DEPARTMENT OF ECOLOGY
State of Washington

Standard Operating Procedure EAP106, Version 2.0

Verification and Layout of Sites (Narrow Protocol)

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Purpose of this Document

The Washington State Department of Ecology develops Standard Operating Procedures (SOPs) to document agency practices related to sampling, field and laboratory analysis, and other aspects of the agency's technical operations.

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SIGNATURES AVAILABLE UPON REQUEST

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

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Although Ecology follows the SOP in most instances, there may be instances in which the Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Revision History	Summary of changes	Sections	Reviser(s)
12/11/17	1.8	Reworded 6.1.1 for clarity Reworded 6.1.2 for clarity	6.0	Meghan Rosewood-Thurman
12/28/2021	1.9	Complete re-edit of text, revised footer format	All	Meghan Rosewood-Thurman

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program's (EAP) Standard Operating Procedure (SOP) for stream verification and layout in rivers and streams, for the Watershed Health Monitoring program (WHM), Ambient Biological Monitoring Program (BIO) and other related studies during a Data Collection Event (DCE).

1.2 This SOP includes procedures for sites sampled with the Narrow Protocol. See SOP EAP105 (Hartman, 2019) which describes site layout for the Wide Protocol.

2.0 Applicability

2.1 This document is derived from methods of the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program, Western Pilot (Peck et al, 2005).

2.2 Follow this SOP when performing data collection events (DCEs) as described in section 1.1.

2.3 This SOP explains how to verify that a candidate site is suitable for sampling. It also describes how to establish the boundary stations within the site.

3.0 Definitions

3.1 Bankfull Margin: A term used to describe the limit of the stream channel. It is a line on the bank that coincides with the water's elevation during bankfull flow.

3.2 Bankfull Stage: This stage is delineated by the elevation point of incipient flooding, indicated by deposits of sand or silt at the active scour mark, break in stream bank slope, perennial vegetation limit, rock discoloration, and root hair exposure (Endreny 2003).

3.3 Bankfull Width: Horizontal distance between the bankfull stage on the left bank and the bankfull stage on the right bank. For WHM, this is measured to the nearest tenth of a meter.

3.4 Candidate sites: Lists of candidate sites are generated during winter months after evaluating larger lists (e.g. The Washington Master Sample 2022 (Larson, in prog.). WHM staff narrow the larger lists using map-based target criteria to locate landowner contact information and then request access permission.

3.5 DCE: The Data Collection Event is the sampling event for the given protocol. Data for a DCE are indexed using a code which includes the site ID followed by the year, month, day, and the time (military) for the start time of the sampling event. For example: WHM07620-000222-DCE-YYYY-MMDD-HH:MM. One DCE should be completed within one working day, lasting 4 - 6 hours, on average.

3.6 E-forms: Electronic data forms. Term for an application saved into a web browser cache on a device such as a tablet computer. E-forms allow collection and storage of data at remote locations when disconnected from the internet.

3.7 EIM: The Environmental Information Management System (EIM)[1] is the Department of Ecology's main database for environmental monitoring data. EIM contains records on physical, chemical, and biological analyses and measurements. Supplementary information about the data (metadata) is also stored, including information about environmental studies, monitoring locations, and data quality. The "Search by map" feature enables plotting coordinates over orthophotographic imagery. EIM also includes a searchable component for Watershed Health Monitoring Data[2]

3.8 GIS: A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface (National Geographic Society, 2021).

3.9 GPS: A global positioning system (GPS) is a network of satellites and receiving devices used to determine the location of something on Earth (National Geographic Society, 2021). The WHM crew references the GPS to identify coordinates using a hand-held receiver or an on-board receiver within the data recording tablet.

3.10 Index station: The distinct point location mapped by the site coordinates obtained from the Washington Master Sample 2022 (Larson, in prog.) list. The index station is called "X" and is generally located at major transect F; however the point may occur at any elevation in the stream between transects A and K.

3.11 Main channel: Channels in a stream are divided by islands (dry ground that rises above bankfull stage). Main channels contain the greatest proportion of flow.

3.12 Major Transect: One of 11 equidistant transects across the length of a site. These transects run perpendicular to the thalweg and are labeled as follows: A (furthest downstream), B, C, D, E, F, G, H, I, J, and K (furthest upstream).

3.13 Minor transect: One of 10 equidistant transects across the length of a site that is sampled using the Narrow Protocol. Each minor transect is located midway between major transects. Minor transects are A5, B5, C5, D5, E5, F5, G5, H5, I5, and J5.

3.14 m: Meter

3.15 mm: Millimeter

3.16 Narrow protocol: The set of Watershed Health Monitoring SOPs that describe data collection at wadeable sites with an average bankfull width of less than 25 m at the index station.

3.17 NHD: is a geo-spatial, hydrologic framework dataset mapped at the 1:24,000-scale, used to portray surface water on The National Map. The NHD represents the drainage network. (U.S. Geological Survey, 2020) and is the hydrography standard for Washington State (Office of the Chief Information Officer, 2020). The Watershed Health Monitoring program uses NHD to make Strahler order assignments in the new Washington Master Sample 2022 (Larson, in prog.).

3.18 NHDPlus: NHDPlus is a geo-spatial, hydrologic framework dataset envisioned by the US Environmental Protection Agency (Horizon Systems Corporation, 2015). First released in 2006, as the NHDPlusV1, it has consisted of multiple components, one of which has been the 2006 version of the 1:100,000-scale National Hydrography Dataset (NHD). The Watershed Health Monitoring program for the Department of Ecology uses NHDPlus to make Strahler order assignments because Strahler order was not an available attribute of our other hydrography when the project began.

3.19 Protocol: A collection of SOPs used to accomplish a DCE. Watershed Health Monitoring uses two protocols: The Narrow Protocol is used for sampling wadeable streams that are less than 25m average bankfull width. The Wide Protocol is used for rivers or streams that are wider than 25m average bankfull width or too deep to wade.

3.20 QAMP: Quality Assurance Monitoring Plan. The QAMP for WHM is Cusimano et al (2006). An updated version is in early stages of development.

3.21 Reach Type: Determinations of stream or reach types on the Site Verification Form. See Table 1 and Figure 1 for reach type descriptions and locations within a watershed.

[1] http://www.ecy.wa.gov/eim/

[2]https://fortress.wa.gov/ecy/eimreporting/Stream/STREAMSearch.aspx?SearchType=Stream&State=newsearch&Section=all

Table 1: Reach Types (from Montgomery and Buffington 1993, 1997, 1998)

Reach Type	Description
Bedrock	Where the streambed lacks fill material, except for temporary storage spots. Valley walls generally confine bedrock channels.
Braided	Characterized by wide channels containing a series of bars. They have a high supply of sediment and mobile bed forms. They lack valley confinement and are characterized by erodible banks.
Cascade	Occur on steep slopes where energy is high. They are characterized by disorganized cobbles and boulders and by confined valley walls.
Colluvial	A portion of the stream network that is typically in headwaters and consists of intermittent or ephemeral flow with substrate material of mixed sizes. In colluvial valleys, long-term accumulation of sediment is punctuated by periodic catastrophic erosion.
Plane-bed	Characterized by a relatively featureless gravel/cobble bed. There is an absence of tumbling flow, but may include glides, riffles or rapids. They lack lateral flow. Often, Plane-bed surfaces are armored.
Pool-riffle	Typically unconfined, with a laterally oscillating sequence of bars, pools, and riffles. Sediment accumulates in discrete bars.
Regime	Mobile bed forms provide the primary flow resistance. They are typically low-gradient sand bedded channels with low slope. The frequency and presence of ripples or dunes throughout the channel bed distinguish a regime channel from a pool-riffle channel
Step-pool	Coarse materials that are organized into discrete series of steps, separating pools that contain finer materials. They consist of alternating turbulent steps that flow over into tranquil pools.

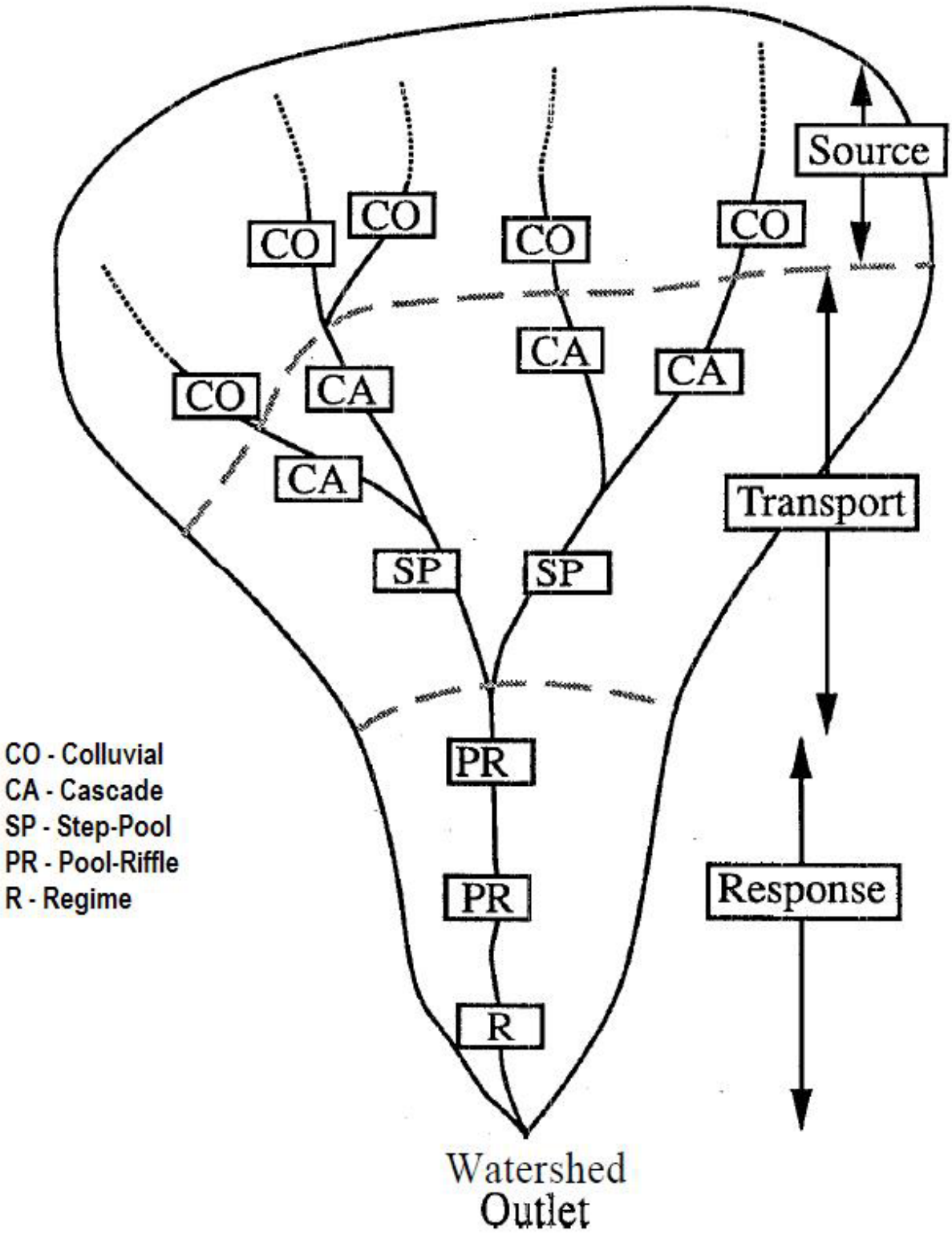

Figure 1: Idealized reach type positions (aerial view) within a watershed (modified from Figure 22 of Montgomery and Buffington (1993)).

3.22 Site: A site is defined by the coordinates provided to a sampling crew and the boundaries established by the protocol's site layout method using this SOP or the Wide protocol SOP EAP105, (Hartman, 2019). Typically, a site is centered on the index station and equal in length to 20 times the average of 5 bankfull width measurements. Sites cannot be longer than 2 km nor shorter than 150 m. Narrow protocol sites range from 150 m to 500 m long. Wide Protocol sites are up to 2 km long and most-frequently longer than 500 m. The most downstream end of a site coincides with major transect A; the most upstream end coincides with major transect K.

3.23 SITE ID: Identity code for the proposed sampling site from the Washington Master Sample 2022 (Larson, in prog.).
The Format is WHM07620 - # # # # # #

- Random sites have a WHM07620-prefix.
- Statewide sentinel sites have a SEN06600- prefix.
- Ambient Bioassessment Sites have a BIO06600- prefix

3.24 Station: Any location within the site where an observation is made or part of a sample is collected.

3.25 STR: Status and Trends Regions (STRs) are based on Salmon Recovery Regions (SRRs) that were first described by the Governor's Salmon Recovery Office (JNRC, 1999) and are displayed in their latest form by the Washington State Recreation and Conservation Office (RCO, 2020) STR membership is as follows:

- Puget STR_____Puget Sound, & Hood Canal/Puget Sound SRRs
- Coastal STR_____Coastal SRR
- Lower Columbia STR___Lower Columbia SRR
- Mid-Columbia STR_____Mid-Columbia SRR
- Upper Columbia STR___Upper Columbia SRR
- Snake STR_____Snake SRR
- Northeast Wash. STR___Northeast Washington SRR
- Unlisted STR_____No SRR identified

3.26 Strahler order: Strahler (1957) described a system of naming sizes of streams based on their position in the watershed. 1st order streams are headwaters. 2nd order streams are where two 1st order streams converge. A 3rd order stream is where two 2nd order streams converge, etc. (Figure 2). For WHM, we use the Strahler order assignments provided by NHDPlus.

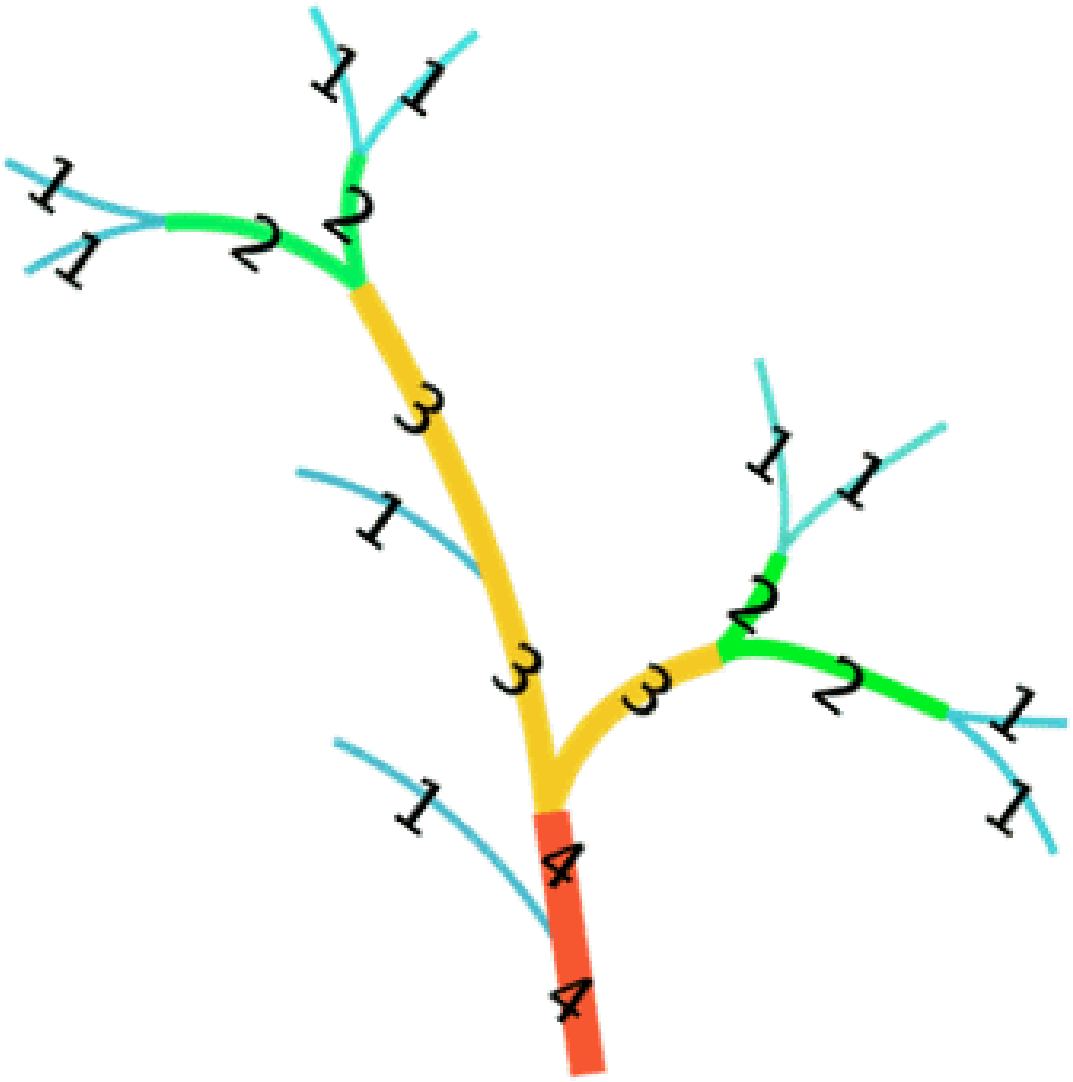

Figure 2: Strahler Order (modified from USGS, 2021)

3.27 Thalweg: Path of a stream that follows the deepest part of the channel (Armantrout, 1998). For WHM, we emphasize Armantrout's use of the word "path" because the thalweg longitudinal profile excludes (sometimes deeper) side pools that are not part of the dominant flow path.

3.28 Thalweg station or transect: One of one hundred (100) equidistant measurement locations in the thalweg, across the length of a site. For example, the thalweg stations at/above each major transect are named as follows:

- A0, A1, A2, A3, A4, A5, A6, A7, A8, A9,
- B0. B1, B2, B3, B4, B5, B6, B7, B8, B9,
- C0, C1, C2, C3, C4, C5, C6, C7, C8, C9,
- …

- J0, J1, J2, J3, J4, J5, J6, J7, J8, J9, and
- K0.

3.29 WHM: Watershed Health Monitoring, a status and trends monitoring program within the Environmental Assessment Program at the Washington State Department of Ecology.

3.30 WHM Sampling Frame: This is the 1:24,000-scale hydrography from which the Master Sample Points were selected. It is described in Ecology (2018).

3.31 Wide protocol: The set of WHM SOPs that describes the sample and data collection at non-wadeable sites or sites wider than 25 m bankfull width. It is an abbreviated version of the Narrow Protocol and is typically accomplished by use of rafts.

4.0 Personnel Qualifications/Responsibilities

4.1 This SOP pertains to all Environmental Assessment Program field staff collecting and entering data for WHM.

4.2 All field staff must comply with the requirements of the EAP Safety Manual (Ecology, 2019).

4.3 All field staff must have completed the annual WHM field training and be familiar with both WHM protocols: Narrow Protocol and Wide Protocol. The training includes sampling goals and objectives as defined in the QAMP.

4.4 Field staff must be annually trained to minimize the spread of invasive species. See SOP EAP070 (Parsons, et al., 2018).

4.5 Field staff should know how to identify bankfull stage. Below are some useful resources:

- Hydrologic Processes: Bankfull Discharge (EPA, 2012)
- Identifying Bankfull Channel Edge Part 1 (Grizzell, 2008a)
- Identifying Bankfull Channel Edge Part 2 (Grizzell, 2008b)
- A Guide for Field Identification of Bankfull Stage in the Western United States (Leopold et al. , 1995)
- Fluvial Geomorphology Module, UCAR COMET Program and NOAA River Forecast Center (Endreny, 2003)

5.0 Equipment, Reagents, and Supplies

5.1 GPS receiver

5.2 Maps

5.3 Tablet (charged) with WHM e-forms.

5.4 Measuring devices (measuring rod, 50 m tape, laser rangefinder)

5.5 Flagging and permanent marker

5.6 Wading gear (pre-cleaned of organisms)

5.7 Paper (waterproof) version of field data forms with number 2 pencil and clip board

5.8 Paper (waterproof) site diagram form

5.9 Digital Camera

6.0 Summary of Procedure

6.1 Each random sample site must always correspond with a stream on the WHM Sampling Frame represented by the randomly derived coordinates for X.

6.2 Navigate to the site using the coordinates provided by the Master Sample or site list. Verify you are at the correct location and determine if the site is suitable for sampling. Next, establish a data collection event (DCE) in the e-forms and complete the site verification page. Determine the site length and layout the 11 major transects and complete a site diagram.

6.2.1 Details of navigating to site coordinates

6.2.1.1 Ensure that landowners have granted permission to access streams through their property.

6.2.1.2 Obtain the coordinates for candidate sampling sites at the WHM project Sampling Schedules page (Ecology, 2021). Enter them into your GPS receiver (set to the North American Datum of 1983 (NAD83) or to World Geodetic System of 1984 (WGS84)).

6.2.1.3 Navigate to X. The stream might not pass through the exact coordinates due to map errors or channel migration. Get as close as possible.

Note: Be aware that, on the ground, X may seem to correspond with a different stream than what it represents on the map (the sample frame). This is often the case near confluences. Always be sure to zoom in as closely as possible when examining the GIS display relative to the sample frame.

Note: Normally, X will serve as the middle of the site and will be located at Major Transect F. The site can be moved to maintain Strahler order, or for reasons of safety/permission, as long as X does not become downstream of Transect A nor upstream of Transect K.

6.2.2 Details of verifying a site's sampling suitability

6.2.2.1 Use clues on the map, road signs or conversations with local residents to confirm your location, as necessary.

6.2.2.2 All four persons on the crew should agree that the site is safe to survey before you begin.

6.2.2.3 All the sites on the candidate list should meet the WHM target criteria based on a GIS assessment. This type of assessment is not always accurate, so field crews should make a final determination on target status based on field conditions. The site should be:

- **Non-federal** and **non-tribal**,
- **Freshwater**, not marine, brackish, or tidal,
- **Perennial**, with **observable flow** during the sample period, across **most of the site**,
- A flowing **stream/river**, not a pond, reservoir, or wetland,
- Of a size **class** and sampling **sequence** meeting the criteria **for the study**,
- Represented by the **WHM sampling frame** AND the corresponding **NHD**,
- Of **consistent** NHD reach and Strahler order from top to bottom,
- In a natural channel (**pre-dating humans**).

Note: Natural channels do not need to be pristine or unmodified. Being straightened or re-directed or with a modified flow regime would not disqualify a site if the stream had existed prior to humans.

6.2.3 Establish the Data Collection Event on the Tablet

6.2.3.1 Turn on the Tablet (Contact the WHM data coordinator for instructions on downloading and using the e-forms).

6.2.3.2 Click the button to create a new Data Collection Event (Figure 3).

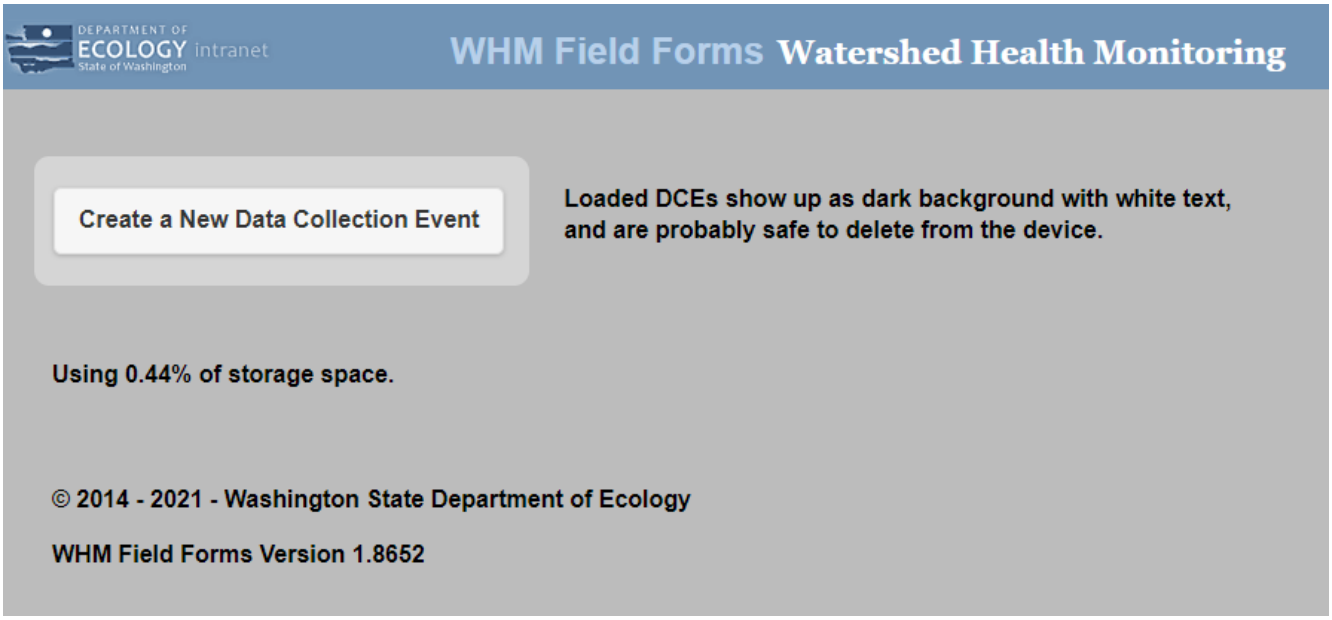

Figure 3: How to create a New Data Collection Event in the e-forms.

6.2.3.3 Select the prefix for your sampling project and search for the site you will sample by Site ID (Figure 4, upper and lower left).

6.2.3.4 Give the DCE a start date and time. Clicking on the circle calendar logo will auto populate the current date and time (Figure 4, upper right).

6.2.3.5 Verify that your site information is correct and then click the Create DCE! Button (Figure 4, lower right).

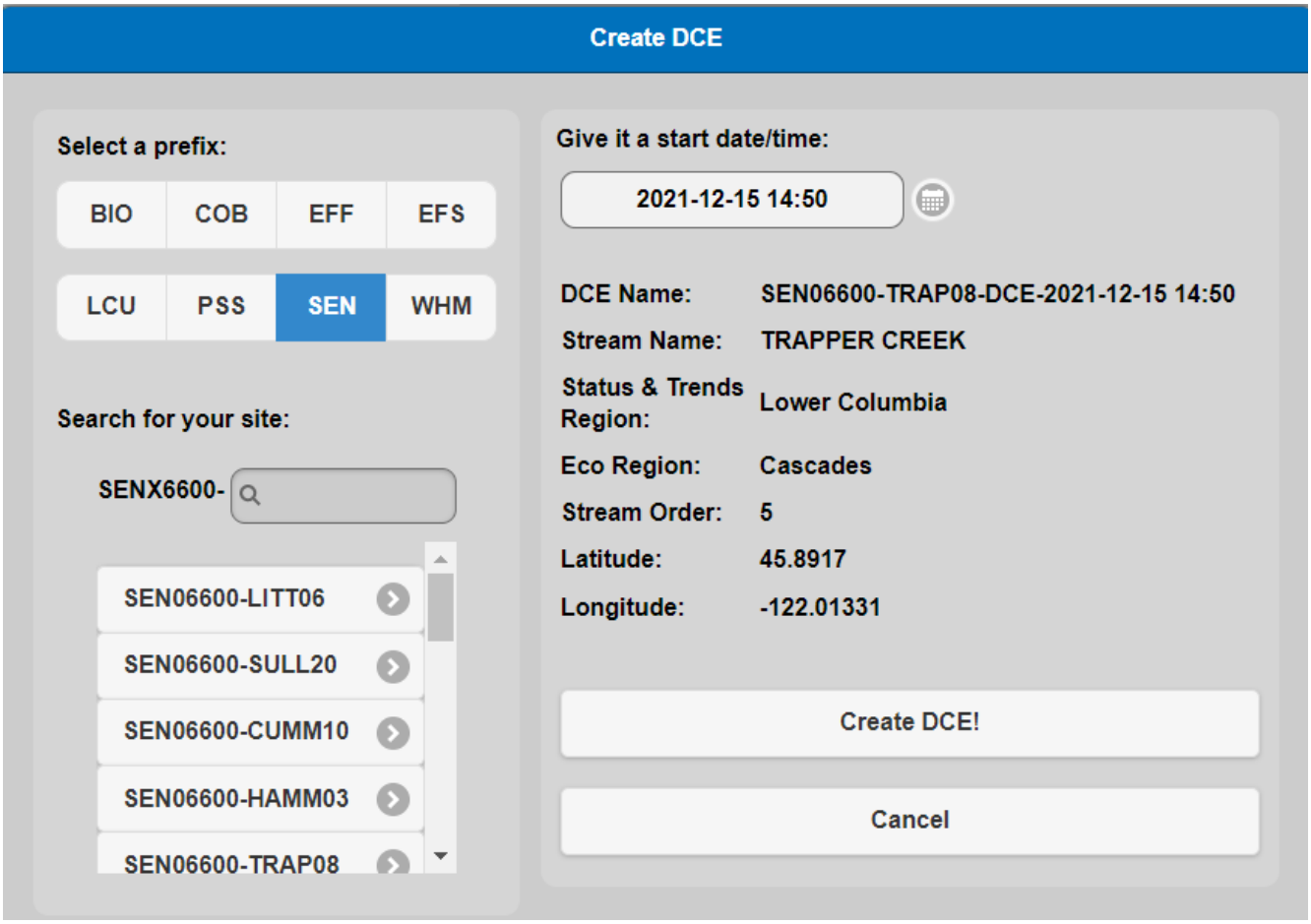

Figure 4: Creating a DCE in the e-forms

6.2.4 Complete the Site Verification page (Figure 5).

6.2.4.1 Fill out the Reach Type. Refer to Table 1 and Figure 1 for a description of Reach Type and watershed positon. The e-forms have a reach type cheat sheet available on the Site Verification page (Figure 5).

6.2.4.2 Select the Narrow protocol for this SOP. For the Wide protocol, see SOP EAP105, (Hartman, 2019).

6.2.4.3 Select Transect A for Narrow protocol.

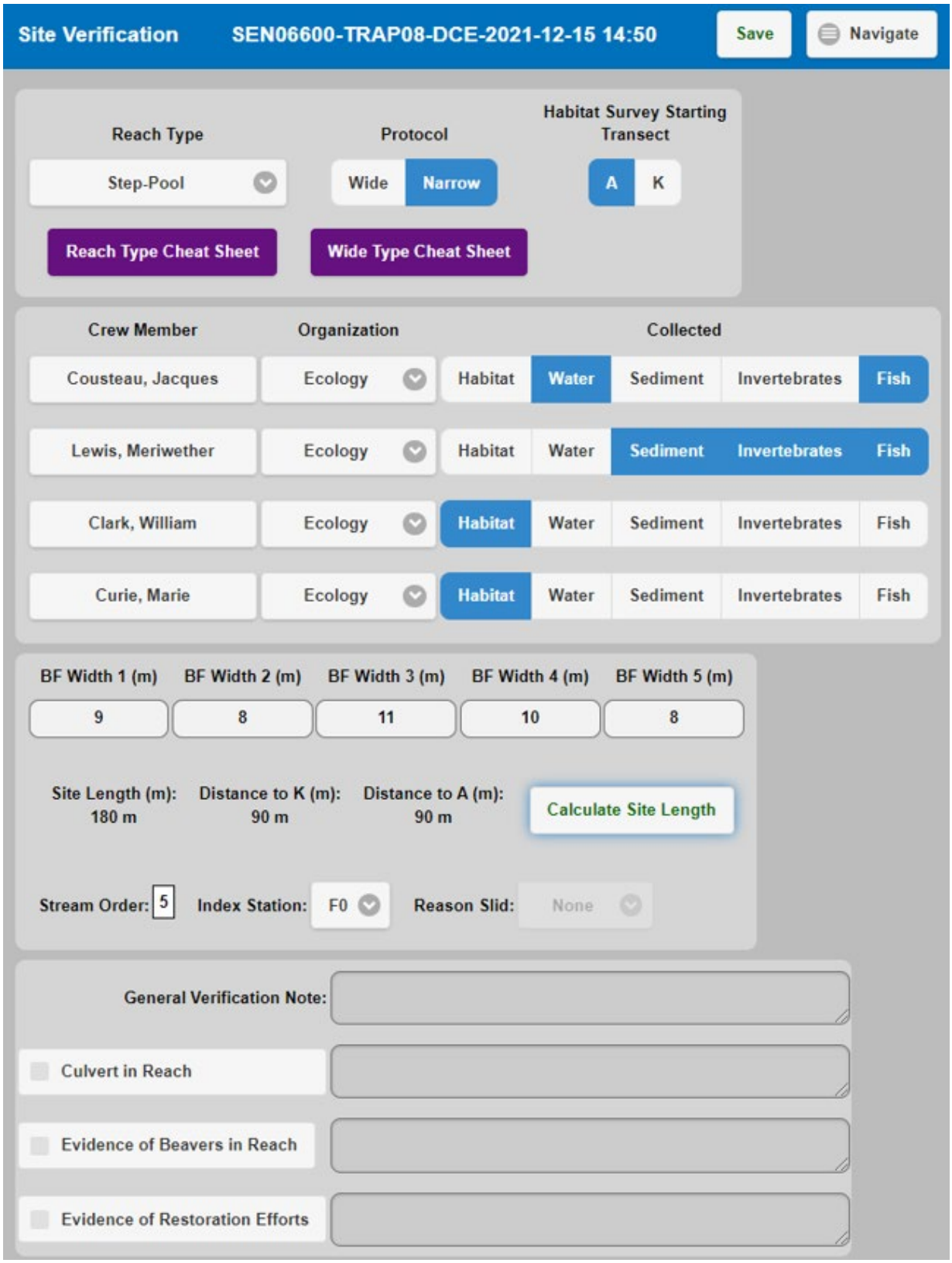

Figure 5: Filling out the Site Verification Page details in the e-forms

6.2.4.4 Enter each crewmembers name, organization and data type they collected.

6.2.5 Determine the site length based on the bankfull widths near the Index Station.

6.2.5.1 Identify Bankfull Stage. Refer to the guidance in section 3.5.

6.2.5.1.1 Measure Bankfull Width. Measure the distance (nearest whole meter) between bankfull stage on the left and right banks, at each of five locations near the Index Station:

- The Index Station (X)
- One bankfull width upstream from X
- Two bankfull widths upstream of X
- One bankfull width downstream from X
- Two bankfull widths downstream of X

6.2.5.1.2 Record each value on the Site Verification page (Figure 5).

6.2.5.1.3 Click Calculate Site Length. The form will calculate site length based on an average of the five bankfull width measurements.

- For sites > 7.5 m to 25 m wide, length = average width x 20.
- For sites ≤ 7.5 m wide, length = 150 m.

Note: For sites > 25 m wide, refer to SOP EAP105 (Hartman, 2019) prior to sampling.

6.2.6 Divide the total site length by 10. This is the distance between the major transects. For example, a 150 m site length would have 15 m spaced between each major transect flag.

6.2.7 Mark the 11 major transects with flagging and a permanent marker: A, B, C, D, E, F, G, H, I, J, and K.

6.2.7.1 Measure along the path of the thalweg and place the 11 flags equal distances apart, following the path of most dominant flow. (Figure 6). A is furthest downstream; K is furthest upstream.

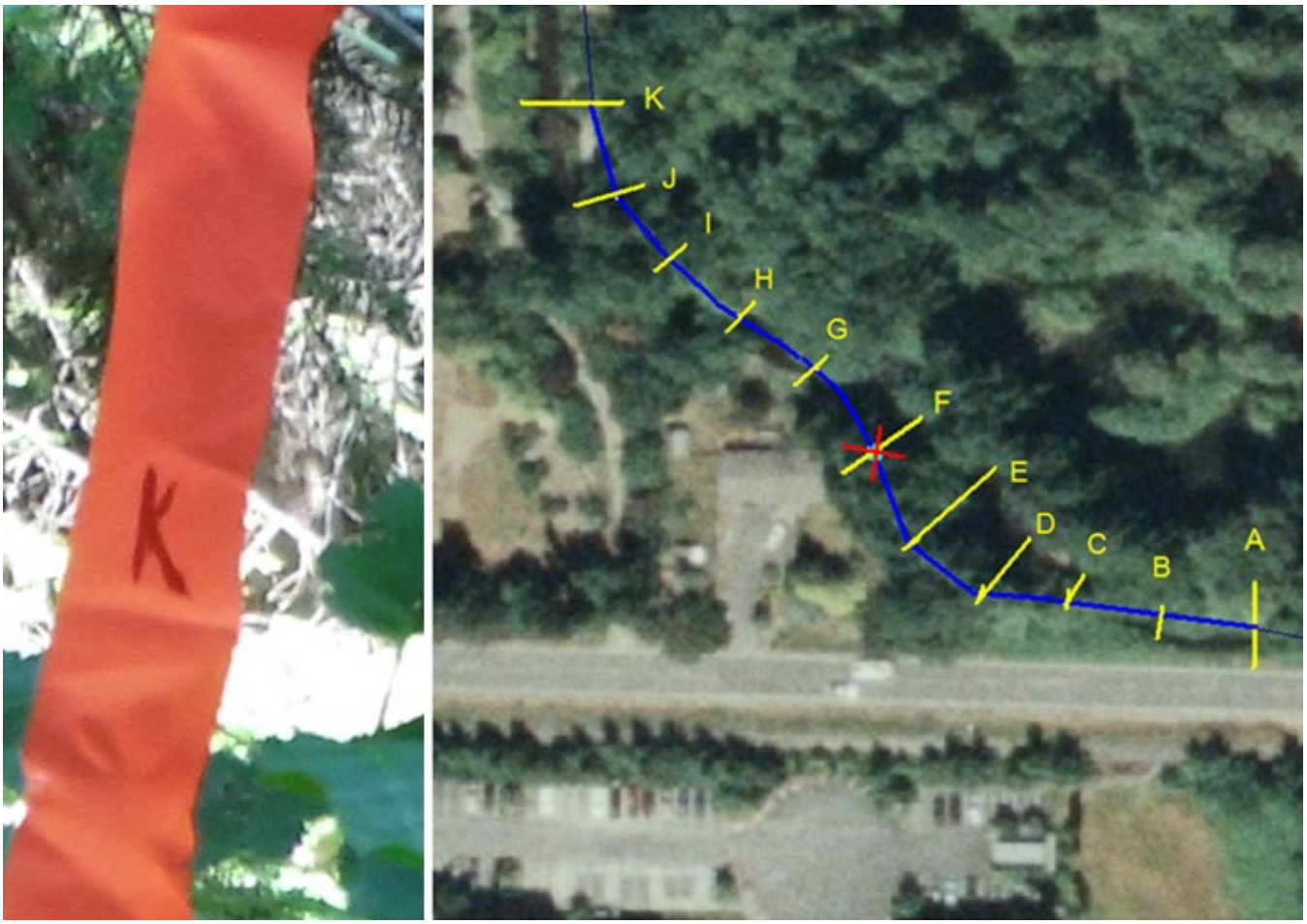

Figure 6: Flagging a site for the Narrow Protocol. A is the farthest downstream, K is the farthest upstream and F (X) is the index station. The transects are equally spaced on the course of the thalweg.

6.2.8 Enter any general notes, or unique information about the site in the General Verification Notes on the Site Verification page. (Figure 5).

6.2.9 If there is a Culvert in Reach, check the box on the Site Verification page and enter any additional details in the note box. (Figure 5).

6.2.10 If there is Evidence of Beavers in Reach, check the box on the Site Verification page and enter any additional details in the note box.

6.2.11 If there is Evidence of Restoration Efforts, check the box on the Site Verification page and enter any additional details in the note box.

6.3 Click the save button at the top right and use the navigation button to move to additional pages in the e-forms.

7.0 Records Management

7.1 During the course of each DCE, draw a site diagram using a paper form and a pencil (Figure 7).

7.1.1 Fill out the Site ID number, DCE year, date and time.

7.1.2 Draw a detailed map of the stream with transects. Mark roads, paths or directions to the site.

7.1.3 Add any features that are unique to the site, such as logjams, fences, bedrock or human influence.

7.1.4 Add a north arrow for reference

7.2 Email a digital photograph of the site diagram to the project coordinator when submitting the electronic data forms for the DCE.

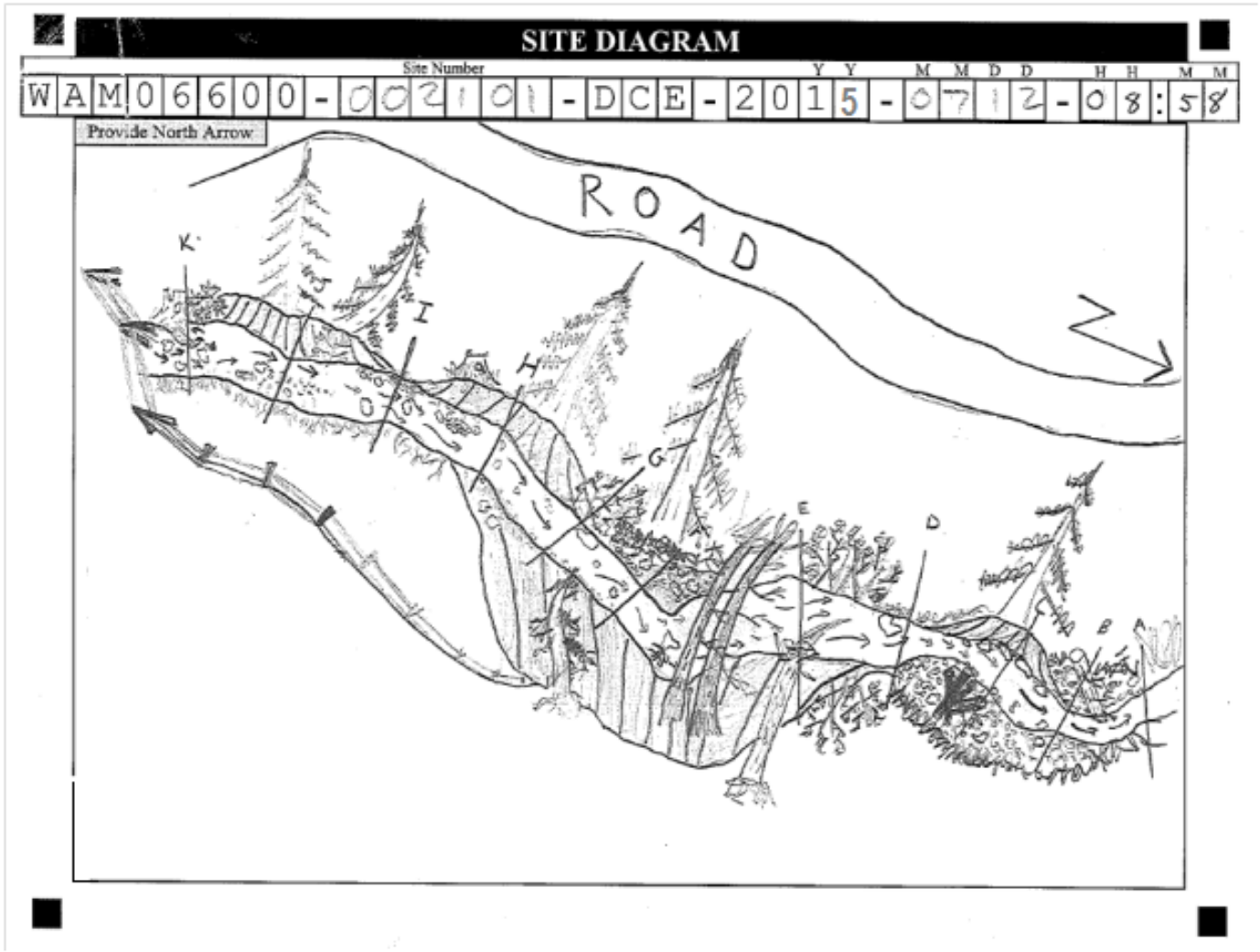

Figure 7: Draw a site diagram at the end of each survey.

7.3 Contact the Watershed Health Monitoring Data Coordinator for the latest guidance document describing how to validate, complete, and load WHM field forms to the WHM database.

8.0 Quality Control and Quality Assurance

8.1 PROJECT QA/QC procedures are discussed in the Quality Assurance Monitoring Plan (Cusimano et al., 2006); a new version will be available 2022.

9.0 Safety

9.1 All field staff must comply with the requirements of the EAP Safety Manual (Ecology, 2019).

10.0 References

10.1 Armantrout, N.B., compiler. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society, Bethesda, Maryland.

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[3] https://apps.ecology.wa.gov/publications/summarypages/0603203.html
[4] https://fortress.wa.gov/ecy/gispublic/DataDownload/EAP_ENV_MasterSample.htm
[5] http://teams/sites/EAP/Pages/safety.aspx
[6] http://www.ecy.wa.gov/programs/eap/stsmf/sampling.html
[7] http://fgmorph.eng.buffalo.edu/
[8] https://web.archive.org/web/20121030031039/http:/water.epa.gov/scitech/datait/tools/warsss/bankfull.cfm
[9] http://www.dnr.wa.gov/Publications/fp_bfw_video_pt1.wmv
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