

Cross-section
Particle Size Distribution
Stream Shading
Flow/ Velocity
Pools & Pool Tail Surface Fine Sediment

Stream Channel Morphology

Stream Channel Morphology

Cross-section

Bankfull Stage

(Core Attribute)

Importance:

The bankfull stage corresponds to the discharge at which channel maintenance is often the most effective. This discharge is a major factor in shaping channels sensitive to disturbance by management activities, such as gravel bed streams. The bankfull stage discharge is associated with a momentary maximum flow that has a recurrence interval of about 1.5 years (Dunne and Leopold, 1978).

Objective of this Attribute:

Identify bankfull stage in order to determine associated channel characteristics such as bankfull width, bankfull depth, and bankfull width-to-depth ratio. The location of bankfull stage is also important for stream classification.

How to Identify this Attribute:

The determination of bankfull stage should focus on the identification of the flat depositional surface adjacent to the stream channel that corresponds to the elevation of the floodplain. Depositional surfaces are most readily observed on low gradient streams but may be less evident in steep streams or in recently incised channels. When floodplains are not well defined, other indicators can serve as surrogates to identify bankfull stage. These include vegetation, changes in sizes of bank materials, and water stain or lichen lines on substrate. However, these must be used with care since specific indicators vary with stream type and geographical region. Vegetation, in particular, may exhibit regional differences. For example, the base of alders is an indicator of bankfull stage in some ecosystems, while willows indicate bankfull stage in others. Some perennial herbaceous plants that provide streambank stability, such as sedges, may extend below bankfull stage.

By using the presence of depositional surfaces as the conceptual underpinning, the identification of bankfull stage links directly back to the basic definition of bankfull discharge established by Leopold and Wolman (1964) which states, "Bankfull discharge is defined as that water discharge when stream water just begins to overflow into the active floodplain; the active floodplain is defined as a flat area adjacent to the channel constructed by the river and overflowed by the river at a recurrence interval of about two years or less."

Note: It is important that bankfull stage is correctly identified. To do so, a length of approximately 20 channel widths should be selected in the sensitive reach where representative bankfull stage locations can be identified and marked with survey flags. Locating bankfull stage should be done in fastwater habitat units using field indicators and, when available, regional curves of bankfull dimensions.

The USDA video and DVD for identification of bankfull stage is a helpful reference (USDA 1995).

Where to Identify this Attribute:

Identify bankfull stage at the following sites:

- 1) Start of sensitive reach (to determine large woody debris minimum length tally)
- 2) Particle size distribution transects
- 3) Cross-section locations
- 4) Width-to-depth/entrenchment locations

References:

Dunne and Leopold 1978

Harrelson et al. 1994

Leopold and Wolman 1964

USDA 1995

Cross-section

(Core Attribute)

Importance:

Channel cross-section measurements express the physical dimensions of the stream perpendicular to flow. They provide fundamental understanding of the relationships of width and depth, streambed and streambank shape, bankfull stage and floodprone area, etc. All of these are important attributes of channel condition and indicators of the health of aquatic and riparian ecosystems. Cross-section measurements also serve as essential criteria for stream classification. Monumented cross-sections are used to determine channel condition and trend since they can be monitored repeatedly.

Objectives of This Measurement:

Measure channel cross-section to determine indicators of channel condition. These include width/depth ratio, bank angle, channel shape, floodprone area, etc.

Measure cross-sections to establish permanent monitoring sites to determine change in channel condition over time.

How Many Measurements to Take:

Measure up to three cross-sections per sensitive reach, each within fast water habitat units. If there are more than three candidate sites for cross-sections within the sensitive reach, randomly select three. If there are three or fewer candidate sites measure them all. (In reaches with more than three candidate sites, the ones not selected for cross-sections will become candidates for width-to-depth and entrenchment measurements).

Where to Take the Measurement:

Identify candidate sites during the first pass along the sensitive reach. Flag and number each candidate site and record its distance from the start of the sensitive reach. Candidate sites are fast water habitat units in straight sections typical of the sensitive reach. Candidate sites must have clear bankfull stage indicators. Do not use pools as candidate sites.

Measure the cross-section at the widest point in the selected candidate site.

How to Take the Measurement:

The standard SCI method is described below and shown in Figure 1. It is designed to use lightweight gear so that cross-sections can be easily measured at remote sites as well as more accessible sites. It utilizes permanent site marking stakes, a string line and level, a measuring tape, engineering survey flags, and a depth rod. Alternately, a survey level and rod can be used following standard surveying techniques such as described in Harrelson, 1994.

Establish a horizontal measuring line across the channel between permanent end-point markers of sufficient stability, elevation, and distance from water's edge so they will not be washed out over time. End-point markers should be higher than two times maximum bankfull stage depth, preferably on a terrace or high bank (twice maximum bankfull stage depth approximates a 50-year flood). End-point markers are designated left pin (LP) and right pin (RP). The left pin is on the left bank facing downstream.

The horizontal measuring line must be a level, tight string line. The height of the string line on the end-point markers must be noted on the form so that future cross-section measurements are made at the same elevation. Place a measuring tape alongside the string line for reading distances at which depth measurements are taken across channel. Always start measurements at the left bank facing downstream.

Prior to taking depth readings, bankfull stage must be identified and marked. It must be the same elevation on both banks (the height from the string line down to bankfull stage must be identical). Bankfull stage cross-sectional area should be consistently similar at cross-section sites in the reach. If not, bankfull stage may not have been correctly identified. Compare the bankfull stage cross-sectional area measurements in the field as sites are measured to assure consistency.

Begin cross-section measurements at the left pin and end at the right pin. Take depth readings with rod at intervals representing 5-10 percent of total width measured, at all locations of significant slope changes across the channel, at bankfull stage, and at water's edge. Intervals may be at fixed widths where channel shape remains similar, but will be non-uniform across full width measured since certain points must be identified. As an example of the number of depth measurements to take, if a channel width is 10 m, 10% intervals yield 10 depth measurements and 5% intervals yield 20. Examples of significant slope changes in the channel include noticeable breaks between streambed and streambank, channel bars, terrace edges, large boulders, and undercut banks.

In the case of undercut banks, measure the depth at the top and bottom of the undercut and enough undercut widths to accurately depict the shape of undercut (see Figure 1). Record the depth and undercut widths on the datasheet. To determine the distance from the left bank, subtract the undercut width from the distance from left stake at the top of the undercut (TUC). It is important to record the cross-section point in the proper sequence so that the cross-section may be graphed. The sequence should be ordered so that a continuous line may be drawn from point to point depicting the cross-section profile. Plot the cross-section in the field and sketch the channel profile. Identify bankfull stage, water surface elevations, end-points, and undercut banks. Confirm the data accuracy and verify enough measurements were collected to provide a precise profile.

Make all measurements to the nearest 0.01 m.

Once depth measurements are completed, the measurements associated with cross-sections can be made. Gradient and entrenchment are measured using separate protocols. Width/depth ratio is calculated from data collected at the cross-section.

Permanent Identification:

- Cross-sections must be referenced with permanent monuments wherever monitoring change in stream morphology over time is desired. Permanent references include the following:
- Benchmarks – A benchmark should be a permanent feature near the cross-section and include a distance and bearing to the cross-section end-point markers. It should also include an elevation from the benchmark to the end-point markers. Refer to standard surveying protocol (Harrelson 1994). It is also helpful to take a bearing from one end-point marker to the other.
- Cross-section end-point markers – It is essential to install markers that will remain in place permanently. Rebar (about 1 m by 0.015 m sunk into the ground with only a short piece above ground) is a standard marker. Shorter rebar (i.e., 18") can sink into the ground as time goes on, or can be pulled out. Other marker options include angle iron or T-stakes. Wilderness cross-section markers may have to be unobtrusive, but are still essential since remeasurement is impossible without a permanent marker. End-point markers must be of sufficient stability, sufficient elevation, and distance from water's edge so they will not be washed out over time.
- Photographs – Photos are a key tool for relocating the cross-section site and showing change over time. Even with benchmarks and the cross-section's known distance upstream from the start of the sensitive reach, they often provide the best clue to relocating cross-section markers. At a minimum, four photo angles should be used:

upstream, downstream, and left and right banks. Additional photos are recommended if there are important details of the site to display, such as the end-point pins and the bankfull stage flags. All photos of cross-sections should be taken with the string line and/or tape in place for better depiction of the location.

- Georeference – GPS units can be used to identify the cross-section location. However, GPS accuracy limitations are such that GPS will not find the precise spot where end-point pins are located. Georeferencing, however, is a good tool for locating the cross-sections so they can be mapped. If cross-sections are georeferenced, the start and end-points of the sensitive reach should also be georeferenced.

Cross-section Remeasurement:

Remeasurement of cross-sections should be done over time when it is expected there may be changes in channel morphology. Frequency of remeasurement depends on a number of environmental and management variables. These can include change in management practices in the watershed upstream of the cross-section, staffing, and changes in channel form due to large storm events. However, it is recommended that cross-sections be remeasured frequently enough to respond to the management questions for which they were established. As a guide, a range of 2-5 years is recommended. More frequent measurements may be considered if measurable annual change is expected, or a large natural event has affected the watershed.

Procedure for remeasuring cross-sections is the same as for their establishment. However, the following points should be considered:

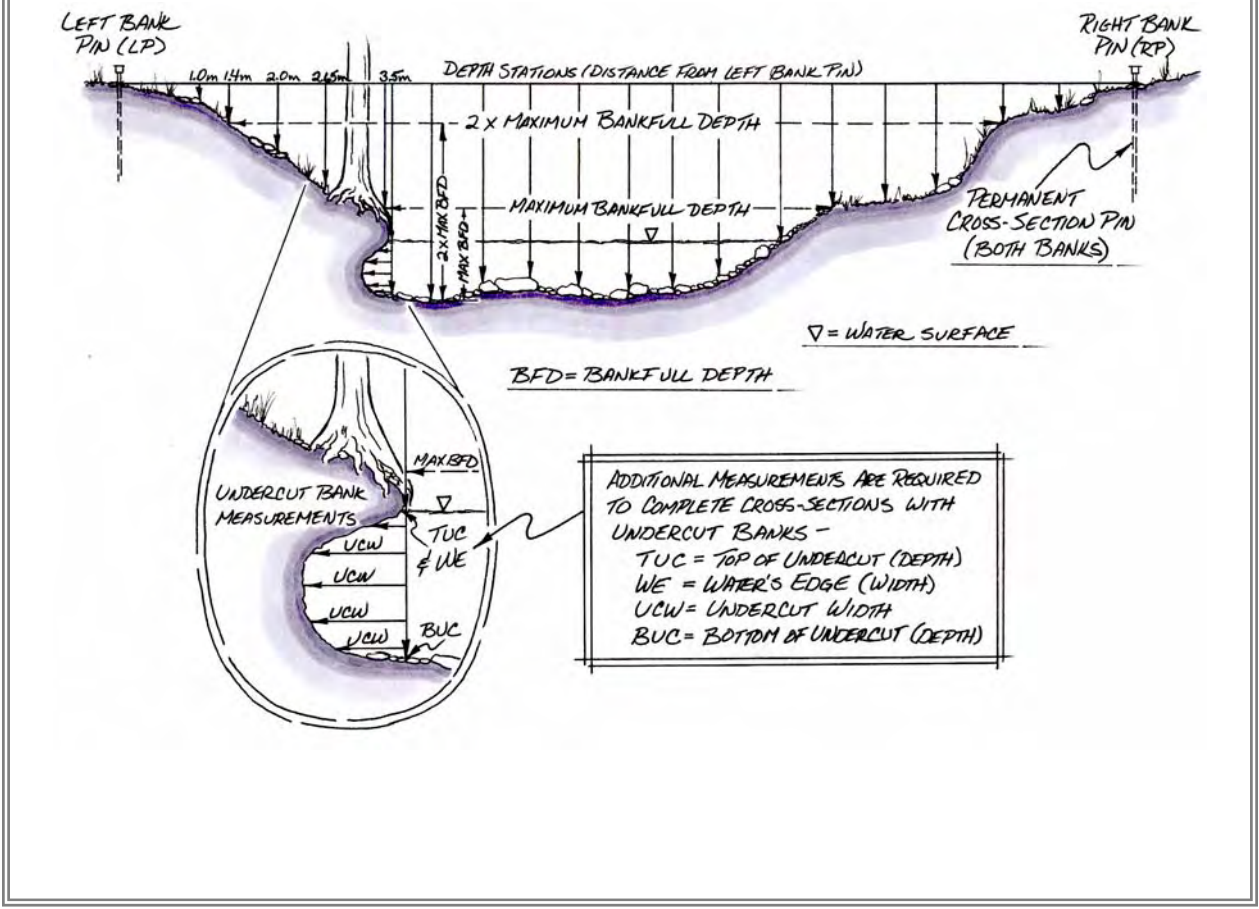
If the existing end-point markers are missing or appear to have been moved (i.e., bent or partially pulled up), establish new ones at the same site and consider it a new cross-section.

If the existing end-point markers were established lower than two times maximum bankfull depth, consider site factors to determine if they should be relocated higher (such as whether the present location appears to be subject to washing out). It is advisable to have the end-point markers above two-times maximum bankfull depth if practical to minimize them being dislodged or lost. When relocated higher, the original cross-section data are still usable if the existing end-point markers are in place. The only change is that additional height and width are added.

References:

Harrelson et al. 1994

--- CROSS-SECTION ---



ADDITIONAL MEASUREMENTS ARE REQUIRED TO COMPLETE CROSS-SECTIONS WITH UNDERCUT BANKS -

- TUC = TOP OF UNDERCUT (DEPTH)
- WE = WATER'S EDGE (WIDTH)
- UCW = UNDERCUT WIDTH
- BUC = BOTTOM OF UNDERCUT (DEPTH)

Figure 1 – Cross-section

Water Surface Gradient

(Core Attribute)

Importance:

Gradient of the stream surface is an essential element of many stream classification systems and a primary attribute for stratifying sensitive reaches in the R5 SCI database. In addition, knowledge of gradient helps provide understanding of the geomorphological processes shaping the channel.

Gradient must be measured in order to compare the reach with other reaches in the SCI database, and to help classify the reach stream type.

Objective of This Measurement:

To determine the water surface gradient in percent slope.

How Many Measurements to Take:

Three, one at each channel cross-section.

Where to Take the Measurement:

Gradient is measured at the channel cross-section location for a distance upstream and downstream that incorporates at least one pool-riffle or step-pool sequence. If such sequences are not present, measure the longest possible distance in order to represent the average gradient in the area of the cross-section.

How to Take the Measurement:

Distance between end-points upstream and downstream from the cross-section should be as long as practical. End-points should be located on the same channel feature (e.g. pool tail) and include as many pool-riffle or step-pool sequences as is practical. At least one pool-riffle or step-pool sequence must be included. In the case of streams where these sequences are not present or not easily identifiable, locate end-points that are as representative as possible of average gradient. Measure the distance, or “run,” between the gradient survey end-points along the thalweg. Determine the water surface elevation change, or “rise,” between the end-points. Divide rise by run and multiply by 100 to calculate gradient.

A hand level and tripod is the minimum tool for measuring gradient. More sophisticated surveying instrumentation such as a laser level may be used if available and practical. Do not use a monopod for mounting an instrument since it cannot be held steady. Lightweight camera tripods can be adapted to firmly hold a hand level. The lightweight tripod and hand level are often more practical in wilderness or other remote stream reaches.

If the end-point is difficult to see (i.e., vegetative obstructions, stream curvature, distance too far), the gradient measurement should be collected in increments. The gradient survey may be taken sighting upstream or downstream; if increments are needed to complete the survey, the instrument must be relocated or turned in place and sighted in the opposite direction.

There are two recommended general instrument locations for measuring gradient – In-stream and Off-stream:

In-stream Sighting:

To measure gradient with a single sighting (where the entire gradient “reach” can be observed without obstruction), the observer at the instrument places the tripod in the thalweg and attaches the level to the top of it (see Figure 2). The observer records the height of the instrument sight line and the height of the water surface above the streambed. The observer at the instrument sights through the level to an observer with a measuring rod

at the other end-point of the survey. The observer at the rod notes the height on the rod that is level with the height of the instrument. The observer at the rod records this height and the height of the water surface above the streambed.

To calculate the gradient reach rise, first subtract the water-surface height from the height of the instrument. At the rod end, subtract the water-surface height from the level height observed from the instrument. For example, when sighting upstream, if the instrument height is 1.5 m above the streambed and the water-surface height is 0.2 m, the difference is 1.3 m. If the rod level height is 1.1 m and its water-surface height is 0.3 m, the difference is 0.8 m. The water-surface slope elevation change between the survey end-points is 0.5 m (1.3 m - 0.8 m), or the rise. Note: for single in-stream sightings, viewing upstream is usually easier because it is easier to read the rod end when level height is lower than at the instrument.

To complete the gradient calculation, divide the rise by the run (the distance along the thalweg between the downstream and upstream measuring points) and multiply by 100 to obtain percent gradient. Using the above example over a 50 m length between end-points, $0.5 \text{ m}/50 \text{ m} \times 100 = 1\%$ gradient.

To measure gradient with a double in-stream sighting (upstream and downstream), place the instrument in the gradient reach where both end-points can be viewed without obstruction. Point the instrument at one end-point (i.e., back sight) and record level height on the rod and water height at the rod. Turn the instrument to the other end-point (i.e., foresight) and, with the rod relocated at that end-point, record level height on the rod and water height at the rod. Calculate the gradient reach rise and run in the same manner as described above to complete the gradient measurement.

Off-Stream Sighting:

Gradient measurements and calculations are done in the same manner as double in-stream sighting. The difference is that the instrument is placed outside the stream, often on a nearby floodplain or terrace. This method is most commonly done with a survey level so it is not subject to falling in the water.

Common to both sighting locations and methods is obtaining rise and run measurements. In some cases the single in-stream sighting may be the quickest. In other cases in-stream or off-stream double sighting, or even a series of double sightings may be the most practical (such as where visual obstructions or a transit is already on site).

Reference:

Harrelson et al. 1994

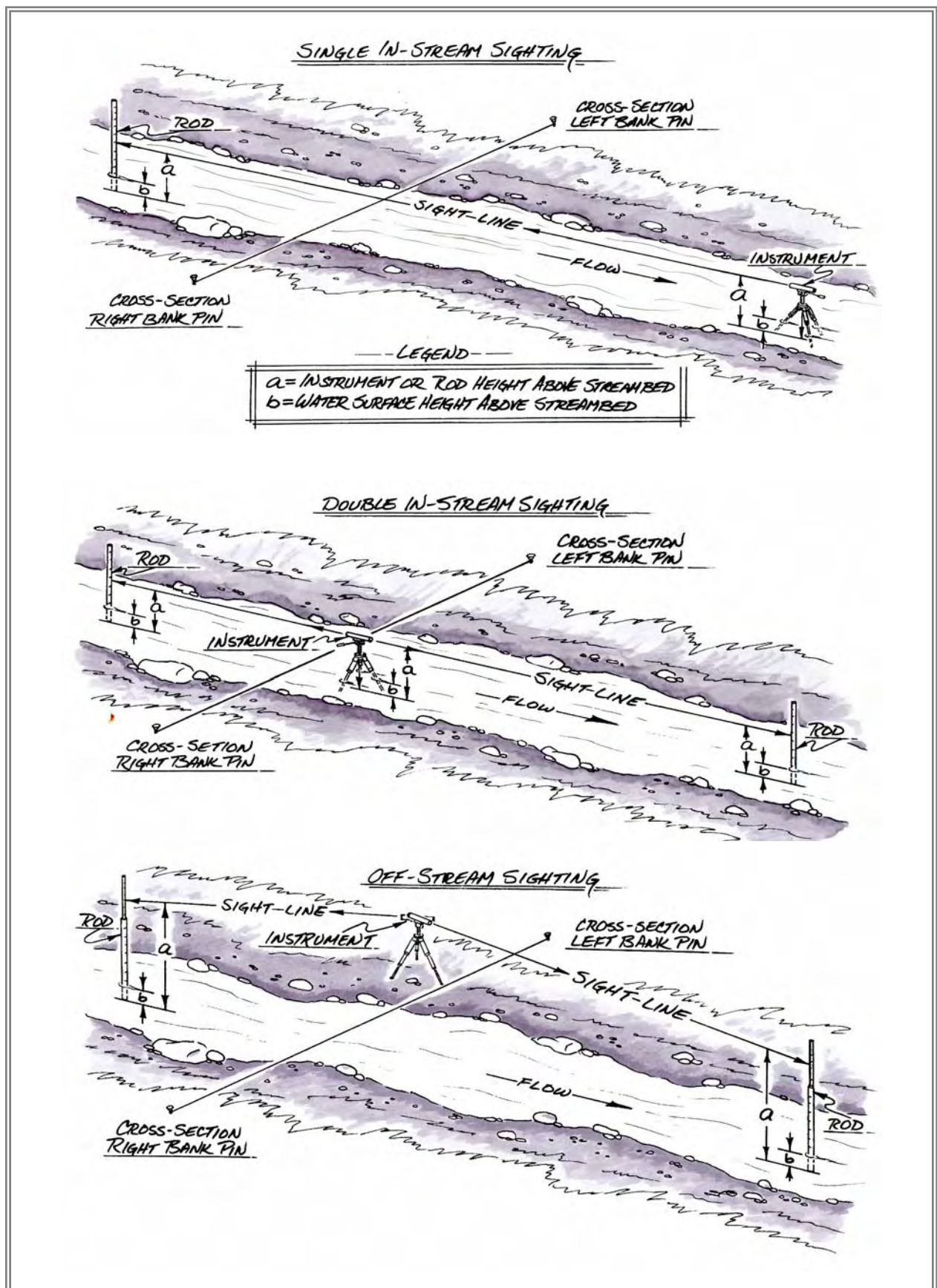


Figure 2 – Water Surface Gradient

Width-to-depth Ratio

(Core Attribute)

Importance:

Stream width-to-depth ratio is a key indicator of channel condition. A low width-to-depth ratio generally indicates good conditions for aquatic flora and fauna and riparian vegetation. Low width-to-depth ratios result in deeper water for aquatic species and a higher water table to support growth of riparian and meadow vegetation.

Objective of this Measurement:

Characterize stream morphology and aquatic habitat.

How Many Measurements to Take:

Take three measurements at the cross-sections and up to five additional measurements (depending on available candidate sites). For example, if there are seven remaining candidate sites after the cross-sections have been selected, randomly select five additional sites for width-to-depth measurements. If there are fewer than five remaining, measure them all.

Where to Take the Measurement:

Randomly select up to five sites from among the remaining cross-section candidate sites after the three cross-section sites have been selected. Candidate sites are in fast water habitat units in straight sections typical of the sensitive reach. Do not take width-to-depth measurements in other habitat types (i.e., pools).

How to Take the Measurement:

Width-to-depth measurements are taken at the same time as entrenchment measurements.

Once bankfull stage has been identified, stretch a measuring tape between bankfull stage flags. Starting at bankfull stage on the left bank, take a minimum of 10 depth measurements before reaching bankfull stage on the right bank. Include the thalweg, water's edge, and major slope changes in the channel cross-section. Take depth measurements at intervals that result in a representative sample of bankfull depths.

Make all measurements to the nearest 0.01 m.

Bankfull stage cross-sectional area should be consistently similar at width-to-depth sites in the reach. If not, bankfull stage may not have been correctly identified. Compare the bankfull stage cross-sectional area measurements in the field as sites are measured to assure consistency.

To calculate the mean depth, the total number of depth measurements should be divided by $n+1$, in order to account for the zero depths at the streamshore. For example, if 10 depth measurements are taken, divide the sum of those 10 depth measurements by 11.

Document the presence of undercut banks (UC) in the notes column on the data sheet but disregard computing undercuts when measuring width-to-depth ratio. It is beyond the scope of this attribute to assess undercut area and in, most cases, undercuts have a negligible effect on the width-to-depth ratio.

References:

Bauer and Burton 1993

Platts 1987

Rosgen 1996

Cross-section Diagram and Location Sketch (collected from sensitive reach)

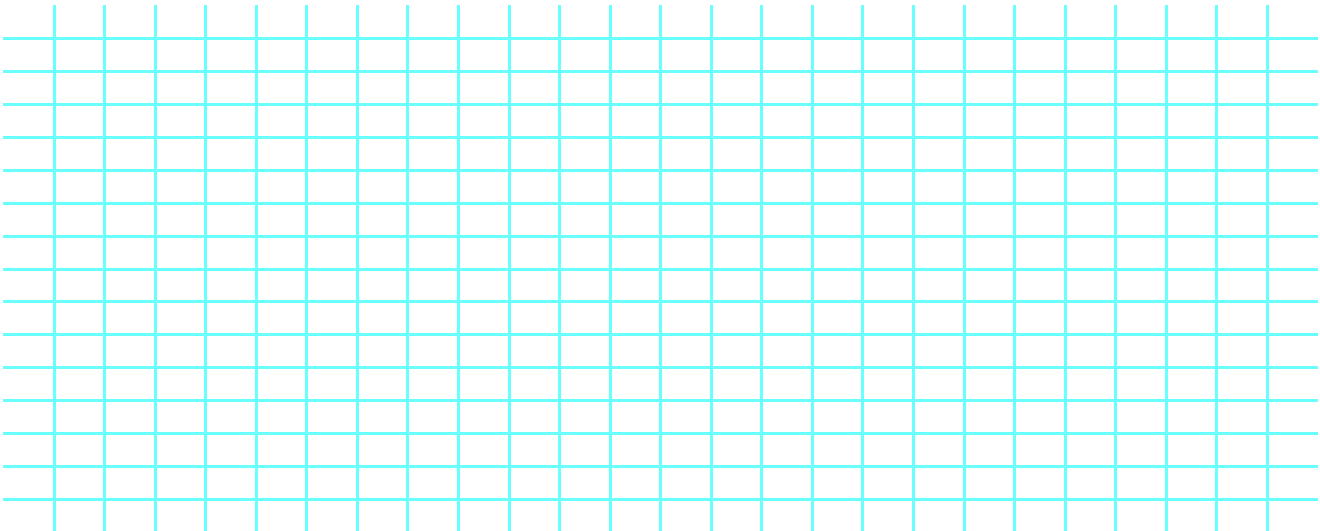
Forest/National Park/Other Ownership:

District:	Observers:
Stream:	
Reach #:	Date:
Cross Section #:	Distance From Start of Sensitive Reach:

Cross-section Diagram

Left Bank

Right Bank



Cross-section Location Sketch

Sketch stream channel and flow direction; benchmark location, left and right pin location, north arrow, and natural features that help ID site (i.e., large boulders or large trees). Record benchmark and pin data below sketch. Record bearings in degrees magnetic north.

BM Type:	Bearing: BM To LP	Distance: BM to RP	BM: UTME
LP Type:	Distance: BM to LP	Distance: LP to RP	BM: UTMN
RP Type:	Bearing: BM To RP	BM: Way pt.#	BM: Zone

Stream Channel Morphology

**Particle Size
Distribution**

Particle Size Distribution

(Core Attribute)

Importance:

Streambed materials are key elements in the formation and maintenance of channel morphology. These materials influence channel stability, resistance to scour during high flow events, and also act as a supply of sediment to be routed and sorted throughout the channel. The amount and frequency of bedload transport can be critically important to fish spawning and other aquatic organisms that use stream substrate for cover, breeding, or foraging.

Particle size distribution can change over time as a result of management activities and/or natural disturbances. Detecting change is important for making decisions related to managing aquatic communities and ecological processes.

Objective of This Measurement:

Detect status and change of streambed particle size distribution.

How Many Measurements to Take:

Conduct a particle count of 100 particles in each of the four riffles sampled for macroinvertebrates, for a total count of 400 particles in the sensitive reach.

Where to Take the Measurements:

Take the particle count in the four riffles sampled for macroinvertebrates (see Macroinvertebrate protocol). Measure and record the distance upstream from the start of the sensitive reach to the lower end of each riffle, and the length of each riffle.

Measurement is conducted on the stream bottom so that the streambed is sampled without incorporating bank materials. The stream bottom is the area of the stream that is practically bare of vegetation caused by the wash of waters of the stream from year to year. It is therefore at a level less than bankfull stage and excludes streambanks.

Riffles are the preferred sampling location for detecting change since they have a relatively homogenous particle size composition. This reduces sampling variability and makes it more likely to detect change than by sampling different habitat types (i.e. pools, runs). The objective of this procedure is to compare riffle particle size distribution over time and between reaches.

The riffle particle count may be suitable for reach characterization. Although the riffle D50 is likely to be different than a count across habitat types, it will usually be in the same particle category. Where a reach characterization across habitat types is desired, a different protocol should be employed.

How to Take the Measurements:

At each riffle, locate ten equally spaced transects perpendicular to the main axis of the channel. Proceed across the transect and count 10 particles at evenly spaced intervals. The minimum distance between sample points should not be less than the size of the largest particle in the riffle. (Note: where an anomalously large particle is present use the largest dominant particle size in the riffle. For example, if a riffle is 70% gravel and 30% cobble but has one very large boulder, use the largest cobble as the minimum spacing guide).

Record each particle on the data form in the "wet" or "dry" column to denote whether it is within or outside the wetted width of the channel at the time of the particle count. This allows analysis of the particle size distribution for the macroinvertebrate sample (in the wetted area) as well as the entire channel. To select an individual particle for measurement,

reach down over the tip of the boot while averting the eyes. Collect the first particle touched by the tip of the index finger. Use a gravel template to measure the intermediate axis size class of the particle. A class-defined ruler may be used if a gravel template is unavailable but care should be taken to determine the correct size class. Sizes larger than 180 mm, or particles that cannot be extracted from the streambed, need to be measured with a ruler. For gravel-bed streams, tally particles smaller than 2 mm in size into a class defined as "<2 mm" because particles smaller than this are difficult to representatively sample. If a large proportion of the count (approximately more than 50%) is less than 2mm in size, volumetric sampling is suggested.

The particle count procedure varies for very small streams. Some reaches may be so narrow that 10 particles cannot be collected between streambanks while maintaining intervals greater than the largest particle size between sample points. In steeper, small stream systems, suitable riffle substrate for macroinvertebrate collections may be limited. Collection of macroinvertebrate samples may disturb (and remove) some or most of the substrate, making subsequent particle counts impossible. In these cases, the following technique will be employed. At each macroinvertebrate site (typically pool tails rather than true riffles) alternatively collect 12 or 13 particles for measurement using the following systematic approach. Within the macroinvertebrate sampler frame, superimpose an imaginary 3x4 grid. At each of the grid sample points, select a particle as per the "toe point" method. Wash the particle as per the macroinvertebrate collection procedure, then place the rock in a bucket for subsequent measurement. If 13 particles are to be collected, select the 13th particle from the center of the sample area. By collecting 12 particles from four samples and 13 particles from four samples, a total of 100 particles are collected from the eight macroinvertebrate sample locations. Measure and record the length of the intermediate axis of all particles collected.

Vendor Information – Gravel Template

Federal Interagency Sedimentation Project (FISP)

US SAH-97 Gravelometer

Phone (601) 634-2721

www.stream.fs.fed.us/news/streamnt/oct97/oct97a5.html

References:

Bunte and Abt 2001

Harrelson 1994

Potyondy 2003

Wolman 1954

Particle Size Distribution

Stream Name: _____

Observers: _____

Date: _____

Reach #: _____

<(mm)	< in	< Ft	Particle	Tally		Total # (wet)	Total # (dry)	% Total	Cum % Total
				Dry	Wet				
2	0.08	-----	Fines						
2.8	0.11	-----	V Fine Gravel						
4	0.16	-----	V Fine Gravel						
5.6	0.22	-----	Fine Gravel						
8	0.31	-----	Fine Gravel						
11	0.43	-----	Med Gravel						
16	0.63	0.05	Med Gravel						
22.6	0.89	0.07	Coarse Gravel						
32	1.26	0.10	Coarse Gravel						
45	1.77	0.15	V. Coarse Gravel						
64	2.52	0.21	V. Coarse Gravel						
90	3.54	0.30	Small Cobble						
128	5.04	0.42	Small Cobble						
180	7.09	0.59	Large Cobble						
256	10.08	0.84	Large Cobble						
512	20.16	1.68	Small Boulder						
1024	40.31	3.36	Med Boulder						
2048	80.63	6.72	Large Boulder						
> 2048	>80.6	13.33	V Large Boulder						
Solid	Solid	Solid	Bedrock						

Particle Size Distribution

Stream Name: _____

Observers: _____

Date: _____

Reach #: _____

<(mm)	< in	< Ft	Particle	Tally		Total # (wet)	Total # (dry)	% Total	Cum % Total
				Dry	Wet				
2	0.08	-----	Fines						
2.8	0.11	-----	V Fine Gravel						
4	0.16	-----	V Fine Gravel						
5.6	0.22	-----	Fine Gravel						
8	0.31	-----	Fine Gravel						
11	0.43	-----	Med Gravel						
16	0.63	0.05	Med Gravel						
22.6	0.89	0.07	Coarse Gravel						
32	1.26	0.10	Coarse Gravel						
45	1.77	0.15	V. Coarse Gravel						
64	2.52	0.21	V. Coarse Gravel						
90	3.54	0.30	Small Cobble						
128	5.04	0.42	Small Cobble						
180	7.09	0.59	Large Cobble						
256	10.08	0.84	Large Cobble						
512	20.16	1.68	Small Boulder						
1024	40.31	3.36	Med Boulder						
2048	80.63	6.72	Large Boulder						
> 2048	>80.6	13.33	V Large Boulder						
Solid	Solid	Solid	Bedrock						

Particle Size Distribution

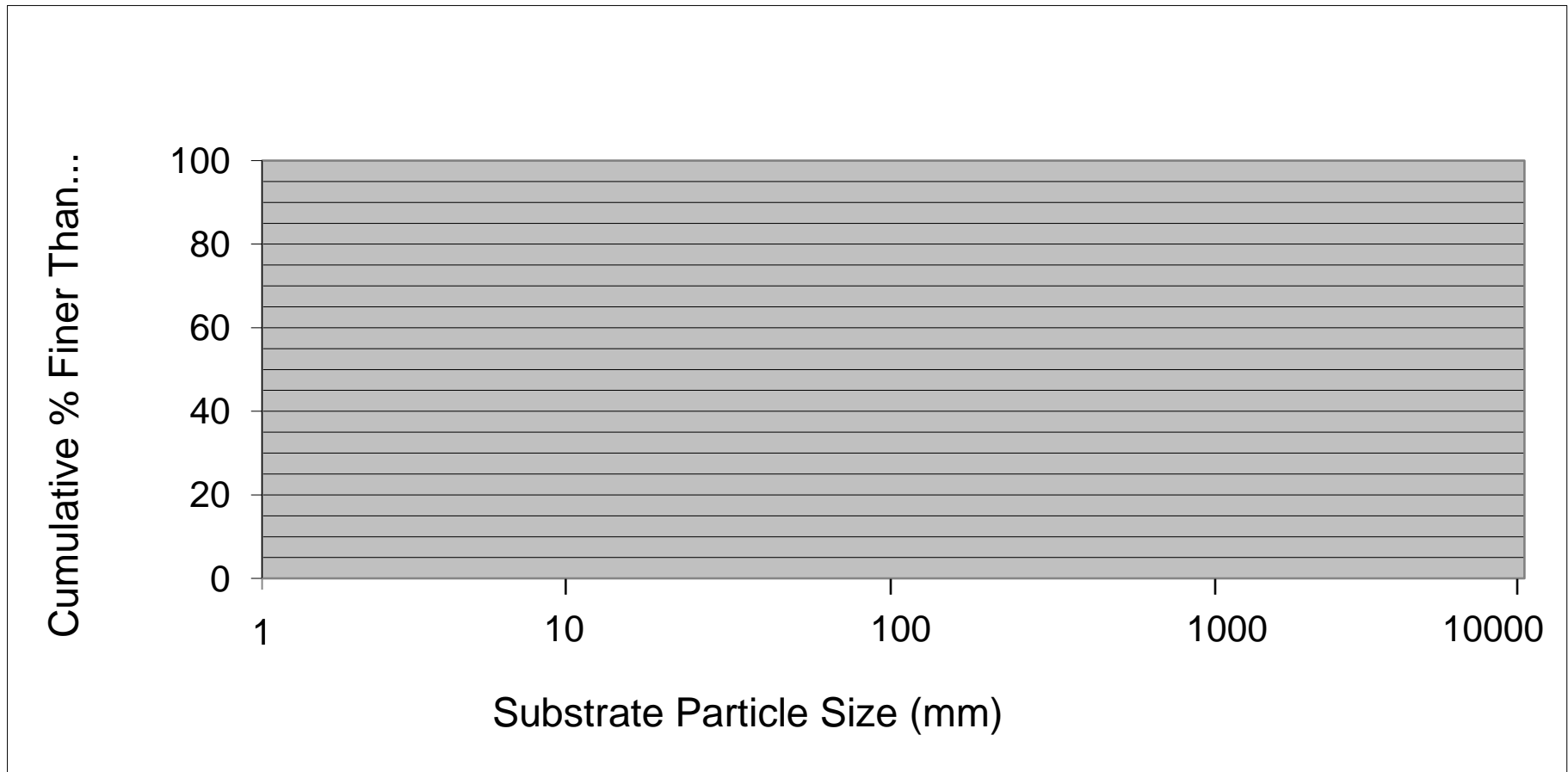
Stream Name:

Observers:

Date:

Reach #:

Use graph below... Cumulative %	Finer than... (mm)
D95=	
D84=	
D50=	
D35=	
D16=	
D5 =	



Stream Channel Morphology

Stream Shading

Stream Shading

(Core Attribute)

Importance:

Stream temperature has impacts on the health, behavior, and survival of aquatic organisms and is strongly influenced by streamside shading. Streamside vegetation is a primary source of energy to most streams. Manipulation of riparian vegetation that affects shade to aquatic systems is a key Forest Service management concern.

Objective of This Measurement:

Determine the average canopy cover in the survey segment.

How Many Measurements to Take:

Fifty, one at each transect.

Where to Take the Measurement:

At mid-wetted width of the channel, approximately 0.3 m (12") above water surface.

How to Take the Measurement:

Stream shading is measured using a Solar Pathfinder. At each sample location, level the instrument facing south at a height of approximately 0.3 m above the water surface. Before taking measurements, make sure that the declination on the pathfinder is correct, and that the path for the appropriate latitude is on the pathfinder. Look for the reflection of the sky and objects providing shade (trees, ridges, etc.) on the instrument dome, as viewed from no more than 15 degrees from vertical, at a distance between 0.3 (12") and .45 m (18").

Use the August sun path. Add the shaded sections along the sun path to yield the percent shade for each sample. When totaling the shade numbers, observe the portion of each section that is shaded. Consider fractions of individual sections, i.e. if half of a "6" section is shaded, record "3"; if 2/3 of "3" section, record "2," etc. Document the total number on Form 9. See Figure 6.

Tips for Using Pathfinder:

Glare from the sun can severely affect the observer's ability to read shade values. It may be helpful to hold a clipboard or hand above the pathfinder in a position that reduces glare while still allowing shade to be observed.

Vendor Information – Solar Pathfinder

Solar Pathfinder
3680 HWY 438
Centerville, TN 37033
(931) 593-3552
Solarpathfinder.com

Reference:

Platts et al. 1987

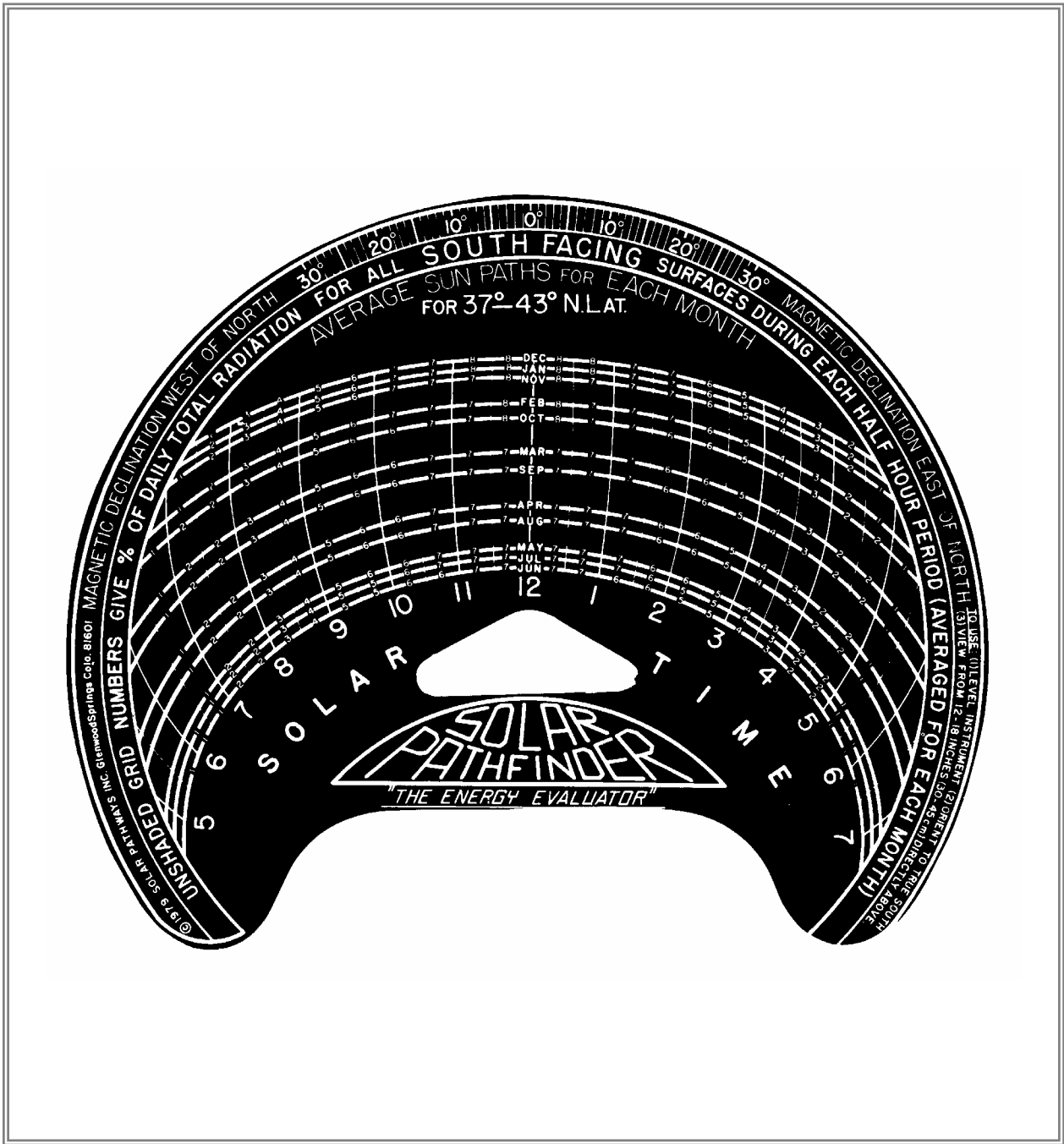


Figure 6 – Solar Pathfinder Sun Path

Stream Shading

Stream: _____

Observers: _____

Date: _____

Reach #: _____

Site	GPS every 20 m	Lux	Densiometer	% Shade (* overstory density)	Solar Pathfinder	% Total Shade
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						

* # Sun x 1.04 = % overhead not occupied by canopy(n/o) --> 100 - % n/o = % overstory density

Stream Shading

Stream: _____

Observers: _____

Date: _____

Reach #: _____

Site	GPS every 20 m	Lux	Densiometer	% Shade (* overstory density)	Solar Pathfinder	% Total Shade
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						

* # Sun x 1.04 = % overhead not occupied by canopy(n/o) --> 100 - % n/o = % overstory density

Stream Shading

Stream: _____

Observers: _____

Date: _____

Reach #: _____

Site	GPS every 20 m	Lux	Densiometer	% Shade (* overstory density)	Solar Pathfinder	% Total Shade
71						
72						
73						
74						
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
91						
92						
93						
94						
95						
96						
97						
98						
99						
100						
101						
102						
103						
104						
105						

* # Sun x 1.04 = % overhead not occupied by canopy(n/o) --> 100 - % n/o = % overstory density

**USDA Forest Service Pacific Southwest Region
Stream Condition Inventory (SCI)**

**Field Form #9
Page 1 of 2**

Streambank Stability, Stream Shading, Streamshore Water Depth,
Streambank Angle and Aquatic Fauna (collected from survey segment)

Forest/National Park/Other Ownership:	
District:	Observers:
Stream:	
Reach #:	Date:
Transect Interval (m): _____	

Bank	L	R	L	R	L	R	L	R	L	R
Transect #	1		2		3		4		5	
Stability Rating ¹										
Shading ²										
Shore Depth ³										
Bank Angle ⁴										
Aquatic Fauna ⁵										
Transect #	6		7		8		9		10	
Stability Rating										
Shading										
Shore Depth										
Bank Angle										
Aquatic Fauna										
Transect #	11		12		13		14		15	
Stability Rating										
Shading										
Shore Depth										
Bank Angle										
Aquatic Fauna										
Transect #	16		17		18		19		20	
Stability Rating										
Shading										
Shore Depth										
Bank Angle										
Aquatic Fauna										
Transect #	21		22		23		24		25	
Stability Rating										
Shading										
Shore Depth										
Bank Angle										
Aquatic Fauna										

1 - Stability Rating: #1 >75% cover, #2 >75% cover with instability elements (cracking, bank failure, etc.), #3 <75% cover.

2 - Record to nearest percent (i.e., 38)

3 - Record only on reaches with gradient < 2%, to nearest 0.01 m (i.e., 0.12). If bank angle is > 90 degrees, shore depth is zero.

4 - Record only on reaches with gradient < 2%, to nearest degree (i.e., 75, 120)

5 - Record 4-character code for herptofauna (Apx. E) and numeric code for fish (Apx. F). Put remarks on Form 10.

Note: circle all estimated values.

**USDA Forest Service Pacific Southwest Region
Stream Condition Inventory (SCI)**

Streambank Stability, Stream Shading, Streamshore Water Depth,
Streambank Angle and Aquatic Fauna (collected from survey segment)

Forest/National Park/Other Ownership:	
District:	Observers:
Stream:	
Reach #:	Date:

Bank	L	R	L	R	L	R	L	R	L	R
Transect #	26		27		28		29		30	
Stability Rating ¹										
Shading ²										
Shore Depth ³										
Bank Angle ⁴										
Aquatic Fauna ⁵										
Transect #	31		32		33		34		35	
Stability Rating										
Shading										
Shore Depth										
Bank Angle										
Aquatic Fauna										
Transect #	36		37		38		39		40	
Stability Rating										
Shading										
Shore Depth										
Bank Angle										
Aquatic Fauna										
Transect #	41		42		43		44		45	
Stability Rating										
Shading										
Shore Depth										
Bank Angle										
Aquatic Fauna										
Transect #	46		47		48		49		50	
Stability Rating										
Shading										
Shore Depth										
Bank Angle										
Aquatic Fauna										

1 - Stability Rating: #1 >75% cover, #2 >75% cover with instability elements (cracking, bank failure, etc.), #3 <75% cover.
 2 - Record to nearest percent (i.e., 38)
 3 - Record only on reaches with gradient < 2%, to nearest 0.01 m (i.e., 0.12). If bank angle is > 90 degrees, shore depth is zero.
 4 - Record only on reaches with gradient < 2%, to nearest degree (i.e., 75, 120)
 5 - Record 4-character code for herptofauna (Apx. E) and numeric code for fish (Apx. F). Put remarks on Form 10.
 Note: circle all estimated values.

Stream Channel Morphology

Flow/ Velocity

Flow Fact Sheet

What is Flow?

Stream *flow*, or discharge, is the amount of water that moves past a fixed point during a given period of time. Flow may be described in terms of different time scales:

- . *Instantaneous Flow* is a single measurement at one place at one time.
- . A *hydrograph*, or record of changing flow for a selected period of time, is developed from repeated measurements at one location. Hydrographs may be determined in various ways: for a single storm or span of time such as individual years or seasons, or as statistical averages of many storms, years or seasons.
- . *Flow regime* refers to patterns in a stream's hydrographs, whether natural or the result of human activities. Characteristics of flow regimes that might be important for stream assessment include annual peaks or lows, duration of peaks or lows, and average time between recurrences of a particular size storm.

Why is Flow Important?

Flow is linked to conditions throughout the watershed (the area of the earth's surface from which water runs toward the stream, above the measurement site). Flow affects many aspects of aquatic systems at all of the above time scales:

Instantaneous Flow

- . Wetted area of stream and amount of aquatic habitat present
- . Increased or decreased numbers of organisms that prefer certain velocities
- . Aeration of water, amount of dissolved oxygen available for aquatic organisms
- . Stability and level of water temperature
- . Dilution of pollutants entering the creek

Hydrograph for storm events

- . Frequency and extent of flooding
- . Dislodging of flow-sensitive organisms or microhabitat structures
- . Distribution and transport of pollutants along the creek
- . Erosion and movement of sediment from creek bed and banks

Flow Regime

- . Seasonal or annual water supply to stream and surrounding riparian zone
- . Flushing that reduces silt or debris clogging some habitats, e.g. spawning gravel
- . Groundwater recharge
- . Requirements of animals and plants at different ages during their life cycles
- . Long-term channel-forming processes such as downcutting or siltation

How is Flow Measured?

Instantaneous Flow

While there are only a few basic approaches to measuring flow, many variations have been developed for varying objectives and in response to the wide range of field conditions encountered. Below are a few common approaches and variations:

Direct measurement

- . Measure time required to fill a container of known size
- . Variations: use aprons, weirs and other temporary structures to direct flow and improve its capture in the container

Calculation from separate measurements of velocity and cross-sectional area

- . Measure water depth at several points on a transect across the stream and calculate cross-sectional area; take a corresponding velocity measurement at some or all points, using a current meter or floating object. Variations include:
 - . use of weirs or temporary structures to alter cross-section to be more convenient for measurement
 - . surveying the channel shape in advance; measuring water depth and using its relationship to the channel cross-section to calculate wetted cross-section.
 - . using repeated measurement of velocity and area at a range of different water depths at the same location as a basis for estimating instantaneous flow for other water depths
 - . using other characteristics such as "hydraulic jump" or channel slope and roughness to estimate velocity.

Tracer

- . Calculate flow by placing a dye, salt or other substance in the creek and monitoring its passage at a point farther downstream.

Continuous flow monitoring to characterize hydrographs and flow regime

Automated stations are frequently used to record flow observations at regular time intervals for extended periods. These stations usually convert water depth measurements to flow using the principles of the velocity-area method described above.

Qualitative assessments

This category includes a variety of observations that usually relate the discharge to channel features. An example is included in the Visual Assessment SOP 5.2.1. Such techniques may be useful for preliminary evaluations of flow as a component of habitat (e.g. "is there potential for the velocity or volume of water to prevent fish passage?").

What Affects Flow in Streams and Rivers?

Natural Factors

- . The amount and timing of rainfall or snowfall in the watershed
- . Watershed size and topography (whether the ground is hilly or flat; the steepness, location and orientation of sloping areas)
- . Geology and soil characteristics throughout the watershed
- . Shape and size of the stream channel and the adjacent floodplains
- . Height of the underground water table and movement of groundwater
- . Logs and other debris in the channel
- . Suspended sediment in the water
- . Vegetation: amount and type growing in the watershed, channel and floodplain
- . Evaporation and evapotranspiration (water taken up by plants from the ground)

Human Factors

- . Dams
- . Diversions or pumping of water into or out of the stream
- . Impervious surfaces on parts of the watershed (roads, sidewalks, buildings, etc.)
- . Alterations to channel and floodplain, installation of culverts or other structures
- . Alteration of water table by wells or groundwater pumping
- . Litter and debris which clogs pipes and culverts

What are the Water Quality Objectives¹ for Flow?

Water quality objectives for flow vary from region to region. Check with the Regional Water Quality Control Board in your area. Although many Regional Boards may not include numerical flow objectives in their Basin Plans, they can also address the effects of flow on beneficial uses of waterbodies through permitting or other activities.

Other agencies that may establish flow objectives for individual streams include:

- . DWR and local water suppliers
- . CDFG, USFWS and NMFS (as an important aspect of habitat, especially for threatened or endangered species)
- . FERC (for licensing of dams and dam operations)
- . CALFED (in regard to inflows to the Delta and San Francisco Bay)
- . USGS

¹ A water quality objective is a law or regulation that consists of the beneficial designated use or uses of a waterbody, the numeric and narrative water quality criteria that are necessary to protect the uses of that particular waterbody and an antidegradation statement.

Sources and Resources

This Fact Sheet is implemented by the Clean Water Team (CWT), the Citizen Monitoring Program of the California State Water Resources Control Board. This Fact Sheet has been authored by Arleen Feng, Neil Berg, and Mark Abramson, members of the Flow work-group of the 2000-2001 Technical Advisory Council for Citizen Monitoring. The original fact sheet is presented, without any revisions.

Please contact your Regional CWT Coordinator for further information and technical support. For an electronic copy, to find many more CWT guidance documents, or to find the contact information for your Regional CWT Coordinator, visit our website at www.swrcb.ca.gov/nps/volunteer.html

If you wish to cite this FS in other texts you can use "CARCD 2001" and reference it as follows:

California Association of Resource Conservation District (CARCD). (~2001). Flow Fact Sheet. in: Guidelines for Citizen Monitors: Products of the 2000-2001 Technical Advisory Council on Citizen Monitoring. Prepared in collaboration with the Wild On Watershed Program and the Clean Water Team for the Citizen Monitoring Program of the State Water Resources Control Board, Sacramento, CA.

Discharge

The surface areas of the wetted channel and individual habitat units change with discharge, so measured values are highly dependent on the amount of water flowing in the channel at the time of the survey. This methodology is designed to be applied during relatively stable flow conditions characteristic of the summer low flow period. Surveys should not be conducted during periods of high water associated with summer storms, during extreme low base-flow conditions when sections of typically perennial streams are dry, or during periods of rapidly fluctuating discharge.

Discharge should be measured at the time you begin the survey each segment and recorded on the habitat unit survey form. If discharge changes significantly during the time the segment is being surveyed, additional discharge measurement should be taken and recorded on subsequent survey forms.

In order to obtain comparable data, future surveys of the same segment should be conducted at a discharge similar to the discharge at the time of the original survey. At this time, the sensitivity of the methodology to changes in discharge has not been determined. Pending further analysis we recommend that discharge at the time of repeat surveys be within 10% of the discharge during the original survey.

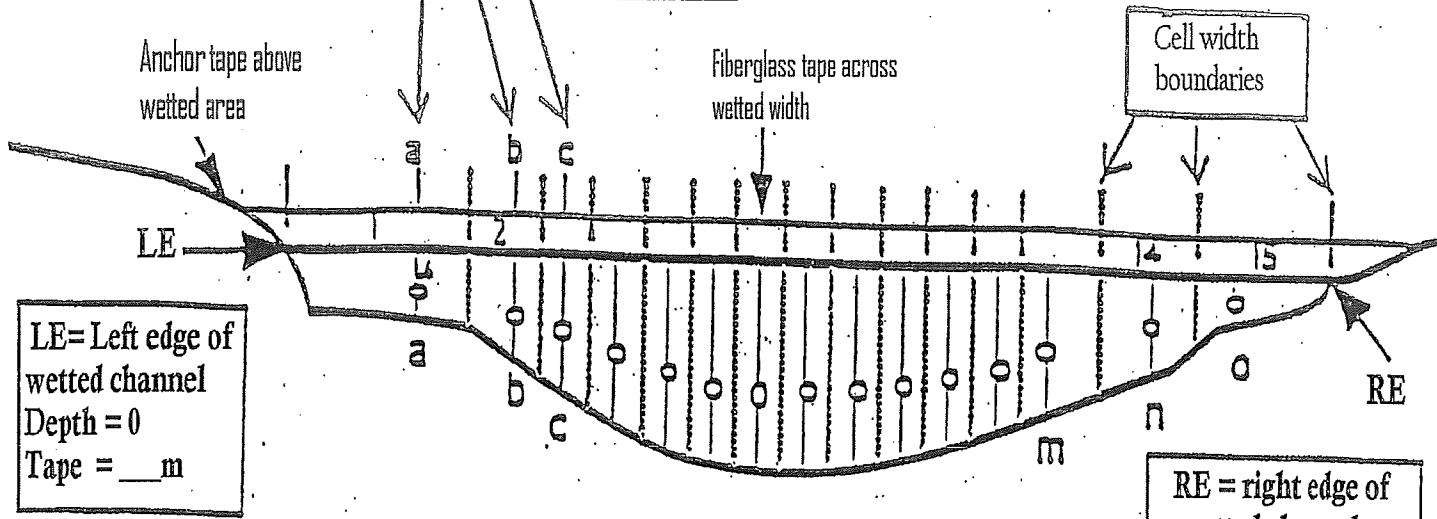
Discharge should be determined using standard stream flow measurement methods. First, select a suitable location (within the segment being surveyed) with adequate depth and smooth, laminar flow.

A suitable site should not have flow diversions, side-channels, or undercut banks. It should be relatively free of turbulence and flow obstructions such as large rocks, logs, and aquatic vegetation.

Stretch a fiberglass tape across the wetted portion of the stream channel and perpendicular to the direction of flow (Figure 1). Attach each side of the tape securely. Note the distance on the tape corresponding to the water's edge on each side of the stream. Assemble your flow meter, attach it to the wading rod, and test it.

DOWN STREAM VIEW

Stations:
location noted on tape where depth and velocities are taken



LE = Left edge of wetted channel
Depth = 0
Tape = ___ m

RE = right edge of wetted channel
Depth = 0
Tape = ___ m

Cell Width:

Edge cells - distance from wetted edge to first station + 1/2 the distance to the next station
for example: cell 1 = LE - a + 1/2 a - b
cell 15 = 1/2 n - o + o - RE

Middle cells - split the difference between stations
for example: cell 2 = 1/2 a - b + 1/2 b - c
cell 14 = 1/2 m - n + 1/2 n - o

Velocity:

Station depth of water < 2.5 ft / .6m:
take one velocity at .6 of depth (from surface) at stations

Station depth > 2.5 ft / .6m:
take velocities at .2 and .8 of depth at stations and average together

NOTE: To capture high flow areas of stream take smaller cell measurements in those locations.

Cell Discharge = Cell Width X Cell Depth X Cell Velocity

Stream Discharge = The sum of all cell discharges

Average cell depth:
Depth at station from surface of substrate to stream's surface

DISCHARGE MEASUREMENT

Stream Velocity and Stream Flow

Stream flow is measured as the volume of water that passes a given area in a unit of time. It is typically measured in cubic feet per second (cfs).

Equipment & Supplies

5 gallon bucket

Flourisine dye or other floatable object as an orange, orange peel or a pine cone

Measuring tape

Stop Watch

Velocity #1- (floating method) – Find a relatively straight uniform section of channel (approximately 6-10 feet long) and measure and mark the length of this section. Float an orange, orange peel, pine cone, stick or flourisine dye from just above the reach begin timing the transport of the floated material from the beginning of the reach to the end. Record this time and repeat until a consistent average time is established. Divide the length of the reach by the average time recorded for the floated material to pass through this section. This is the velocity of the stream in feet per second.

Velocity #2- (hydraulic jump method) – Hold a ruler or stadia rod in the water and record the change in the height of the water above the water surface (where the water hits the rod), this measurement is known as the hydraulic jump. The equation to calculate velocity based on hydraulic jump is $v=(2gh)^{1/2}$ where v = velocity in feet per second, g = gravity constant of 32 ft per sec², and h = hydraulic jump (ft).

Velocity #3 - (Pygmy current meter method)- See Form.

Other methods are also available for measuring velocities but are not discussed further here.

Stream Flow -Method #1 (based on average velocity) – To determine the flow, multiply the velocity by the cross sectional area of the channel. [X-sectional Area(sq. ft) x velocity (ft per sec)]=stream flow (cubic ft per second or cfs).

The plot of the streams cross-sectional profile can be utilized to determine the cross-sectional area of the stream. When plotted on a grid, the squares of the graph are counted for the area that falls below the left and right waters edge, the area can easily be determined. Make sure the velocity measurement is taken at the same cross-section. Or if the velocity measurements are made at another uniform section of channel that is roughly rectangular measurements of average width (ft) and depth (ft) can be made to estimate a x-sectional area. The flow calculation can then be made by multiplying this area by the velocity.

Stream Flow-Method #2 (direct measurement) - One of the quickest simplest methods is taken in low flow channel as culvert stream x-ings. Using a 5 gallon bucket (0.6685 ft³), time how long it takes the bucket to fill with water draining from the downstream end of the culvert. Take at least 3 readings and average the time. By dividing 0.6685 ft³ by the average time (in seconds) the actual flow in cfs is determined.

Stream Flow-Method #3 (Mannings Equation) - Use the Stream channel cross-sections to determine the cross-sectional area and the wetted perimeter count off of the graph. Apply these values to the equations and follow the directions on the streamflow forms.

Using indicators of bankfull stage repeat the exercise to determine the flow at bankfull. Repeat these measurements again for any areas where evidence of high flow is noted on the surveys.

Stream Velocity

Stream Name: _____ Site #: _____
 Date: _____ Time: _____
 Observer(s): _____

Average Velocity: V= _____ fps

1) Stream Velocity- Floating method

(Using a relatively straight, and uniform section of channel.)

Length of Reach: _____ ft
 Time (1): _____ sec.
 Time (2): _____ sec
 Time (3): _____ sec
 Average Time: _____ sec
 Velocity = Length (ft) / Ave Time (sec) : _____ fps

2) Stream Velocity-Hydraulic Jump method

$$v = (2gh)^{1/2}$$

h=hydraulic jump (ft)

h= _____ units-->convert to ft

g=gravity constant =32 ft per second sq

v=velocity (ft per sec)

h= _____ ft

v= _____ fps

h is measured by holding a stadia rod or ruler in the water and determining the height of the water on the front of the rod as compared to the water surface on the sides of the rod, this increase is the hydraulic jump.

3) Stream Velocity - Pygmy Current Meter

Count revolutions of cups with headphones

If water depth <2.5' measure velocity at 60% of depth from water surface

If water depth >=2.5' measure velocities at 20% and 80% of depth from surface and average

Pygmy revolutions/second = water velocity foot per second

# of Revolutions	Seconds
_____	30
_____	_____

Ave revolutions= _____

Velocity= Rev/Sec= _____ fps

4) Stream Velocity - Other Flow Meter

Flow Rate	Units
1 _____	_____
2 _____	_____
3 _____	_____
4 _____	_____
5 _____	_____

Average Flow Rate _____

Velocity= _____ fps

Stream Flow Measurements

Stream Name: _____
 Observer(s): _____
 Date: _____

Average Flow: Q= _____ cfs

Stream Flow - Method #1: Based on an Average Velocity

Q = stream flow (Cubic ft per sec)

Q = A(sq ft) x v(fps)

A = x-sectional area from plot of cross-sectional profile or from measurements taken below,
 where v = velocity (ft per sec)

Assuming a rectangular channel.....

Width (1) _____ ft	Depth (1) _____ ft
Width (2) _____ ft	Depth (2) _____ ft
Width (3) _____ ft	Depth (3) _____ ft
Average Width _____ ft	Average Depth _____ ft

Area = w x d = _____ sq ft
 Average Velocity = _____ fps

(See velocity sheet. Average appropriate measurements)

Q=Flow = A (sq ft) * velocity(fps): _____ cfs

Stream Flow-Method #2: Direct Measurement at a culvert

Applicable for low flows only (<0.5 cfs)

(Using a 5 gallon bucket.)

Time (1): _____ sec
 Time (2): _____ sec
 Time (3): _____ sec
 Average Time: _____ sec

**(1 gallon = 0.1337 ft³, so a 5 gallon bucket holds 0.6685 ft³.)*

Q=Flow = 0.6685 ft.³ / Ave Time(s): _____ cfs

Stream Flow -Method #3: Cross-sectional profiles and Mannings Equation

Mannings Equation

$$\text{Flow (cfs)} = (A \cdot R^{0.667} \cdot S^{0.5}) / n$$

A = X-sectional Area (sq ft)

R = Hydraulic Radius = cross-sectional area/wetted perimeter (should approximate mean depth) ft

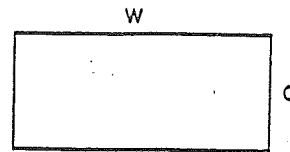
S = Slope of Water Surface hundredths of a percent (i.e. 2% slope = 0.02)

n = 0.04 to 0.05 (highest roughness uses 0.05)

Rectangular Channel:

Area: $A = w \cdot d$ (area where flow occurs)

Wetted Perimeter: $w_p = w + 2d$



Trapezoidal Channel:

Area: $A = (w \cdot d) + (1/2x \cdot d) + (1/2y \cdot d)$

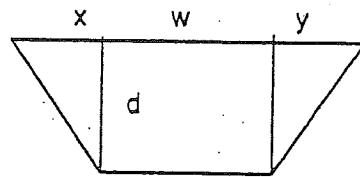
Wetted Perimeter: $w_p = ((x^2 + d^2)^{0.5}) + ((y^2 + d^2)^{0.5}) + w$

$x =$ _____ ft

$w =$ _____ ft

$y =$ _____ ft

$d =$ _____ ft



Hydraulic Radius: $R = \text{Area} / w_p$

Area = _____ sq ft

$w_p =$ _____ ft

$R =$ _____ ft

Water Slope: $S =$ _____

$n =$ _____

$$\text{Flow (cfs)} = (A \cdot R^{0.667} \cdot S^{0.5}) / n$$

= _____ cfs

Stream Flow -Method #4: Pygmy Meter

See attachments

Stream Channel Morphology

**Pools & Pool Tail
Surface Fine Sediment**

Pools

(Core Attribute)

Importance:

Pools are an important component of habitat for aquatic organisms. They are important for different reasons to different aquatic species and may provide deep water and cool summer temperatures, winter refuge, and areas for rearing of fish and amphibians. They are also important components and indicators of channel morphology. Residual pool depth is measured to characterize pools in the survey segment because it reduces variability in pool depths that result from differences in stage.

Objectives of This Measurement:

Quantify the number of pools in the survey segment.

Determine range of residual pool depths within the survey segment. Residual pool depth is the difference between maximum pool depth and pool tail depth.

Document whether wood is a factor in pool formation.

How Many Measurements to Take:

Measure every pool in the survey segment.

Criteria for Determining Pools:

- Flow: Slow or no velocity during summer low flows.
- Morphology: Hydraulic control at pool tail, usually a concave longitudinal profile.
- Dimension: Dominant feature occupies most of stream width and includes thalweg (backwater and sidewater pools are not measured). Length is greater than wetted width. Depth is greater than non-pools. Maximum depth is more than twice pool tail depth. (Exceptions to these criteria can be found. These units should be considered pools if criteria described above are present).

Where to Take the Measurement:

Measure pool depth at the deepest point.

Measure pool tail crest depth. This is the deepest point in the channel cross-section at the downstream end of the pool where the water breaks from smooth to turbulent flow. See Figure 3.

How to Take the Measurements:

Use the staff rod to measure the pool at its deepest point, to the nearest .01 m. Use the tape or string machine (hip chain) to measure the length of the pool. Record this information on the data form.

Also note if the pool is formed by wood.

Reference:

Kershner et al. 2004

USDA 1994

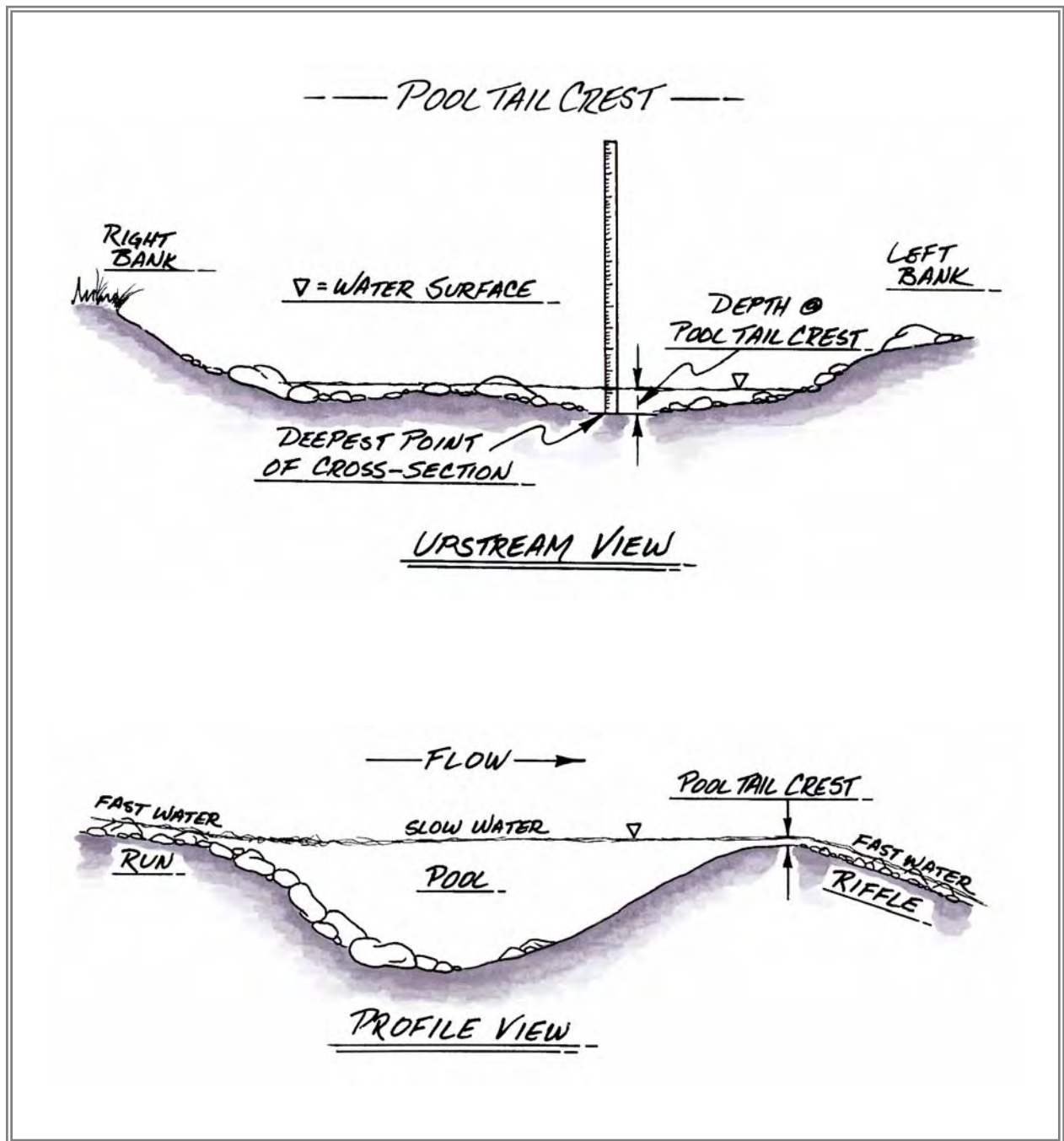


Figure 3 – Pool Tail Crest

Pool Tail Surface Fine Sediment

(Core Attribute)

Importance:

Watershed and streambank disturbance often result in increased sediment input to streams. Increased fine particles in the stream substrate can impair aquatic food production and decrease survival of young salmonids. Salmonid mortality is increased when water interchange between streams and redds is reduced by fine sediment and by filling interstitial spaces resulting in barriers to movement of alevins. Particles of 2 mm or less are the principal barriers, although particles up to 8mm have resulted in increased mortality.

Objective of This Measurement:

To quantify the percentage of fine sediment less than 2 mm on the pool tail substrate.

How Many Measurements to Take:

Three grid measurements are conducted at each pool tail within the survey segment. The grid is a 14-inch square frame with 49 line intersections and one corner (50 points total). Counts are made of percent fines at the intersections and one identified corner.

Where to Take the Measurement:

At each pool tail, stand on the pool tail crest. Define the extent of each pool tail unit by estimating a zone that incorporates the downstream 10% of the total pool length. It will lie within the wetted stream width. Within the area defined, make three random tosses of the grid. See Figure 4. The first measurement is in the thalweg within that 10% zone; the second measurement midway is upstream between thalweg and left wetted edge; and the third measurement is midway upstream between thalweg and right wetted edge.

Exception: Placing the sampling grid 10% of the distance upstream of some pool tail crests could result in measurements that may not be reasonably called pool tail substrate. Pool tails are usually a depositional feature, dominated by fine to cobbl-sized substrate. Where such conditions do not exist, avoid measuring pool tail surface fines.

How to Take the Measurement:

Count and record the number of intersections lying above substrate 2 mm or less. A viewing tube, dive mask, etc. can aid in viewing the grid by breaking the water surface turbulence.

Each point represents 2% fines. Multiply the points per toss by two and record on Form 8.

Special Cases:

Aquatic vegetation - In some streams, aquatic vegetation may be growing or otherwise cover parts of the area to be sampled by the grid, making its use difficult or impossible. If that is the case, an alternative procedure for that pool tail is employed. At such a location, the pool tail area is defined. Transects are then run across the area, with a particle selected at the toe point of each stride. If the particle falls into the <2 mm size class, it is tallied. This procedure is continued until 100 particles have been selected. Transects and strides should be staggered such that the entire pool tail area is sampled equally. The tallied number of particles under 2 mm represents the percent surface fines estimate for the pool tail.

- Small streams - If three tosses will not fit in the area defined by wetted width and the 10% pool length zone, take two tosses, or only one if possible. Do not overlap tosses.

References:

Bauer and Burton 1993

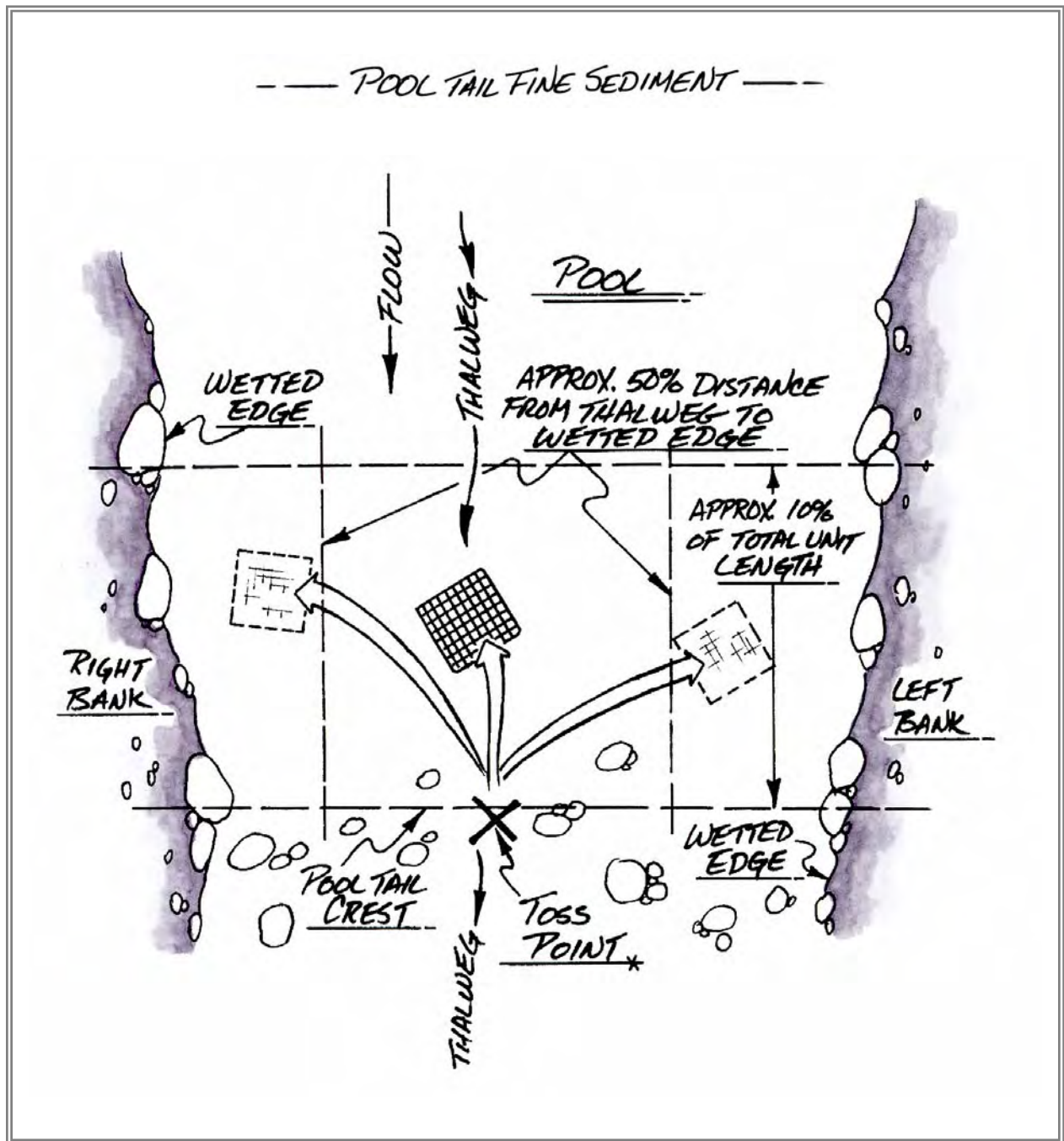


Figure 4 – Pool Tail Fine Sediment Measurement Area

