

Southeast Coast Network

National Park Service
Inventory and Monitoring Division



Standard Operating Procedure 1.2.18

Using a Total Station to Conduct a Stream Survey— Version 1.1

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Summary

The following standard operating procedure (SOP) outlines the procedure for collecting accurate x, y, and z coordinate data to survey river and stream transects using a robotic total station and data collector. Total stations allow extremely accurate spatial data to be collected and tied to a permanent benchmark. These data can be used to detect small geomorphic changes between surveys. Many different types of total stations and surveying gear are available and newer models will be available in the future. This SOP outlines basic steps for using the Trimble S6 robotic total station and the TSC3 data collector. It is assumed that the user is familiar with the basics of fluvial geomorphology and surveying and that the surveyor knows how to properly setup and use a total station (see SOP 1.2.17 *Setting Up and Configuring a Total Station—Version 1.1* [McDonald et al. 2022]).

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #
2022/03/24	Cooper, C. S.	Minor procedural, specificity	Operational Review	1.1

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Equipment/Materials List

- Trimble S6 Total Station*
 - Batteries
 - Battery charger
- Tripod for total station
- Trimble TSC3 data collector*
 - fully charged
 - antenna
 - data-logger rod-mounting cradle
- Prism and rod (with level)
- Bi-pod for prism rod
- Tape measure
- Compass
- Survey wire and chaining pins (6)
- Clipboard
- Forms 3 (three copies) and 3a (Appendix A)
- Pencil

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

Total Station Setup and Configuration

Refer to SOP 1.2.17 *Setting Up and Configuring a Total Station—Version 1.1* (McDonald et al. 2022) for instructions on how to setup and configure a Trimble S6 robotic total station using a TSC3 handheld data collector.

Procedure

The goal of the detailed transect surveys is to collect data to characterize the cross-sectional morphology of the detailed transects, allow for the identification and quantification of erosion and fluvial development, and provide an understanding of the out-of-channel features or habitats that characterize or influence the reach.

When beginning the detailed transect survey, the surveyor should first place a chaining pin behind each benchmark and secondary benchmark, then tie survey wire between the chaining pins on each of the three transects to be surveyed. The resulting lines will assist the surveyor in keeping a straight course along each transect during the survey. The first setup is on the benchmark that has a line-of-sight to two other benchmarks (detailed transect or tie-in). This step is needed so that another benchmark can be used as the back-sight to verify positional accuracy and ensure the total station is setup consistently during subsequent surveys. If a tie-in point was needed to complete the survey network, Form 3a (Appendix A) will have the coordinates of this benchmark in case the data need to be entered manually.

Prior to setting up the total station over each benchmark, walk the transect and fill out Form 3 (Appendix A). The purpose of Form 3 is to provide a context for the points that will be surveyed along each transect. Be sure to note the presence or absence of diagnostic geomorphic surfaces (e.g., floodplain or terrace) and provide a short description of the riparian habitat on each side of the stream (i.e., ground cover and presence/absence of woody plants).

Finish this initial reconnaissance by drawing a quick sketch of the cross-section with annotations that will help interpret the data by identifying the top of the bank (bankfull and/or channel full), bottom of bank, presence of emergent mid-channel bars, and any other noteworthy features. Once Form 3 has been filled out, set up the total station, name the project according to the PARK, reach number, and date of survey, and then begin surveying (see SOP 1.2.17 [McDonald et al. 2022] for more details).

The following procedure is an idealized survey and modifications may need to be made depending on the characteristics of each reach:

1. Start on the side of the river where the benchmark is located (usually river left). Collect the first point far enough and high enough away from the stream to characterize the out-of-channel area beyond the benchmark. If possible, survey a point that is at a height that is twice the bankfull depth above the channel bed. Refer to any previous surveys to determine appropriate extent. Mark the starting location (river left or river right) on Form 3.

2. Select 'Measure Topo' from the 'Measure' menu (Figure 1). On the 'Measure Topo' screen, first define the point name. The point name will be a number that corresponds to the transect and number of points recorded (four-digits long starting with benchmark number). For example, the first detailed transect's (BM 1's) first point will be 1001, the second detailed transect's (BM 2's) first point will be 2001, and the third detailed transect's (BM 3's) first point will be 3001. After recording each point, the last digit will automatically change to the next in the series (e.g., BM 2's points will be 2001, 2002, 2003).

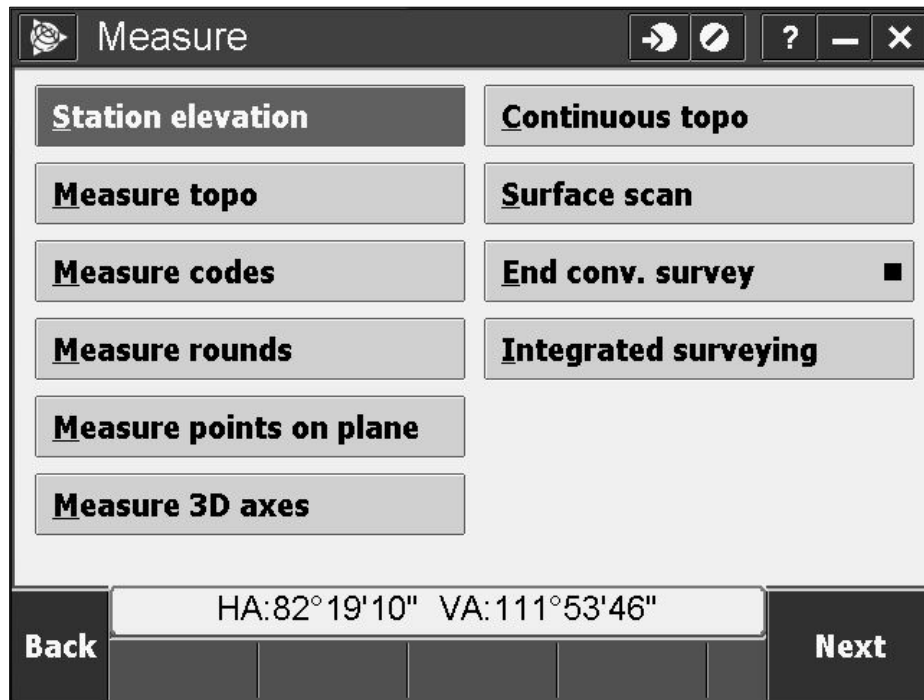


Figure 1. Trimble Access Measure menu.

3. After the name has been entered, enter a point code (Table 1 and Form 3). The purpose of the point code is to help interpret the data and identify key geomorphic surfaces.
 - a. Add the 'L-' or 'R-' prefix to denote river left or right.
 - b. Label the point '-OC'(out of channel) unless it is a diagnostic point (Table 1) or between left water's edge 'LWE' and right water's edge 'RWE' (which would be a 'CH' or channel point).
 - c. Also, be sure to label the -OC points that are to the left of the left benchmark as LBMOc (for data processing reasons).

Table 1. Point codes to be used when conducting the stream surveys.

Point Code Name	Abbreviation
Left	L-
Right	R-
Benchmark	-BM
Backsight Point	BS
Out of channel	-OC
Channel full	-CF-
Floodplain Margin	-FPM
Bank full	-BF-
Bottom of Bank	-BB
Water's edge	-WE
Channel	CH
Longitudinal Profile	LONG
Water Surface	WS-

4. Once the first point is surveyed, collect points along the installed survey line line that runs between the primary and secondary benchmarks. Point spacing should be slope-dependent and should be close enough to accurately represent local slope (i.e., greater slope = more points).
5. While conducting the survey, be sure to collect all of the diagnostic points from Table 1 that are present (e.g., channel-full (bank-top), bankfull (bank-top), and edge of water) as well as additional points between each diagnostic point to accurately capture topographic variability (Figure 2).
 - a. Use the common point codes to label each point (Form 3).

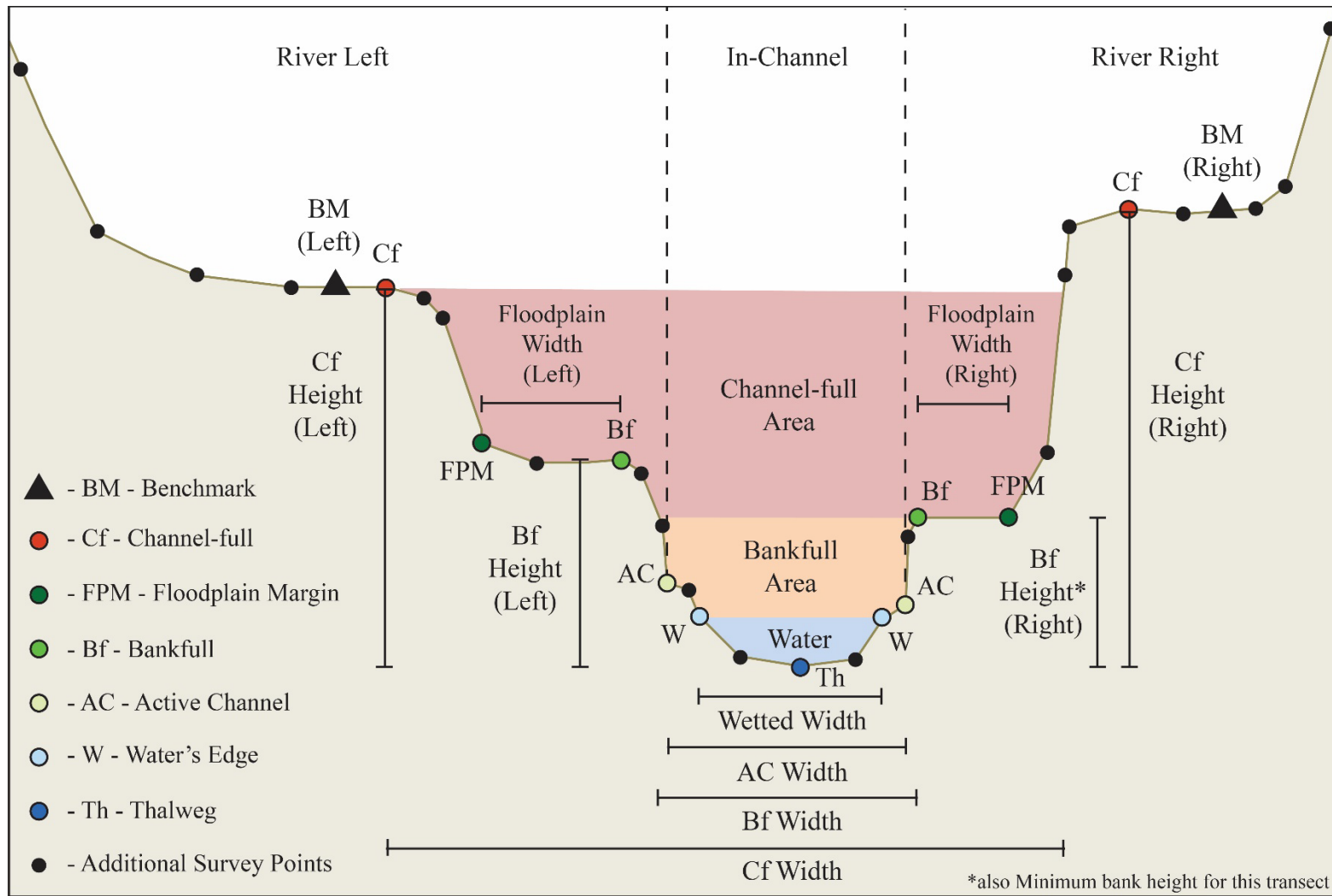


Figure 2. Hypothetical stream cross-section with location of survey points. Triangles indicate benchmarks and colored points indicate the various potential diagnostic points with abbreviations and description. Black points represent unnamed survey point locations needed to accurately represent cross section. The blue water surface point needs be surveyed on all 11 transects. NOTE: Be sure to survey the left benchmark!

6. Finish the detailed transect by surveying a point far enough and high enough away from the stream to characterize the out-of-channel area beyond the secondary benchmark. If possible, survey a point at least two times higher than bankfull depth on the side opposite the total station.
7. Once the detailed transect has been surveyed, record all longitudinal profile points visible from this setup. The longitudinal profile points should be taken on the water surface in the middle of channel at each standard transect (1–11). So that an accurate representation of the energy grade line within the reach can be created, water surface points also should be collected on riffle- and step-tops. Record which longitudinal profile points were surveyed from each benchmark on Form 3.
 - a. Water surface points should be named WS## (e.g., water surface on transect 1 labelled as WS01) and use the code 'LONG' for these points.
 - b. For riffle- and step-tops, name the points based on which transects it is between (e.g., a riffle-top between transects 5 and 6 should be labelled WS56).

Note: When processing the data, the benchmark on river left (regardless if primary or secondary) will be used to compare all subsequent surveys. Be ABSOLUTELY SURE the river left benchmark is surveyed if the total station is not set up on it.

8. Once all of the points are recorded (see **Note** above) be sure to select 'End Conventional Survey' in the 'Measure' menu (Figure 1) to save the points.
9. Upon completing the transect survey and before moving on the next transect, take a hydration break (5 minutes minimum).

Repeat these steps until all three of the detailed transects have been surveyed and all longitudinal profile points (transect water surfaces and riffle- and step-tops) have been recorded.

Literature Cited

McDonald, J. M., M. B. Gregory, J. Riley, and E. N. Starkey. 2022. Setting up and configuring a total station—Version 1.1. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.2.17. National Park Service, Athens, Georgia. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2293669> (last accessed June 2022).

Appendix A. Data Sheets

SECN Stream Habitat Assessment Form 3 - Detailed Cross-Sections (Version 1.0, June 2018)																	
Park -	Site # -	Date -	Start Time -	End Time -													
Crew leader -		Sampling Crew -															
BM #	Transect # -	Bank Side -															
Northing -	Easting -	Elevation -	Datum -														
Site Description -																	
Description of transect -																	
River Left - Out of Channel (Note - Presence/Absence of floodplain, terrace, vegetation, etc.)																	
River Left - Bank (Note - Presence/Absence of undercutting, slumping, etc.)																	
In-Channel (Note - Presence/Absence of bars, emergent boulders, large woody debris, etc.)																	
River Right - Bank (Note - Presence/Absence of undercutting, slumping, etc.)																	
River Right - Out of Channel (Note - Presence/Absence of floodplain, terrace, vegetation, etc.)																	
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;">Total Station Codes</th> </tr> </thead> <tbody> <tr><td style="padding: 2px;">L - Left</td></tr> <tr><td style="padding: 2px;">R - Right</td></tr> <tr><td style="padding: 2px;">BM - Benchmark</td></tr> <tr><td style="padding: 2px;">OC - Out of Channel</td></tr> <tr><td style="padding: 2px;">Cf - Channel-full</td></tr> <tr><td style="padding: 2px;">Fpm - Floodplain margin</td></tr> <tr><td style="padding: 2px;">Bf - Bankfull</td></tr> <tr><td style="padding: 2px;">BB - Bottom of Bank</td></tr> <tr><td style="padding: 2px;">WE - Water's Edge</td></tr> <tr><td style="padding: 2px;">CH - Channel</td></tr> <tr><td style="padding: 2px;">LONG- Longitudinal Profile</td></tr> <tr><td style="padding: 2px;">WS- Water Surface</td></tr> </tbody> </table>			Total Station Codes	L - Left	R - Right	BM - Benchmark	OC - Out of Channel	Cf - Channel-full	Fpm - Floodplain margin	Bf - Bankfull	BB - Bottom of Bank	WE - Water's Edge	CH - Channel	LONG- Longitudinal Profile	WS- Water Surface
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WS- Water Surface																	
Longitudinal Profile - (Circle points surveyed from this benchmark)																	
WS01	WS02	WS03	WS04	WS05	WS06	WS07	WS08	WS09	WS10	WS11							
If the water surface at riffle tops/steps between transects was surveyed, indicate the position with an arrow between transect WS#s																	
Notes:																	

Figure A-1. Example of Stream Habitat Assessment Form 3 – Detailed Cross Sections.

SECN Stream Habitat Assessment Form 3a - Tie-in Points (Version 1.0, June 2018)

Park -	Site # -	Date -
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Tie-in Point 1	Location -	Bank Side -
Northing -	Easting -	Elevation - Datum -
Site Description -		

Tie-in Point 2	Location -	Bank Side -
Northing -	Easting -	Elevation - Datum -
Site Description -		

Tie-in Point 3	Location -	Bank Side -
Northing -	Easting -	Elevation - Datum -
Site Description -		

Tie-in Point 4	Location -	Bank Side -
Northing -	Easting -	Elevation - Datum -
Site Description -		

Tie-in Point 5	Location -	Bank Side -
Northing -	Easting -	Elevation - Datum -
Site Description -		

Figure A-2. Example of Stream Habitat Assessment Form 3a – Tie in Points.