

Southeast Coast Network

National Park Service
Inventory and Monitoring Division



Standard Operating Procedure 1.2.14

Wadeable Stream Reach Selection and Location of Sampling Points—Version 1.1

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Summary

The following standard operating procedure (SOP) outlines the procedure for selecting stream reaches to be used in *Monitoring Wadeable Stream Habitat Conditions in Southeast Coast Network Parks: Protocol Narrative* (McDonald et al. 2018a). The techniques and procedures outlined in this SOP are based on methods used by the U.S. Environmental Protection Agency (EPA 2013), the U.S. Department of Agriculture (USDA; Harrelson et al. 1994), and the U.S. Geological Survey (USGS; Fitzpatrick et al. 1998). Procedures have been customized for use in streams draining the Piedmont and Coastal Plain parks in the Southeast Coast Network.

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #
2022/03/24	Cooper, C. S.	Update equipment list and remove use of rebar	Operational Review	1.1

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Overview

The purpose of this standard operating procedure (SOP) is to provide a standardized method to select and set up stream monitoring reaches as part of the *Monitoring Wadeable Stream Habitat Conditions in Southeast Coast Network Parks: Protocol Narrative* (McDonald et al. 2018a). The first portion of this SOP describes the steps to follow to select stream segments for monitoring, and the second portion of this SOP describes the steps to follow to set up and properly monument the reaches selected for monitoring. Refer to the protocol narrative for detailed definitions of the following terms: basin, stream segment, stream reach, and transect.

Following the methods outlined in this SOP will ensure that the stream reaches selected for survey: (1) are representative of the processes influencing the streams in each park; (2) can address current and anticipated management concerns, and (3) offer the most utility for future complementary studies.

Prior to field assessments, all monitoring reaches need to be pre-approved by park resource managers. If deemed necessary by the resource manager, the park is responsible for completion of compliance (such as those required pursuant to the National Environmental Protection Act (NEPA; 42 United States Code (USC) 4321 et seq.), and the National Historic Preservation Act (NHPA; Section 106 of 16 USC 470 et seq.).

Equipment/Materials List*

*Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Stream Segment Identification

- Desktop or laptop computer
- ArcGIS with spatial analyst extension
- Shapefile of National Hydrography Dataset high definition (NHDhd) streams
- Shapefile of park administrative (ownership) boundaries

Reach Assessments

- Handheld GPS loaded with sample reach locations
- Digital camera
- Small hammer or mallet
- Hand auger, 5 centimeters (2 inches [in]) in diameter
- Benchmark PVC pipe, 0.5 meter (19.7 in) in length by 5 centimeters (2 in) in diameter schedule 40 PVC, twelve per stream (six for benchmarks and secondary benchmarks, three for tie-in points when needed)
- Brass monument marker with 1 centimeter (0.4 in) diameter magnet glued to underside (nine per stream); three stamped with benchmark identification (BM1, BM2, and BM3), three stamped with secondary benchmark identification (BM1S, BM2S, and BM3S) and three to identify tie-in points (when needed; no stamping necessary)
- Pin flags
- Small container of concrete, approximately 1 gallon (3.8 liter [L]) bag per benchmark
- Small bucket for mixing concrete
- Initial site assessment form: Reach map–Form A (Figure A-1)
- Topographic map suitable for finding selected reaches (i.e., 1:24,000 USGS topographic map with stream coverage and selected point locations)

Segment/Reach Selection

Three levels of selection criteria are applied to all sample reaches: (1) GIS analyses of relevant data layers that are available, accurate, and reliable; (2) relevant management concerns; and (3) field assessments. Field evaluation of potential stream reaches is necessary because the resolution of available geospatial data is often too imprecise for a determination of the suitability of any given sample reach. In order to provide the most relevant information for management, reaches are either: (1) paired to represent disturbed versus undisturbed conditions; or (2) chosen to represent conditions/processes affecting multiple similar-sized streams within the park.

Reaches are selected in five stages: (1) identification of potential stream segments in GIS; (2) consultation with park staff; (3) in-the-field suitability evaluation; (4) basin-scale assessment in GIS; and (5) final decision. Each of these stages are discussed in detail in the following section.

Identification of Potential Stream Segments in GIS

Potential stream segments are identified in a GIS using the NHD high definition (NHDhd) data set and the park ownership boundaries. This point coverage will be used to discuss potential survey locations with park staff as well as locate the stream segments in the field. Use the following steps to create a point coverage of all of the perennial stream segments in each park.

1. Open ArcCatalog, navigate to the SECN GIS drive:
 \GIS\projects\StreamHabitat\Wadeable\PARK\Survey folder and create a new point shapefile.
 - a. Name the shapefile 'PARK_PotentialSites'
 - b. Pick the correct UTM zone (Figure 1)

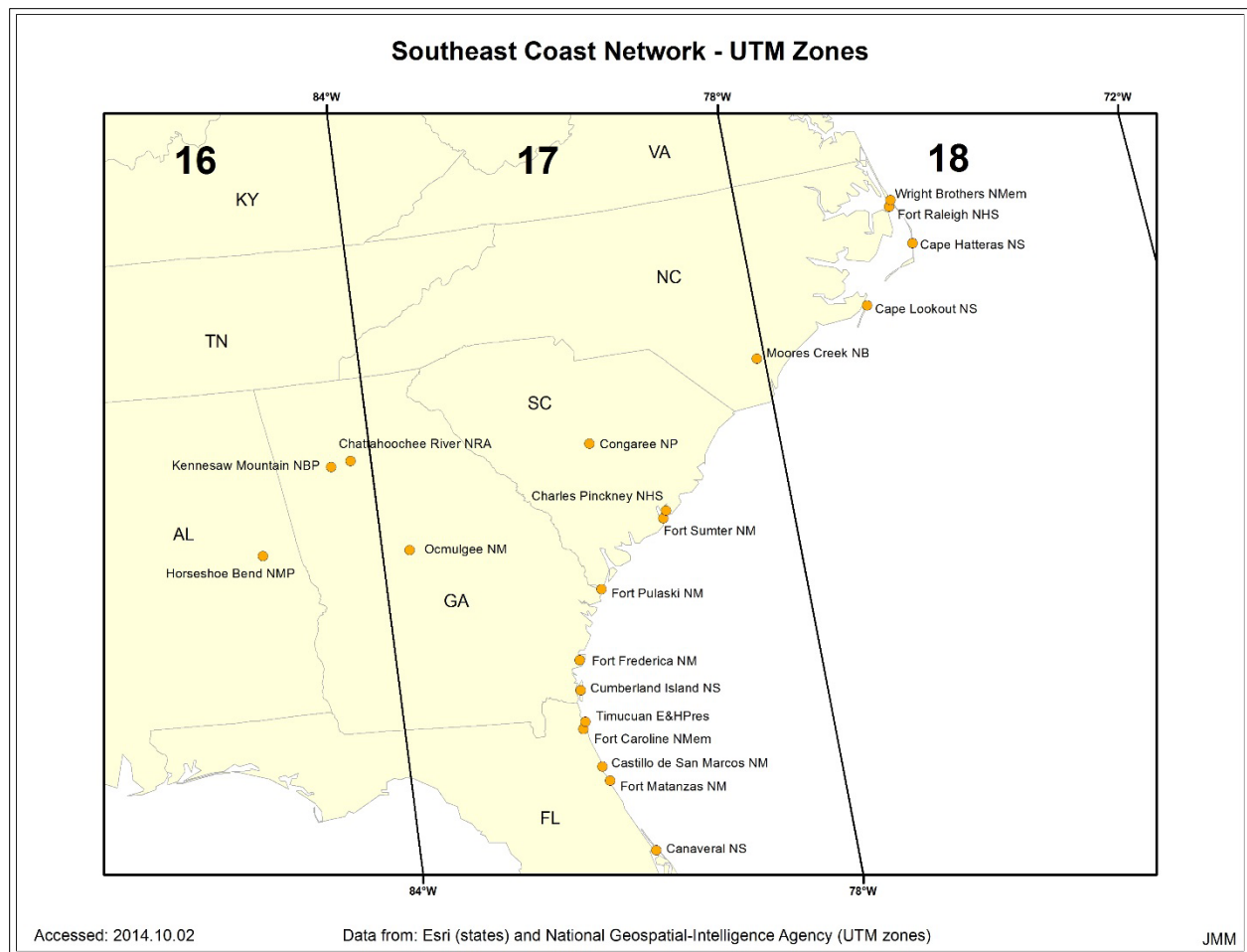


Figure 1. UTM zones for the parks in the Southeast Coast Network.

2. Open ArcMap and add:
 - a. NHDhd stream coverage
 - b. Park ownership boundary
 - c. PARK_PotentialSites shapefile
3. In the Editor menu, click Start Editing and use the next step to create the PARK_PotentialSites coverage
4. Add a point to every stream segment (a stream segment is a portion of stream between tributary junctions) within park boundaries that meet the following criteria:
 - a. Perennial (as classified by the NHDhd data set)
 - b. Within park ownership boundaries
 - c. The segment is at least 400 feet (122 meters [m]) in length.

5. Once all of the stream segments have been marked, save edits and end the editing session.

The last step is to make a map or series of maps that can be used when consulting with the resource manager at each park. Data that should be included in these maps are topography, land cover, road data, and any trails layers that are available. If the park has the ability to access GIS software, make sure the data are saved to an encrypted external hard drive or USB drive so they are available for discussions with park staff.

Consultation with Park Staff

Once all potentially wadeable stream segments are identified in GIS, a resource manager at each park needs to be consulted to:

1. Identify stream segments with current or potential management concerns,
2. Determine issues that may prevent accessing any of the stream segments, and
3. Determine the long-term applicability of each potential survey segment.

One important consideration for long-term monitoring is the need to have access to the segment in perpetuity. If a segment that is not fully-contained within the park boundary is deemed relevant to park management, it is the responsibility of the park to obtain the permits that are required to gain access, install needed benchmarks, and survey the reach. After an updated and annotated list of potential stream segments is assembled, all accessible stream segments need to be evaluated in the field.

Field Suitability Evaluation

Field surveys are conducted on each accessible stream segment to locate a representative stream reach within the candidate segment that is suitable for data collection. Conditions that are likely to make a reach unsuitable for sampling include: presence of beaver dams or ponds; lack of a defined channel; or hazardous conditions (i.e., wildlife or treacherous wading conditions). Although the goal is to select a representative reach and not to provide easy access, it is also important to consider crew fatigue and strike a balance between these two goals.

Sample reaches are excluded if upon inspection:

- The sample reach is not wadeable.
- The sample reach is not a free-flowing (e.g., flow obstructed due to beaver impoundments), perennial, single channel, lotic system.
- The sample reach is potentially unsafe (e.g., presence of potentially toxic material or highly-incised stream with high undercut banks).
- The reach can only be accessed by traversing through large wetlands.
- Impenetrable vegetation or manmade obstructions prevent sampling of the entire reach.

While conducting the field suitability evaluation, the objective is to provide a general understanding of the stream segment and identify a potential representative reach within the segment that can be monitored. While conducting the evaluation, make notes about the following characteristics:

1. Is the stream wadeable?
2. Channel width
3. Bank heights
4. Bank angles
5. Amount and degree of bank undercutting
6. Riparian coverage
7. Dominant bed sediment
8. Amount and types of geomorphic channel units
9. Amount and degree of floodplain development
10. Anthropogenic disturbance (i.e., trails (official and social) and refuse)

Finish the evaluation of each segment by taking a photograph of the potential survey reach within the stream segment and record the latitude and longitude of the spot where the picture was taken.

Basin-Scale Assessment in GIS

Using the list of suitable potential stream reaches, conduct a basin analysis to characterize the variability of the geomorphic and land cover characteristics of the watersheds draining to the potential stream survey reaches. The purpose of this stage of reach selection is to determine basin-scale similarities between reaches so that paired reaches can be selected or a representative reach can be monitored that will provide an understanding of similar streams in the park. To conduct the basin-scale analysis use the latitude and longitude points of the representative stream reach pictures taken during the field evaluations as the outlets for the basin analysis (follow the methods outlined in SOP 1.2.15 *Wadeable Stream Basin- and Segment- Scale Data Summary—Version 1.0* [McDonald et al. 2018b]).

Final decision

Use the results of the basin-scale assessment to assist in the final selection of stream reaches. Final reach selection should be done by SECN personnel who can provide the best professional judgment required to adequately assess reach utility, safety, and suitability issues. Reaches are chosen that strike a balance between being relevant to management goals, are complementary to future studies, are representative of conditions within the park, and are safe to survey.

If possible, an alternate reach should be identified for every potential reach in case upon revisiting the reach or in consultation with park staff the reach is deemed unsuitable or unsafe. All ‘final’

selections need to be confirmed by park staff prior to installing the permanent benchmarks and conducting the initial survey. A report is provided to the park and uploaded to IRMA outlining why each stream segment was chosen or rejected.

Initial Reach Setup

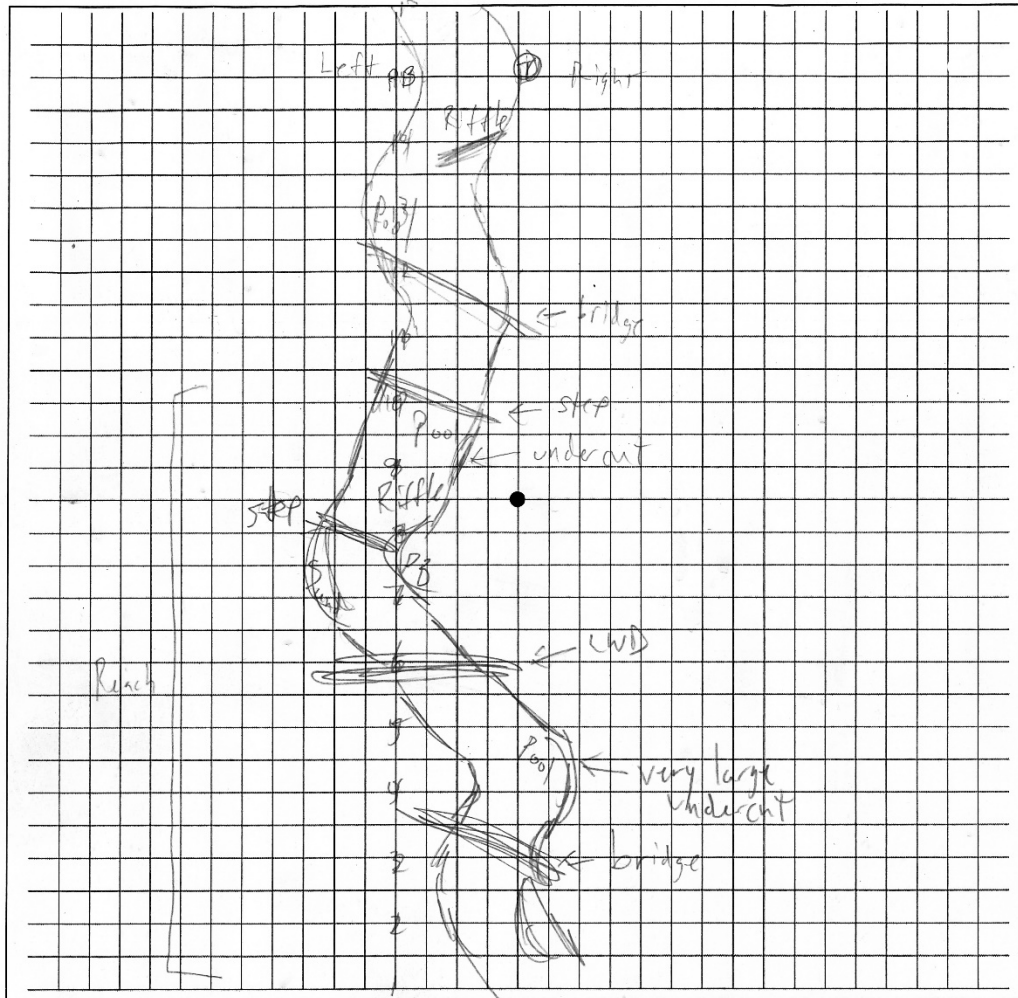
Once the reaches have been confirmed by park staff, load all location data (latitude and longitude) onto a GPS device so that the previously identified suitable stream reaches can be relocated. The following steps describe how to perform the initial reach setup which includes laying out the transects and installing the permanent benchmarks. All subsequent assessments will use the GPS location and benchmarks to re-locate the transects that are to be surveyed. Be sure to conduct the initial reach setup (and all subsequent surveys) when the stream is running at or near baseflow.

- Prior to going into the field, use the maps created during the field suitability evaluation to determine the safest and most efficient route to each reach. Use slope, land cover, and distance to road/trail networks in this determination.
- When near the reach, use a field-capable GPS or paper map to navigate to within approximately 10 meters (32.8 ft) of the field assessment photograph point. Note that dense canopy cover can inhibit the use of GPS. Be sure to bring a topographic map with proper coverages that will allow sample locations to be located using reckoning and orienteering methods.
- Once the previously identified suitable reach has been located, conduct a preliminary assessment of stream conditions and record them on the initial site (reach) assessment map (Figure 2 and Appendix A). The purpose of this preliminary assessment is to pick the most representative portion of the stream segment. In order to determine assessment and reach lengths, take six representative wetted width measurements (measured to the nearest cm). To ensure the resultant average wetted width is representative of the segment, be sure to take these measurements on a variety of geomorphic channel units (e.g., on two pools, two runs, and two riffles).
- After the mean wetted width has been determined (round to nearest 0.5 meter [1.64 ft]), scout upstream and downstream from the field assessment photograph point a distance approximately 30 times the mean wetted width of the reach (15 times up and 15 times down) to ensure that there are no natural or man-made impediments or hazards that would make the reach unsuitable (assessment length from Form A).
- While scouting, draw an initial reach assessment map (Figure 2) noting:
 - Riparian vegetation
 - Bank condition
 - Evidence of disturbance
 - Anything that would endanger the safety of the crew or make the reach unsuitable for sampling

- If a reach is unsuitable for any reason, note the conditions that make it unsuitable and continue to the designated alternate reach (see previous section 'Final Decision').
- If a reach is suitable, finish the reach assessment map by recording a general description of the reach and sketch in areas amenable for total station setup.

SECN Wadeable Stream Habitat Initial Site Assessment (Form A): Reach Map

Park: CHAT Site #: 02 Stream: "undercut" Date: 6/5/17



Wetted Widths (m)	1.7	1.6	0.95	Average Wetted Width* (m)	1.7 ↓ 1.5	Assessment Length (m) (Average W.W. x 30)	45	Reach Length (m) (Average W.W. x 20)	30	Distance Between Transects (m) (Reach length/10)	3
	1.8	2.0	2.2								

Comments / Map Legend:

Benchmarks are on T2(1), T6(2), T10(3)
all on river left

*Rounded to the nearest half meter.

Figure 2. Example of the initial site assessment map. Detailed transects (benchmarks) were moved from their preferential transects due to large trees blocking line-of-sight on T1 and T11.

Choosing the Middle of the Reach

Using the Initial Reach Assessment Map as a guide, determine where the middle of the reach will be located, ensuring that the stream can be surveyed for the required distance (10 times the mean wetted width) upstream and downstream (20 times the mean wetted width).

When choosing the middle of the reach, be sure to choose a location that is representative of the assessment area. Areas that are relatively free of vegetation, while easier to survey, may not be representative of the stream segment.

Although the goal is to select a representative reach on a stream segment rather than select a reach for ease of access, it is also important to consider crew fatigue and strike a balance between the two.

Reach Length and Standard Transect Locations

Once the middle of the reach (transect 6) has been identified, use the following procedure to determine the locations of the other standard transects that will be surveyed:

- Total reach length is calculated by multiplying average wetted channel width by 20 (see Appendix A), and the distance between standard transects is determined by dividing total reach length by 10 (distance between transects will equal two times average wetted width).
- Using a reel tape or other measuring device, mark five transects downstream from the center and five transects upstream from the center transect (11 total). Distances should be the curvilinear distance between the banks measured from the center of the stream channel.
- Mark the location of each transect with a highly visible temporary flag. Transects should be numbered so that transect 1 is the furthest downstream transect, and transect 11 is the furthest upstream transect (Figure 3).
- Once transects have been flagged, use the instructions in the following section to install permanent benchmarks that will be used during the detailed/total station surveys.

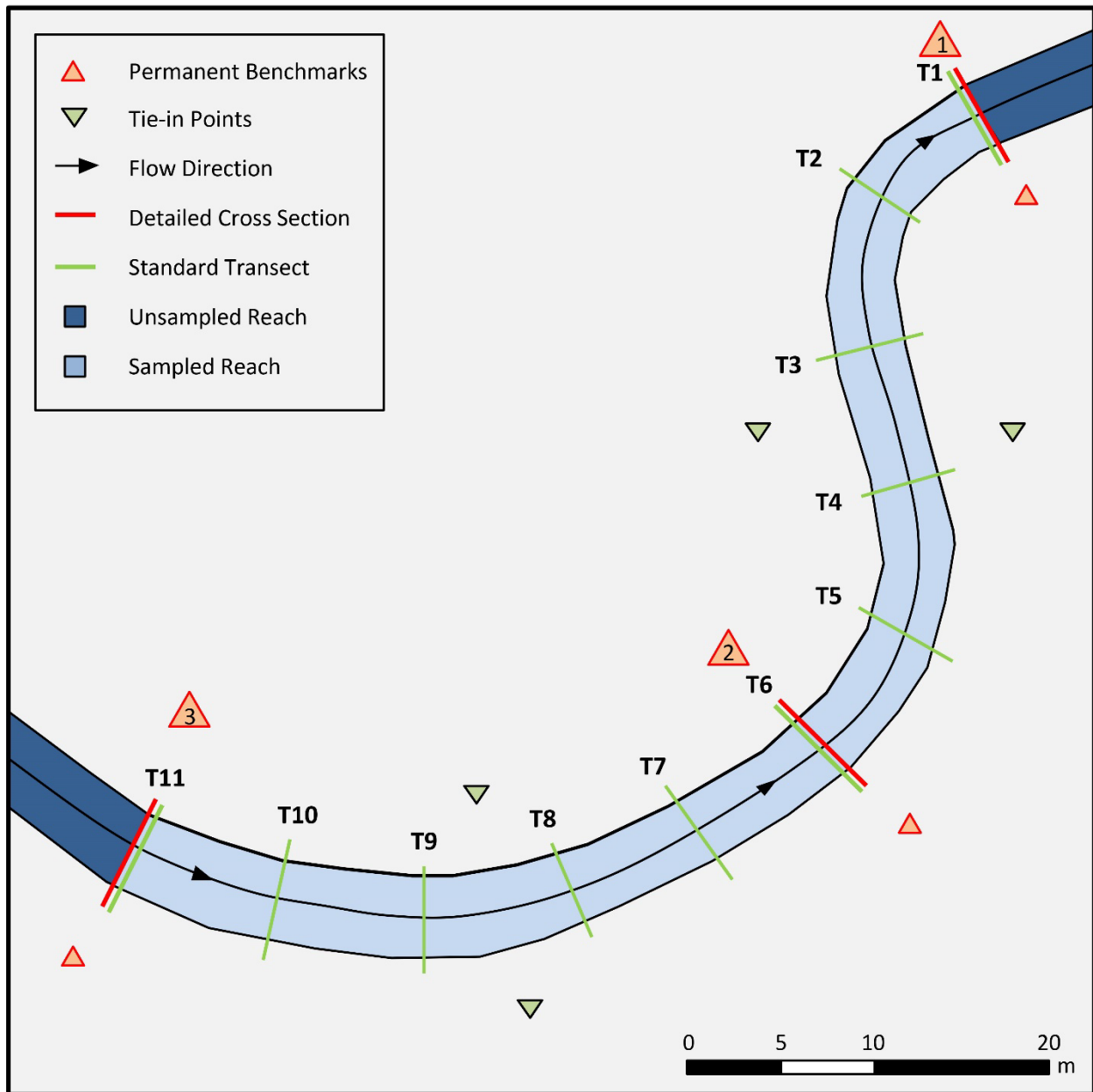


Figure 3. Example layout of a stream reach with benchmarks and regular and detailed transects. The permanent benchmarks are installed during reach assessment. Benchmarking the tie-in points is optional and only needed if there is no line-of-sight between benchmarks.

Benchmark Installation

Preferentially, identify a location on river left on the first, sixth, and eleventh transect to install permanent (concrete) benchmarks and a location on river right opposite these permanent locations (and perpendicular to flow) to install the secondary benchmarks. If impenetrable vegetation, unsafe bank conditions, or bedrock prevent total station surveying of the first, sixth, or eleventh transect, the permanent benchmarks/detailed transects should be moved to the closest suitable transect. If the geography of the reach prohibits installation of the permanent benchmark on river left, identify a

location on river right to install the permanent benchmark and make a note of the change in benchmark location.

Once total station survey-suitable transects are identified, benchmark locations should be located that are at least 10–15 meters (32.8–49.2 ft) outside of areas of active geomorphic activity (e.g., at least 10 meters [32.8 ft] from the top of cutbanks or point bar crests). Additionally, all benchmarks need to have a line-of-sight to at least one other benchmark so that they can be tied together when conducting the total station surveys. If the geography of the reach or impenetrable vegetation prevents a line-of-sight connection of the benchmark network, install an additional ‘tie-in’ benchmark(s) so that all benchmarks can be tied together.

When installing the benchmarks:

- Be sure to wear eye protection.
- Be sure that the primary and secondary benchmarks form a line perpendicular to the active stream channel.
- Drive the 0.5 meter- (1.6 ft-) long, 5 centimeter- (19.7 in-) diameter PVC pipe into the ground with a small mallet so that the top of the pipe is approximately level with the ground surface. Note that a hand auger may be needed to dig the hole in areas of the Piedmont and Coastal Plain where highly cohesive sediments prevent the PVC pipe from being driven into the soil. If the soil is loose and unconsolidated, place a handful of gravel at the bottom of the augered hole to provide a more stable base for the benchmark.
- Once the PVC pipe is securely set in place, fill the inside of the pipe with concrete. Use a stick or pin flag to remove trapped air bubbles from the concrete inside the PVC pipe. Place the monument marker (with magnet), labeled with the correct identifier (“BM1” for furthest downstream transect, “BM2” for the middle transect, and “BM3” for the furthest upstream transect), on top of the pipe and allow the concrete to set (Figure 4).
- Use the above procedure to install the secondary benchmark on the opposite stream bank, making sure to use the monument marker labeled with the correct identifier (“BM1S” for furthest downstream transect, “BM2S” for the middle transect, and “BM3S” for the furthest upstream transect).
 - Once the secondary benchmark has been installed, take a compass bearing from the primary benchmark to the secondary benchmark to help re-locate the secondary benchmark during subsequent surveys.
 - A metal detector or magnetometer will be needed on subsequent surveys to relocate the benchmarks.

Once all benchmarks are installed and all of the compass bearings are recorded, the reach setup is complete and the reach is ready to be surveyed.



Figure 4. Example of a secondary benchmark (BM1S) placed on each detailed cross-section during the initial site assessment.

Literature Cited

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Appendix A. Data Sheets

SECN Wadeable Stream Habitat Initial Site Assessment (Form A): Reach Map											
Park: _____		Site #: _____		Stream: _____		Date: _____					
Wetted Widths (m)				Average Wetted Width* (m)		Assessment Length (m) (Average W.W. x30)		Reach Length (m) (Average W.W.x 20)		Distance Between Transects (m) (Reach length/10)	
Comments / Map Legend:											
*Rounded to the nearest half meter.											

Figure A-1. Form A—SECN Wadeable Stream Habitat Initial Site Assessment: Reach Map.