focus of this indicator should be on the presence of rooted upland plants in the streambed or thalweg of the channel. Rooted upland plants growing on the bank should not be considered. A strong presence of rooted upland plants such as in Figure 17 will result in a score of 0. Figure 18 depicts a heavily vegetated channel that is composed entirely of OBL wetland plants and would be assessed a score of 3. All hydrologic features may receive a full range of scores for this indicator.

Strong – Rooted upland plants are observed and cover over 75% of the flow path (0 points).
Moderate - Majority of the streambed is composed of rooted upland plants (1 point).
Weak - Some portion of the streambed is interrupted by rooted upland plants (2 points).
Absent - No rooted upland plants were observed in the channel (3 points).

Figure 17. Strong Presence of Upland Plants: This channel is dominated by upland grassland plants.

Figure 18. Absence of Upland Plants: This stream channel is heavily vegetated with obligate wetland plants.

Presence of Fibrous Roots in the Streambed

Are fibrous roots present within the thalweg of the streambed?

Fibrous roots are small, spreading, non-woody growth that frequently form a dense mat in the first few inches of the soil. Flowing water of sufficient velocity will prevent the establishment and growth of plants that produce fibrous roots in the channel. Like the presence of upland plants, higher scores for this indicator are determined by its absence. Vegetation type is not considered, and a strong root system generated by either hydrophytic plants or upland vegetation are scored equally.

Observations should be made closest to the stream thalweg and coverage should be determined along the length of the stream without consideration for its width. The channel in Figure 19 is heavily vegetated with both OBL and FACW plants. Roots extend beyond the canopy cover into portions of the thalweg. The dense root mat throughout most of the channel is a strong presence and receives a score of 0. The channels visible in Figure 20 show that fibrous roots are absent from the main portions of the channels. A score of 3 should be assessed to each of these channels since flows are frequent enough to remove all vegetation. All hydrologic features may receive a full range of scores for this indicator.

Strong – Dense network of fibrous roots persistent in stream thalweg (0 points).
Moderate – Discontinuous network of roots present in stream thalweg and surrounding area (1 point).
Weak – Very few fibrous roots are present anywhere in the streambed (2 points).
Absent – No fibrous roots are present (3 points).

Figure 19. Strong Presence of Fibrous Roots: Much of this channel is vegetated and both upland and aquatic plant fibrous roots are present along the thalweg.

Figure 20. Absence of Fibrous Roots: Each of these channels is devoid of any vegetation and the channel bottoms are free from any root structures.

Attached Filamentous Algae

Are there benthic or epiphytic algae growing in the reach?

Filamentous algae require prolonged periods of flowing water to develop. Turbidity, nutrient concentrations, and other biological factors may influence or prohibit its growth. The presence of filamentous algae is an indicator of at least intermittent flow. Benthic and epiphytic types of algae are considered the same for this indicator and neither species nor density measurements are collected. Its presence in flowing water or as dead material attached in a dried portion of the stream channel are of equal importance. In its presence, all hydrologic features will be assessed a value of 1.5 while its absence is scored 0.

Present – Attached filamentous algae is found within the reach (1.5 points).
Absent – No filamentous algae observed (0 points).

Figure 21. Presence of Benthic Filamentous Algae

Presence of Freshwater Mussels

Are there unionid mussels present within the stream reach?

South Dakota waters provide habitat for 35 species of native freshwater mussels. Many of these unionid mussels are sensitive to water quality. Their inability to migrate to more permanent systems during periods of drought combined with slow growth rates and long lives make them exceptional indicators of perennial waterbodies. Consistent mussel sampling is challenging, and they are most frequently observed as dead shells along the shore. Declining populations have made locating many species difficult. Their presence should be considered a strong indicator of a perennial stream; however, their absence indicates very little. Live mussels should be photographed and promptly returned to the water; dead shells should be photographed and may be vouchered for later identification. The presence of live mussels or fresh dead shells (remnants of flesh present) are scored with 6 points. Shells may remain in the environment for dozens to hundreds of years and are impossible to accurately age in the field. Their presence may be remanent of historic hydrologic regimes. Shells that lack flesh remain important indicators but will receive a score of 3. Sites without any indication of freshwater mussels will be scored 0 points.

Live/Fresh Dead with Flesh – Unionid mussels are currently found within the reach (6 points).
Shells – Unionid mussels were historically found within the reach (3 points).
Absent – No Unionid mussels were observed (0 points).

Presence of Macroinvertebrates

Is there a macroinvertebrate community present?

Macroinvertebrate communities native to prairie systems have adapted to harsh conditions including prolonged periods of drought. One study found 26 families from 7 orders representing all 6 invertebrate habitat guilds in first through third order intermittent streams (Vander Vorste, Rasmussen and Troelstrup Jr. 2008). The presence of diverse communities in intermittent streams may make the use of a macroinvertebrates reliant on higher level taxonomic metrics for differentiation between intermittent and perennial streams.

To maintain a more rapid field protocol, macroinvertebrate community presence and absence will be used with 1.5 points being assessed to reaches with macroinvertebrates. Sampling will consist of using a D-frame net in each available habitat until macroinvertebrates are found or all habitats are sampled unsuccessfully. Alternatively, environmental DNA may be used to identify the presence of a community.

Present – Macroinvertebrates found within the reach (1.5 points).

Absent – No macroinvertebrates observed (0 points).

Presence of Fish

Is there a diverse community of fish or are there sensitive species present within the reach?

Prairie stream hydrology can be extremely variable between seasons and years. A stream that may flow for nearly an entire summer on a wet year may be completely dry for a year or more during droughts. To adapt to these harsh systems, some populations are extremely mobile and utilize intermittent and ephemeral flows to move throughout drainages. As a result, the presence of fish may not always indicate a perennial or even intermittent system. Species identification and community assessment will aid in determining flow frequencies. The prevalence descriptions are guidelines for assessing a value. Scoring this indicator requires knowledge of the fish community and should consider any outside factors that may be influencing the community. An example of this would be sampling an intermittent stream flow near its confluence with a perennial system that is actively flooding. Flood waters may drive many species to seek temporary refuge in the backflow of an intermittent channel which may result in a more diverse community than the intermittent channel can support.

Species such as black bullheads, short nose gar, northern pike, common carp and fathead minnows are opportunistic species that tolerate poor water quality. They are frequently some of the first species to migrate during flood conditions and may be found in intermittent to ephemeral flows. Darters, shiners, and dace may be more frequently associated with perennial systems. Methods for capture may include traditional collection techniques such as seines or backpack electro fishers which are selected for effectiveness based on site conditions. All habitats available should be sampled. Alternatively, analysis of environmental DNA may be used to identify the community present.

Strong – A diverse community in both species and multiple length frequency groups, often consisting of adults and young within a species, cold-water species, or sensitive threatened or endangered species (3 points).

Moderate – Multiple species are found but limited to highly tolerant species with a tendency to migrate. Frequently only adults or juveniles of a species are present (2 points).

Weak – A single mobile or highly tolerant species (1 points).

Absent – No fish are observed (0 points).

Iron Oxidizing Bacteria

Is iron oxidizing bacteria present along the reach?

Iron-oxidizing bacteria convert ferrous iron to ferric iron that precipitates out as a reddish-orange slimy deposit in the stream. The bacteria presence requires water, oxygen, and a source of ferrous iron. Groundwater frequently has high concentrations of dissolved iron and the presence of iron oxidizing bacteria along a stream is often indicative of a groundwater seep. This indicator is assessed as either present (1.5 points) being assigned or absent with zero points.

Present – Iron oxidizing bacteria are found within the reach (1.5 points).
Absent – No iron oxidizing bacteria are observed (0 points).

Figure 22. Presence of Iron Oxidizing Bacteria

Use Estimation

The SDAM is intended to isolate individual indicators of hydrologic frequency for evaluation. Viewed and scored individually, they may be summed to give an estimate of the features hydrologic permanence. When these indicators are viewed together as an entire system, they frequently provide an impression of the type of fishery and likelihood of recreation for the site. Site assessments should conclude with documentation of the observer's impression of the locations overall potential for fish propagation and recreation based on that visit. Some visits, due to a variety of factors such as droughts, floods, or other limitations may leave the field crew in doubt as to the appropriate fishery or recreational use. In those cases, the site may be assessed as having insufficient data to accurately determine the use.

Based on observation made during this visit, what type of fishery would you expect?

9 None – Site does not appear to have adequate amounts of water to support fish most of the year.
6 Warm Water Marginal – Water is expected to persist for at least part of the year, but habitat is best described as a wetland and conditions may be harsh and limit diversity or survivability.
5 Warm Water Semi-permanent – System appears to have diverse habitat, but flow ceases for portions of normal years.
4 Warm Water Permanent – System appears to have continuous flow during normal years and provide habitat for a diverse community of aquatic life.
3 Cold Water Marginal – Site appears to have habitat suitable for cold water species for part of the year.
2 Cold Water Permanent – Site appears to have habitat suitable for cold water species throughout the year.
0 Insufficient – Due to factors such as droughts, floods, or other limitations may result in insufficient data to make an assessment.

Based on observation made during this visit, what type of recreation would you expect?

9 None – No recreation is expected at this site.
8 Limited Contact – Evidence of human activities that would result in contact with the water is present.
7 Immersion Recreation – Evidence of human activity that would result in immersion in the water is present.
0 Insufficient – Due to factors such as droughts, floods, or other limitations may result in insufficient data to make an assessment.

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Appendix A. Field Data Sheet

Geomorphology				
Indicator	Strong	Moderate	Weak	Absent
Presence of water	Flow is evident throughout the sample reach. 3	Water is present in most of the channel, but flow is difficult or impossible to observe. 2	Dry channel with standing pools. 1	No water present, even in scour holes near roadways. 0
Continuity of Channel	A well-developed channel with continuous bed and bank through entire reach. 3	Channel bed and bank are prevalent but interrupted. 2	Channel bed and bank features are present but difficult to locate. 1	Bed and bank features are absent. 0
Channel Feature Sequence (Riffles - Pools - Runs - Glides)	Stream has multiple clearly distinct features present with obvious transitions between them. 3	Riffles and pools are present, but transitions are difficult to observe. 2	One type of feature dominates the system with only small breaks between. 1	Stream consists of a single unbroken feature. 0
Sediment Particle Size	Well-developed channel incised through the soil profile. Particle sizes in the channel are noticeably different from those outside the channel. There is a clear distribution of various sized substrates in the channel. 3	There is a well-developed channel, but it is not deeply incised through the soil profile. Particle size differs somewhat between the stream substrate and adjacent land. Some coarse sediment is present in the streambed in a continuous layer. 2	The channel is poorly developed. Some coarse sediment is present in the streambed but is discontinuous. Particle size differs little between the stream substrate and adjacent land. 1	No channel is evident. Little or no course sediment present. There is no difference between particle size in the stream substrate and adjacent land. 0
Wetland Deposits	Soft dark organics dominate reach substrates 3	Soft dark organics cover most of the reach 2	Some soft dark organics present but not dominant 1	No soft dark organics observed 0
Gasses/Odors	Wetland gasses and odors observed 3		No wetland gases or odors observed 0	
Bankfull Features	Multiple Features distinctly visible 3	Features present but questionable or inconsistent. 2	A single feature observed. 1	No features visible 0
Depositional Features	Depositional bars, benches or large amounts of alluvium are present throughout the reach. 3	Depositional features are present but not consistent throughout the reach. 2	A single depositional feature is noted such as a debris line or sediment on plants or debris. 1	No depositional features were found within the reach. 0
Stream Order	YES – The reach being evaluated is 3rd order or greater in NHDplus. 3		NO – 2nd order or less in NHDplus 0	

Biology				
Indicator	Strong	Moderate	Weak	Absent
Aquatic plants and Hydric Soil Indicators	Obligate Wetland (OBL) plants dominate the stream corridor or submerged aquatic vegetation is present. 3	Corridor is broken by beds of OBL or Facultative wetland (FACW) vegetation 2	Few OBL or FACW are observed along the stream corridor. 1	No OBL or FACW plants observed. 0
Rooted Upland Plants in the Streambed	Rooted upland plants are observed and cover over 75% of the streambed. 0	Majority of the streambed is composed of rooted upland plants 1	Some portions of the streambed are interrupted by rooted upland plants 2	No rooted upland plants are observed in streambed. 3
Fibrous roots in streambed.	A strong network of fibrous roots is persistent in the stream thalweg and surrounding channel. 0	A discontinuous network of fibrous roots is present in the stream thalweg and surrounding area. 1	Very few fibrous roots are present anywhere in the streambed. 2	No fibrous roots are present. 3
Attached Filamentous Algae	Filamentous algae is observed. 1.5		None observed. 0	
Bivalves	Bivalves are confirmed to exist within the reach. 6		No evidence of Bivalves could be located 0	
Presence of Fish	Diverse community of species and variable lengths Coldwater species Sensitive or T/E species 3	Multiple species are found but limited to highly tolerant species with a tendency to migrate. Frequently only adults or juveniles of a species are present. 2	A single mobile or tolerant species. 1	No fish are observed. 0
Macroinvertebrates	Present – Macroinvertebrates present in reach. 1.5		Absent – Macroinvertebrates not present in reach. 0	
Iron Oxidizing Bacteria	Present – Iron-oxidizing bacteria/fungi present in reach. 1.5		Absent – Iron-oxidizing bacteria/fungi not present in reach. 0	

Appendix B. Landowner Survey Questions

Date: **Station ID:**

1. Person surveyed is best described as:
   Landowner Local Resident Other

2. How often is water present?
   Only during heavy precipitation.
   A few weeks to months each year.
   Most of the year.
   Almost Always.

3. Is the water used for livestock?
   Never Seldom Often Uncertain

4. Is the water used for irrigation?
   Never Seldom Often Uncertain

5. Does waterfowl hunting occur on or along the water?
   Never Seldom Often Uncertain

6. Does trapping of beaver, mink, muskrat, or raccoon occur along the water?
   Never Seldom Often Uncertain

7. Does the water normally have fish in it?
   Never Seldom Often Uncertain

8. Do people trap minnows or crayfish?
   Never Seldom Often Uncertain

9. Do people fish?
   Never Seldom Often Uncertain

10. Does camping occur along the water?
    Never Seldom Often Uncertain

11. Does boating, canoeing, or kayaking occur?
    Never Seldom Often Uncertain

12. Do people wade, play, or swim in the water?
    Never Seldom Often Uncertain

13. Do other activities occur such as water skiing, snorkeling, or any other activity where people submerge themselves?
    Never Seldom Often Uncertain

2.0 PFAS Surface Water Sampling

PFAS compounds are analyzed in the parts per trillion (ppt). A part per trillion is the equivalent of one drop of water in an Olympic sized swimming pool (660,000 gallons). PFAS substances are on, or in, many everyday items people use. Because of this, precautions need to be taken to prevent the sampler from possibly contaminating the water sample they are collecting. Following proper sampling protocol reduces the potential for false positives.

This Surface Water PFAS Sampling SOP discusses collection of surface water PFAS samples.
****Read information on the website links at the end of this document.*

PFAS Sample Kits from Lab
Sample kits are provided by the lab that will do the PFAS analysis. (If a full kit is not provided work with the lab to ensure proper collection bottles and preservation is implemented.)

Kits will come in a cooler box with sampling bottles. The bottles included will be a field bottle, field blank bottle and field blank bottle with blank PFAS free water, and possibly a trip blank bottle which is prefilled with PFAS free blank water.

The field bottle is for your stream sample in the field.

Field blanks are required for each sampling location. One field blank bottle is empty, and the other field blank bottle is full of PFAS free water. To prepare the field blank you simply poor the PFAS free water into the empty field blank bottle in the field at the site you are sampling and is carried with the field sample or samples.

Trip blanks are prepared by the laboratory and follow the samples in the same container and returned to the laboratory. Trip blanks must not be opened.

If PFAS are detected above the reporting level (RL) in the sample, trip blanks (where applicable) and field blanks will need to be analyzed and reported. Field blanks and trip blanks do not need to be analyzed or reported if PFAS are not detected in the associated samples.

Prior to sampling
Samplers can encounter PFAS in many ways such as carpets from vehicle interiors, clothing, waders, life jackets, sunscreens, bug sprays, cosmetics, and food packaging to name a few. One should be conscious of using or touching these products to minimize the potential for contaminating the sample. Only wear neoprene or pvc lined waders. If possible, wear 100% cotton clothing that has been washed and dried without using fabric softener. Utilize a high-density polyethylene (HDPE) bucket (you will find the number 2 in a triangle or HDPE printed on the bottom of bucket) for carrying samples and meter to and from stream. **Use an** HDPE spray bottle and wash bottle for rinsing equipment and washing hands as necessary.

PFAS surface water sample collection
When collecting the PFAS sample the number one thing is to keep your hands clean. This is accomplished by washing with PFAS free hand soap and water or washing in the stream being sampled. Dry hands with cotton cloth or untreated paper towels, followed by wearing a pair of clean, powder free, nitrile gloves (no latex gloves). If you touch something that may contaminate your gloves (like your face or vehicle carpet) carefully change them for a new clean pair. This process should be completed at each site before each new PFAS sample is collected.

Sample bottles should always be closed and only opened to fill during sample collection. If collecting multiple water samples collect the PFAS sample first. Wade into the thalweg to collect your sample facing into the flow. Open your HDPE bottle and submerge below the surface, do not fill past shoulder of bottle, then put the cap right back on paying special attention to not touch the inside of the cap or bottle. It is best to not set the cap down but if you do, place the bottom of the cap facing up on a PFAS free surface.

For sampling where wading into the stream is not possible or unsafe the bridge it and dip rod are ok to use. Make sure these sampling devices are clean and triple rinse in the stream prior to sample collection as a precaution.

Wipe bottles dry then fill out all necessary information on the bottle labels. Utilize Avery 5523 waterproof shipping labels if a label is not provided.

Put the sample in a Ziploc bag and preserve the sample on loose ice in its own cooler. The sample needs to be cooled to <6^{o} C and minimize the time in sunlight. Deliver or ship to lab for analysis as there is a 48-hour hold time.

Website links
Information in this SOP can be found in the following websites. There is also much more detailed information in the following links that you should familiarize yourself with and will answer questions you might have that aren't specifically addressed in this SOP for the sake of being concise and set to our DANR water
quality sampling needs.

Michigan's PFAS SOP EGLE Surface Water PFAS Sampling Guidance (michigan.gov)

Minnesota's PFAS SOP Guidance for Per- and Polyfluoroalkyl substances (PFAS): Sampling (state.mn.us)

Montana's PFAS SOP TMDL Document Template (mt.gov)
General PFAS Sampling Guidance (michigan.gov) Read Section 4.

EPA Draft Method 1633 Section 8 covers sample collection, preservation, storage, and holding times.

Method 1633 Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS (epa.gov)

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