# EFFECTIVENESS MONITORING FOR STREAMS AND RIPARIAN AREAS

# SAMPLING PROTOCOL FOR STREAM CHANNEL ATTRIBUTES

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By

PACFISH/INFISH Biological Opinion Effectiveness Monitoring Program (PIBO-EM) Staff - Multi-federal Agency Monitoring Program; Logan, UT

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For Information about PIBO Effectiveness Monitoring,
contact Eric Archer, telephone: 435 755-3565.

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# INTRODUCTION

The PACFISH/INFISH (PIBO) Effectiveness Monitoring Program for aquatic and riparian resources was developed in 1998 in response to monitoring needs addressed in the Biological Opinions for bull trout (USFWS 1998) and steelhead (NMFS 1995). The primary objective is to determine whether priority biological and physical attributes, processes, and functions of riparian and aquatic systems are being degraded, maintained, or restored in the PIBO area. The program samples within the interior Columbia River basin on lands managed by U.S. Forest Service (FS) Regions 1, 4, and 6 and the Idaho and Oregon/Washington State Offices of the Bureau of Land Management (BLM).

This document describes the sampling methods used by the PIBO program during 2008. The methods are a result of 10 years of use, evaluation, and peer review. Most recently, we have worked with the Aquatic and Riparian Effectiveness Monitoring Program in an effort to standardize methods between the two programs. The result is a document titled "Effectiveness Monitoring for Streams and Riparian Areas within the Pacific Northwest: Stream Channel Methods for Core Attributes" (USDA 2006). The PIBO protocol incorporates all methods described in this document. In addition, we would like to recognize the following authors and acknowledge the original citations for each method, while recognizing that numerous modification have been made.

- Harrelson et al. (1994) - Reach layout, bankfull elevation, gradient, and sinuosity.
- Wolman (1954) and Lazorchak et al. (1998) - Streambed particle counts
- Bauer and Burton (1993) and USFS R5 SCI Guidebook (1998) - Pool tail fines
- Bauer and Burton (1993) and Platts et al. (1987) – Bank stability
- Kershner et al. (2004) - Defining habitat units
- Lisle (1987) - Residual pool depths
- Platts et al. (1987) - Bank angle and undercut banks
- Rosgen (1996) - Channel cross-sections
- Hawkins et al. (2003) - Macroinvertebrates
- Moore et al. (2002) and Hankin and Reeves (1988) - Large wood

Finally, the protocol and the individual methods were designed and tested specifically to sample a stream reach and to monitor the effects of management activities. Reach lengths are a minimum of 20 bankfull channel widths, range from 160 to 480 meters, and are wadeable.

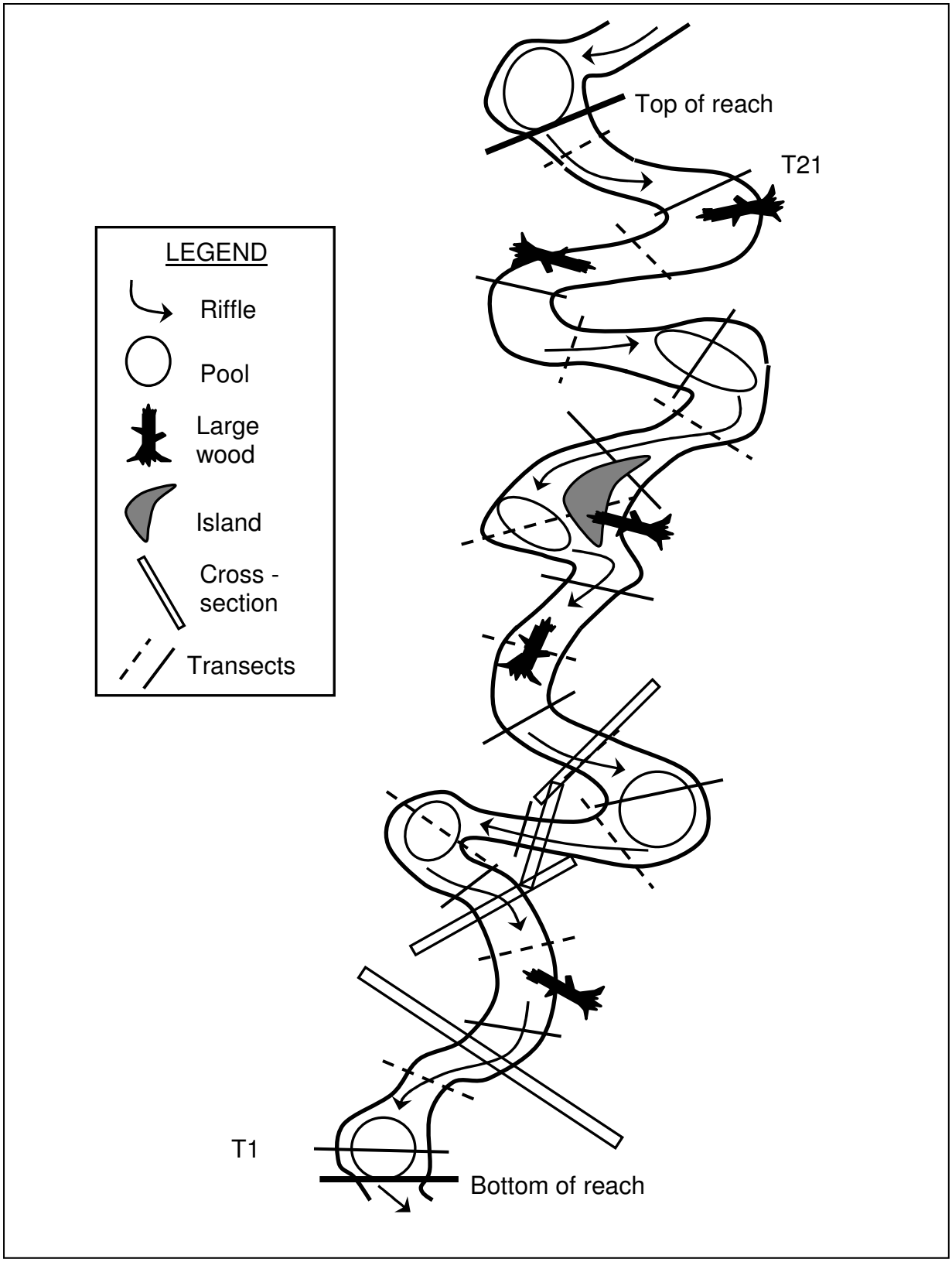



Figure 1. Overview of reach layout showing locations of transects, channel cross-sections, pools, riffles and large wood.

Table 1. Sampling differences among reach types

| | Reach Type | | | |
|---|---|---|---|---|
| Attributes | Integrator | DMA | Dry Integrator | Sentinel |
| Alkalinity & conductivity | Y | | | Y |
| Reach map | Y | Y | Y | Y |
| GPS readings | Y | Y | Y | Y |
| Macroinvertebrates | Y | | | Y |
| Streambank measurements | Y | Y | Y | Y |
| Change in elevation | Y | Y | Y | Y |
| Photos | Y | Y | Y | Y* |
| Pools | Y | Y | | Y |
| Cross-sections | Y | Y | Y | Y |
| Bankfull width | Y | Y | Y | Y |
| Particle counts | Y | | Y | Y |
| Pool tail fines | Y | | | Y |
| Large wood | Y | | Y | Y |

Y = collect attribute

## SAMPLING ORDER

1. Locate the flag at the downstream end of the reach.
2. New site: Identify the pool tail near the flag and mark the exact downstream end of the reach.
   Previously sampled site: Identify the exact starting location identified by scout.
3. Locate Transect 1 using the random starting distance.
4. Take a Bottom of Reach (BR) GPS reading and establish the BR site marker (unless the site is in a wilderness area, in which case you will use a distinct feature near the BR as a site marker).
5. Sample macroinvertebrates.
6. Determine the bankfull elevation
7. New site: measure initial bankfull widths to identify the width category
   Previously sampled site: use width category on 'Scouting Pre-Established Reaches' form
8. Determine the reach length by measuring along the thalweg and placing transect flags.
9. Take a Top of Reach (TR) GPS reading, establish the TR site marker (unless the site is in a wilderness area, in which case you will use a distinct feature near the TR as a site marker), and measure conductivity and alkalinity.
10. Determine straight length by measuring the straight-line distance between the top and bottom of reach.
11. Conduct pool sampling (pool tail depth, maximum depth, length) and pool tail fines.
12. Take photos of the reach. The photos should be taken during the most favorable light conditions (10:00 am to 3:00 pm).
13. Measure channel cross-sections.
14. Conduct transect sampling (bank angle, undercut depth, bank stability, bank type, bank material, location of greenline quadrats).
15. Measure bankfull widths and pebble counts at transects.
16. Assess and measure large wood.
17. Draw reach map and measure the elevation change.
18. Review **all** forms for completeness.
19. Review entries in the data logger.
20. Check to make sure you have all equipment and forms.

# SAMPLE SITE LOCATION

## Determine the Start of the Reach

1. Locate the start of the reach (downstream end) which will always be at a pool tail for new sites. For previously sampled sites the start of reach may or may not be a pool tail.
   a. Previously sampled sites: First, see the 'Scouting Pre-Established Reaches' or 'Site Scouting' form for specific instructions about the start of reach location. Locate the reach using the reach description page, topographic map, site markers, UTM coordinates, and photographs. It is extremely important that the start of the original reach is correctly located. In the event that the pool tail has shifted or the pool has disappeared, locate the start of the reach at the pool tail closest to the original start location. The pool tail must be within ±10m of the original spot. If there is no pool tail ±10m of the original spot, start the reach at the exact same spot in the BR photos. If you are uncertain, 1) call your supervisor, Arch, and Boyd; 2) sample the reach and make an obvious note on Form 1 and make a note for your supervisor.
   b. New sites: Locate the BR using the site scouting form, which includes directions, UTM coordinates and a topographic map. Identify the pool tail closest to the orange PIBO flagging. Make sure that the pool meets the criteria for pools (see page 23). If there is not a pool near the flagging, continue upstream to the first pool tail.
2. Mark the exact start of the reach by placing flags in the streambank.
3. Get a random number (k) 0 – 7 by using the random function in the data logger. Establish the first transect (k) meters upstream from the start of the reach. Measure this distance along the thalweg beginning at the BR pool tail. Place a red transect flag (labeled as #1) in both streambanks and perpendicular to the channel.

## Reach Location

Use the global positioning system (GPS) receiver to record the Universal Transverse Mercator (UTM) easting, northing, and zone for the BR and TR (and Mid-reach UTMs for reach extensions; see Appendix G) and site markers for the BR and TR. Make sure your GPS is set using the NAD CONUS 27 datum. Refer to PIBO manual of manuals (M.O.M.) for settings and adjustments to the GPS receiver.

1. Take two readings at each location.
2. Turn the GPS on at least 5 minutes before recording coordinates.
3. Reading must have an accuracy of <± 50m. If that level of accuracy is met, record the coordinates and accuracy on Form 1.
4. If this level of accuracy cannot be attained within 10 min, use the GPS's 'average position/location' function with at least 200 'measurement counts' to attain coordinates. To access this function hold down the 'enter' button until 'mark waypoint' screen opens and then press the 'menu' button.
5. After 200 'measurement counts' are obtained with the 'average position/location' function, record the coordinates and accuracy on Form 1 and write 'avg. or average' with the accuracy.
6. For each location (BR, TR, and both BR and TR site markers) take the two readings/coordinates and calculate the average UTM coordinates; record on Form 1 and in the data logger.

## Monument the Site

Bottom of reach (BR) and top of reach (TR) markers are used to monument the site location. These markers will assist others in finding the start and end of the original sample reach. Site markers will not be placed in designated wilderness areas. Rather, a distinctive feature (large spanner, snag, rock or tree) near the BR and TR will be used to monument the site in wilderness areas.

1. Locate a distinctive feature near the BR and TR that will be easily identified.
   a. Something relatively permanent like a piece of large wood in the stream (e.g. a large spanner, snag, or tree).
   b. Sometimes riparian zones are characterized by a continuous patch of similar vegetation; try to pick something that might stand out such as a big clump of sage or one conifer near the start of the reach.
2. Make sure the BR marker has 'EMP BR' written on it and the TR marker has 'EMP TR' written on it.
3. Attach one of the markers to your chosen spots.
4. Take a GPS reading of the site markers location and record them on Form 1.
5. Enter a brief description of the site marker location on Form 1 (eg. US of BR 5m on RL attached to trunk of large juniper).
6. Take a compass bearing from the BR marker to the BR and from the TR marker to the TR and record them on Form 1.
7. Finally, measure the distance from the marker to the thalweg at BR and TR and record it on Form 1.

## Record Disturbance

If any of the following disturbances are visible at any time while sampling a reach, record them in the logger. For example, if you see 1 or more burned stump record 'Fire' in the logger. If you see 1 or more cow pies, select 'Grazing' in the logger.

- Fire
- Grazing
- Mining
- Timber Harvest
- If you see another form of disturbance, type it in.

## Photo Points to Document the Reach

Photos are important for relocating sites, documenting reach condition, and detecting change through time. They are included in our annual reports and presentations, and used by others outside of our program. Photos are one of the easier tasks that you will perform, please relax, take your time and take quality photos.

**General information: how to take photographs:**

- Always take the Reach ID/Date photo first. The remaining photos can be taken in any order.
- Do not zoom, set the resolution to "better" or "medium".
- To ensure proper lighting, do not take photos looking into the sun, take photos with the sun at your back. Also, try to minimize photographs where part of the frame is in the shadows and part in the sun.
- Hold the camera 1.5 meters from the ground (use a depth rod as a guide).
- A depth rod in should be in the following photos: TR and BR, stream cross-sections, misc. stream, and distinct feature.
- Circle only ONE option on Form 4 (i.e. RR or US, not both).
- If you use a disposable camera do NOT get it wet.
- If you use a disposable camera, turn in the camera at the end of the hitch regardless of how many photos you took.
- Do not take photos displaying unprofessional behavior.
- **You must be wearing a shirt and boots/shoes.**

**General information: recording details about each photo on Form 4 and in the data logger**

- Photo Number: Record the number in the display screen on the back of the camera after you take the photo.
- Rod Location:
    - Transect Number – List the number of the closest stream transect to the depth rod.
    - Direction from Transect – Circle whether the depth rod is upstream or downstream of the transect.
    - Distance – Measure the distance from the rod to the transect.
    - Streambank – Record whether the rod is on River Right (RR) or River Left (RL).
- Description: Mandatory photos already have a written description; please add additional comments when useful. For other photos include a written description.
- Camera Location:
    - Camera Facing – Circle whether the camera is facing upstream (US), downstream (DS), river right (RR), or river left (RL). Choose only one.
    - Distance to Rod – Distance from camera to depth rod.
    - Bearing to Rod – Use a compass and record the bearing from the photo point to the depth rod.
- Year repeated: Fill in the year from which the photo is being repeated (from Reach ID on photo pages). Leave BLANK if photo is new.

## There are 2 different scenarios for shooting photographs:

1. Duplicating photos from a **previously sampled site**, and
2. Taking photos at a **new site** which has not yet been sampled.

## Photo Points from Previously Sampled Sites & Sentinels

Objective: to duplicate old photos as closely as possible in order to determine how a specific location has changed through time. For example we want to be able to put a 2003 misc. stream photo beside the 2008 misc. stream photo and easily tell that the photos were taken from the same exact location, with the same orange boulder in the lower left corner, with the horizon line in the middle of the both photos.

Photos should be duplicated as closely as possible using the following procedures:

1. Old photos will be provided when you sample an old site or sentinel site.
2. Use an old photo's description (10m US from Transect 10, facing DS, etc) to help you re-locate where it was taken. Beware; old photo descriptions may have errors. It is more important to duplicate the photo than it is to duplicate the description info.
3. After relocating where the old photo was taken from, visual compare the old photo with what you are seeing through the camera's viewfinder.
   a. Pay particular attention to the corners of the old photo, does your photo have the same features in each corner?
   b. Does your photo look like it is too close or too far away? If so move.
   c. Is the horizon the same? For example, is the meadow behind the stream towards the top of the old photo, but near the middle of yours? If so make the necessary adjustments.
   d. Once you take the new photo, compare it to the old version. If they don't match, shoot it again.
4. Record the year of the photo you are duplicating. For example, if you are re-sampling a 2002 site, enter '2002' as the 'year repeated' on form 4.

<u>Top & Bottom of Reach:</u> If the Top / Bottom of Reach has moved since the last sample, only take photos of the current TR / BR and leave 'year repeated' blank.

<u>Cross-sections:</u>

- Use old photos to identify where cross-sections were located during the previous sample.
- Set up a cross-section in the same location, using the current bankfull elevation that your crew has identified.
- Frame the shot exactly as the original photo, and take a repeat photo.
- If you will NOT be taking your cross-section measurements at the same place as previous years, then ALSO take a photo of your cross-section (leaving the 'year repeated' column blank).

<u>Missing or Unrepeatable Old Photos:</u>

If a photo is missing (no Top of Reach – US for example) or unrepeatable (horribly out of focus, no description, etc), take a new photo and leave the 'year repeated' blank

<u>Reach Extension:</u>

- Duplicate the original Top of Reach photos, record the 'year repeated'
- In addition, take photos of the current top of reach, leaving the 'year repeated' blank.

Do not repeat old vegetation photos: Misc. Veg, Greenline, Riparian CS 1 and 3.

## Photo Points from New Sites

**Take photos of the following at each reach.**

- Reach ID/Date: Write the stream name, group/order, reach type, date, and crew on the back of Form 2 and take a photograph. Use a large marker and take this photo first.
- Site marker location (BR and TR): Take the photographs looking towards the reach with the marker in the foreground. Have a second person pointing at the marker. If in a wilderness area do not place a marker, instead choose a good distinctive feature to use as the marker and take a photo of it with someone pointing at it.
- Reach overview: Should be taken from a location where the greatest extent of the reach can be observed. This is often on a hillside or terrace. Sometimes this is a hard shot, try your best.
- The bottom and top of the reach: Take a photograph looking both upstream and downstream. Stand parallel to the channel at a distance of 5 meters.
- Stream XS (cross-sections) 1 & 3: Take a photograph with the tape stretched across the channel and the depth rod at either the left or right edge of water and elevationally with the bottom at the waters surface. Stand parallel to the channel at a distance of 5 or 10 meters (> 8 meter width category).
- Misc. Stream: Take a representative photo of the steam channel. Make sure to get both banks of the stream.
- Distinctive feature: Photograph a distinctive feature that will help relocate the site for future visits.

**Some points to remember when taking photos at new sites:**

- Try to include both banks in the photo. For smaller streams stand back from the object of interest a distance of 5 meters. For larger streams (> 8 meters wide) stand back 10 meters or at the best distance to assure you can see both banks.
- Try and disperse your photos throughout the sample reach, this will lead to a better documented reach.
- Take a photo of stream cross-section 2 when there are only two cross-sections in the reach.
- Take a photo of the distinctive feature used as a site marker in wilderness areas.
- Reference transects instead of the BR and TR.

*Elk Creek*
*123–07–I–M2–07*
*June 11, 2007*

## MACROINVERTEBRATE SAMPLING

**Objective:** Describe the composition and health of the macroinvertebrate community.

**Where to take samples:**

1. Sample four riffles (fast-water habitat units).
2. Begin sampling at the first riffle (fast-water habitat) encountered at the site and continue upstream to the next 3 riffles (fast-water habitat units). If no fast-water habitats occur, take the samples from shallow, slow-water habitat units.
3. Determine net placement within each habitat unit by generating 2 pairs of random numbers between 0 and 9 on the data logger. The first number in each pair (multiplied by 10) represents the percent upstream along the habitat unit's length. The second number in each pair represents the percent of the stream's width from river left (RL) looking downstream. Repeat this process to locate the second sampling location.
4. Take samples where the length and width distances intersect (estimate by eye). If it is not possible to take a sample at one or both of these locations (log in the way, too deep, cannot seal bottom of net, etc.), generate an additional set of random numbers and sample the new location.

**Sampling Method:**

1. Collect samples using a Fixed Area Design (0.72 $m^2$) from fast water habitats with a 500 µm mesh net. Take invertebrate samples from 4 different fast-water (e.g. riffles, runs) habitat units. Take 2 separate 0.09 $m^2$ fixed-area kick net samples from each unit for a total of 8 samples. If no fast-water habitats occur, take the 8 samples from shallow, slow-water habitat units. Combine the 8 individual samples into a single sample that will be used to represent the study area.
2. Place the kick net so the mouth of the net is perpendicular to and facing into the flow of water. If there is no detectable flow, orient the net to most easily facilitate washing benthic material into the net. Collect invertebrates from within the 0.09 $m^2$ sampling frame in front of the net. Work from the upstream edge of the sampling plot backward and carefully pick up and rub stones directly in front of the net to remove attached organisms. Quickly inspect each stone to make sure you have dislodged everything and then set it aside. If a rock is lodged in the stream bottom, rub it a few times concentrating on any cracks or indentations. After removing all large stones, disturb small substrates (i.e. sand or gravel) to a depth of about 10 cm by raking and stirring with your hands. Continue this process until you can see no additional organisms or organic matter being washed into the net. After completing the sample, hold the net vertically (cup down!) and rinse material into the bottom of the cup. If a substantial amount of material is in the net, empty the net into the 14-liter bucket for processing before continuing to the next sample location. Otherwise, move to the next sample location and repeat the above procedure to create a composite sample.
3. Field processing requires a 14-liter bucket, a white plastic washtub, and a 500 µm sieve. Use the bucket to decant organisms from inorganic substrates into the sieve. Use the washtub to transfer stream water into the bucket and then to visually inspect inorganic residue for heavy organisms that were not decanted.
4. Continue this process until all 8 samples have been collected and placed in the bucket. Make sure you thoroughly wash organisms from the net by vigorously pouring water down the net and into the cup. If the net has a cup at the end, remove the cup over the top of the bucket and wash it out.
5. Remove and release from the bucket/washtub/sample jar all vertebrates, including fish and amphibians. Also remove and release crayfish.

6. Add water to the bucket and decant invertebrates and organic matter from the sample by stirring the contents of the bucket and then pouring suspended material through the 500-µm sieve. Repeat this process until no additional material can be decanted. Transfer the material in the sieve (invertebrates and organic matter) into the 2-liter sample jar with a small spoon and then wash any remaining material in the sieve into the jar with a squirt bottle. Place the inorganic residue remaining in the bucket into the plastic washtub and cover with water to a depth of 1 cm. Inspect the gravel on the bottom of the tub for any cased caddis flies or other organisms that might remain. Remove any remaining organisms by hand and place in the sample jar.
7. Once all samples have been processed, fill the jar/s with 95% EtOH. Immediately label the jars inside and outside. Preserve this composite sample in 1 or more sample jars depending on the amount of material collected. If there are multiple jars, label them as 1 of 2 and 2 of 2, etc. and then tape them together.
8. Record the number of bug jars on Form 1 and in the data logger.

Reach ID: 150-05-IK-M2-05 Jar # 1 of 2
Stream Name: Big Ramey Cr
Date: 06/15/05

Figure 2. Example of macroinvertebrate label.

## ESTABLISH BANKFULL ELEVATION, WIDTH CATEGORY, AND CHANNEL TRANSECTS

### Identify Bankfull Elevation

Examine the bankfull indicators (described below) throughout the reach to identify the bankfull elevation. Recognize that all six indicators are rarely present at an individual site.

- Examine streambanks for an active floodplain. This is a relatively flat, depositional area that is commonly vegetated and above the current water level unless there is a large amount of spring runoff or there has been a substantial rain event (i.e. stream running at bankfull stage).
- Examine depositional features such as point bars. The highest elevation of a point bar usually indicates the lowest possible elevation for bankfull stage. However, depositional features can form both above and below the bankfull elevation when unusual flows occur during years preceding the survey. Large floods can form bars that extend above bankfull whereas several years of low flows can result in bars forming below bankfull elevation.
- A break in slope of the banks and/or change in the particle size distribution from coarser bed load particles to finer particles deposited during bank overflow conditions.
- Define an elevation where mature key riparian woody vegetation exists. The lowest elevation of birch, alder, and dogwood can be useful, whereas willows are often found below the bankfull elevation.
- Examine the ceiling of undercut banks. This elevation is normally below the bankfull elevation.
- Stream channels actively attempt to reform bankfull features such as floodplains after shifts or down cutting in the channel. Be careful not to confuse old floodplains and terraces with the present indicators.

### Identify Bankfull Height

After you identify bankfull elevation, measure the vertical distance from the water's surface to the dominant bankfull height measured throughout the reach. This vertical distance can be used when bankfull indicators are not present at a particular point along the streambank. Bankfull height is needed for streambank measurements, bankfull widths, pebble counts, large wood, and cross-sections.

### Establish Width Category

<u>Previously sampled sites:</u> Use the original width category which is given on the 'Scouting Pre-Established Reaches' form.

<u>New sites:</u> Five bankfull widths will be collected (Figure 3). Measure the bankfull width perpendicular to the main channel.

1. The 1$^{st}$ bankfull width measurement will be taken at Transect 1.
2. The 2$^{nd}$-5$^{th}$ bankfull width measurements will be taken upstream from the 1$^{st}$, spaced at 16 meter intervals following thalweg.
3. Record all five bankfull widths on Form 1 and calculate the average. Use the average to determine the width category from Table 2 on the next page. The width category will determine the spacing of additional transects. Record the width category on Form 1 and in the data logger. The minimum reach length is defined for each width category and is equal to 20 times the bankfull width.
4. In some instances a measurement cannot be taken due to dangerous obstacles or a tributary/side channel confluence. Skip that measurement. At least 3 measurements should be obtained.

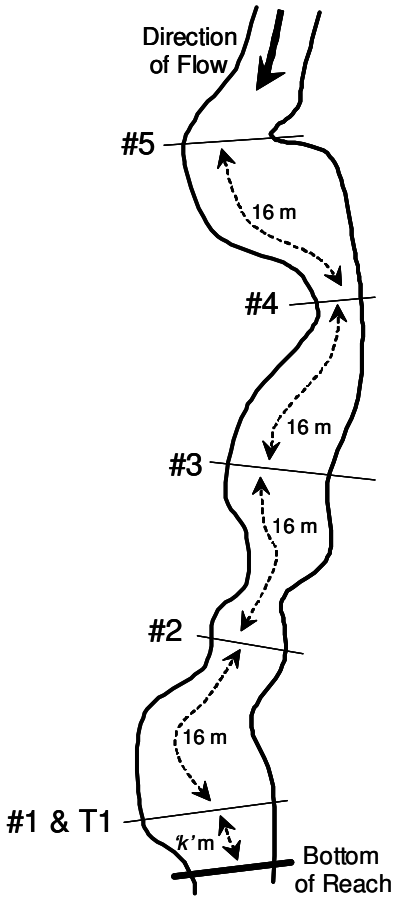



Figure 3. Initial bankfull width measurements for determining the width category.

| Table 2. Width categories for determining the minimum reach length. | | |
|---|---|---|
| Average bankfull width in meters | Width category | Minimum reach length in meters |
| 0 to 8 | 8 | 160 |
| 8.1 to 10 | 10 | 200 |
| 10.1 to 12 | 12 | 240 |
| 12.1 to 14 | 14 | 280 |
| 14.1 to 16 | 16 | 320 |
| 16.1 to 18 | 18 | 360 |
| 18.1 to 20 | 20 | 400 |
| 20.1 to 22 | 22 | 440 |
| > 22.1 | 24 | 480 |

## Establish Channel Transects

1. Beginning at the first transect flag, place subsequent transects at regular intervals, one "width category" value, as measured along the thalweg. Place flags in both banks and perpendicular to the main channel.
2. If side channels are encountered, use the 'side channels' section below to determine flag placement.
3. Continue placing transect flags to the end of the reach.
4. The end of the reach (upstream boundary) is located at the first pool tail encountered after the 21st transect.
5. End the reach at Transect 25 if a pool tail has not been encountered.
6. Record the total number of transects in the data logger.
7. Place red flags at Transects 1, 5, 10, 15, and 20 to designate the location of riparian cross-sections. Place orange flags at other transect labeled odd (O) or even (E).

**Side Channels**

- Do not sample in tributaries (F Figure 4).
- Channels that are separated from the main channel by islands < bankfull elevation are considered part of the main channel (E Figure 4).
- A side channel is any channel separated directly from the main channel by an island/bar with an elevation above bankfull (A Figure 4).
- Place flags in all side channels that have flowing water through their entire course (A Figure 4).

The following criteria must be met in order for a non-flowing side channel to be included in the survey:

1. Sample non-flowing side channels if they are a continuous feature whose thalweg is at no point ≥ to the bankfull elevation of the main channel (D Figure 4). Determine the thalweg location by envisioning where water would flow through the side channel.
2. Conversely, do not collect measurements in discontinuous side channels, where at any location (normally at the upstream end) the side channel's thalweg is ≥ the bankfull elevation (B & C Figure 4); unless at that transect the island is below bankfull; then the flag will be placed on the outside bank of the side channel (transect 12 in Figure 4).
3. If you determine that the highest point of the side channel's thalweg is close to bankfull, use your hand level and stadia or depth rod to determine if that point is ≥ bankfull elevation of the main channel (ideally perpendicular to that point).

**Tertiary Side Channels**

Tertiary channel:

- Simply stated, tertiary channels are narrow and or discontinuous.
- Side channel whose average width is <20% of the average bankfull width measured during reach set up (procedure explained on page 48). Measure the bankfull width, and code large wood located in tertiary channels that meet this criterion.
- Or, a discontinuous side channel, which means any location of the side channel's thalweg is ≥ the bankfull elevation.
    a. Measure and code large wood located in discontinuous channels (page 50).
    b. Do not measure the bankfull width of discontinuous side channels (Figure 4, page 14: channels B & C).

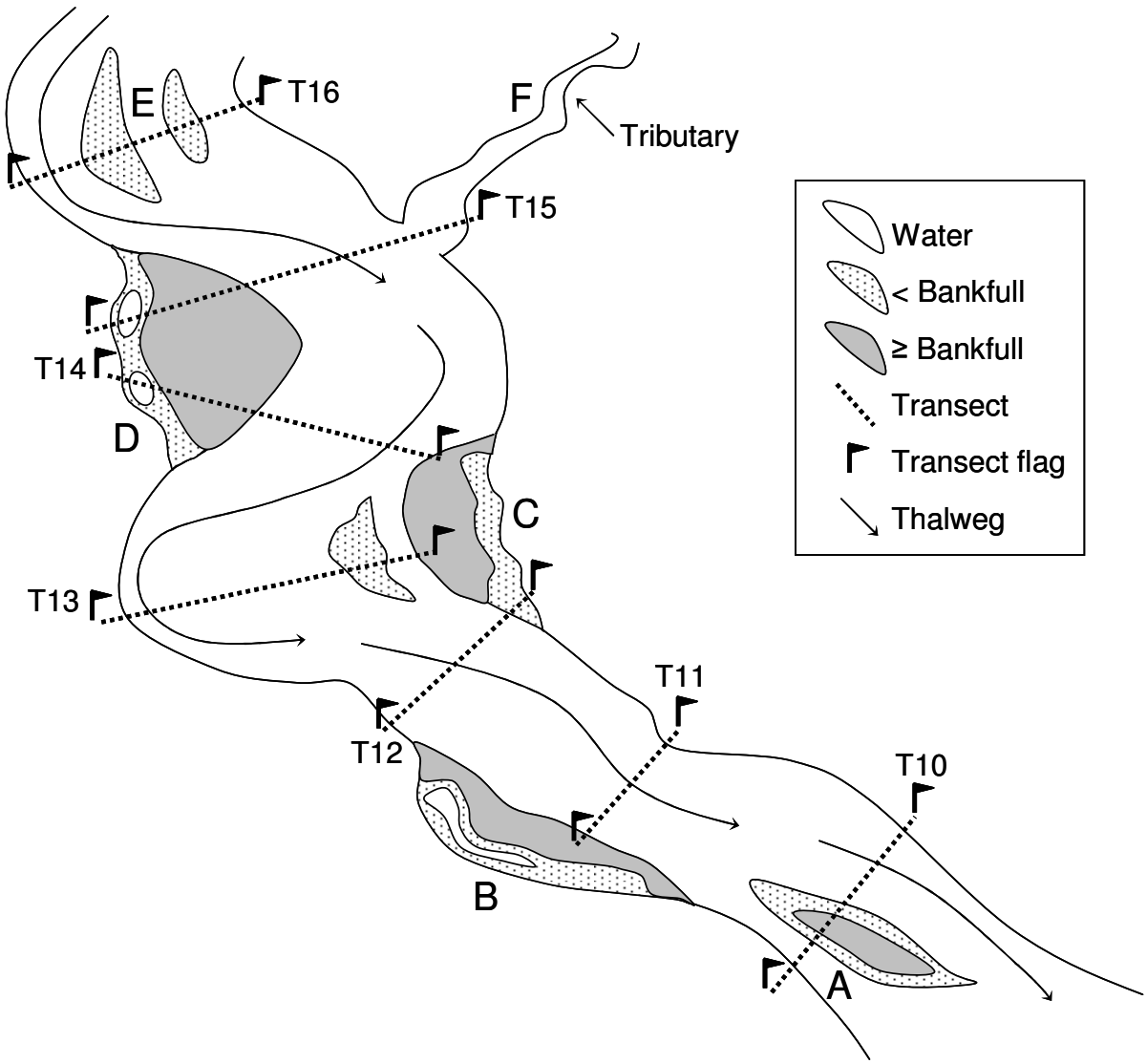



Figure 4. Transect placement when side channels are encountered. Place transects across all flowing channels (A & E), and across non-flowing side channels that are entirely below bankfull elevation (D). DO NOT place transects across side channels whose thalwegs are at any point ≥bankfull elevation (B & C), unless at that transect the island is below bankfull; then the flag will be placed on the outside bank of the side channel (RL transect 12).

## Measuring Reach Length

The reach length is measured along the thalweg from the bottom of the reach (BR) to the top of the reach (TR). Use the following formula to calculate the length. Record the data on Form 1 and in the data logger.

Reach length = ((# of transects -1) * width category) + random distance to 1$^{st}$ transect + distance from last transect to top of reach

## Measuring Straight Length (Valley Length)

To obtain valley length, measure the straight-line distance between the points where the thalweg crosses the top and bottom of the reach. Record the data on Form 1 and in the data logger.

## Reach Map

The reach map is on Form 2. The reach map is drawn to describe the reach and help relocate the site in the future. Draw the reach map to scale (relatively) and strive for clean and simple drawings. Show the stream channel extending at least 10 m above and below the reach boundaries; locations of shrubs and trees, large wood, bars, islands, and beaver ponds; location of the hill slopes, roads, fences, side channels, tributaries, etc. In addition, show any distinct feature that will help in relocating the site.

**Commonly Used Symbols for Reach Maps**

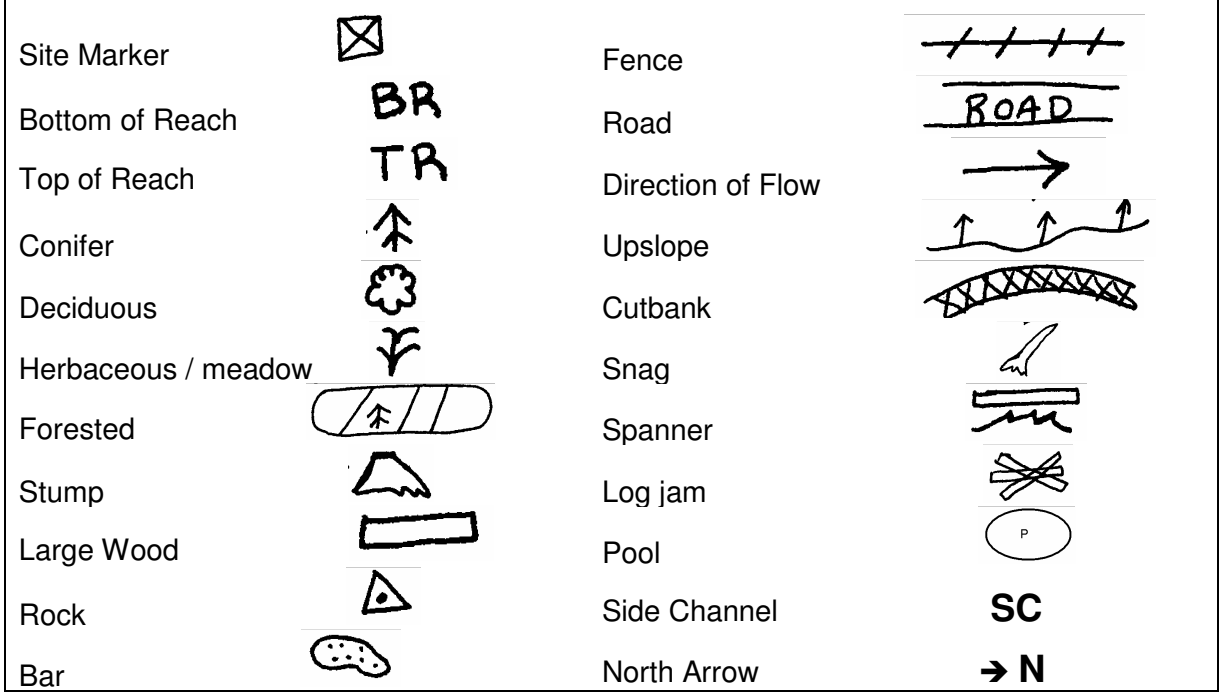
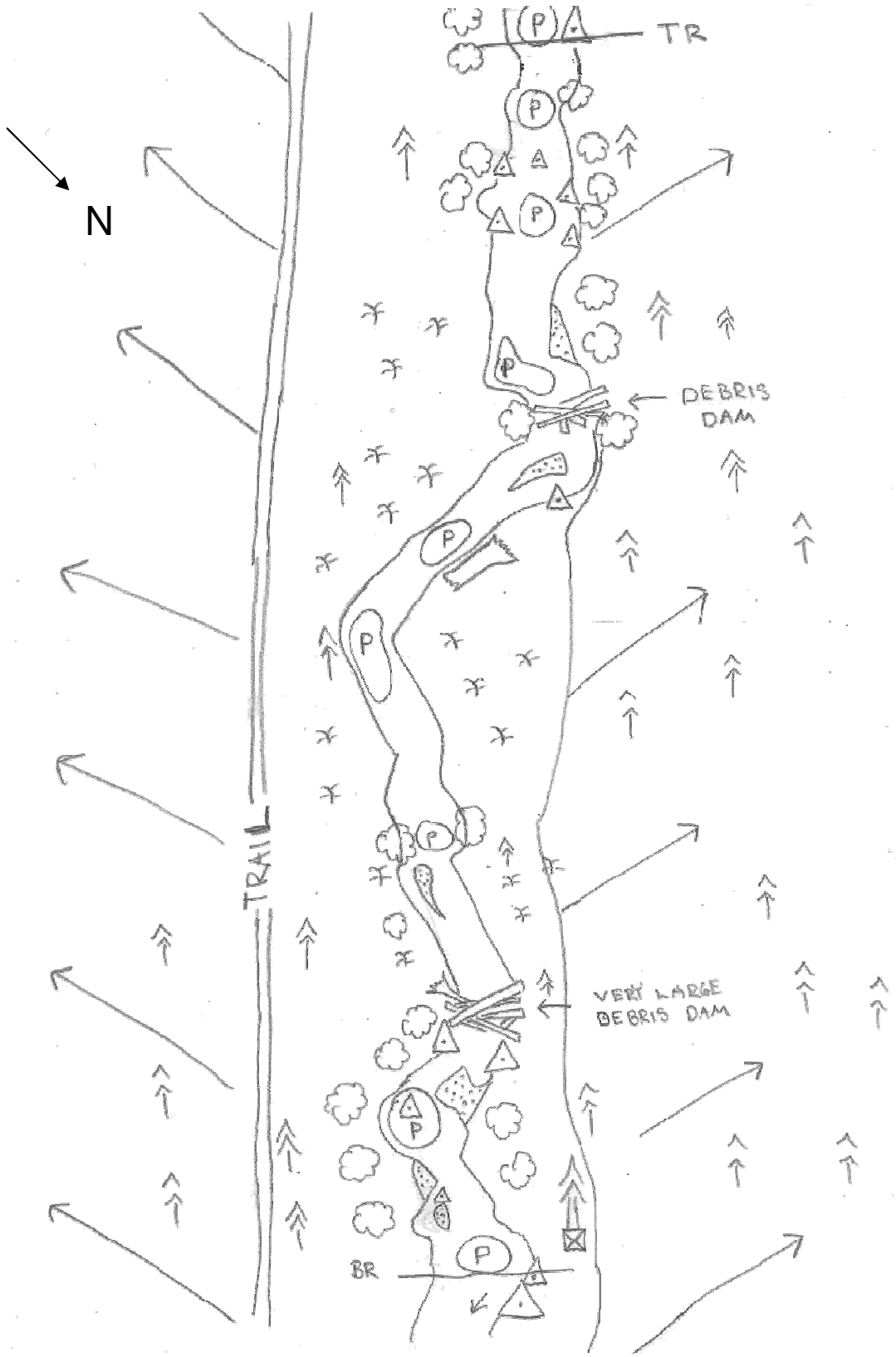



Table 3. Commonly used symbols for reach maps.




Figures 5. Example of a well drawn reach map.

## Measuring Change in Reach Elevation

**Equipment:** automatic level, tripod, and stadia rod

**Definitions:**
Elevation change = vertical difference or drop between the water surface at the Top of the Reach (TR) and the water surface at the Bottom of the Reach (BR).

Gradient = the percent slope of the stream reach (elevation change / reach length)

**Introduction:**
- Measure elevation change between the water surface at the Top of the Reach (TR) and the water surface at the Bottom of the Reach (BR) using a tripod and surveyors' level
- Measure elevation change 2 or more times
- The second measurement must be ±10% of the first measurement
- If the second measurement falls outside the ±10% window continue measuring elevation change until 2 measurements are within ±10% of one another.
- Record elevation changes on Form 1 and in the data logger
- If you knowingly make an error while shooting elevation change, DO NOT enter this data into logger

**Overview:**
One person operates the level and records heights from the stadia rod. The other person positions the stadia rod at the BR, any intermediate spots (if necessary) and at the TR. It is very important to keep the stadia rod plumb (vertical in all directions) when taking measurements. The person operating the level will be able to tell if the stadia rod is plumb or not and will communicate what needs to happen to the other person using the 2-way radios. **The bottom surface of the stadia rod must be held at the surface of the water, not the stream bottom when positioned at the BR and TR.**

**LEVEL SET UP**
**STEP 1: Leveling with Tripod and Affixing Level**
- Be very careful when handling the levels because they are fragile and expensive.
- The levels must be setup properly or the measurements will not be accurate.
- Stomp the tripod legs into the ground; when it is stable, **carefully** mount the level on the top of the tripod. Thread the support screw in the center of the tripod into the corresponding hole on the bottom of the level. How tight? Just right – don't break it.

**STEP 2: Center the bubble**
Once the level is secured onto the tripod, do as much leveling as possible using the tripod legs while looking at the bubble window.

**STEP 3: Fine adjustments**
Use the knobs for fine scale leveling. The three knobs can be adjusted independent of one another and it may seem counterintuitive, but if the level moves one way the bubble goes the other. Once the bubble is **entirely** within the center circle is level.
- Be careful when using the fine adjustment knobs because they will break if they are tightened too hard.
- Be EXTREMELY careful, do not bump the tripod and level once it is set up or you will have to start over.

**EXAMPLE 1: Measuring elevation change with one shot**

Position the level somewhere between the BR and TR. Under ideal conditions, you will be able to view the stadia rod through the level when it is at the BR and TR. Record the heights from the stadia rod that line up with the horizontal crosshair inside the level for both locations on the back of Form 1. Calculate elevation change. Figure 6 shows how to record individual shots and calculate elevation change.

You must measure the elevation change either two or more times. Between repeat measurements, the tripod must be re-leveled or moved (you must move 1 tripod leg at least) to get an independent measurement. In order for the two measurements to be valid, the measurements must be ±10% of one another. For example, in Figure 6 the elevation change of the first shot is 1.21m (4.1 – 2.89). The second shot must be ±10% of the first. To calculate this range, multiply 1.21m by 0.9 to establish the lower threshold (1.09m), and multiply 1.21m by 1.1 to establish the upper threshold (1.33m) (Figure 6). Because the second elevation change was within the ±10% range (1.19m), a third measurement was not required.

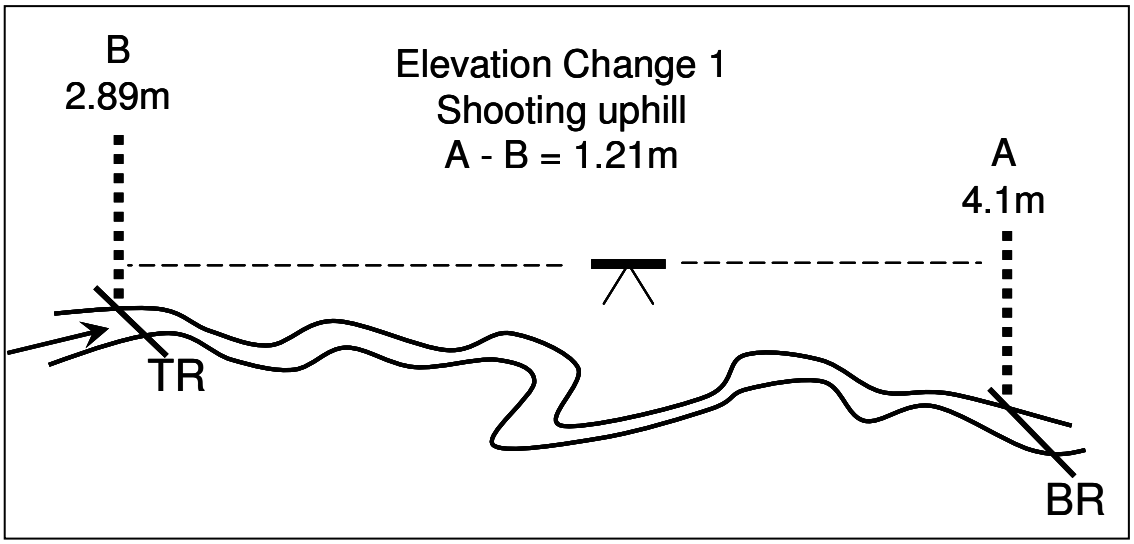



Figure 6: Measuring elevation change using a single shot. The 1st of 2 elevation changes is depicted above.

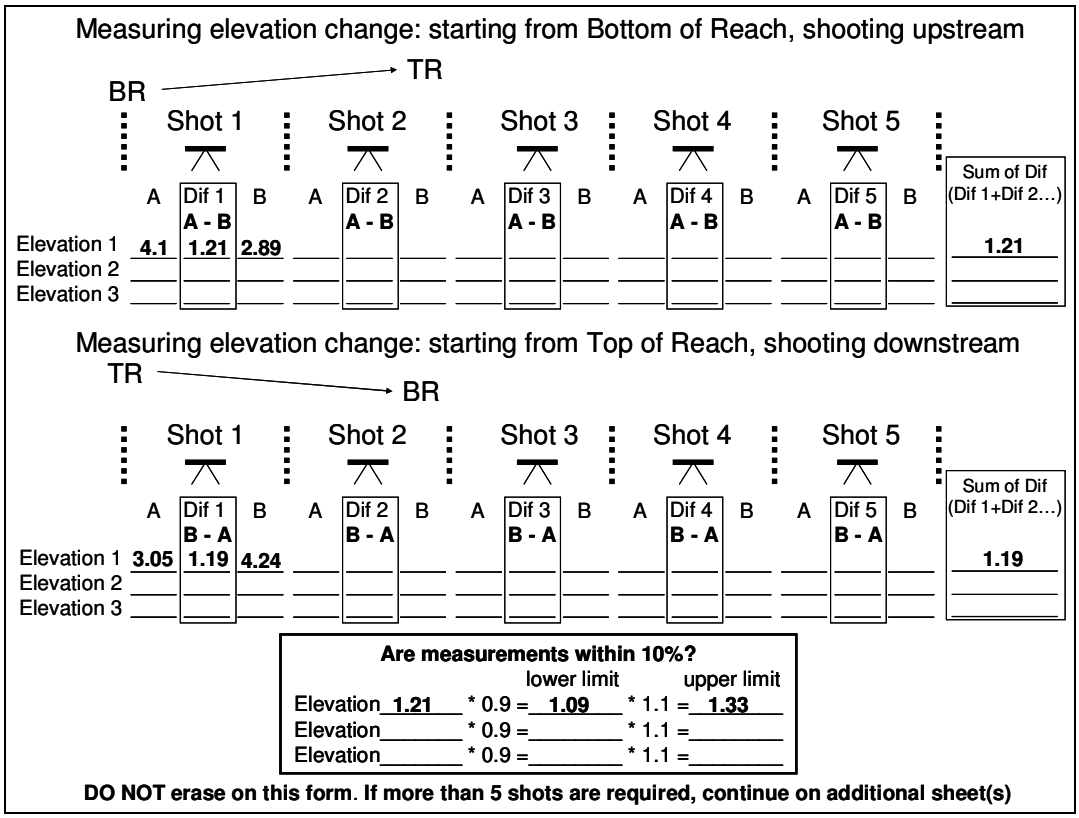
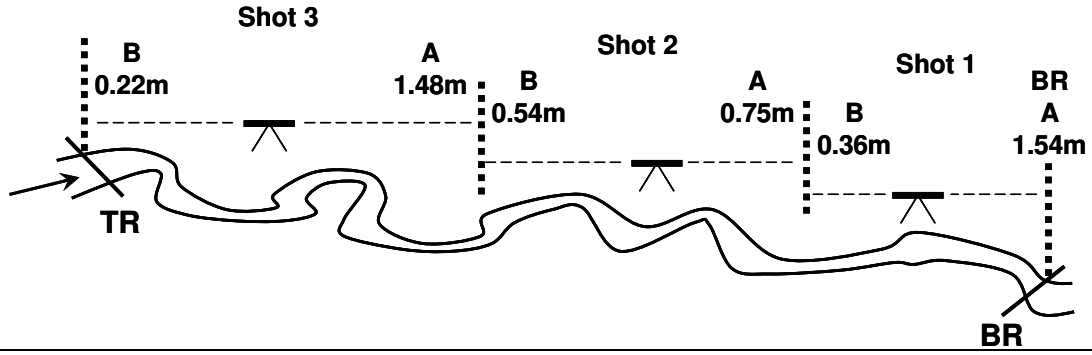



Figure 6. Measuring elevation change using a single shot. (Top) The 1st of 2 elevation changes is depicted above. (Bottom) When shooting from BR to TR (uphill, record on top of form 1) A – B = elevation difference for each shot, when shooting from TR to BR (downhill, record on bottom of form 1) B – A = elevation difference.

**EXAMPLE 2: Measuring elevation change with multiple shots**

Very often, you will not be able to measure the reach elevation change with 1 shot. In the following example, 3 shots are required.

When moving the level to the next shooting location, it is imperative to keep the stadia rod on the **exact same** spot. Intermediate rod positions serve as reference points "connecting" level shot #1 to shot #2, and so on (Figure 7). Also, as stated earlier, the rod must be at the water's surface at the BR and TR, but is not necessary for intermediate readings.




Measuring elevation change: starting from Bottom of Reach, shooting upstream

BR → TR

| | Shot 1 | | | Shot 2 | | | Shot 3 | | | Shot 4 | | | Shot 5 | | | Sum of Dif (Dif 1+Dif 2…) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | Dif 1 **A - B** | B | A | Dif 2 **A - B** | B | A | Dif 3 **A - B** | B | A | Dif 4 **A - B** | B | A | Dif 5 **A - B** | B | |
| Elevation 1 | 1.54 | 1.18 | 0.36 | 0.75 | 0.21 | 0.54 | 1.48 | 1.26 | 0.22 | | | | | | | 2.65 |
| Elevation 2 | 1.77 | 1.10 | 0.67 | 0.63 | 0.33 | 0.30 | 1.56 | 1.20 | 0.36 | | | | | | | 2.63 |
| Elevation 3 | | | | | | | | | | | | | | | | |

Measuring elevation change: starting from Top of Reach, shooting downstream

TR → BR

| | Shot 1 | | | Shot 2 | | | Shot 3 | | | Shot 4 | | | Shot 5 | | | Sum of Dif (Dif 1+Dif 2…) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | Dif 1 **B - A** | B | A | Dif 2 **B - A** | B | A | Dif 3 **B - A** | B | A | Dif 4 **B - A** | B | A | Dif 5 **B - A** | B | |
| Elevation 1 | 0.29 | 1.13 | 1.42 | 0.48 | 0.16 | 0.64 | 0.41 | 1.08 | 1.49 | | | | | | | 2.37 |
| Elevation 2 | | | | | | | | | | | | | | | | |
| Elevation 3 | | | | | | | | | | | | | | | | |

**Are measurements within 10%?**

| | | lower limit | | upper limit |
|---|---|---|---|---|
| Elevation 2.65 | * 0.9 = | 2.39 | * 1.1 = | 2.92 |
| Elevation_____ | * 0.9 = | _____ | * 1.1 = | _____ |
| Elevation_____ | * 0.9 = | _____ | * 1.1 = | _____ |

**DO NOT erase on this form. If more than 5 shots are required, continue on additional sheet(s)**

Figure 7: Calculating reach elevation change using three shots. When the first two measurements are not within ±10% threshold, calculate elevation change a third time.

In this example the first elevation change measurement was 2.65m. The ±10% limits were calculated. The 2nd elevation change was 2.37m, which is outside the 10% threshold, so a 3rd elevation change was calculated. NOTE that elevation change measured uphill (from BR to TR) is recorded on the top of the form, and elevation change measured downhill is recorded on the bottom of the form.

**EXAMPLE 3: Measuring reach elevation change with multiple shots: how to compensate for shots with negative elevation change.**

In some situations you will have a shot with a negative elevation change, shot 2 in the following example (Figure 8). It is **critical to record the numbers in the appropriate area on the form** as shown in the previous examples. This way, the negative elevation change will be accurately recorded.

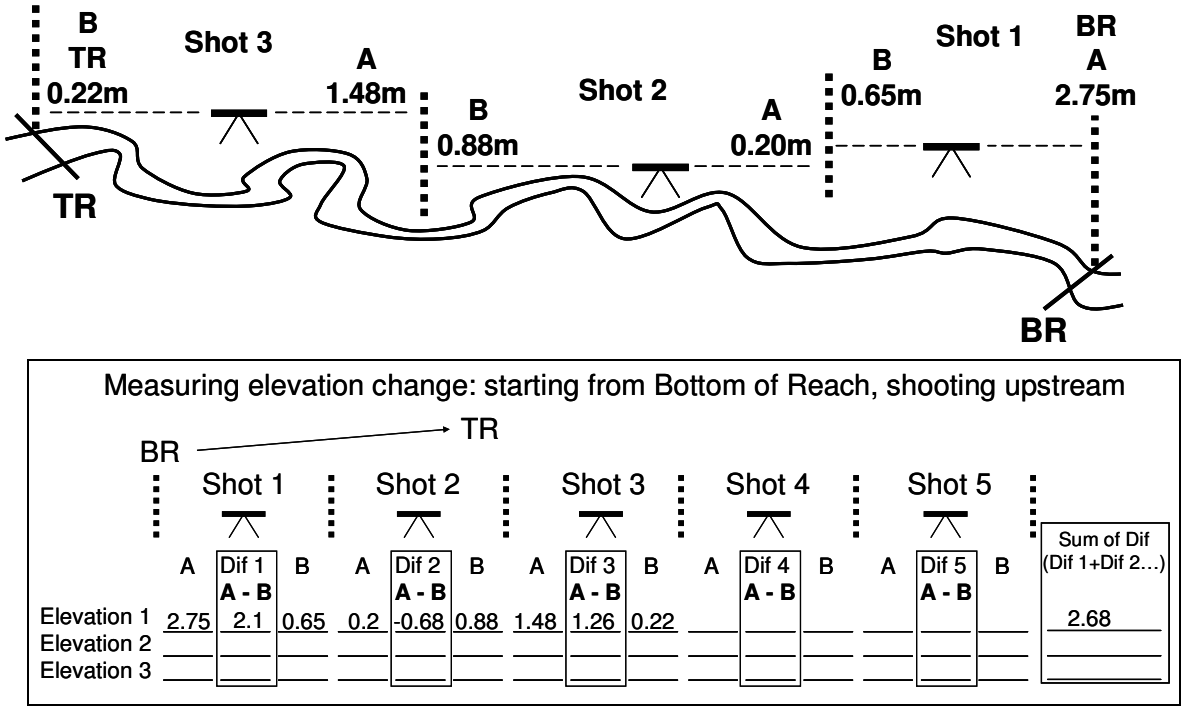



Figure 8. Measuring reach elevation change with multiple shots. In this example shot 2 has a negative elevation change.

# WATER CHEMISTRY

## Conductivity

Measure conductivity once at the upstream end of each reach using a hand held conductivity meter. Measure immediately after transects are laid out and upstream of the last transect flag to insure that the channel sediment has not been disturbed. Take the reading in flowing water, near the center of the channel, and record in parts per million (ppm) on Form 1 and in the data logger. Recalibrate the conductivity meter at the end of each 8-day sampling period.

## Alkalinity

Measure and record total alkalinity and P alkalinity once, at the same time and location as conductivity. Record measurements to the nearest 4 ppm on Form 1 and in the data logger. Specific instructions below:

### PHENOLPHTHALEIN [P] ALKALINITY

1. Fill glass titration tube to 5 mL line with sample water.
2. Add two drops of Alkalinity Indicator # 1 (3870). Cap and mix. If no red color develops, P alkalinity is zero. Proceed to step 7. If red, proceed to Step 3. For kits with tablets substitute 2 drops for 1 white P tablet.
3. Fill Direct Reading Titrator with Alkalinity Reagent B. Insert Titrator in center hole of titration tube cap.
4. While gently swirling tube, slowly depress plunger until red color disappears. Record test result where plunger tip meets titrator scale. Record as P Alkalinity in ppm $CaCO_3$.

EXAMPLE: Plunger tip is 3 minor divisions below 80 line. The test result is 80 + (3 x 4) = 92 ppm, since each division is equal to 4 ppm.

5. If plunger tip reaches the bottom line on the titrator scale (200 ppm) before the endpoint color change occurs, refill titrator and continue titration. When recording test result, include original amount of reagent titratrated (200 ppm).
6. Without moving plunger, remove Titrator and titration tube cap from titration tube containing sample from Step 4.

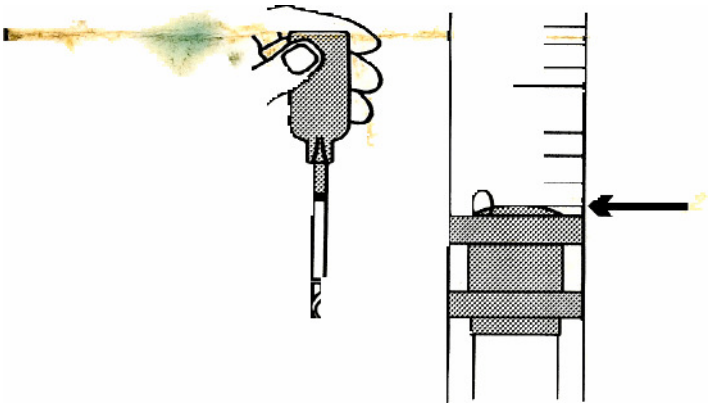
NOTE: Do not move the titrator plunger after P Alkalinity endpoint has been obtained.

### TOTAL [T] ALKALINITY

7. Add two drops Alkalinity Indicator #2. Cap and swirl to mix. A blue color will appear. Insert full Titrator in center hole of titration tube cap. For kits with tablets substitute 2 drops for one black tablet.kp
8. While gently swirling tube, slowly depress plunger until blue color changes to green or red, depending upon which type of kit you are using. Record test result as T Alkalinity in ppm $CaCO_3$. Include total amount of titration reagent added. (See Step 5).

**DIRECT READING TITRATOR INSTRUCTIONS**

1. Fill the titration tube to the line with the water sample.
2. Add the reagents as specified in the instructions for the individual test method. Cap the tube with the special titration tube cap. Mix by swirling gently.
3. Depress the plunger of the Titrator to expel air.
4. Insert the Titrator into the plastic fitting of the titrating solution bottle.
5. To fill the Titrator invert the bottle and slowly withdraw the plunger until the bottom of the plunger is opposite the zero mark on the scale.



**NOTE:** When filling the titrator from a container not fitted with a special plug. Submerge the tip of the titrator below the surface of the solution and withdraw the plunger.

**NOTE:** A small air bubble may appear in the Titrator barrel. Expel the bubble by partially filling the barrel and pumping the titration solution back into the inverted reagent container. Repeat this pumping action until the bubble disappears.

6. Turn the bottle right-side-up and remove the Titrator.
7. Insert the tip of the Titrator into the opening of the titrator tube cap. Slowly depress the plunger to dispense the titrating solution. Gently swirl tube to mix. A slight rotating or twisting motion may permit the plunger to move more smoothly.
8. Continue adding the titrating solution until the specified color change occurs. If no color change occurs by the time the plunger tip reaches the bottom of the scale, refill the Titrator to the zero mark. Continue the titration. Include both titration amounts in the final test result.
9. Read the test result directly from the scale opposite the bottom of the plunger tip.
10. Discard the remaining titration solution and the contents in the glass Titrator.

# POOLS

## Pool Length and Residual Pool Depth

Objectives:
- Quantify the relative length and frequency of pool habitat in each reach.
- Determine the average residual depth of pools.

Pool Criteria: Scour, Dam, & Plunge Pools
Sample every pool within the reach that meets the following criteria for low flow conditions. Use blue flags to delineate pool boundaries.
1. Pools are depressions in the streambed that are concave in profile, laterally and longitudinally.
2. Pools are bound by a head crest (upstream break in streambed slope) and a tail crest (downstream break in streambed slope).
3. Only consider main channel pools where the thalweg runs through the pool, and not backwater pools.
4. Pools span at least 50% of the wetted channel width at any location within the pool. So a pool that spans 50% of the wetted channel width at one point, but spans <50% elsewhere is a qualifying pool.
   NOTE: If a side channel is present, the pool must span at least 50% of the main channel's wetted width; disregard side channels width when making this determination.
5. Maximum pool depth is at least 1.5 times the pool tail depth.

Pool Criteria: Scour & Dam Pools
6. Pool length, measured along the thalweg, is greater than the pools width, measured perpendicular to the thalweg, at the widest point.

Pool Criteria: Plunge Pools
7. Pool length, measured along the thalweg, is less than the pools width, measured perpendicular to the thalweg, at the widest point.
8. The thalweg drops vertically over an obstruction (log, boulder, etc) at the pool's head crest.
9. Pool's max depth must be within a specified distance of the obstruction. This distance is 20% or less of the reach's width category. Example: if a reach has a 10m width category, then a plunge pool's max depth must be 2m or less from the obstruction.

Note: If a pool meets criteria 8 & 9 above, but not 7, then classify the pool as 'scour'.

Note: When islands are present only consider pools in the main channel; don't measure pools in side channels.

Note: When evaluating criteria 4 above, only evaluate the wetted width of the main channel.

Sampling Method:
1. Measure the pool length (nearest 0.1m), maximum depth (nearest cm), and pool tail crest depth (nearest cm) for each pool (Figure 9) that meet the above criteria.
2. Measure pool length along the thalweg between the head crest and tail crest.
3. The maximum depth represents the deepest point in the pool and is found by probing with a depth rod until the deepest point is located. NOTE: estimate maximum depth if it is unsafe to measure.

4. The pool tail crest depth is measured at the maximum depth along the pool tail crest and is normally (but not always) at the thalweg.
5. Record the pool type in the data logger.
   a. Full-channel pool – Concave shape of the pool (measured perpendicular to the thalweg) at any location is > 90% of the wetted channel width.
   b. Partial-channel pool – Concave shape of the pool (measured perpendicular to the thalweg) at any location is between 50 and 90% of the wetted channel width.
6. Record the pool's formation in the data logger: scour, dam, or plunge. Consider a pool dammed if a wood obstruction is backing up all water and forming the pool tail crest (no flow under the wood)
7. Measure the pool tail crest depth on dammed pools along the top of the obstruction if **all** flow is going over the obstruction. If all of the water is not flowing over the obstruction, the pool is a scour or plunge pool, and you will locate the pool-tail in front of or behind the obstruction.

Note: When considering whether to lump or split two potential pools in a situation where both habitat units meet the above criteria for pools, consider them two pools upstream pool has a pool tail that is ≤10cm deeper than the downstream pool tail. Conversely, consider it one pool if the upstream pool tail depth is >10cm deeper than the downstream pool tail depth.

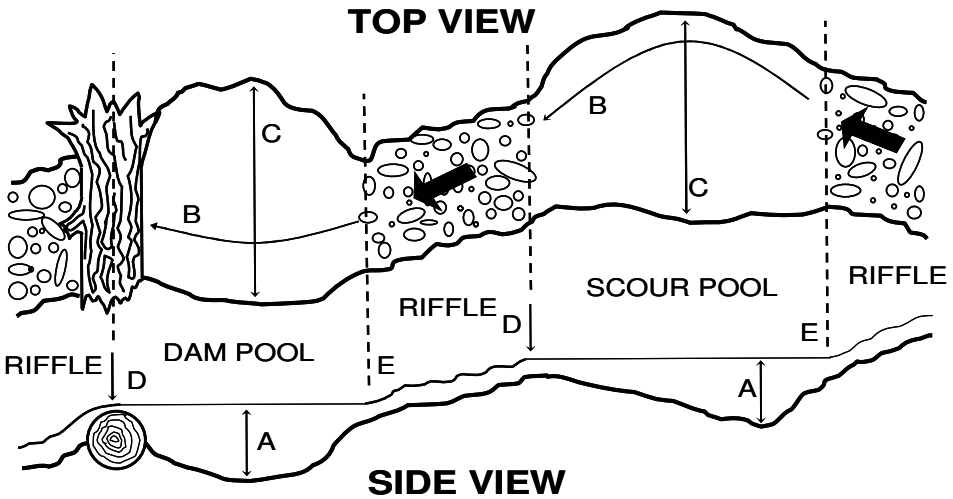



Figure 9. Top and side views of scour and dam pools. Max depth (A), length (B), width (C), tail crest (D) and head crest (E) are labeled.

## Percent Surface Fines on Pool Tails

Objective:

- Quantify the percentage of fine sediments on the pool tail surface of scour pools and plunge pools.

Where to take measurements:

1. Collect measurements in the first ten scour and plunge pools of each reach beginning at the downstream end. Exclude dam pools.
2. Sample within the wetted area of the channel.
3. Take measurements at 25, 50, and 75% of the distance across the wetted channel, following the shape of the pool tail.
4. Take measurements upstream from the pool tail crest a distance equal to 10% of the pool's length or one meter, whichever is less.
5. Locations are estimated visually.

Sampling method:

1. Assess surface fines using a 14 x 14 inch grid with 49 evenly distributed intersections. Include the top right corner of the grid and there are a total of 50 intersections.
2. Take 3 measurements per pool.
   a. Place the bottom edge of the grid upstream from the pool tail crest a distance equal to 10% of the pool's length or one meter, whichever is less (Figure 10).
   b. Place the center of the grid at 25, 50, and 75% of the distance across the wetted channel, making sure the grid is parallel to and following the shape of the pool tail crest.
   c. If a portion of the fines grid lands on substrate 512mm or larger in size (b-axis), record the intersections affected as non-measurable intersections (Figure 11).
3. Record the number of intersections that are underlain with fine sediment < 2 mm in diameter at the b-axis. Place a 2 mm wide piece of electrical tape on the grid and use this to assess the particle size at each intersection.
4. Record the number of intersections that are underlain with fine sediment < 6 mm in diameter at the b-axis. Place a 6 mm wide piece of electrical tape on the grid and use this to assess the particle size at each intersection.
5. Aquatic vegetation, organic debris, roots, or wood may be covering the substrate. First attempt to identify the particle size under each intersection. If this is not possible due to debris, then record the number of non-measurable intersections. Do not attempt to move the obstructing debris

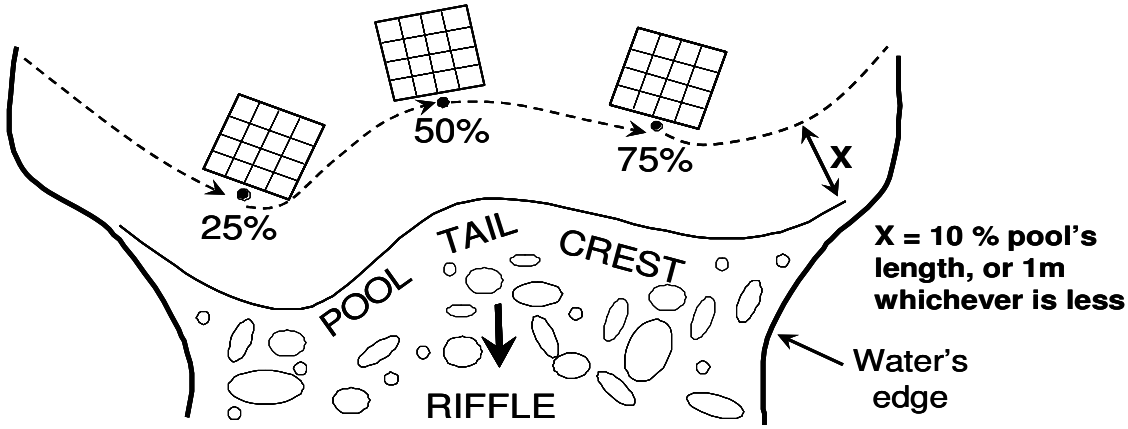



Figure 10. Location and orientation of pool tail fines grids relative to the pool tail crest

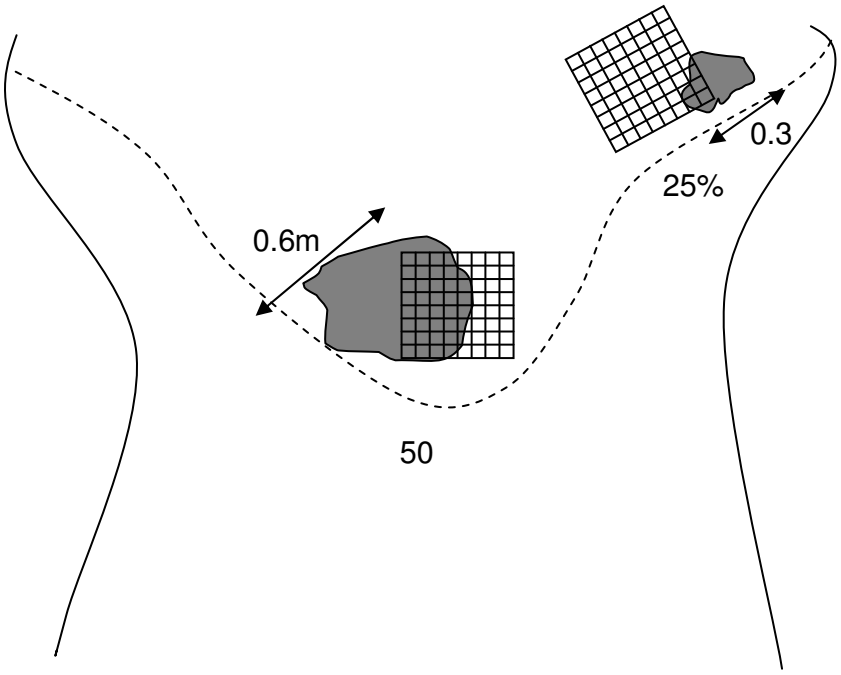



Figure 11. In this figure, all intersections of the fines grid at the 25% placement will be counted and recorded. For the 50% placement, the intersections of the fines grid that land on the boulder (substrate ≥512mm) will be recorded as non-measurement. (AREMP 2006)

**NOTE:** your number of fines < 2mm cannot exceed the number of fines < 6mm

## CHANNEL CROSS-SECTION MEASUREMENTS

Objective:

- Determine bankfull width-to-depth ratio and entrenchment ratio.

Where to take the measurements:

1. Measure one cross-section and entrenchment width within each of the first 4 riffle/runs that meet the following guidelines. If one of the first 4 riffles/runs does not meet these criteria, use the next upstream riffle/run if it is within the reach boundaries. Only sample riffle/runs that meet these criteria, even if fewer than 4 are sampled.
2. The channel must be relatively straight and preferably have clearly defined bankfull indicators either within the riffle or in adjacent habitat units. Do not sample a riffle/run if the entire length of the riffle/run occurs at a meander or the bankfull elevation cannot be determined.
3. When a side channel is present, use the main channel to determine if the channel is straight or meandered.
4. There are no minimum length criteria for the riffle/run.
5. Locate cross-sections at the widest part of the riffle. Measure widths between bankfull elevations with the tape stretched perpendicular to the channel. If islands are present, subtract the width of the island above the bankfull elevation from the total width of both channels.
6. Do not sample areas where human/animal crossings or abandoned channels exist, thereby increasing the channel width.
7. Take measurements at the point where one pool ends, and the other begins, when riffle/runs are not present.

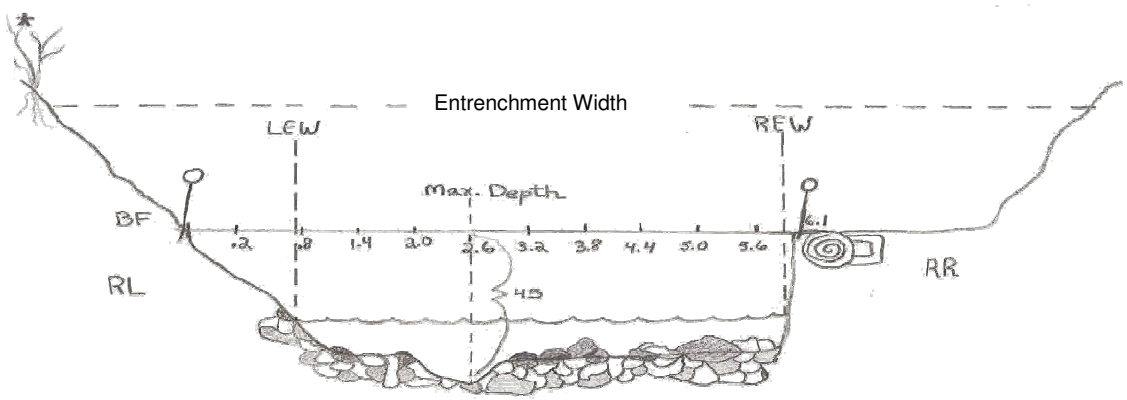
How to take measurements:

1. Determine and flag the bankfull elevation on each bank. Stretch the tape perpendicular to the channel between bankfull elevations with the “zero” end of the tape on the left bank (RL) looking downstream. Make sure the tape is straight and not bowed. Measure and record bankfull width in meters to the nearest cm.
2. Take a minimum of 10 equally spaced depth measurements starting at bankfull on the left bank and ending at bankfull on the right bank. Calculate the distance between measurements by dividing the bankfull width by 10 and rounding down (ex. bf width=7.8m → interval between measurements=0.7m). Randomly choose the location of the first measurement (using the random number table in the data logger) between bankfull on the left bank and the distance of the interval calculated above (Figure 12a).
3. At each depth measurement record the distance along the tape and the depth from the streambed to the bankfull elevation in cm. At the bankfull location of each bank, record the location along the tape and a depth of “0”.

4. In addition, record a measurement type for each applicable depth measurement. Use the following codes:

| Meas. Type Code | Rod Location |
|---|---|
| BFDIST | Bankfull distance on RR |
| LEB | Left edge of bar/island |
| LEW | Left edge of water |
| MAXDEP | Maximum depth |
| ON_BAR | On bar or island |
| ON_BLD | On a boulder |
| REB | Right edge of bar/island |
| REW | Right edge of water |

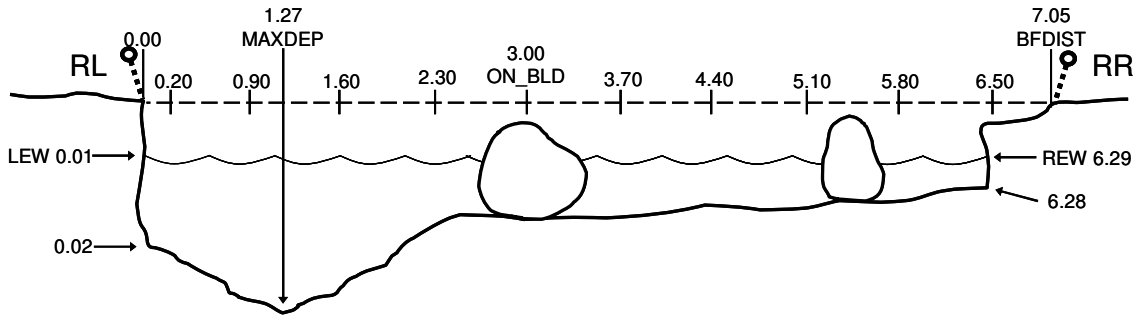
5. Record the maximum bankfull depths from each cross-section on Form 1. NOTE: The average of the maximum bankfull depths is used in conjunction with the local bankfull elevation to determine the upper limit of bank angle (Figure 14) and bank stability plots (Figure 26) when conducting streambank measurements.




| XsecNum | 1 | |
|---|---|---|
| BFDist | BFDepth | MeasType |
| 0.00 | 0 | |
| 0.20 | 10 | |
| 0.70 | 20 | LEW |
| 0.80 | 30 | |
| 1.40 | 40 | |
| 2.00 | 38 | |
| 2.60 | 45 | MAXDEP |
| 3.20 | 40 | |
| 3.80 | 35 | |
| 4.40 | 33 | |
| 6.00 | 30 | |
| 6.08 | 30 | |
| 6.09 | 20 | REW |
| 6.10 | 0 | BFDIST |

| | |
|---|---|
| Random # = | 0.2 m |
| BF Width = | 6.1 m |
| Interval = | 0.6 m |
| Entrenchment Width = | 10.0 m |

Figure 12a. Channel cross-section figure and tables displaying the location of the tape; layout of depth measurements along the tape; additional measurements of LEW, REW, and maximum depth, bankfull distance; and the location for the entrenchment width at twice the maximum BF depth.

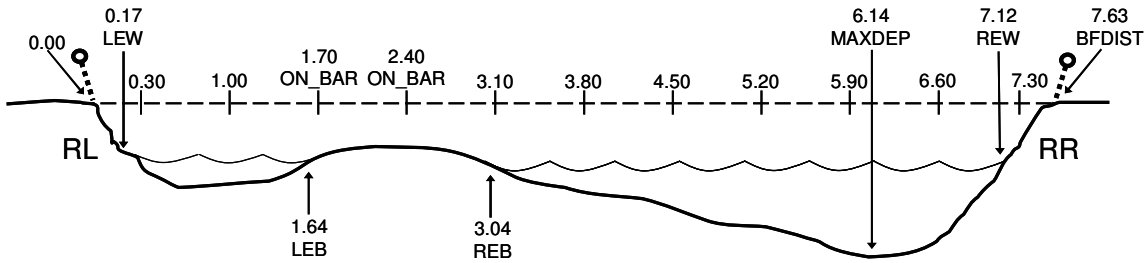



| XsecNum | 2 | |
|---|---|---|
| BFDist | BFDepth | MeasType |
| 0.00 | 0 | |
| 0.01 | 20 | LEW |
| 0.02 | 37 | |
| 0.20 | 39 | |
| 0.90 | 50 | |
| 1.27 | 53 | MAXDEP |
| 1.60 | 41 | |
| 2.30 | 32 | |
| 3.00 | 9 | ON_BLD |
| 3.70 | 32 | |
| 4.40 | 30 | |
| 5.10 | 29 | |
| 5.80 | 27 | |
| 6.28 | 24 | |
| 6.29 | 20 | REW |
| 6.50 | 10 | |
| 7.05 | 0 | BFDIST |

| | |
|---|---|
| Random # = | 0.2 m |
| BF Width = | 7.05 m |
| Interval = | 0.7 m |
| Entrenchment Width = | 11.0 m |

Figure 12b. Channel cross-section with vertical banks and boulders. If measurements fall on boulders a) within wetted channel and b) above water's surface code the measurements 'ON_BLD'.

6. When the streambank is vertical, enter a depth of "0" at bankfull on the tape, "0.01" for the water's edge and the depth to the streambed at "0.02". For example, (0,0), (0.01,0.20 LEW), and (0.02,0.40) (Figure 12b).
7. Only measure to the edge of the bank when an undercut exists. Do not measure beneath the undercut.

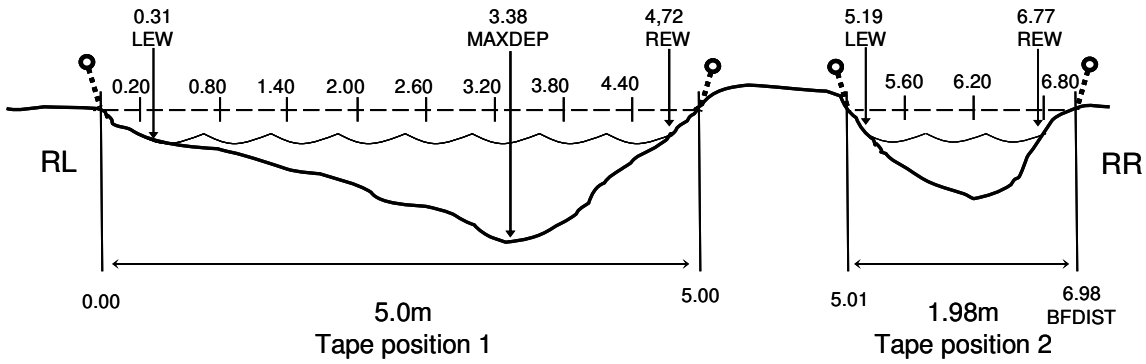



| XsecNum | 3 | |
|---|---|---|
| BFDist | BFDepth | MeasType |
| 0.00 | 0 | |
| 0.17 | 20 | LEW |
| 0.30 | 22 | |
| 1.00 | 25 | |
| 1.64 | 20 | LEB |
| 1.70 | 18 | ON_BAR |
| 2.40 | 15 | ON_BAR |
| 3.04 | 20 | REB |
| 3.10 | 22 | |
| 3.80 | 26 | |
| 4.50 | 30 | |
| 5.20 | 34 | |
| 5.90 | 39 | |
| 6.14 | 44 | MAXDEP |
| 6.60 | 40 | |
| 7.12 | 20 | REW |
| 7.30 | 13 | |
| 7.63 | 0 | BFDIST |

| | |
|---|---|
| Random # = | 0.3 m |
| BF Width = | 7.63 m |
| Interval = | 0.7 m |
| Entrenchment Width = | 13.5 m |

Figure 12c. Channel cross-section with bar below bankfull.

8. Measure islands lower than the bankfull elevation as illustrated above (Figure 12c).




| XsecNum | 4 | |
|---|---|---|
| BFDist | BFDepth | MeasType |
| 0.00 | 0 | |
| 0.20 | 12 | |
| 0.31 | 20 | LEW |
| 0.80 | 23 | |
| 1.40 | 33 | |
| 2.00 | 38 | |
| 2.60 | 41 | |
| 3.20 | 46 | |
| 3.38 | 51 | MAXDEP |
| 3.80 | 42 | |
| 4.40 | 23 | |
| 4.72 | 20 | REW |
| 5.00 | 0 | |
| 5.01 | 0 | |
| 5.19 | 20 | LEW |
| 5.60 | 34 | |
| 6.20 | 39 | |
| 6.77 | 20 | REW |
| 6.80 | 17 | |
| 6.98 | 0 | BFDIST |

| | |
|---|---|
| Random # = | 0.2 m |
| BF Width = | 6.98 m |
| Interval = | 0.6 m |
| Entrenchment Width = | 14.5 m |

Figure 12d. Cross section with island ≥ bankfull height.

9. For islands higher than bankfull, measure the 2 channels separately (Figure 12d). Make sure to record a “0” depth at bankfull for both channels. Record two ‘REW’, two ‘LEW’ and one ‘MAXDEP’. Tapes must be perpendicular to each channel. After entering data, hit F4 to back out, the logger will beep and display a message indicating there are errors. Hit F5, and under ‘comment’ hit F2 and select “island present” as a comment from the drop down menu.

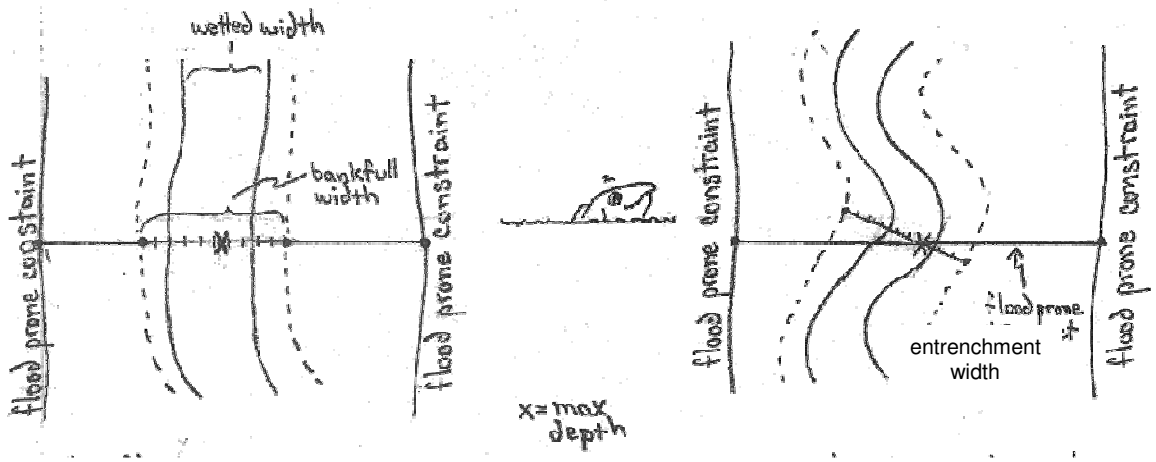



Figure 13. Measure entrenchment width perpendicular to the flood prone constraints (AREMP 2004).

10. Measure the entrenchment width at the cross-section. This is the width of the channel/floodplain at twice the maximum bankfull depth as determined during the cross-section measurement. Use a hand level to determine the correct elevation. Record the width to the nearest 10 cm. The cross-section may have to be rotated so that the entrenchment measurement is perpendicular to the flood prone constraints. Rotate the cross-section at the maximum depth location (Figure 13).
11. The entrenchment width can be difficult to measure in very large systems with wide valley bottoms or thick vegetation. Instead of using a tape, estimate the width by either pacing or using visual estimation and record. If the entrenchment width is estimated, enter an ‘estimated’ comment in the data logger.

## CHANNEL TRANSECTS

Objective:

- Channel transects define the location for measurements of bank angle, bank stability, undercut depth, bank type, bank material, pebble counts and bankfull width.

Where to take measurements:

1. Measure the following attributes at each transect flag (both the right and left banks): bank angle, undercut depth, bank stability, bank material, bank type, location of greenline quadrats.
2. Measure between transect flags: bankfull width and particle size counts.
3. In a few limited situations where a tight meander occurs, the transect may cross a point bar without intersecting the actual bank (located behind the point bar). Enter '-99 point bar' bank angle, 'NA' for bank stability, 'cannot measure' for bank material, 'NA' for bank type, and 'NA' for location of greenline quadrats.
4. Depositional features, such as point bars, are considered depositional when perennial vegetation cover is < 50% and considered streambank when $\geq$ 50% vegetated.
5. In a few situations, it can be difficult to determine differences between the streambed and streambank in reaches with cobble or bedrock substrate. Begin assessing all streambank measurements at the scour line in these situations.

### Bank Angle (Normal and Undercut)

Objective:

- Quantify bank angle and the frequency of undercut banks within the reach.

Where to take the measurements:

Upper limit of measurement = first flat depositional feature at or above bankfull; if this feature is not present, upper limit is depicted in Figure 14.
Lower limit of measurement = where streambed and streambank meet
NOTE: deposition (of streambed material) extends above the scour line, start measurements

1. These methods were described by Platts et al. (1987) and have been more thoroughly defined to increase measurement precision. The bank angle methodology is complex and describes many different situations. The process will be easier if you use the following steps at each location before taking measurements. Define these locations at each flag.
   A. **The location where the streambed and bank meet can be identified by:**
      i. Break in the relatively steep streambank slope to a more gently sloping streambed.
      ii. Associated with a rapid fining of particles from relatively coarse streambed particles to the finer streambank particles.
      iii. Normally (but not always) below the current water level.
      iv. The streambed always has < 50% terrestrial vegetative cover.
   B. **Scour line (SL)** - Locate the scour line by examining features along the streambank. The ceiling of undercut banks, limit of sod forming vegetation, and limit of perennial vegetation are useful in identifying the SL. On depositional features such as point bars, the SL is often defined by the limit of perennial vegetation, or by an indentation in the bar (locally steep area).
   C. **Bankfull elevation** - Use indicators described on page 11.

D. **First flat, depositional feature** - This feature defines the upper boundary of the streambank that will be assessed for bank angle and bank stability. Stop the measurement at the first flat, depositional feature beginning at the bankfull elevation (page 11). If this feature is not present, use Figure 14 to determine the upper limit of bank angle plot. The upper limit is calculated by adding the average maximum bankfull depth from cross-sections (on Form 1) to the bankfull elevation at each transect. If no local bankfull indicator is present, use bankfull elevation determined during reach set up.

2. If the bank is inaccessible at a transect (i.e. dense vegetation or a debris jam), record '-99 cannot measure'.

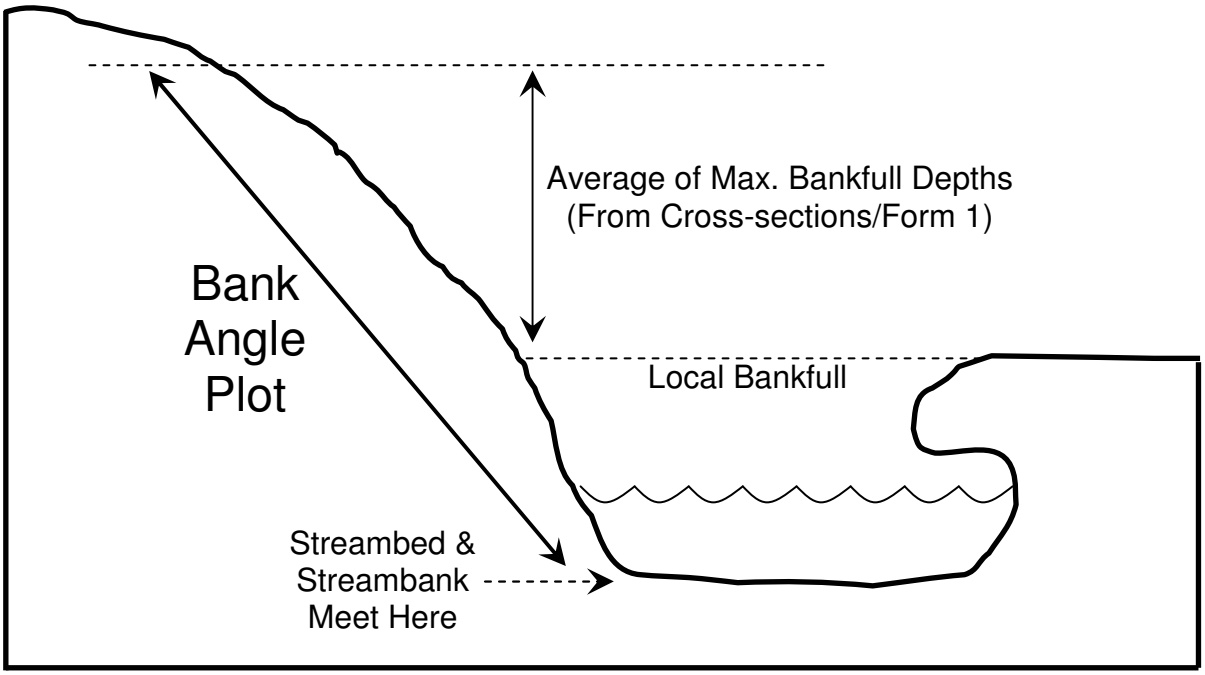



Figure 14. Bank angle plot when flat depositional feature is absent. The upper limit of bank angle plot is determined by adding the maximum bankfull depths from cross-sections to the local bankfull elevation. If a local bankfull indicator is not present, use average bankfull height calculated during reach set up (see bankfull height page 11). The lower limit of the bank angle plot is the point where the streambed and streambank meet.

<u>How to take measurements:</u>

1. For a **non-undercut** bank, lay a depth rod along the bank and perpendicular to the channel at the exact location of the transect flag. Place a compass on top of the depth rod (not on the sides) and record the angle to the nearest degree. **NOTE:** Make sure the compass is set at either 90 or 270º.

   **Simple Banks**

   - If the bank slopes away from the streambed, the bank angle is > 90° from horizontal. To obtain the actual angle for these banks, subtract the value on the compass from 180 (e.g. the compass reading is 30; 180 - 30 = 150°).
   - Forgetting to subtract bank angles from 180 is a common error, before recording data always think, "is the angle obtuse (>90º) or acute (<90º)?"

- Measure the angle from the base of the bank (where the streambed and bank meet) up to the first flat, floodplain-like surface located at or above the bankfull elevation. If a bankfull indicator / feature is not present, use Figure14 to determine the upper limit of bank angle plot. The upper limit is calculated by adding the average maximum bankfull depth from cross-sections (on Form 1) to the bankfull elevation (page 11) at each transect. If no local bankfull indicator is present, use bankfull elevation determined during reach set up.

**Complex Banks: 2 or more angles ≥ 10cm in height**

- Streambanks are rarely one continuous angle from the streambed to the first flat, depositional feature. When a bank has more than 1 angle, consider each angle with a vertical height of ≥ 10 cm.
- Some banks rise steeply from the streambed and then become less steep near the flat floodplain-like surface (convex). Measure the angle of the lower portion of the bank if it is taller than the upper portion (Figure 15). Similarly, measure the angle of the upper portion of the bank if it is taller (Figure 16).
- The same concept applies to concave shaped banks.
- It is difficult to accurately measure the angle when the bank rises in a stair-step fashion. A stair-step bank is defined as 3 or more separate angles each ≥ 10 cm in vertical height. This applies to concave, convex, and relatively straight banks. Measure the average angle by laying the depth rod along the outer corner of the steps (Figure 17). The bottom of the depth rod will be on the streambed and not where the streambed and bank meet.

**Depositional Features**

- Depositional features are not considered part of the bank. On un-vegetated depositional features such as point bars, start the measurement at the point where the top of the depositional feature and streambank meet (Figure 18).
- Do not measure if the deposition ends at or above the first flat, floodplain-like feature (Figure 19). Record '-99 deposition bank'.
- Use the point where the depositional feature becomes > 50% vegetated (perennial species) to define were the deposition ends and bank begins.

**Slump Blocks**

- Slump blocks that have fractured but are still attached to the bank can be large enough to function as part of the bank. They may also have a flat, floodplain-like feature at or above bankfull.
- Measure the angle of the slump block if the bottom of the fracture feature is elevationally above the SL (Figure 20). Measure the angle of the fracture feature behind the slump block if the bottom of the fracture feature is elevationally equal to or below the SL (Figure 21).
- Do not consider slump blocks that are not attached to streambank

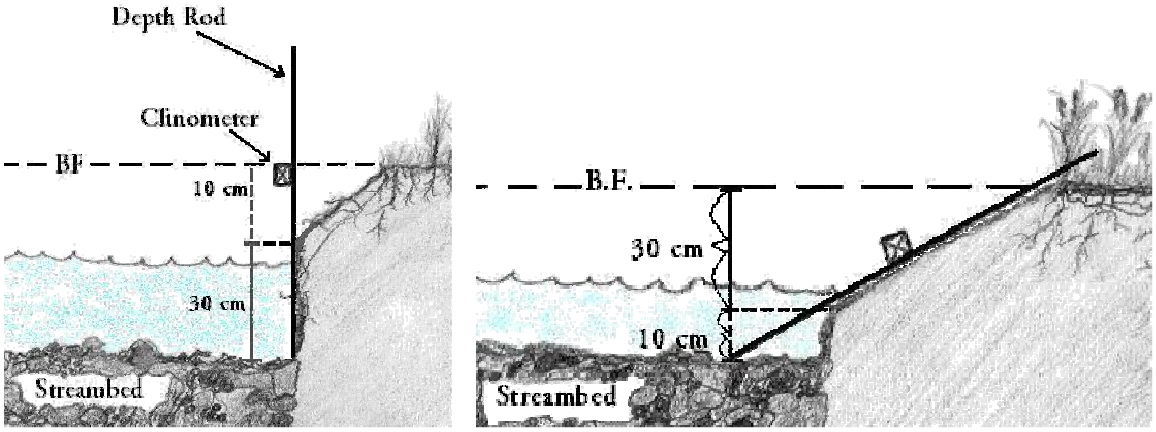
**Logs and Rocks**

- As with slump blocks, view logs (≥ 10 cm) and rocks (≥ 15 cm) as part of the bank if they are embedded within the bank. Consider it embedded if the contact point behind the rock/log and the bank is elevationally above the SL. Measure the bank behind the rock/log if the space is elevationally below the SL.

2. If the bank is **undercut** or vertical (≤ 90°), the bank angle can be read directly from the compass. Measure from underneath the overhang using the following criteria:
   a. The undercut must be ≥ 5 cm deep, ≥ 10 cm in height, and >10 cm in width.
   b. Overhanging bank angles are measured from the deepest point of the undercut up to the ceiling of the overhang (Figure 22).

c. Occasionally the back of the undercut will be a consistent depth, thereby lacking a deepest point (Figure 23). Place the depth rod at the highest elevation, resulting in the smallest angle (angle B).
d. Enter the angle as "1°" if the deepest part of the undercut is elevationally above the ceiling (Figure 24).
e. In some situations, there will be an undercut with a ceiling below bankfull and a second undercut with a ceiling above bankfull. Measure the lower undercut and ignore the upper one.

3. Take a horizontal **undercut depth** measurement using the following criteria:
   a. Measure undercut depths at the same location as the bank angle. After measuring the angle, leave the end of the rod against the deepest point of the undercut and drop the rod until it is horizontal to the water surface and perpendicular to the stream channel. Measure the distance from the deepest point to the outer edge of the bank to the nearest cm (Figure 22).
   b. The previous criteria are for typical undercut banks where the ceiling of the overhang is below or equal to the bankfull elevation. In situations with active erosion or cut-banks, the ceiling of the overhang may be above the bankfull elevation. These banks are measured similar to non-undercut banks. Place the bottom of the depth rod where the streambed and streambank meet and the top at the outer edge of the bank above the undercut. Record the undercut depth as '-99 above bankfull' when the angle is < 90° (Figures. 25 and 26).




Figures 15 and 16. Measure the tallest angle when the bank has two dominant angles.

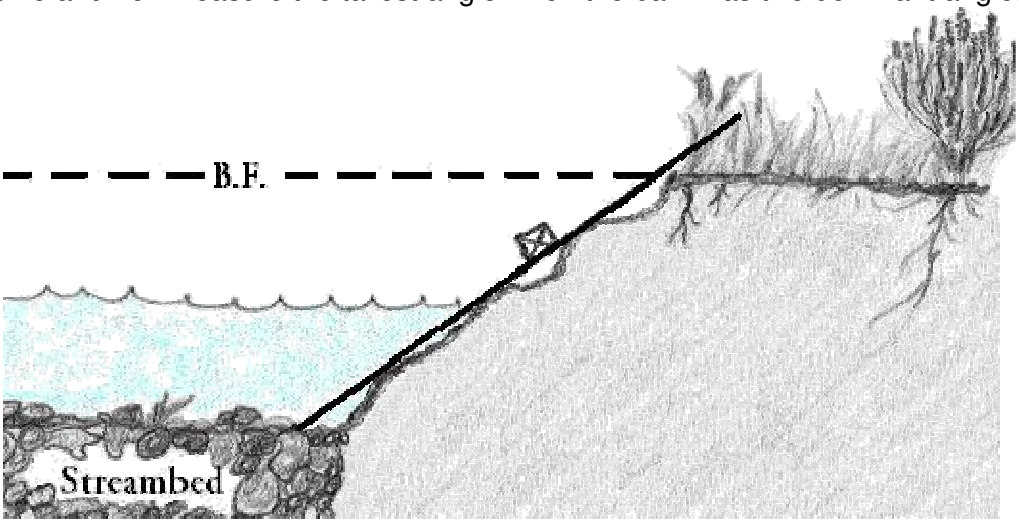


Figure 17. Measure the angle of banks with 3 or more angles by laying the rod along outer edges.

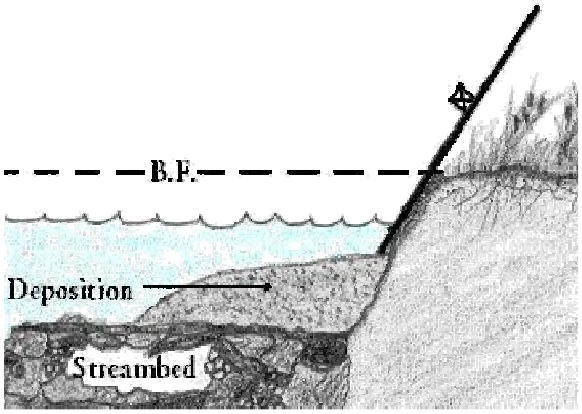



Figure 18. Begin measuring the angle from the point where the deposit and bank meet.

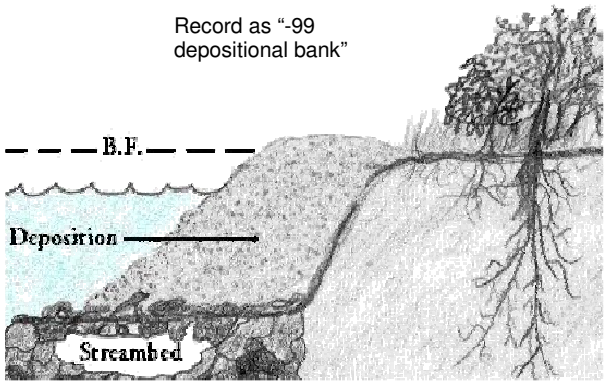
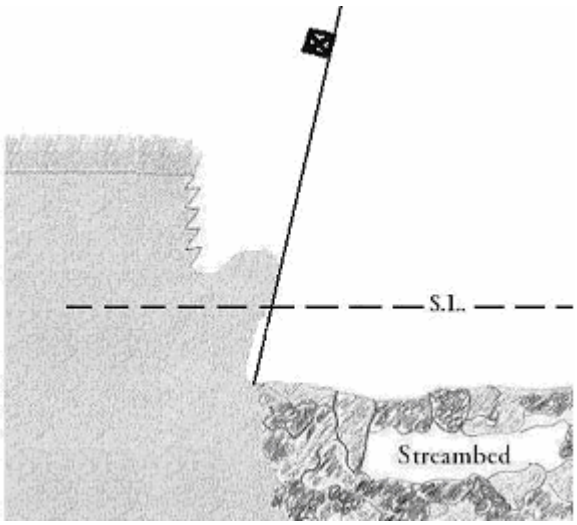
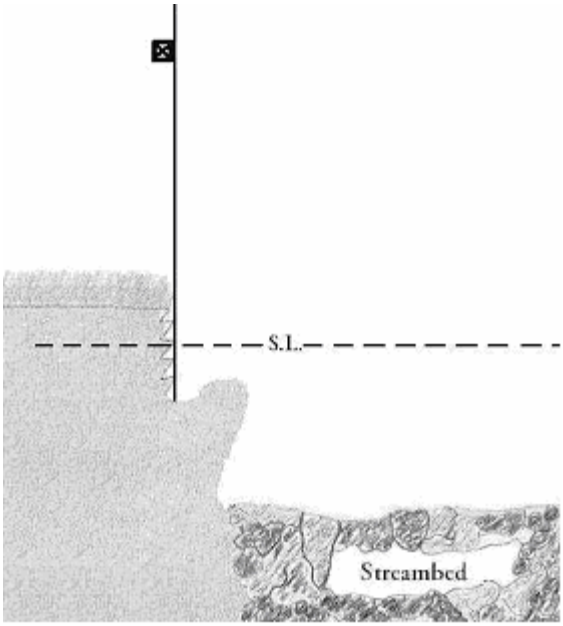



Figure 19. Do not measure an angle when the deposit covers the first flat, floodplain like feature. Record -99 for bank angle.




Figures 20 and 21. Location of bank angle measurements with a slump block still attached and relative to the scour line.

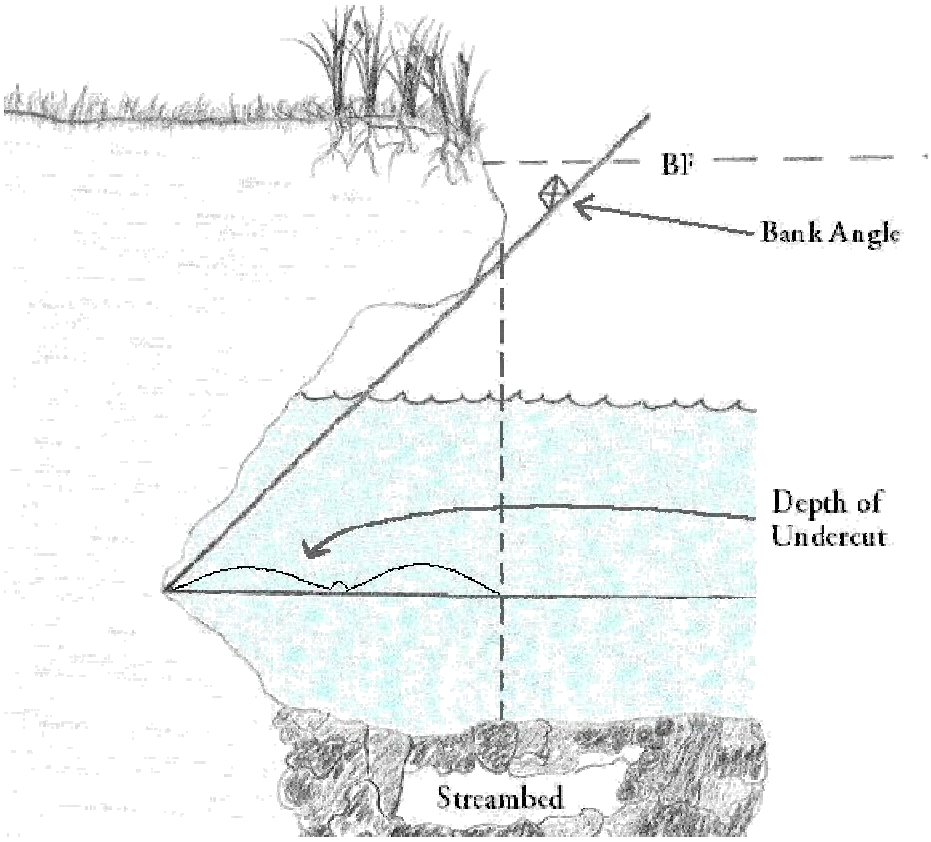



Figure 22. Measure undercut bank angle from the deepest point to the ceiling of the undercut; measure undercut depth from the deepest point to the outer edge of the bank in cm.

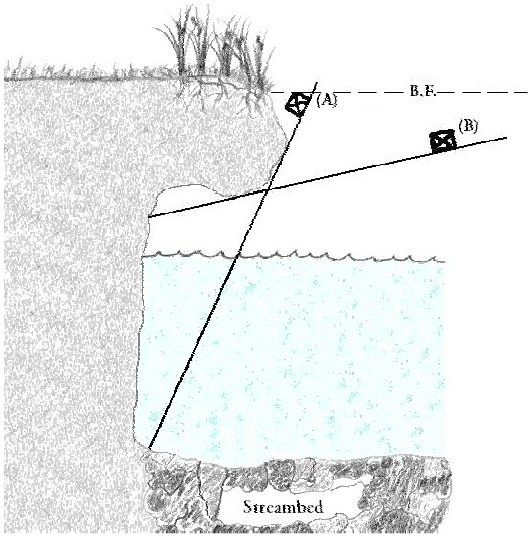



Figure 23. Undercut banks with a constant depth are measured with the base of the depth rod at the highest elevation (angle B, not angle A).

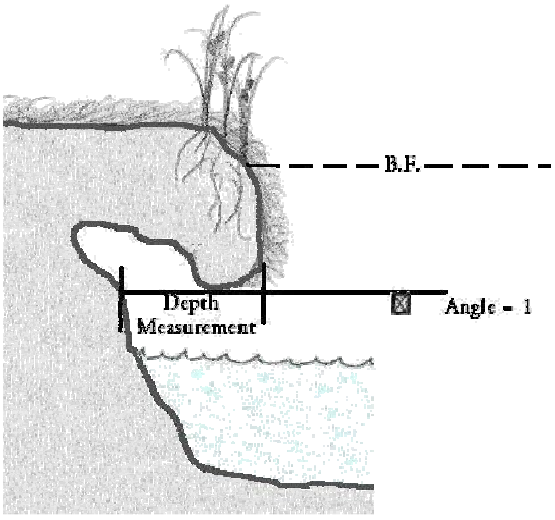
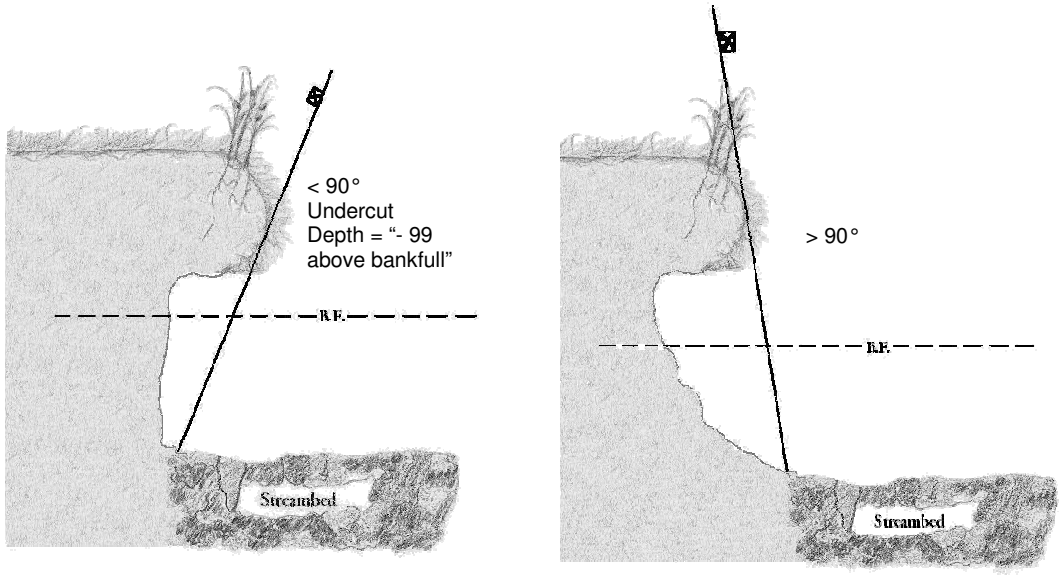



Figure 24. When the deepest point is elevationally above the ceiling of the undercut, take the depth measurement with the depth rod horizontal and directly underneath the ceiling. Record the angle as 1°.




Figures 25 and 26. Undercut banks with the ceiling above bankfull are measured from where the streambed and bank meet to the outside edge of the undercut.

## Bank Stability

Objective:

- Calculate the percentage of streambanks that are stable.

Where to take measurements:

This method was described by Bauer and Burton (1993). They have been modified and more thoroughly defined to increase measurement precision. The following guidelines define the area of bank to evaluate:

1. The stability plot is 30 cm wide (15 cm on each side of the transect flag) and perpendicular to the streambank (not stream channel).
2. Use the following rules to determine the bottom and upper limit of the plot. Depositional features are considered depositional when perennial vegetation cover is < 50% and considered streambank when ≥ 50% vegetated.
   a. When streambank has no depositional features above scour line (SL), the bottom of the plot is at SL.
   b. When streambank has depositional features above the SL, but below bankfull elevation, the bottom of the plot is where the depositional feature ends and streambank begins.
   c. When streambank has depositional features above the SL and bankfull elevation, the bottom of the plot is the first line of perennial vegetation below bankfull. If there is no line of perennial vegetation on the depositional feature record as US.
   d. The upper limit of the plot extends up to the first flat, floodplain-like feature located at or above bankfull. If this feature is not present, use Figure 27 to determine the upper limit of bank stability plot. The upper limit is calculated by adding the average maximum bankfull depth from cross-sections (on Form 1) to the bankfull elevation (page 11) at each transect. If no local bankfull indicator is present, use bankfull elevation determined during reach set up.

3. Unstable features are counted if ≥10 cm in any dimension. Record the unstable feature when both stable and unstable features occur at the same plot. So, if there's a 10 cm wide unstable feature within the 30 cm wide stability plot, record unstable.
4. Hoof prints by themselves are not a sign of instability unless they move the bank by ≥ 10 cm.
5. Slump blocks that have fractured but are still attached to the bank can be large enough to function as part of the bank. They may also have a flat, floodplain-like feature at or above bankfull. They are classified as a fracture feature and evaluated under Part III of the classification key.
6. Do not evaluate the bank as fractured if the bottom of the fracture feature is elevationally above the upper limit of the stability plot.

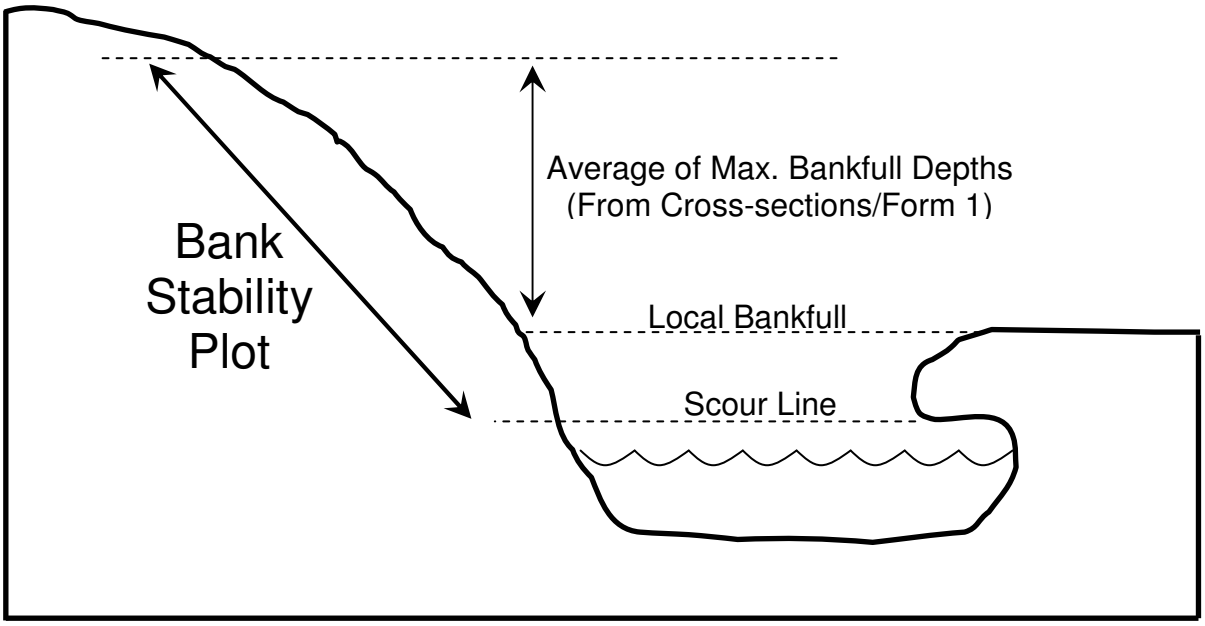



Figure 27. Bank stability plot when flat depositional feature is absent. The upper limit of bank angle plot is determined by adding the maximum bankfull depths from cross-sections to the local bankfull elevation. If a local bankfull indicator is not present, use average bankfull height calculated during reach set up (see bankfull height page 11). The lower limit of the stability plot is the scour line.

How to take measurements:

Streambank cover is an assessment of the percent of bank protected. Banks are considered "covered" if they show any of the following features.

- Perennial vegetation ground cover is greater than 50% (moss is not perennial). Includes live herbaceous vegetation; dead, rooted grasses; and the canopy of shrubs < 1 meter in height.
- Roots of vegetation cover more than 50% of the bank (deep rooted plants such as willows and sedges provide such root cover).
- At least 50% of the bank surfaces are protected by rocks of cobble size (15 cm) or larger. Rocks do not need to be embedded.
- At least 50% of the bank surfaces are protected by logs of 10 cm in diameter or larger. Logs do not need to be embedded.
- At least 50% of the bank surfaces are protected by a combination of the above.

## Streambank Stability Classification Key

Depositional Bank - A streambank with deposition extending above the SL.
Scour Bank - A streambank with no deposition or deposition is below or equal to the elevation of the SL.
Scour Line - Locate the scour line by examining features along the streambank. The ceiling of undercut banks, limit of sod forming vegetation, and limit of perennial vegetation are useful in identifying the SL. On depositional features such as point bars, the SL is often defined by the limit of perennial vegetation, or by an indentation in the bar (locally steep area) just above the SL.
Slump Block - That piece of the bank that is detaching or has detached from the streambank.
Crack - A crack in the streambank (start of a fracture feature), but the slump block has not begun detaching from the bank.
Fractured - Slump block has at least partially broken from the bank and is separated from its original location by $\geq$ 10 cm.
Fracture Feature - The piece of the bank (usually vertical) exposed by the detaching slump block.
Covered - Perennial vegetation cover is greater than 50%, roots and root mats cover more than 50% of the bank, at least 50% of bank consists of rocks $\geq$ 15 cm in size, or at least 50% of bank is covered by large woody debris (LWD) $\geq$ 10 cm in diameter.

I. Streambank present .....go to II
Tributary … .....NA

II. Streambank = Scour Bank ..... go to III
Streambank = Depositional Bank (Figure 28)
Deposition at or above the first, flat depositional feature ..... US
Bank covered (deposition below bankfull)..... CS
Bank not covered (deposition below bankfull)..... UU

III. Bank is not fractured, or the bank is fractured with the slump block no longer attached to the streambank and is either lying adjacent to the breakage or absent ..... go to IV

Bank is fractured <u>with</u> the slump block still attached (Figure 28). Consider the slump block unattached if only gravity/friction is keeping it in place.
A. The bottom of the fracture feature is elevationally below the SL (view only the fracture feature behind the slump block)
Bank not covered
Bank angle within 10° of vertical (80° - 100°)..... UU
Bank angle not within 10° of vertical ..... US
Bank covered ..... CS
B. The bottom of the fracture feature behind slump block is elevationally above the SL (view the bank as the slump block and the fracture feature the vertical, exposed bank)
Bank not covered ..... UU
Bank covered
Fracture feature not covered ..... CU
Fracture feature covered (slump block re-connected to bank) ..... FB
IV. No crack visible from the SL up to a point 15 cm behind the top of the bank..... go to V
A crack is visible within this area (Figure 28)
Bank is not covered..... UU
Bank covered ..... CU

V. All other situations (Figure 29).
Bank not covered
Bank angle within 10° of vertical (80° - 100°)..... UU
Bank angle not within 10° of vertical ..... US
Bank covered ..... CS

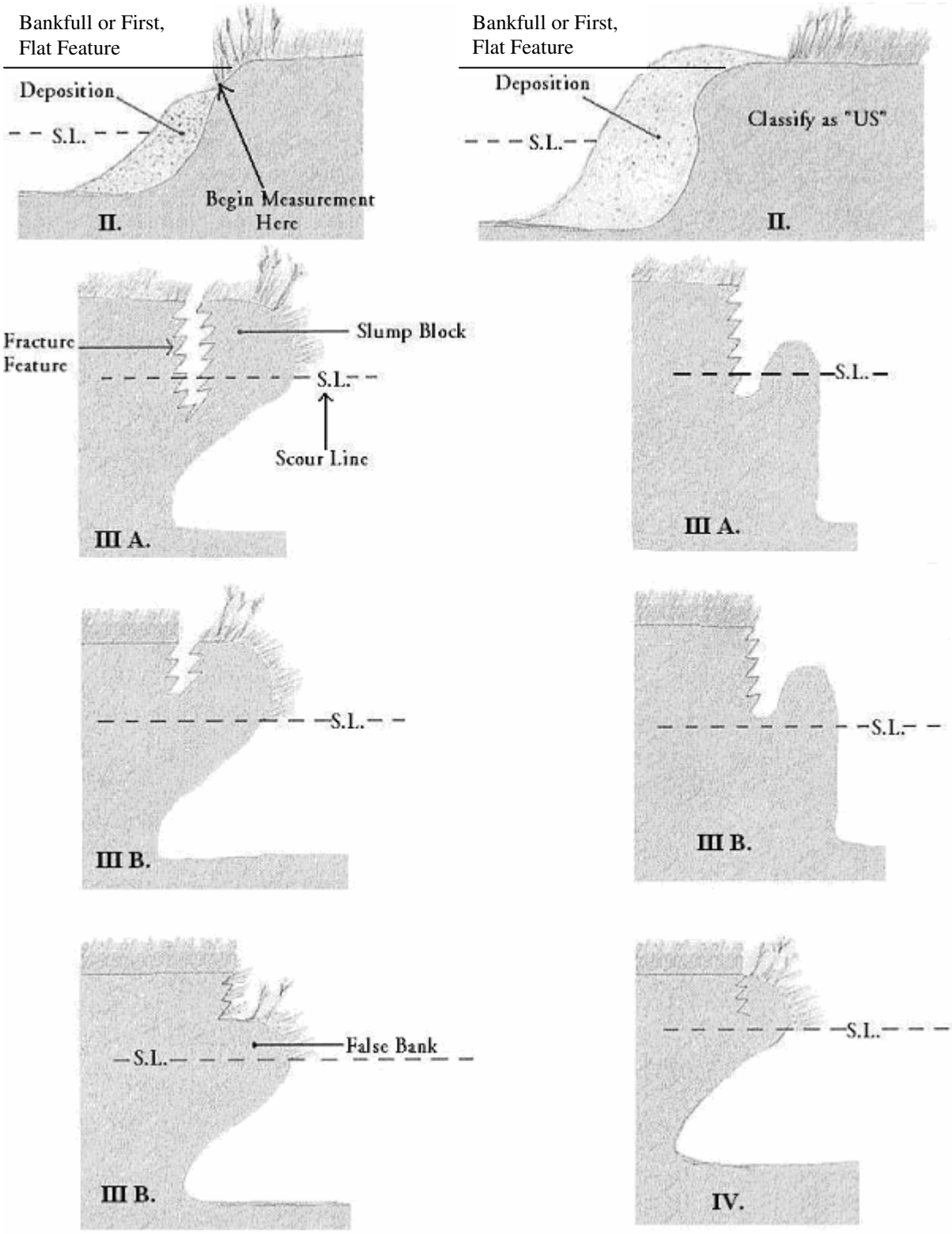



Figure 28. Examples of bank instability types described in sections II, III, and IV in the classification key. The actual stability class chosen depends on whether the bank is covered or uncovered.

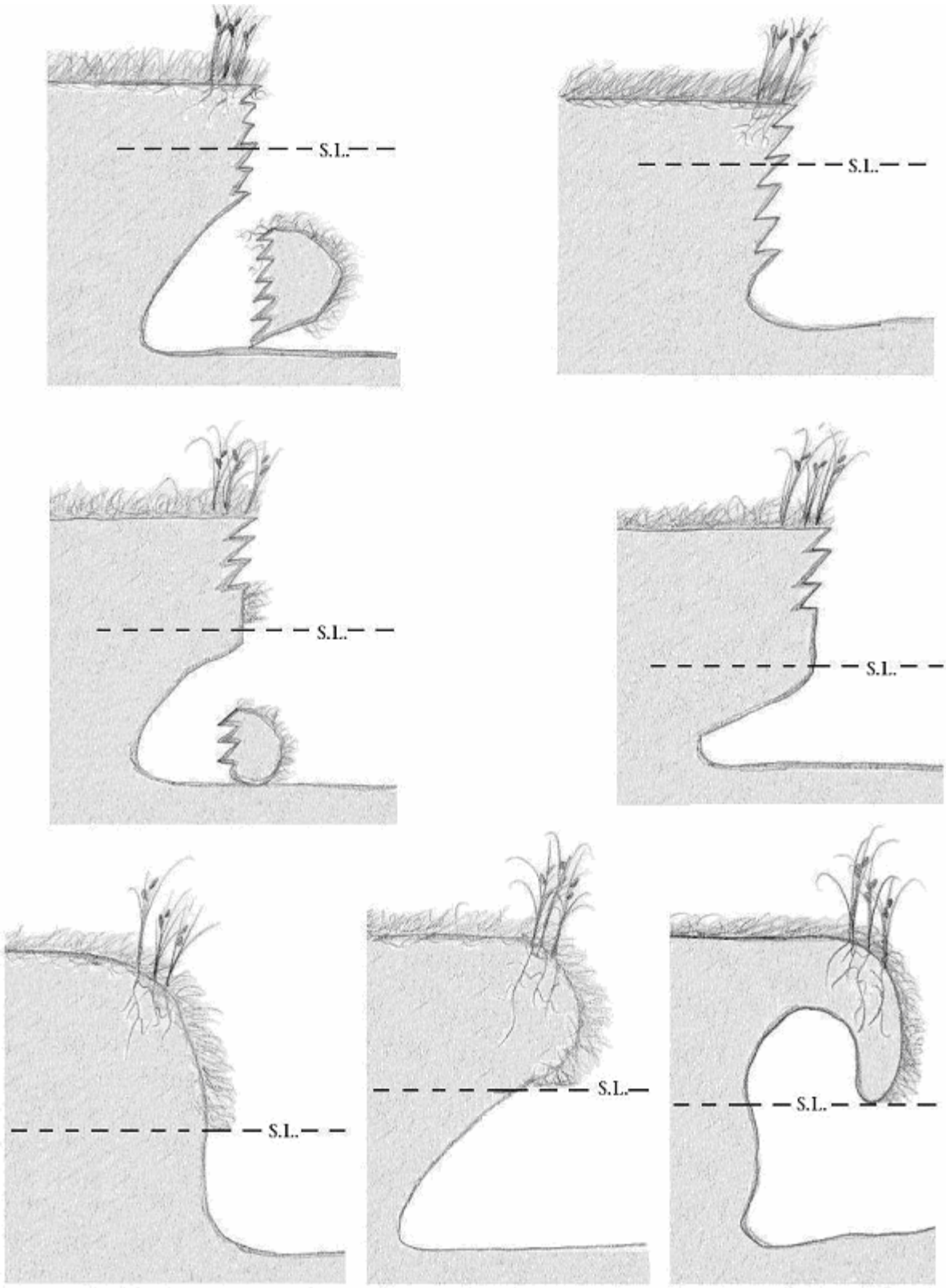



Figure 29. Examples of bank stability types described in section V in the classification key.

## Bank Type

Objective:

- Categorize each transect location based on the fluvial processes forming the streambanks.

How to take the measurements:

Defining the processes that creates the streambank condition at each location is integral to understanding bank stability, bank angles, and undercut bank measurements. Classify the streambanks into one of 4 categories based on association with erosion or deposits, pool or non-pool habitat units, and the relation to the thalweg (Figure 30).

1. Determine whether the transect lies within a pool or riffle/run. Consider all non-pool habitat as riffle/run.
2. Record all measurements on the outside bend in pools as “PO” for pool outside.
3. If the pool occurs in a straight stretch of channel, measure from the thalweg to the bankfull elevation on both banks. The bank closer to the thalweg is “pool outside” while the bank further from the thalweg is “pool inside” (Transects 1 & 2 in Figure 30).
4. Streambanks on the inside of pools are further delineated as erosional or depositional. Erosional banks have no deposition or the deposition is below the SL and classified as “PIE” for pool inside, erosional (Transects 1, 2 & 4 in Figure 30). Depositional banks have deposits that extend above the scour line and are classified as “PID” for pool inside, depositional (Transect 5 in Figure 30).
5. For transects where both banks are beside non-pool habitats, record both banks as “R” for riffle/run.
6. In situations near a pool head or tail or side channel, one bank may be within the pool and one in a riffle/run; use the pool classification for both (Transect 2 in Figure 30). For example, you will never have one bank be ‘PO’ and the other ‘R’ for example.

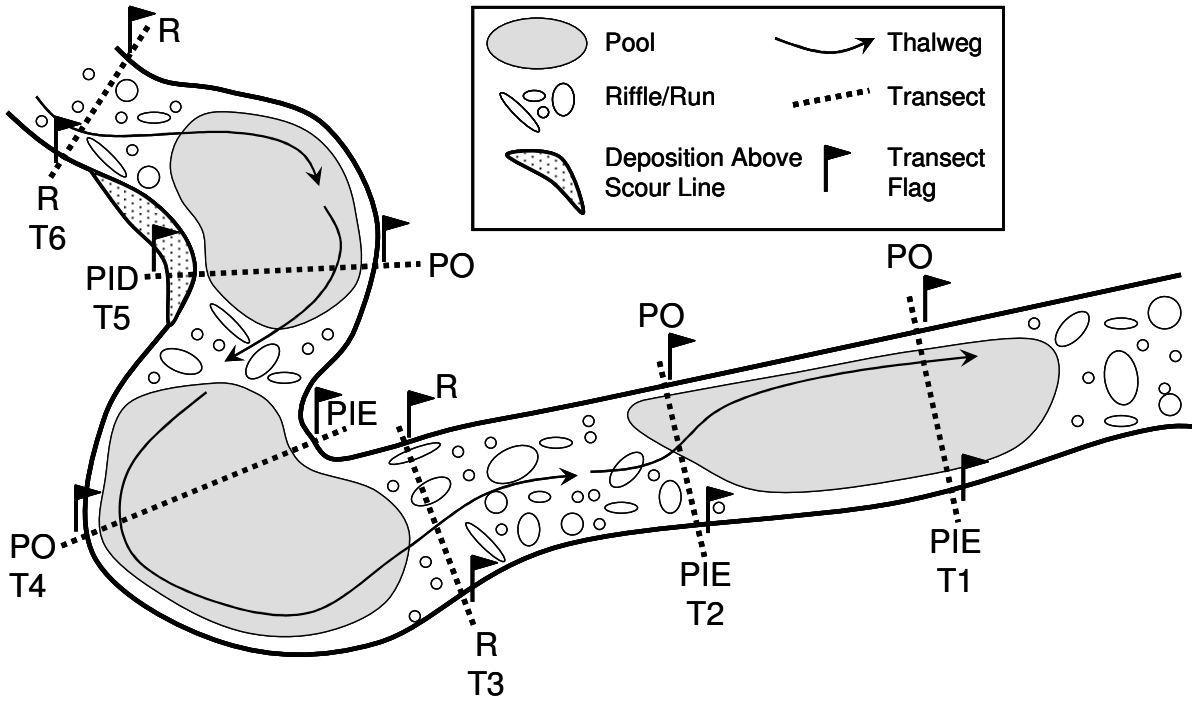



Figure 30. Example of stream showing the four classification categories for bank type.

## Bank Material

Objective:

- Describe the composition of inorganic bank material.

How to take the measurements:

1. Sample and record bank material at each transect for both banks.
2. Sample the soil at the SL on the streambank directly in line with the transect flag. Do not sample if deposition (bars) extend above the SL.
3. Remove roots from the sample if possible. (if not see # 7)
4. Only collect a sample if the material at the SL is part of the streambank. Record ”Cannot Measure” if it is part of the streambed, a log or is inaccessible.
5. Without looking, touch your index finger to the sample location measure the particle to the nearest mm. Record one of the following:
   - ≤ 4 mm consolidated
   - ≤ 4 mm unconsolidated
   - 5 to 64 mm
   - > 64 mm
   - Roots
   - Cannot Measure

6. If the soil is < 4 mm, use the following method to determine whether the soil is consolidated (clay or loam) or unconsolidated (sand). Remove a 3cm x 3cm x 3cm section of soil and apply water until the sample is wet. Roll the sample between your palms. It is considered consolidated if the soil rolls into a cigarette shape, and unconsolidated if it breaks into multiple pieces or crumbles instead of rolling.
7. If the sample contains too many roots to accurately assess the cohesiveness or size of the soil, record as “Roots”.

## Location of Greenline Quadrats

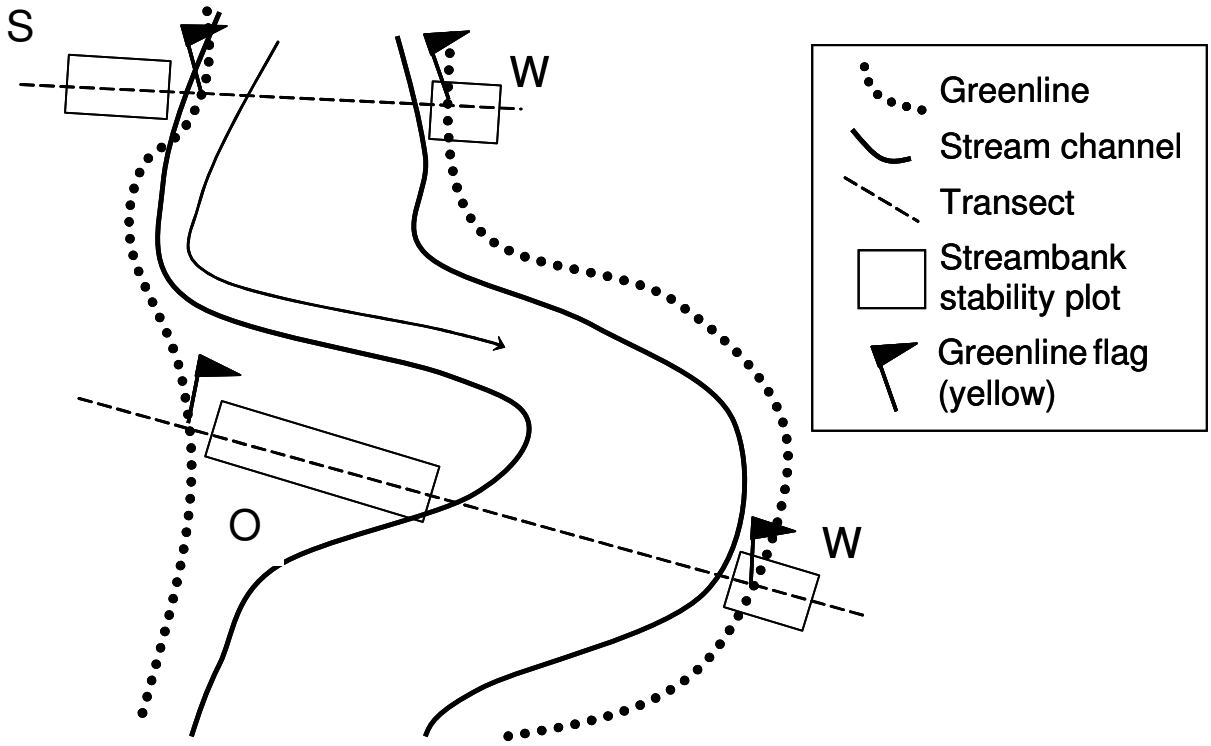
Objective:

- Determine the location of the bank stability plot relative to the greenline data collection point.

Sampling Method:

1. Vegetation technicians will place a yellow flag at the midpoint of the streamside edge of the greenline quadrat. This flag should be in line with the 2 channel transect flags.
2. Stream technicians will record one of three categories based on the location of the greenline quadrat flag relative to the bank stability plot:
   - "W" (within) - when the greenline quadrat flag is within the bank stability plot.
   - "S" (streamside) - when the greenline quadrat flag is on the streamside of the bank stability plot.
   - "O" (outside) - when the greenline quadrat flag is further from the stream channel than the bank stability plot.
     NOTE: if yellow greenline flag is outside your stability plot, but at the trunk of a shrub/tree who's canopy is vertically over the stability plot, consider it "W" not "O"!
3. When "S" or "O" are recorded, measure the horizontal distance from the closest edge of the stability plot to the greenline quadrat flag (to the nearest 0.1 meter).

The location of bank stability plots is described on page 39. Stability plots are 30 cm wide (15 cm on each side of the transect flag) and perpendicular to the streambank (not stream channel).



## Streambed Particle Size Distribution (Pebble Counts)

Objective:

- Determine the percent fines < 2 mm in diameter (D), D50 (median particle size), and D84 (84 percentile particle size) within the reach.

Where to take measurements:

1. Take measurements at all transects.
2. Sample the entire bankfull channel width across the transect.

Sampling Method:

1. Five particles will be sampled across each transect, from flag to flag.
2. Samples will be taken at 10, 30, 50, 70, and 90% of the way across the bankfull channel width, starting from river left (Figure 31).
3. Do not include the width of islands/bars that are ≥bankfull elevation.
4. Visually estimate the sample locations prior to walking across the transect.
5. Sample the particle at the toe of the foot/depth rod. Reach down with the forefinger (without looking down) and pick up the first particle touched. Measure the middle width (B axis) of the particle. Visualize the B axis as the smallest width of a hole that the particle could pass through.
6. Record particles < 2 mm as 2 mm. Record the width of larger particles to the nearest mm. For particles > 4097mm, record as 4097mm.
7. Also record whether the particle was found on the streambed (bed) or streambank (bank). See page 33 for indicators regarding streambed and streambank.
8. In deep water estimate the width of the particle.
9. If unable to measure/estimate particle size because it cannot be seen (covered by large wood, excessive depth, turbidity or dangerous conditions) record “NM not measureable’

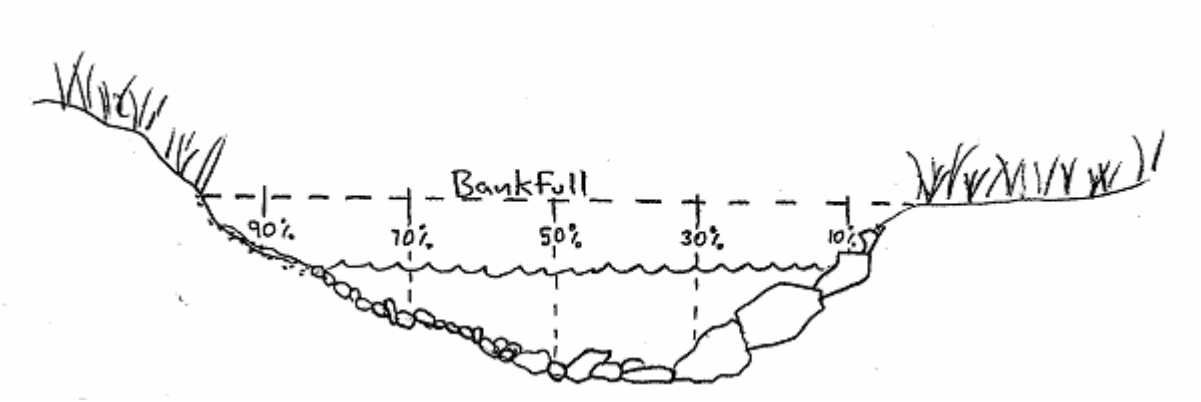



Figure 31. Location across transect for pebble count sampling.

## Bankfull Width

Objective:

- Determine the average bankfull width for the reach.

Sampling Method:

1. Record in the data logger whether measurements are being taken from the TR (StartPt=T) or BR (StartPt=B).
2. Measure the bankfull width to the nearest 0.1 meters perpendicular to the stream channel at all transects.
3. Measure the bankfull width from one transect flag to the other transect flag on the opposite bank.
4. Do not include the width of islands/bars that are above bankfull.
5. When local bankfull indicators are not present use the height from the water surface to the bankfull elevation (bankfull height) defined at channel cross-sections to approximate bankfull.
6. Large wood or heavy brush may obstruct a transect. Also at some tight meanders the transect may cross a point bar without intersecting the actual bank (located behind the point bar). Do not take a measurement at these transects. Record "-99" in the data logger.
7. At transects with tertiary channels, record the total BF width and the tertiary channel width (see explanation below).

Tertiary Channels:

Side channel: any channel separated directly from the main channel by an island/bar with an elevation above bankfull.

Tertiary channel:

a) side channel whose average width is <20% of the average bankfull width measured during reach set up (see 'Establish Width Category' page 11)
b) or, a discontinuous side channel, which means any location of the side channel's thalweg is ≥ the bankfull elevation. Do not measure the bankfull width of discontinuous side channels (Figure 4, page 14: channels B & C).

Determining if a side channel is tertiary:

a) Measure the bankfull width of the secondary channel at ¼, ½, and ¾ of the way up from the downstream end (Figure 32 A)
b) Average these 3 measurements and compare this value to either:
    1) The average bankfull width calculated from 5 initial measurements recorded on Form 1, see "Establish Bankfull Width" on page 11 (when sampling a new site)
    2) "Original Width Category" on "Scouting Pre-Established Reaches" form (when sampling a repeat site)
c) If the channel is a tertiary channel (<20%), record:
    1) the total bankfull width of transect (including the tertiary channel's width) (Figure 32 B)
    2) and the tertiary channel's bankfull width (Figure 32 B).

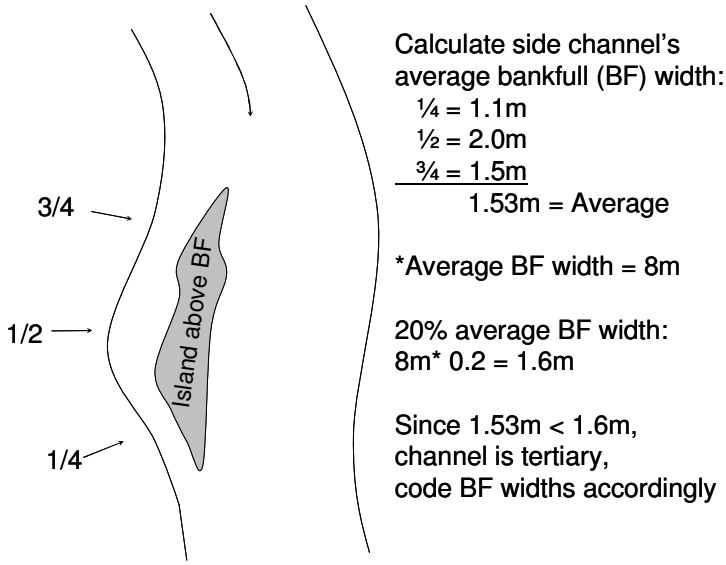



Figure 32 A: Determining if a side channel is 'tertiary'. Measure the side channel's bankfull width at 3 locations: ¼, ½, and ¾ of the way up. Average these 3 measurements. Is this average <20% of the average bankfull width? If it is <20% it is a tertiary channel. In the example above the channel is tertiary because its average width of 1.53m is less than 1.6m (20% of the average bankfull width).

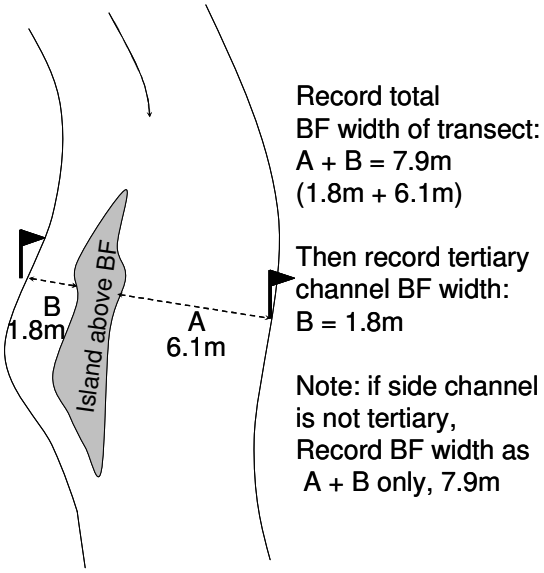



Figure 32 B. Recording bankfull width at a tertiary channel. Record 1) the total bankfull width of transect, including the tertiary channel's width (A + B in the figure above), and 2) tertiary channel's bankfull width (B in the figure above). In this example you would record 7.9m and 1.8m in the logger for this transect.

# LARGE WOOD

Objective:

- Quantify the number and size of large wood pieces that are present within the bankfull channel.

Sampling Method:

1. In order to be counted, each piece must meet the following criteria.
   a. Each piece must be greater than 1 meter in length and at least 10 cm in diameter one-third of the way up from the base. For pieces that are not evenly round, measure the widest axis.
   b. Only include standing trees that lean within the bankfull channel if they are dead. Dead trees are defined as being devoid of needles or leaves, or where all of the needles and leaves have turned brown. Consider it living if the leaves or needles are green (Figure 33).

   *Note: Use caution when assessing the condition of a tree or fallen log. Nurse logs can appear to have living branches when seedlings or saplings are growing on them.*

   c. Wood that is embedded within the streambank is counted if the exposed portion meets the length and width requirements (Figure 34).
   d. Do not count a piece if only the roots (but not the stem/bole) extend within the bankfull channel.
   e. Some pieces crack or break when they fall. Include the entire length when the two pieces are still touching at any point along the break. Treat them separately if they are no longer touching along the break (Figures. 35 and 36).
2. Large wood within the riparian area is separated into two categories (Figure 33).
   a. Category 1 – Pieces in which a portion of the stem extends below the bankfull elevation, thereby interacting with the active channel at bankfull flows.
   b. Category 2 – Pieces in which a portion of the stem extends over the bankfull channel, but lies above the bankfull elevation.
3. Record the piece number, category 1 or 2, estimated length (nearest 10 cm), and estimated diameter (nearest cm) of all qualifying pieces in the reach. The same person will make all estimates for a given reach. Record the name of the estimator in the data logger.
4. Also measure the length (nearest 10 cm) and diameter (nearest cm) of the first 10 pieces beginning at the downstream end of the reach. The person estimating should not be made aware of the measured value.
5. An additional subset of pieces will be measured at sites with more than 10 pieces.
   a. For sites estimated to have between 11 and 100 pieces, measure the first ten pieces, then starting at the 11$^{th}$ piece only measure every 5$^{th}$ piece.
   b. For sites estimated to have over 100 pieces, measure the first ten pieces, then starting at the 11$^{th}$ piece only measure every 10$^{th}$ piece.
6. Measure the length of the main stem and not branches or roots. Begin measurements where the roots attach to the base of the stem when the roots are still connected.
7. Do not measure the length and/or diameter of standing dead trees, pieces buried in log jams, or other pieces that are unsafe to measure. If that piece was one that required measuring, record the estimated length/diameter and leave the measured length and/or diameter blank. Then measure the next required piece, maintaining established interval (see #5 above).
8. Begin counting from the BR to the TR, and from the bottom up when pieces are stacked on each other.
9. For wood in side channels, see Figure 37 to determine what large wood to count.

10. Large wood in isolated side channels, pools or depressions <bankfull elevation is not measured.
11. Tertiary channels: Code qualifying large wood located in tertiary channels (see 'Tertiary Channels' page 48, figure 32 A & B page 49).
    a. A tertiary channel begins and ends at the locations it becomes separated from the main channel by an island ≥bankfull.
    b. If a piece of wood is in both the main channel and tertiary channel, don't code as tertiary.

NOTE: If a qualifying piece of large wood has any roots attached, type in 'roots' as a comment.

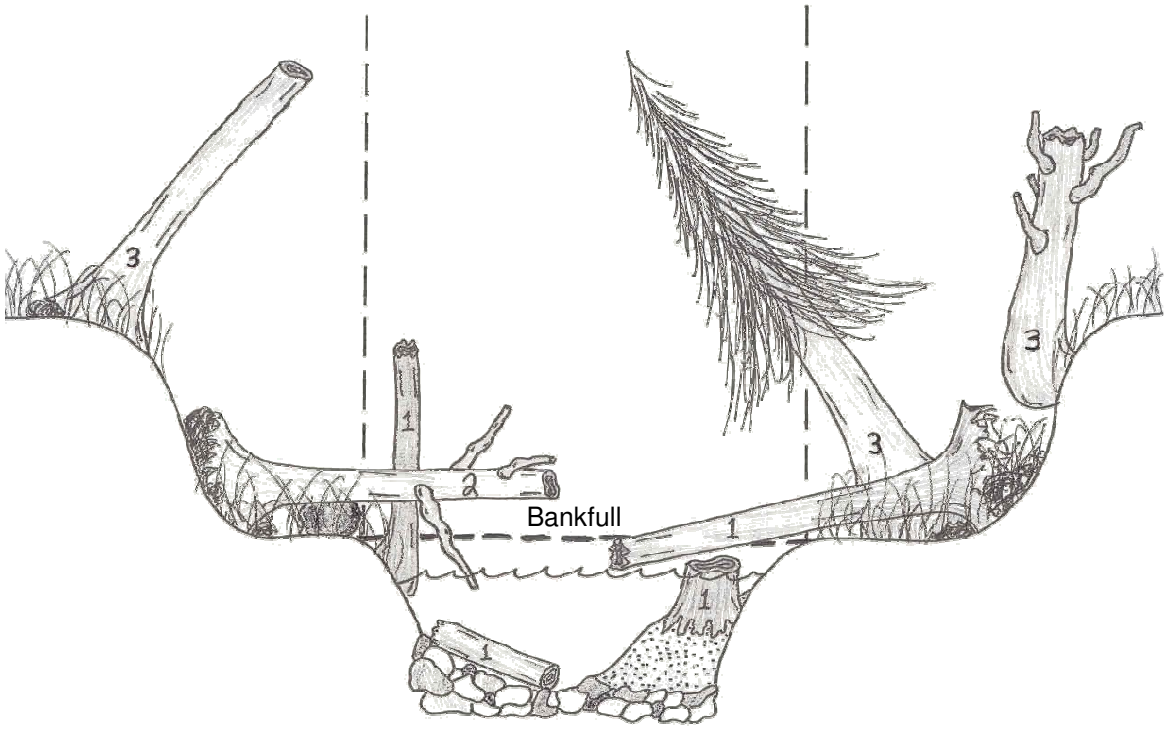



Figure 33. Illustration of large wood. Pieces numbered 1 and 2 would be included in the survey, while pieces numbered 3 would not be counted.

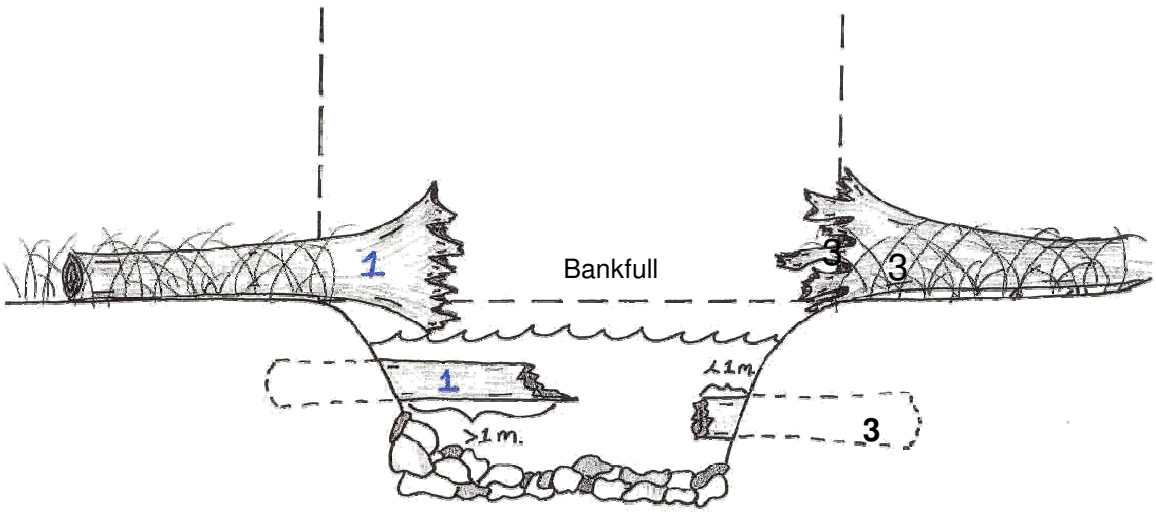



Figure 34. Examples of qualifying large wood (1). The pieces on the right side (3) are not counted (3) because only the roots extend over the bankfull channel (upper) and the exposed section is < 1 m in length (lower).

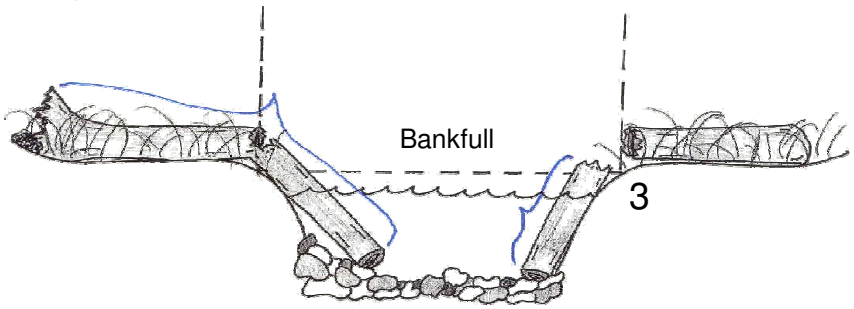



Figure 35. Examples of how to measure the length of broken pieces. Measure the length of the entire piece on the left (pieces still connected). Only measure the piece within the bankfull channel on the right.

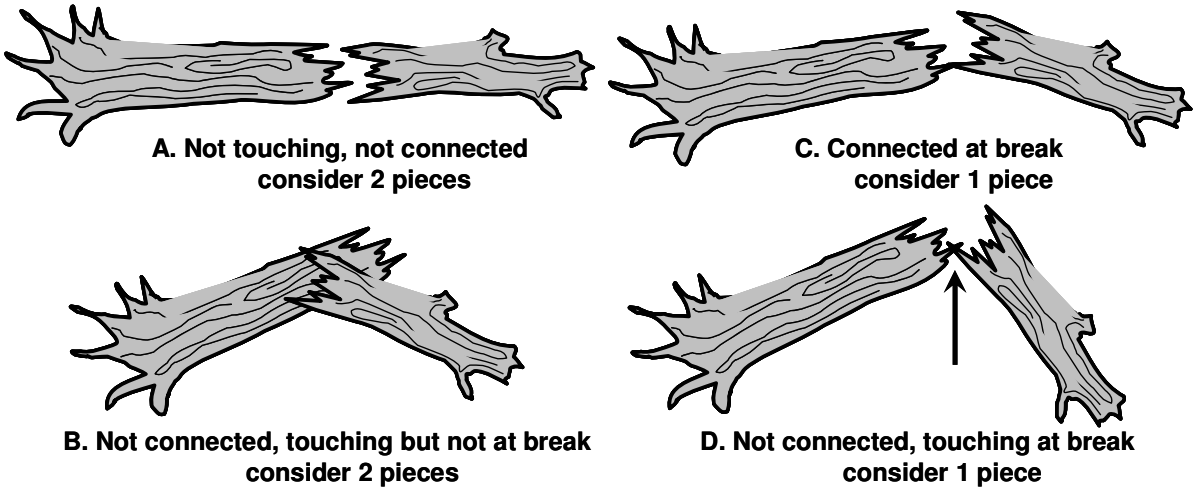
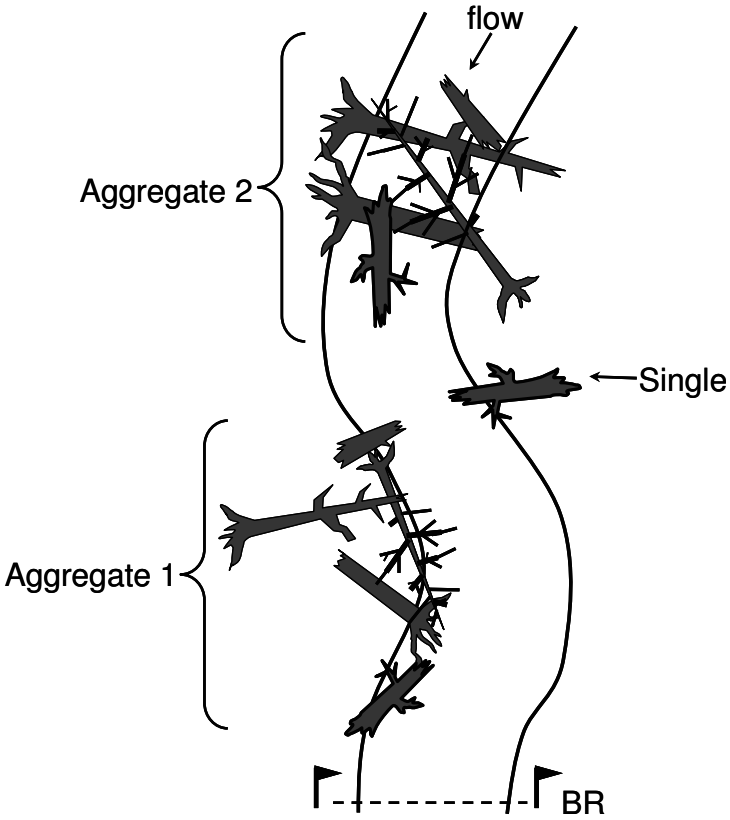



Figure 36. Variations of touching vs. not touching along the break.

Classifying Large Wood Aggregates




Multiple pieces of large wood clustered together (aggregates) can provide valuable fish habitat.

Aggregates must meet the following criteria:

- All pieces meet minimum size requirements for large wood
- Aggregates consist of a minimum of 2 pieces of large wood
- At least 1 of the 2 pieces must be category 1
- To be part of the aggregate, each piece must touch at least one other piece with stem, and / or roots (not just branches)

How to Collect Data

- Code all pieces of large wood in an aggregate by selecting ‘aggregate’ in the logger.
- Once you start estimating/measuring large wood in an aggregate, quantify all pieces in the aggregate before estimating/measuring other large wood in the reach.

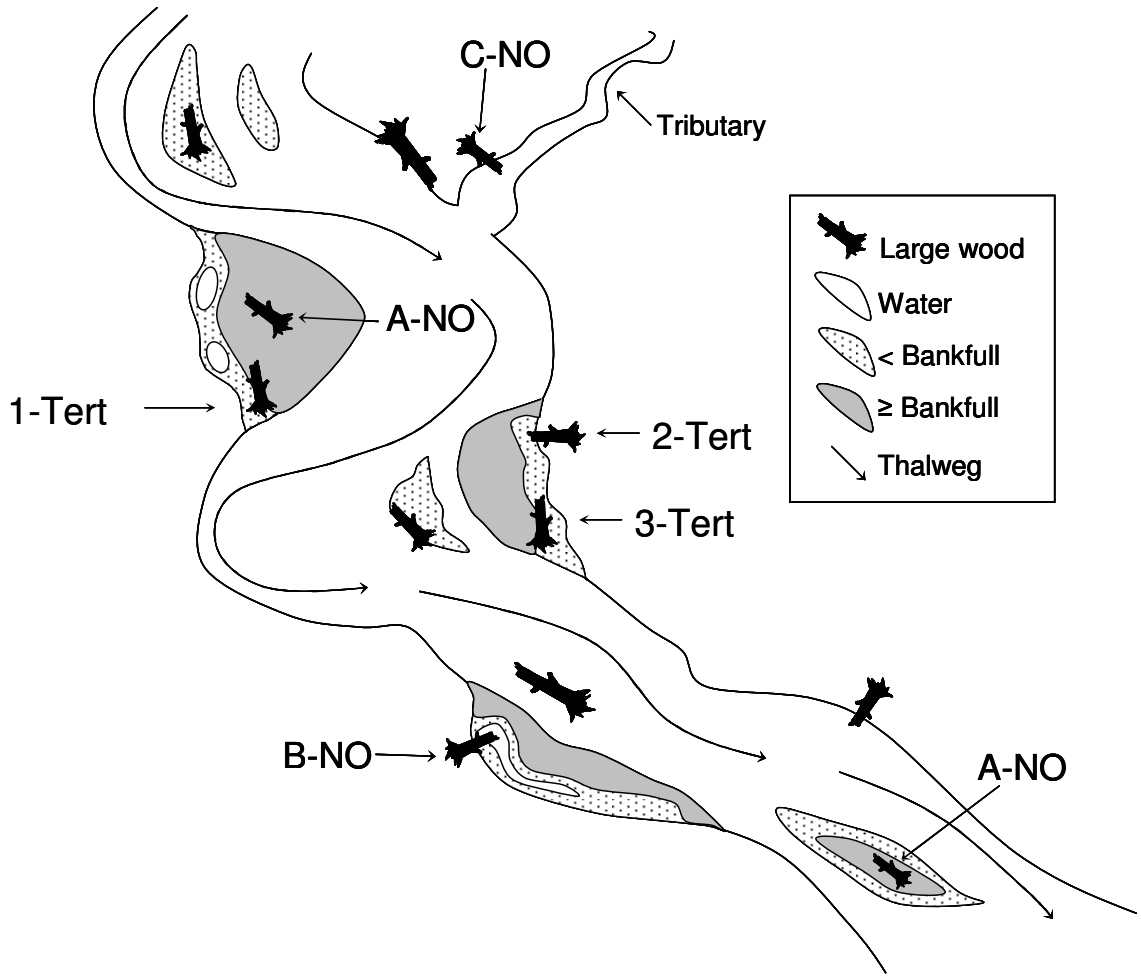



Figure 37. Depiction of qualifying and non-qualifying large wood. Unlabelled pieces qualify because they are within bankfull channel. Large wood on islands ≥bankfull elevation are not measured unless it meets category 2 requirements (A). Large wood in tributary steams is not measured (C). To determine if large wood qualifies, visualize the water level at bankfull; if the stem is touching water or hangs over water, it qualifies. Large wood associated with isolated side channels, pools and depressions does not qualify (B). Pieces 1-3 are located in tertiary channels (page 51) and are coded 'tertiary' in the logger. Piece #1 is in a tertiary channel whose bankfull width is <20% of the reaches average bankfull width. Pieces 2 and 3 are located in a discontinuous tertiary channel.

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# APPENDIX A: EQUIPMENT LIST

| Item | Qty. |
|---|---|
| **Sampling Action Packer** | 1 |
| Flags – stream | 60 |
| Flags – veg | 20 |
| Blue pool flags | 20 |
| Bleach Spray Bottle | 1 |
| Bleach Bottle | 1 |
| Bug Net | 1 |
| Bug Spray Bottle | 1 |
| Pool Tail Fines Grid | 1 |
| Pool Tail Fines Viewer | 1 |
| Conductivity Meter | 1 |
| Alkalinity test kit | 1 |
| Clipboard w/ complete set of waterproof forms. | 1 |
| Field Vests | 1 |
| Data Logger | 1 |
| Extra logger battery | 1 |
| Logger car charger | 1 |
| Logger wall charger | 1 |
| Compass w/ compass | 2 |
| Survey Level | 1 |
| Level Tripod | 1 |
| Stadia Rod | 1 |
| Hand Level | 1 |
| Tape - 50 m | 1 |
| Tape - 30 m | 1 |
| GPS Unit w/ case | 1 |
| Digital Camera w/case | 1 |
| Memory Flash Cards for Camera, 96 or 128 and 16 MB | 2 |
| NiMH Battery Charger, AA/AAA | 1 |
| NiMH Rechargeable Batteries AAA | 16 |
| Clear Plastic Ruler for Pebble Measure | 2 |
| Hand Calculator | 1 |
| Candy Canes | 4 |
| | |
| 2 Gallon Bucket for Bugs | 1 |
| White Pan for Bugs | 1 |
| 500 um Sieve | 1 |
| Forceps | 2 |
| Plastic spoon | 2 |
| Bug Jars w/ lids | 50 |

| Item | Qty. |
|---|---|
| **Camping Gear** | |
| Propane Stove W/ Hose | 1 |
| Propane Tank | 1 |
| Table | 1 |
| Chairs | 3 |
| Tent - 3 person | 1 |
| Tarp | 1 |
| Water jug 5 gal. | 2 |
| Cooler | 1 |
| **Kitchen Gear** | |
| Plates, Bowls, Glasses, Forks, Spoons, Knives | 3 each |
| Can Opener, Cutting Board, Cutting Knife, | 1 each |
| Spatula, Serving Spoon, | 1 each |
| Dish soap & Sponge | 1 each |
| Stock Pot | 1 |
| Saucepan | 1 |
| Skillet | 1 |
| **Back of Truck** | |
| 1.5 m staffs w/ cm increments | 2 |
| Yardstick for Veg. Work | 1 |
| Backpacks | 3 |
| **Safety** | |
| | |
| Fire Extinguisher | 1 |
| First Aid Kit - Hard Case | 1 |
| Shovel | 1 |
| Ax | 1 |
| Saw | 1 |
| | |
| **Crew Items** | |
| Waders, Boots , Wader socks for each person | 3 sets |
| | |
| Macroinvertebrate Jar Labels | 50 |
| Repair Kit for Field Equipment | 1 |
| Backup Disposable Camera | 2 |
| Water Filter | 1 |

# APPENDIX B: Types of Sites

## Integrator Sites

Integrator sites are used to answer the primary question of the PIBO-EMP: *Are current management practices on Federal lands within the study area resulting in improved stream and riparian conditions?* Each year PIBO-EMP samples 36 groups, each group consists of 20 clustered sub-watersheds (HUCs). We will scout and sample 7 integrator sites within each group. Prior to 2007 some groups contained 8 integrator sites. In the expanded study area (group #'s 200-299) 8 groups / year are sampled; <u>six</u> integrator sites are established per group.

## Integrator Sentinel Sites

Sentinel sites are integrator sites that are sampled every year. The sentinel sites serve two purposes, 1) determine how fast attribute conditions change through time and 2) generate a yearly estimate of site variability (e.g. high water year vs. low water year.

### How to Sample a Sentinel Site

- Set up reach and begin samplings using procedures outlined in 'Appendix F locating an un-scouted integrator site'.
- Sample a sentinel like an integrator, with a few exceptions
- Take photos using procedures outlined in 'Photo Points from Previously Sampled Sites and Sentinels'
- There are a few sampling modifications outlined below in question / answer format

Question: Do I use the same **random number** that was used previously (if known)?
Answer: Yes, if provided. If you do not know the random number previously used, generate a new random number and set the reach up accordingly.

Question: Do we end the reach at the same **TR** in the photos even if we do not have 21 transects? Answer: No. Follow the protocol for ending the reach like normal (i.e. end the reach at the first pool-tail encountered after your 21$^{st}$ transect). Make a note (and show this on your site map) about where you ended your reach relative to the TR in the photos if possible.

Question: Do we try to place our **cross-sections** in the same spot as in the photos?
Answer: Not necessarily. If you determine that there are more appropriate areas to place your cross-sections, perform them in the most appropriate place using the criteria in the protocol. However, do your best to set up the cross-section tape at the previously sampled locations (if known) and take a photograph of each.

## Designated Monitoring Areas

Designated monitoring areas (DMA's) are sampled because 1) livestock grazing was targeted in the biological opinions for steelhead and bull trout as being a primary management activity of concern on FS and BLM lands, and 2) it provides a direct link between implementation monitoring being conducted by the field units (did they follow the direction in the allotment management plans?) and effectiveness monitoring (is it resulting in good aquatic and riparian conditions?). Under the implementation module, "DMA" sites are established at a representative area within each pasture, with a list of requirements on how and where to locate them. The field units then evaluate these sites during and after the grazing season to insure that the pasture received proper use (implementation monitoring). For the effectiveness monitoring component, we will sample a subset of all DMA sites within the study area. Specifically, we will sample one DMA site in all grazed sub-watersheds where we sample an integrator reach.

Measurements at these sites address only site specific grazing impacts which preclude most in-channel measurements conducted at integrator reaches. Therefore, we only sample riparian vegetation, streambank measurements, cross sections, pools, and general reach description characters.

**See Appendix G for instructions on how to sample an un-scouted DMA site**

- Use a width category of 6 meters for transect placement at all sites, regardless of the actual bankfull width. Start each DMA reach at a pool tail and end at the 21$^{rst}$ transect.
- Sample the site regardless of the gradient, stream size, or lack of stream flow.
- Riparian Vegetation: Vegetation technicians will sample these sites the same as integrator reaches. Begin at the downstream end of the reach and establish the greenline, and riparian cross-sections.
- Streambank transects: Conduct all streambank transect measurements at DMA sites, except pebble counts. This includes bank angle, undercut depth, stability, bank type, material, and bankfull widths.
- General Reach Description Characteristics: Form 1 (DMA Sites) displays a subset of the descriptive measurements taken at integrator sites and should be used to define the information needed. These include reach length, change in elevation, straight (valley) length, and GPS locations at the bottom and top of the reach. In addition, fill out Form 2 (reach map) and Form 4 (photo log).

## Large River DMA Sites

The BLM in eastern Oregon has DMA sites established along the John Day, Deschutes, and Grande Ronde Rivers. These sites are sampled in a slightly different way.

- Set up the reach with 6 meter transect spacing along one side of the river.
    - You will need to set up 42 because the sampling is only along one bank.
    - The transect flags will be used primarily for vegetation sampling (greenline, Riparian cross sections).
        - Riparian cross-section data is still collected at every 5$^{th}$ transect (# 1,5,10…35, and 40).
    - Do not conduct any streambank measurements.
- Collect all the reach description characteristics described above with the exception of valley length. Measure the reach length along the greenline and not the thalweg.

## Dry Sites

At the time of sampling, some sites may not have any water in the channel. If this is the case, do not sample:

- water chemistry (alkalinity and conductivity)
- biological sampling (macroinvertebrates)
- pools
- pool tail fines

NOTE: Measure and collect all other stream attributes for that reach type (Table 1). Record stream flow conditions on Form 1 and in the data logger.

Unless you can sample an attribute throughout the WHOLE REACH, do not collect it. For example, don't collect pool data is only half the reach is flowing.

When measuring elevation change, place the stadia rod in line with the BR / TR, at the channel's deepest location.

Cross-sections: because there is no water, you cannot record LEW / REW. The logger will give you a warning that LEW / REW are missing; disregard this warning.

# APPENDIX C: Stream Data Logger Overview

## Getting Started

1) Turn on the handheld device.
2) **Load DPP**: Once the device boots, double click on the icon for DataPlus Professional.
3) **DPP Option**: Select option 1, Collect Data, and press enter.
4) **Dataset**: Now you are asked to choose between an Old or New Dataset. Select New Dataset for the first reach of each hitch, and Old Dataset for every subsequent reach in the hitch. **Note**: it is important that you choose New Dataset **only** for the first reach of a hitch.
5) Each dataset identifies the crew and date at the start of a hitch. You will use the same dataset for all sites sampled during a hitch.
6) All dataset names consist of 6 characters and must follow the same format: 2 character CrewCode + 2 character Month + 2 character Day. For example: M10521.
7) Once a particular dataset is selected, the logger takes you to the first reach in that set, at which time you are ready to enter data.

## Entering Data

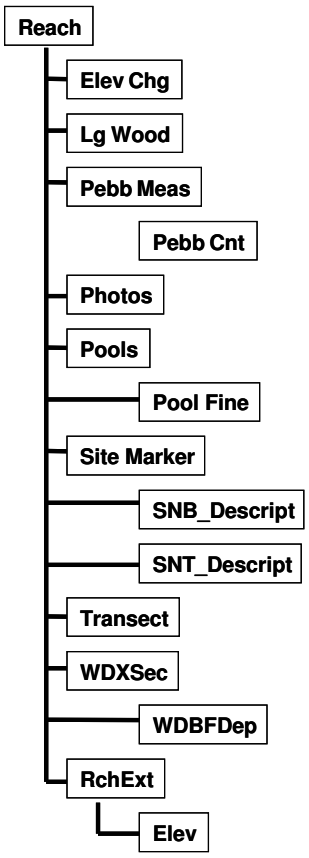
1) **Basic table view/format:** After completing step 7 above, you are taken to row 1 of the REACH table. The parent table for the entire application, REACH contains about 50 columns beginning with Group, Order, RchType, etc. and ending with Bogus. As you enter values for these columns, you are completing exactly 1 row of information in the REACH table. For example:

| Group | Order | RchType | RchName | ….Bogus |
|---|---|---|---|---|
| 27 | 14 | IK | 27-14-IK-M1-07 | |

However, due to the logger's small screen size, REACH is not presented in table format (i.e. rows/columns). Instead it has the look of a fill-in form with labels and blank spaces. Labels are column names. Blank spaces are where you enter the column values. As you enter values into the blank spaces you are completing a single row of data in the logger's internal REACH table.

2) **Auto assignment**: the values for some fields, such as SampDate, RchName and RchID, are written automatically. In most cases these are written only as you "enter through" the field or cell.
3) **RchID creation:** RchID is the key field which organizes your entire dataset. Its value is transcribed from the sampling documentation. If you enter an incorrect RchID we will not be able to match up the data entered in the scout database, veg loggers, and stream loggers.
4) **RchName creation:** As you enter through the RchName field, its value is created automatically from fields 1-4: Group, Order, RchType, CrewCode.
5) **RchName editing:** The RchName can be edited **at any time**. To do so, a) first make the appropriate change to Group, Order, RchType and/or CrewCode, b) second enter through the RchName field. If you do not do step b, RchName will not be updated. Note: **you must make sure the RchName is correct**, since it is used as a check to the RchID for consistency. The RchID and RchName must match up.

6) **Child tables:** In addition to its 50 fields, REACH contains 8 children tables, each of which has multiple columns and some of which have children of their own
7) **Navigation keys**: You will need 3 commands to navigate this table structure: F5, F4 and Blue-PgUp/Blue-PgDn. The first two are used to navigate between tables:
8) **F5:** Use F5 to advance from a parent table to child table. If a parent has more than 1 child, F5 displays a list of all children.
9) **F4:** Use F4 to return you from a child table back to the parent table.
10) **Sibling navigation:** If you wish to navigate between sibling tables (i.e. between children of the same parent), you must first return to the parent using **F4** and then use **F5** to advance to the desired child. You cannot move "sideways", as it were.
11) **Blue-PgUp/Blue-PgDn:** This is used to navigate from row to row within a table. For example, once you have logged a piece of wood in LWD, **Blue-PgDn** will take you to a new row for logging the next piece. **Blue-PgUp** allows you to return to previous rows for editing purposes.
12) **Sample table structure**: Below is the 2007 table structure.




13) **Other keys**: Acceptable values for a particular field might be limited to a list of possible choices. Use **F2** to access such a list. For example, in the LWD table there are only two options for Category: 1 or 2. The **F2** key initiates a drop-down menu listing these choices
14) Some numeric fields require you to enter the decimal and some do not. This is necessary for data migration into the database, and we apologize for the inconvenience. The need to enter leading zeros has been eliminated beginning with the 2004 application

15) **<u>Empty table check</u>:** Upon completing your data collection for a particular reach, immediately page down (**Blue-PgDn)** to the next blank REACH row—i.e. do this while still on site and before shutting the logger down. Paging down to a new row in the REACH table will trigger a program that reports all empty tables for the most recent reach. However, there is a major limitation. It doesn't actually look into each table to see if it contains data. Rather, it tracks—and temporarily stores—information about tables visited during the most recent data collection episode. As a result, if you 1) change to a new row in the REACH table, collect some data and then return to the previous row, or 2) exit REACH for the main DataPlus menu and then return to the same row, the report will not be accurate. So use the report only when moving immediately to the next row in REACH after a complete data collection event.
16) **<u>Data checks</u>:** Beginning in 2004, a number of programs have been written that will check your data for various kinds of potential errors/inconsistencies. Some of these run as you change columns within a table, others as you change lines within a table, and still others run as you leave the table and return to its parent. In each case it is up to you to return to the problematic column/line/table and correct whatever error has been flagged. Prompts are displayed to help navigate back to the problematic feature(s). For example, a program runs each time you return to WDXSEC from WDBFDEP, flagging every error imaginable such as failure to mark a bankfull distance, marking two left edges of the water rather than a left and right, marking a left edge water depth that is considerably higher than the right edge water depth, marking a boulder to the right of the right edge water, etc. Keep in mind that these programs are written to reduce normal data entry error and not to test your intelligence. Read the message(s) carefully and try to correct whatever error(s) has/have been detected. In the case of multiple error messages, if it is easier you can correct 1 or 2 at a time until all such messages disappear.
17) **<u>Required fields and bogus data</u>:** A required field is a field that must be given a value before you are allowed to exit the current page—i.e. current row of data. Some tables contain one or more such required fields. This can create a problem if you mistakenly page down (blue-PGDN) to a new row but have no more data to enter—e.g. you inadvertently page down in LWD after entering the last piece of large wood. To handle such cases we've added a "bogus" field to most tables, which should be used as follows. If you mistakenly enter a row that contains required fields, place bogus data into the required fields **as well as a 1 in the bogus field** to mark that the current row of data is bogus. Then back out using F4. That line will then be deleted once the data is downloaded and placed into our database. If you mistakenly enter a row with no required fields, however, simply back out using F4. The logger automatically deletes rows with no data--i.e. rows with all empty fields.
18) **<u>Dire straits</u>:** If the data logger locks up and nothing works, press Ctrl-Alt-Del (or hold the on/off key for 10 seconds) to reboot. Disconnecting and reconnecting the battery will also initiate a reboot.

**Backing Up Data**

There is an icon on the desktop called 'backup' or in some cases 'short cut to backup'. Simply double click on this icon to back up all records to a storage card.

# APPENDIX D: Gear Decontamination

**Objective**
In order to eliminate the spread of invasive species (namely New Zealand Mud Snail), EMP gear MUST be decontaminated after every sample. The only exception to this is if two or more sites are being sampled on the same stream (key site, integrator site, random). **After sampling a site, gear should be decontaminated by one crew member while another crew member fills out forms, and enters data into the logger, etc. These tasks will be completed before leaving a site!**

**Procedure**
Using the scrub brush and remove all visible mud/organic material from boots and waders before decontamination.

The felt wading boots are most likely to carry invaders and will need to be soaked in a solution of Sparquat and water (5oz. Sparquat to every gallon of water) for five minutes to ensure decontamination. Waders will also need to be put in Sparquat/water solution for five minutes (from the waist down is sufficient). Large Rubbermaid Roughtotes are supplied to each crew/scout specifically for this purpose.

Gear items that need to be sprayed down thoroughly with the Sparquat/water solution include:

- Bug nets
- Pool Fines Grid
- 50m and 30m tapes (as used)
- and Sieves

Sampling gear decontamination should be done while the boots and waders are soaking to make sure that this process is as efficient as possible.

When decontamination is complete, put the used Sparquat/water solution back into the 7gal Aquatainer and rinse the waders, boots, and other gear with water. You may re-use this solution for 2-3 days, however you will need to discard the used solution (at least 100m away from any water source) and make a new batch after this point so that the procedure continues to be effective. In general, re-new your Sparquat solution in the middle of each hitch and make sure that the Sparquat/water solution produces a copious amount of suds when it is agitated.

**Preventing spread of invasive plants**
If your truck gets especially muddy during a hitch, please take the time to rinse the wheel wells and undercarriage thoroughly before traveling to another group. If your truck is especially muddy when you return from a hitch, you will need to rinse the mud off before you clock out. Plan your last work day to include this duty (if necessary) along with the normal 'End of Hitch' duty of making sure the inside of the trucks are relatively clean (wipe the dashboard, etc. and vacuum if necessary).

## APPENDIX E: Sampling Sites with Beaver Activity

**Safety First! Please be careful walking around beaver dams!**

**Why do beaver dams matter?** PIBO EM is attempting to assess changes in riparian and aquatic habitats due to land management. Beavers also influence riparian and aquatic habitats; therefore we want to sample reaches that have beaver activity.

**STEP 1: Is the site scouted?**

**Scouted:**

- If the scout indicates beaver dams are in-active, sample using normal procedures.
- If the scout indicates beaver dams are active, proceed to 'STEP 3: How to Sample a Reach with Beaver Dams'.

**Unscouted:**

- Proceed to 'STEP 2: Determine if a Reach has Active vs. In-Active Beaver Dams'.

**STEP 2: Determine if a Reach has Active vs. In-Active Beaver Dams**

- If the reach is scouted, use the scout's determination of whether the beaver dams are active vs. in-active (even if you don't agree).
- If the reach is not scouted, use the criteria below to make the active vs. in-active determination.
- If you determined beaver dams are active proceed to 'STEP 3: How to Sample a Reach with Active Beaver Dams'.
- If you determined beaver dams are in-active, sample the reach using normal sampling procedures.

**Active beaver dams:**

- Are currently being maintained by beavers.
- May have new materials (e.g. sod, freshly cut or green twigs, etc.).
- Create a pool upstream from the dam.

**In-active beaver dams:**

- Are not being currently maintained by beavers.
- May be breached, meaning the channel goes through or around the dam. Essentially the dam is not functioning to create a pool.
- Have no evidence of maintenance [i.e. lack of new materials (sod, freshly cut or green twigs, etc.)
- Are often breached, meaning the stream channel has cut through or beside the dam.
- Don't create a pool, or create a pool that is smaller / shallower than the pool that existed when the dam was actively maintained (look for evidence that the water was at a higher level).
- Sample reaches with in-active beaver dams using 'normal' procedures

**STEP 3: How to Sample a Reach with Active Beaver Dams**

1: Locate and flag the original BR and TR. Place the TR marker at (or near) the original TR location if the marker is absent. Fill out the marker section of form 1.

2: Enter ‘beaver’ for ‘disturbance’ in the logger.

3: Walk the entire reach, identify and flag the up and downstream boundaries of the beaver impacted area(s) using the criteria below.

4: FORM 15: Enter the original reach length, ‘A’. Measure the lengths of all un-impacted areas of the reach, and record the total un-impacted length by ‘B’. Record the longest continuous un-impacted length by ‘C’. Calculate the percent of the reach that is being impacted by beavers (‘E’ on Form 15).

5: Fill out the ‘crews’ section of FORM 15

6: Classify the reach into one of the following two scenarios:

> **Scenario A**: >50% of the reach length is impacted by beavers and / or the reach does not have ≥80m of continuous un-impacted channel. Sample using procedure A below.
>
> **Scenario B**: Reach is <50% beaver impacted AND has at least 80m of continuous un-impacted channel. Sample using procedure B below.
>
> **NOTE:** If the reach was scouted, it should meet the ‘Scenario B’ criteria.

**Determining Up & Downstream Boundaries of Beaver Impacted Areas**

**Upstream Boundary:** Use the criteria below to determine the upstream boundary of the beaver pool:

| **Beaver Pools:** | **Upstream of Beaver Pools:** |
|---|---|
| -Low/zero water velocity | -Flowing water |
| -Wide wetted width | -‘Normal’ wetted width |
| -Elevationally below beaver dam height | - Elevationally above beaver dam height |
| -Fine substrate | -‘Normal’ substrate |

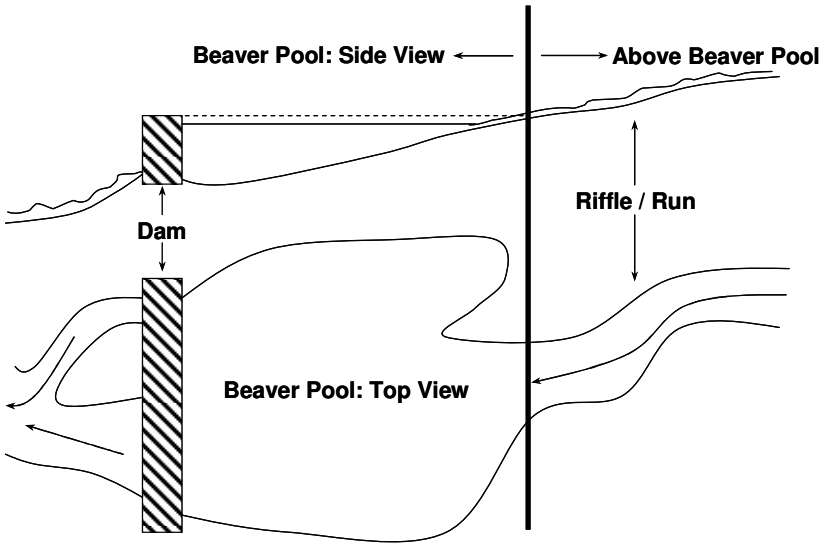



Figure 1. Top and side views of a beaver pool and how to distinguish the upstream boundary.

**Downstream Boundary:**

- The beaver dam is the downstream boundary of a beaver impacted area.
- Sometime there are dams on multiple channels which create one pool. Consider all dams that create one pool as one dam.

NOTE: There may be side channels downstream from beaver dams. Follow normal procedures for determining if measurements are taken in the side channels.

REMEMBER: A side channel, even a flowing channel, must have a streambed that has <50% vegetative cover throughout its entire course. If at any point the channel has ≥50% vegetative cover, do not take measurements within it.

For example, if a beaver dam results in water flowing over terrestrial vegetation, do not record measurements there.

**Scenario A: >50% of the total reach length is beaver impacted and / or there is not<80m of continuous un-impacted channel.**

| | Scenario A |
|---|---|
| Attributes | Collect data, Yes or NO |
| Alkalinity & conductivity | Yes* |
| Reach map | Yes* |
| GPS readings | Yes |
| Macroinvertebrates | Yes* |
| Streambank measurements | No |
| Change in elevation | Yes, unless BR and / or TR are impacted by beavers. |
| Photos | Yes* |
| Pools | No |
| Cross-sections | No |
| Bankfull width | No |
| Particle counts | No |
| Pool tail fines | No |
| Large wood | No |
| Temp probe | If a probe was not placed by a scout, place one. **However don't place probes at DMA sites.** |

Yes* = see instructions below

**Filling out Form 1:**

- Don't measure **valley length.**
- Measure **elevation change** of the entire reach, not the un-impacted area. Don't measure elevation change if the original BR and / or TR are impacted. Comment on Form 1 if this is the case.
- **Reach marker** info: we want marker descriptions, coordinates, and photos to identify the 'original' TR and BR, NOT the top / bottom of the un-impacted channel!
- Record **GPS coordinates** from the original BR / TR, NOT the top / bottom of the un-impacted channel!
- *Measure **water chemistry** at the bottom of the reach, not the top of reach. If there is a beaver dam / pool at BR, measure water chemistry below the dam / pool even if it is downstream from the reach.

***Filling out Form 2: REACH MAP**

- The reach map should depict the entire 'original' reach length.
- Draw and label beaver dams, beaver pools, side channels, etc.

***Filling out Form 4: PHOTO LOG**

- Fill out 'year repeated' where appropriate.
- Take photos of the original BR, TR, BR marker, and TR marker.
- Repeat the old photos as well as you can. It may be difficult because:
    - The stream looks dramatically different.
    - The stream may be difficult to wade; do not wade into beaver pools if it seems unsafe!
    - There are no transect flags to help re-locate old photo points.
- When taking repeat photos, enter the same photo description from the original photos into the logger (transect number, direction from transect, camera facing, bearing to rod, etc.). NOTE: if old information is incorrect, correct it. For example if the old photo states the rod was on RR when it is obviously on RL, enter RL.
- Repeat the cross section photos if you can locate the original spot. Secure the tape at the original location, but at the bankfull elevation <u>you determine</u>. If there are no bankfull indicators, pin the tape near the water's surface.
- Additional photos
    - Record all of the following photos as 'reach overview' in the logger. There is not enough space on Form 4 for additional 'reach overview' photos. Record this information on the bottom of Form 15.
    - <u>Beaver dams:</u> Take photographs of the dam(s) looking both upstream and downstream. Hold the rod on / beside the dam. Take the photographs parallel to the channel at a distance that allows you to see as much of the dam as possible.
    - <u>Top of beaver impacted area:</u> Take photographs of the top of the beaver impacted area(s) looking both upstream and downstream. Hold the rod on either bank at the upstream end of the beaver impacted area(s). Take the photographs parallel to the channel at a distance that allows you to see as much of the beaver pool as possible.
    - <u>Beaver pool overview:</u> Take at least one overview photo of each beaver pool / impacted area. These photos should be taken from a location where the greatest extent of the beaver pool(s) can be observed. This is often a hillside or terrace. Sometimes this is a difficult shot, but try your best.
    - There are two blank spaces on the bottom of Form 15 for any additional photos you feel are relevant.

***Macroinvertebrates**

- Our objective is to determine if different macroinvertebrate assemblages are found downstream from beaver impacted areas.
- Locate the most downstream beaver-impacted area within the reach and take samples downstream from this location.
    - <u>If there are 4 or more riffles in between the BR and the first beaver impacted area,</u> collect 8 samples within the first four riffles downstream from the impacted area.
    - <u>If there are between 1 and 3 riffles between the most downstream beaver-impacted area and the BR</u>, evenly distribute your 8 samples within the available riffles

- <u>If there are no riffles between the BR and the most downstream beaver impacted area, or the BR is impacted by beavers:</u>
  A. Collect 8 samples from the 1st four riffles downstream from BR.
  **OR**
  B. Evenly distribute samples in riffles found within 50m downstream from the impacted area.

  Select the option (A or B) which results in samples being collected <u>closest</u> to the beaver impacted area.

NOTE: the objective is to collect macroinvertebrate samples in close proximity to dams, but downstream. If your reach doesn't fit one of the above scenarios perfectly, do the best you can!

**Scenario B: ≤50% of the total reach length beaver impacted AND ≥80m continuous length un-impacted channel.**

| Attributes | Scenario B<br>Collect data, Yes or NO |
|---|---|
| Alkalinity & conductivity | Yes* |
| Reach map | Yes* |
| GPS readings | Yes* |
| Macroinvertebrates | Yes* |
| Streambank measurements | Yes* |
| Change in elevation | Yes, unless beaver dam at BR or TR |
| Photos | Yes* |
| Pools | Yes* |
| Cross-sections | Yes* |
| Bankfull width | Yes* |
| Particle counts | Yes* |
| Pool tail fines | Yes |
| Large wood | No |
| Temp probe | If a probe was not placed by a scout, place one. **However don't place probes at DMA sites.** |

Yes*= see instructions below

NOTE: Conduct sampling within the ≥80m continuous un-impacted channel. If there are two or more ≥80m (or greater) sections of continuous un-impacted channel, only sample the longest one.

Step 1: Start at the downstream boundary of the ≥80m continuous un-impacted channel; place your BR flags here. From here, measure a random distance upstream (0-7m) to establish the first transect.

Step 2: Continue placing transects **using the original width category** until you reach the downstream end of a beaver impacted area or the original TR. Do not place a transect flag within 1 bankfull width downstream of the dam. Record this reach length on form 1.

**Filling out Form 1:**

- Don't measure **valley length**
- Measure **elevation change** of the entire reach, not the un-impacted area. Don't measure elevation change if the original BR and / or TR are impacted. Comment on Form 1 if this is the case.
- **Reach marker** info: we want marker descriptions, coordinates, and photos to identify the 'original' TR and BR, NOT the top / bottom of the un-impacted channel!
- *Record **GPS coordinates** from the original BR / TR, NOT the top / bottom of the un-impacted channel!
- *Measure **water chemistry** from the bottom of the reach, not the top of reach. If there is a beaver dam / pool at BR, then measure water chemistry below the dam / pool even if it is downstream from the reach.

***Filling out Form 2: REACH MAP**

- Reach map should depict the entire 'original' reach length, as well as the ≥80m continuous un-impacted length. Label the up and downstream boundaries of the un-impacted length as 'BVR-TR' and BVR-BR'
- Draw and label beaver dams, beaver pools, side channels

***Filling out Form 4: PHOTO LOG**

- Take photos of the original BR, TR, BR marker, TR marker.
- Repeat old photos as well as you can, it may be difficult because:
    - The stream looks dramatically different
    - Stream may be difficult to wade (don't take photos if unsafe!)
    - There are no transect flags to help re-locate old photo points
- When taking repeat photos, enter the same photo descriptions from original photos into the logger (transect #, direction from transect, camera facing, bearing to rod, etc.)
- Repeat cross section photos if you can locate original spot. Pin the tape in the original location, at the bankfull elevation you determine. If there are no Bankfull indicators, pin the tape near the water's surface.
- Additional photos
    - Record all of the following photos as 'reach overview' in the logger. There is not enough space on Form 4 for additional 'reach overview' photos. Record this information on the bottom of Form 15.
    - <u>Beaver dams:</u> Take photographs of the dam(s) looking both upstream and downstream. Hold the rod on / beside the dam. Take the photographs parallel to the channel at a distance that allows you to see as much of the dam as possible.
    - <u>Top of beaver impacted area:</u> Take photographs of the top of the beaver impacted area(s) looking both upstream and downstream. Hold the rod on either bank at the upstream end of the beaver impacted area(s). Take the photographs parallel to the channel at a distance that allows you to see as much of the beaver pool as possible.
    - <u>Beaver pool overview:</u> Take at least one overview photo of each beaver pool / impacted area. These photos should be taken from a location where the greatest extent of the beaver pool(s) can be observed. This is often a hillside or terrace. Sometimes this is a difficult shot, but try your best.
    - There are two blank spaces on the bottom of Form 15 for any additional photos you feel are relevant.

***Macroinvertebrates**

- Our objective is to determine if different macroinvertebrate assemblages are found downstream from beaver impacted areas.
- Locate the most downstream beaver-impacted area within the reach and take samples downstream from this location.
    - <u>If there are 4 or more riffles in between the BR and the first beaver impacted area,</u> collect 8 samples within the first four riffles downstream from the impacted area.
    - <u>If there are between 1 and 3 riffles between the most downstream beaver-impacted area and the BR</u>, evenly distribute your 8 samples within the available riffles
    - <u>If there are no riffles between the BR and the most downstream beaver impacted area, or the BR is impacted by beavers:</u>
        A. Collect 8 samples from the 1st four riffles downstream from BR.
        **OR**

C. Evenly distribute samples in riffles found within 50m downstream from the impacted area.

Select the option (A or B) which results in samples being collected closest to the beaver impacted area.

NOTE: the objective is to collect macroinvertebrate samples in close proximity to dams, but downstream. If your reach doesn't fit one of the above scenarios perfectly, do the best you can!

***Pools**
Collect data at all pools that are not in beaver impacted areas.

NOTE: This is the only attribute you will measure in **all** un-impacted areas of the reach.

***Measure the following attributes within the continuous un-impacted area ≥80m, where you set up transects.**

- Streambank measurements
- Bankfull width, pebbles
- Cross sections
    - Repeat cross sections if they are within this continuous un-impacted area, but enter the old photo description info into the logger (camera / rod location, etc.)

## APPENDIX F: Locating an Un-Scouted Integrator Site

The PIBO EM sample design consists of a 5-year rotation of sites (e.g. sites sampled in 2001 were re-sampled in 2006, 2002 sites were re-sampled in 2007, etc). It is crucial to re-sample the same exact location originally sampled**.**

**Things to consider:**

- Sampling may take longer
- Some of the sampling scenarios outlined below are complex and require attention to detail. Please take the extra time to make sure you're setting up the BR and TR correctly.
- If you have questions, call!

**Objective: precisely locate the BR and TR locations using all information provided. Make corrections if necessary**

- **Site scouting sheet:**
  - Collect UTMs at all sites

  Edit the following if necessary:
  - Drive
  - Hike
  - Marker description
- **Photo pages**
  - Familiarize yourself with photos on your approach
  - Keep photos accessible while hiking to site
- **Reach map**
  - Pay particular attention to the labeled features
  - Keep in mind, art skills vary!

  **Beware!** Some information may be incorrect, if so make corrections on appropriate forms.

**Step 1: Familiarize yourself with site information while driving toward the site**

- Examine photos
- Program UTMs into your GPS
- The site you're sampling has a marker, unless it's in the wilderness, or the marker is gone.

**Step 2: locate the site**

- Use all available info, think it through, be patient
- Confirm marker location. Is the marker OK? Will it be there for another 5 years?
  - If yes, leave it there, correct marker directions if necessary
  - If no, remove and relocate the marker. Carefully fill out UTMs and description.

It is unlikely, but you may encounter

- Beaver activity. Fill out 'beaver impacted site' form.
- Site is on private land. Do not sample, go to next site, and call.
- Inadequate information. Carefully scrutinize all information and try your best. If you cannot locate the site, call.
- Stream flows through a different channel. Call.
- Location is now privately owned. Do not sample, go to next site on list, Call.

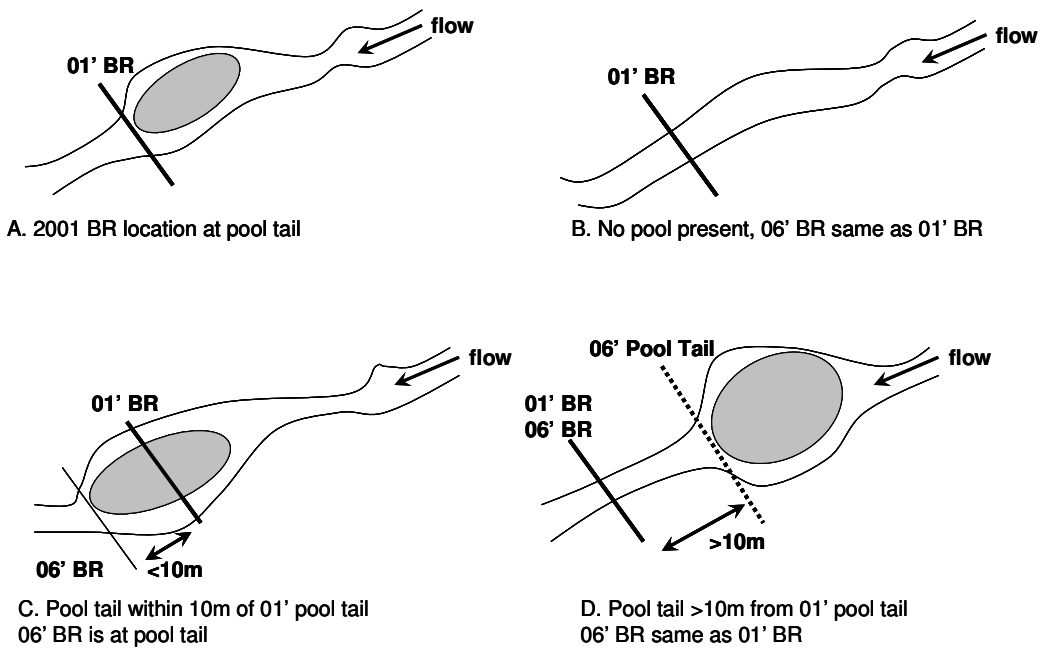



Figure A. Establishing Bottom of Reach (BR) location when relocating sites. This example depicts a site originally sampled in 2001 and then re-sampled in 2006.

**Step 3: Pinpoint your BR location using one of the four scenarios depicted in Figure A**

A. Depicts the ideal scenario, original BR pool tail has not moved. Use all information provided to precisely establish your BR location in the same exact spot.
B. Depicts a stream that has changed dramatically. Original BR pool tail is no longer present. If this is the case ask yourself, "am I in the correct location?" If you are confident you are in the right spot, use all information provided to locate your BR in the same exact spot as the previous sample (even though there is no pool tail).
C. The original pool tail location has moved, but is within 10m up or downstream of the original spot. If this is the case, your BR is the pool tail, update necessary BR information.
D. The original pool tail location has moved, and is not 10m up or downstream of the original spot. If this is the case, use all information provided to locate your BR in the same exact spot as the previous sample (even though there is no pool tail)

**Step 4: Pinpoint your TR location**

- Unless you are at a sentinel site, there will probably not be a top of reach (TR) marker.
- Use all info to relocate previous TR location.
- Use the old reach length. After confirming the BR location, use old random number if provided, and place transect flags until you've gone upstream a distance equal to the original reach length.
- Use same info above to locate TR location (scenario A, B, C, D)

**Step 7: Place TR marker**

- Write 'EMP TR' on it
- Record UTMs and description.

**Step 8: Determine the degree of reach overlap.**

Remember, your goal is to re-sample the same EXACT reach originally sampled. Record your 'degree of reach overlap' as Perfect, High, Moderate or None using the criteria below.

1) **Perfect:** you are sure that your BR and TR locations are the same, your reach perfectly matches the original reach.
2) **High:** your reach overlaps most of the original reach. Either the BR or TR location is confirmed, but you are unsure if the reaches overlap perfectly.
3) **Moderate**: you are confident your reach overlaps the original reach to some degree, but are unable to confirm EITHER the original BR or TR. Do not sample, Call
4) **None:** you have no evidence to suggest there is overlap. Do not sample, Call

Additionally, record specific comments regarding relocation on the 'Scouting Pre-Established Reaches' form.

**Step 8: Begin sampling**

- Use original width category, even if you don't agree.
- Beware of consistency issues! Does the width category on site scouting sheet match width category on photo pages? If not, multiply the original number of transects by both width categories. The correct width category matches the original reach length.

## Appendix G: Locating an Un-Scouted DMA Site

Some DMA sites you sample may not have been scouted; if this is the case your supervisor will provide you will information about how to locate each un-scouted DMA.

- DMA site locations are pre-selected and you will be given UTMs and/or directions to locate them.
- Often DMA sites are marked with a green T-post, but you will not always be able to find one.
- DMA sites may be up or downstream of T-posts, this information should be provided to you.
- DMA sites are exempt from criteria used to select integrator sites. This means a DMA might have high gradient, numerous side channels, tributaries, etc.
- All DMA's are sampled using 6m transect spacing, so sites will be ~120 m long.
- An IK site will have a reach length proportionate to bankfull width just like a 'normal' integrator.

NOTE: A key sentinel site will only be sampled the year that the rest of it's group is sampled. For instance Key Sentinel site 177-04 will be sampled the same year as the other HUCs in group 177.

## FORM 1 - INTEGRATOR REACH

| Group: | Order: | Reach Type: | Crew: |
|---|---|---|---|
| Stream Name: | | | Sample Date: |

| Temp Probe Condition (circle one) | Stream Flow (circle one) | Stream Flow Comments: |
|---|---|---|
| 1) OK (in flowing water) | 1) Flow (whole reach) | |
| 2) Missing | 2) Flow (part of reach) | |
| 3) Moved (buried in sediment) | 3) No flow (water in pools) | |
| 4) Moved (in non flowing water) | 4) No flow (dry) | |
| 5) Moved (out of water) | 5) Other (make comment) | |
| 6) Removed (no water) | | |

**Reach Information**

| | | | |
|---|---|---|---|
| Width Category: | Random Start Distance (m): | Elev. Change 1 (m): | Elev. Change 4: |
| Reach Length (m): | | Elev. Change 2: | Elev. Change 5: |
| Straight Length (m): | # of Bug Jars: | Elev. Change 3: | Elev. Change 6: |
| P Alkalinity: | Alkalinity: | Conductivity: | |

**Bottom of Reach Site Marker**

| | |
|---|---|
| Bearing to BR: | Dist. To BR (m): |
| Description of Marker Location: | |
| | |

**Top of Reach Site Marker**

| | |
|---|---|
| Bearing to TR: | Dist. to TR (m): |
| Description of Marker Location: | |
| | |

Reach Length = (((# of transects – 1) * width category) + random distance for 1st transect + distance from last transect to top of reach)

Reach Length = (((_____ - 1) * _____) + _____ + _____) = _____ m

**UTM Coordinates for Bottom of Reach, Top of Reach, and Site Markers**

| | | Accuracy | Zone | UTM Easting | | | | | | | UTM Northing | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bottom of Reach | 1st | | | | | | | | | | | | | | | | |
| | 2nd | | | | | | | | | | | | | | | | |
| | Avg | | | | | | | | | | | | | | | | |
| Top of Reach | 1st | | | | | | | | | | | | | | | | |
| | 2nd | | | | | | | | | | | | | | | | |
| | Avg | | | | | | | | | | | | | | | | |
| BR Site Marker | 1st | | | | | | | | | | | | | | | | |
| | 2nd | | | | | | | | | | | | | | | | |
| | Avg | | | | | | | | | | | | | | | | |
| TR Site Marker | 1st | | | | | | | | | | | | | | | | |
| | 2nd | | | | | | | | | | | | | | | | |
| | Avg | | | | | | | | | | | | | | | | |

**Completion Check List: Fill Out and Initial Before Leaving Reach**

| Attribute | Info. Collected | Info Entered | Entered on Summary | Explanation if Answer "N" |
|---|---|---|---|---|
| Reach Map | Y N | Y N | | |
| Pools | Y N | Y N | | |
| Pool Tail Fines | Y N | Y N | | |
| Cross-Sections | Y N | Y N | | |
| Large Wood | Y N | Y N | | Present Y N |
| Pebble Counts/BF Widths | Y N | Y N | | |
| Transect Measurements | Y N | Y N | | |
| Change in Elevation | Y N | Y N | | |
| GPS Readings | Y N | Y N | | |
| Photos | Y N | Y N | Y N | |
| Macroinvertebrates | Y N | Y N | Y N | |
| Backup Logger Data | | | | Performed Y N |

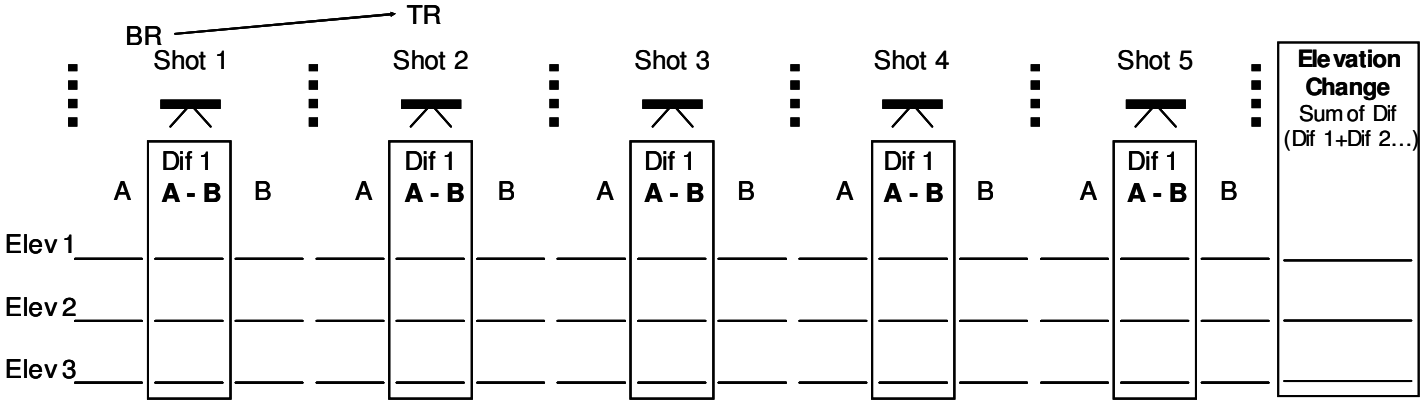
**FORM 1 - INTEGRATOR REACH COVER SHEET (backside)**

**Bankfull Widths for Width Category, Maximum Depths from X-sections and Measuring Change in Reach Elevation**

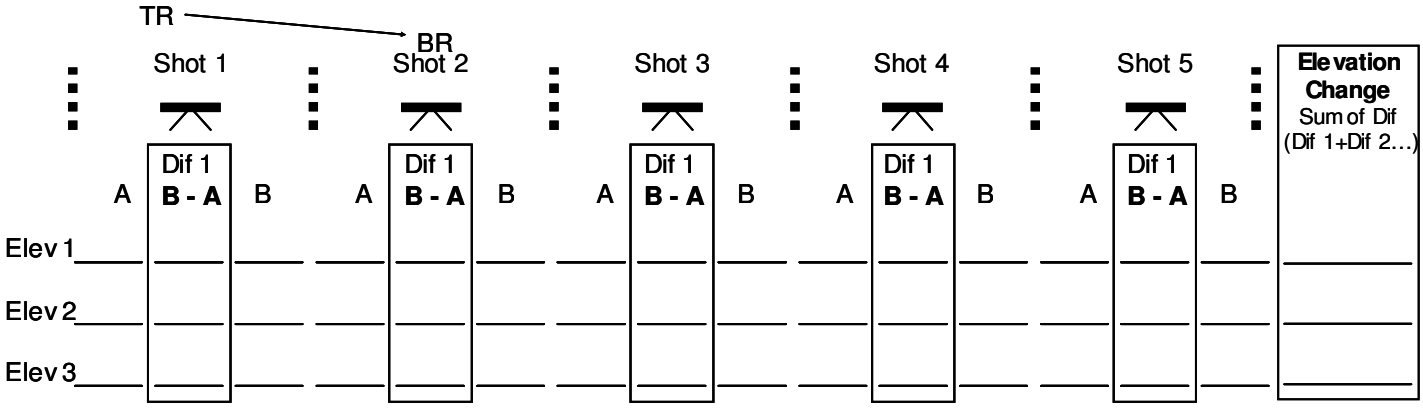
| Bankfull Widths for Width Category | |
|---|---|
| Measurement # | Bankfull width (nearest 0.1 m) |
| #1 – T1 | |
| #2 | |
| #3 | |
| #4 | |
| #5 | |
| Average | |

| Maximum Depths from X-sections | |
|---|---|
| Cross-Section # | Maximum Depth |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| Average | |

Measuring elevation change: starting from Bottom of Reach, shooting upstream




Measuring elevation change: starting from Top of Reach, shooting downstream




**Continue measuring reach elevation until 2 reach elevations are within 10%**

lower limit upper limit

Elevation_____ * 0.9 =_____, Elevation_____ * 1.1 =_____

Elevation_____ * 0.9 =_____, Elevation_____ * 1.1 =_____

Elevation_____ * 0.9 =_____, Elevation_____ * 1.1 =_____

**DO NOT erase on this form. If more than 5 shots are required, continue on additional sheet(s)**

| FORM 2 - REACH MAP | |
|---|---|
| Stream Name: | Reach ID: |
| Date: | |

# FORM 4: PHOTO LOG

| Stream Name: | Reach ID: | Date: |
|---|---|---|
| Width Category (circle one): 6 (DMA), 8, 10, 12, 14, 16, 18, 20 | | Memory Card #: |

| Photo # | Rod Location | | | | Description | Camera Location | | | Year Repeated |
|---|---|---|---|---|---|---|---|---|---|
| | Tran # | Direction From Trans | Distance to Transect | Streambank | | Camera Facing | Distance to Rod | Bearing to Rod | |
| | | | | | Reach ID / Date | | | | |
| | | | | | Reach Overview | | | | |
| | | | | | BR Site Marker Location | | | | |
| | | | | | TR Site Marker Location | | | | |
| | | | | RR RL | Bottom of Reach - US | US | | | |
| | | | | RR RL | Bottom of Reach - DS | DS | | | |
| | | | | RR RL | Top of Reach - US | US | | | |
| | | | | RR RL | Top of Reach - DS | DS | | | |
| | | US DS | | RR RL | Stream XS - 1 (OLD) | US DS | | | |
| | | US DS | | RR RL | Stream XS - 3 (OLD) | US DS | | | |
| | | US DS | | RR RL | Stream XS - 1 (NEW) | US DS | | | |
| | | US DS | | RR RL | Stream XS - 3 (NEW) | US DS | | | |
| | | US DS | | RR RL | Distinctive Feature | RR US RL DS | | | |
| | | US DS | | RR RL | Misc. Stream | RR US RL DS | | | |
| | | US DS | | RR RL | Misc. Stream 2 | RR US RL DS | | | |
| | | US DS | | RR RL | Misc. Stream 3 | RR US RL DS | | | |

**REMEMBER: THE OBJECTIVE IS TO DUPLICATE OLD PHOTOS AS ACCURATELY AS POSSIBLE!!!**

**Year Repeated: when duplicating a photo enter the year the original photo was shot. Leave blank if new photo.**

**Stream XS (OLD) should be in same location old crew did it, but using your bankfull height**

**FORM 9**
**CHANNEL CROSS-SECTIONS**

| Stream Name: | Reach ID: |
|---|---|
| Date: | Comments: |

| Cross-Section 1 | | | Cross-Section 2 | | | Cross-Section 3 | | | Cross-Section 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. on Tape (m) | BF Depth (cm) | Meas. Type | Dist. on Tape (m) | BF Depth (cm) | Meas. Type | Dist. on Tape (m) | BF Depth (cm) | Meas. Type | Dist. on Tape (m) | BF Depth (cm) | Meas. Type |
| | | | | | | | | | | | |
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| | | | | | | | | | | | |
| Entrenchment Width XS1 (m): | | | Entrenchment Width XS2 (m): | | | Entrenchment Width XS3 (m): | | | Entrenchment Width XS4 (m): | | |

| FORM 10<br>POOL DATA | | | | | |
|---|---|---|---|---|---|
| Stream Name: | | | Reach ID: | | Date: |
| Pool # | Pool Tail Depth (cm) | Maximum Depth (cm) | Length (m) | Pool Type (Full or Partial ) | Formation (Scour, Dam, or Plunge) |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |
| 16 | | | | | |
| 17 | | | | | |

| POOL-TAIL FINES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pool # | Grid 1 | | | Grid 2 | | | Grid 3 | | |
| | # Fines < 2mm | # Fines < 6mm | # Non-Meas. | # Fines < 2mm | # Fines < 6mm | # Non-Meas. | # Fines < 2mm | # Fines < 6mm | # Non-Meas. |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |

**Do not collect pool-tail fines in dam pools**

**FORM 11**
**TRANSECTS**

| Stream Name: | Reach ID: |
|---|---|
| First transect @ meters from bottom of reach | Date: |

| Tran. # | Bank | Bank Angle | Undercut Depth (cm) | Stability | Bank Type | Bank Material | OSW and Distance (m) | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | R | | | | | | | |
| 1 | L | | | | | | | |
| 2 | R | | | | | | | |
| 2 | L | | | | | | | |
| 3 | R | | | | | | | |
| 3 | L | | | | | | | |
| 4 | R | | | | | | | |
| 4 | L | | | | | | | |
| 5 | R | | | | | | | |
| 5 | L | | | | | | | |
| 6 | R | | | | | | | |
| 6 | L | | | | | | | |
| 7 | R | | | | | | | |
| 7 | L | | | | | | | |
| 8 | R | | | | | | | |
| 8 | L | | | | | | | |
| 9 | R | | | | | | | |
| 9 | L | | | | | | | |
| 10 | R | | | | | | | |
| 10 | L | | | | | | | |
| 11 | R | | | | | | | |
| 11 | L | | | | | | | |
| 12 | R | | | | | | | |
| 12 | L | | | | | | | |
| 13 | R | | | | | | | |
| 13 | L | | | | | | | |
| 14 | R | | | | | | | |
| 14 | L | | | | | | | |

**FORM 11**
**TRANSECTS**

| Stream Name: | Reach ID: |
|---|---|
| First transect @ meters from bottom of reach | Date: |

| Tran. # | Bank | Bank Angle | Undercut Depth (cm) | Stability | Bank Type | Bank Material | OSW and Distance (m) | Comments |
|---|---|---|---|---|---|---|---|---|
| 15 | R | | | | | | | |
| 15 | L | | | | | | | |
| 16 | R | | | | | | | |
| 16 | L | | | | | | | |
| 17 | R | | | | | | | |
| 17 | L | | | | | | | |
| 18 | R | | | | | | | |
| 18 | L | | | | | | | |
| 19 | R | | | | | | | |
| 19 | L | | | | | | | |
| 20 | R | | | | | | | |
| 20 | L | | | | | | | |
| 21 | R | | | | | | | |
| 21 | L | | | | | | | |
| 22 | R | | | | | | | |
| 22 | L | | | | | | | |
| 23 | R | | | | | | | |
| 23 | L | | | | | | | |
| 24 | R | | | | | | | |
| 24 | L | | | | | | | |
| 25 | R | | | | | | | |
| 25 | L | | | | | | | |
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**FORM 12**
**LARGE WOOD**

| Stream Name: | | | | | | | Estimator: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach ID: | | | | | | | Date: | | | | | | |
| Piece # | Wood Cat | Est. Length (m) | Est. Diam. (m) | Meas. Length (m) | Meas. Diam. (m) | Tert Chan? | Piece # | Wood Cat | Est. Length (m) | Est. Diam. (m) | Meas. Length (m) | Meas. Diam. (m) | Tert Chan? |
| 1 | | | | | | Y N | 26 | | | | | | Y N |
| 2 | | | | | | Y N | 27 | | | | | | Y N |
| 3 | | | | | | Y N | 28 | | | | | | Y N |
| 4 | | | | | | Y N | 29 | | | | | | Y N |
| 5 | | | | | | Y N | 30 | | | | | | Y N |
| 6 | | | | | | Y N | 31 | | | | | | Y N |
| 7 | | | | | | Y N | 32 | | | | | | Y N |
| 8 | | | | | | Y N | 33 | | | | | | Y N |
| 9 | | | | | | Y N | 34 | | | | | | Y N |
| 10 | | | | | | Y N | 35 | | | | | | Y N |
| 11 | | | | | | Y N | 36 | | | | | | Y N |
| 12 | | | | | | Y N | 37 | | | | | | Y N |
| 13 | | | | | | Y N | 38 | | | | | | Y N |
| 14 | | | | | | Y N | 39 | | | | | | Y N |
| 15 | | | | | | Y N | 40 | | | | | | Y N |
| 16 | | | | | | Y N | 41 | | | | | | Y N |
| 17 | | | | | | Y N | 42 | | | | | | Y N |
| 18 | | | | | | Y N | 43 | | | | | | Y N |
| 19 | | | | | | Y N | 44 | | | | | | Y N |
| 20 | | | | | | Y N | 45 | | | | | | Y N |
| 21 | | | | | | Y N | 46 | | | | | | Y N |
| 22 | | | | | | Y N | 47 | | | | | | Y N |
| 23 | | | | | | Y N | 48 | | | | | | Y N |
| 24 | | | | | | Y N | 49 | | | | | | Y N |
| 25 | | | | | | Y N | 50 | | | | | | Y N |

**FORM 12**
**LARGE WOOD**

| Stream Name: | | | | | | | Estimator: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach ID: | | | | | | | Date: | | | | | | |
| Piece # | Wood Cat | Est. Length (m) | Est. Diam. (m) | Meas. Length (m) | Meas. Diam. (m) | Tert Chan? | Piece # | Wood Cat | Est. Length (m) | Est. Diam. (m) | Meas. Length (m) | Meas. Diam. (m) | Tert Chan? |
| 51 | | | | | | Y N | 76 | | | | | | Y N |
| 52 | | | | | | Y N | 77 | | | | | | Y N |
| 53 | | | | | | Y N | 78 | | | | | | Y N |
| 54 | | | | | | Y N | 79 | | | | | | Y N |
| 55 | | | | | | Y N | 80 | | | | | | Y N |
| 56 | | | | | | Y N | 81 | | | | | | Y N |
| 57 | | | | | | Y N | 82 | | | | | | Y N |
| 58 | | | | | | Y N | 83 | | | | | | Y N |
| 59 | | | | | | Y N | 84 | | | | | | Y N |
| 60 | | | | | | Y N | 85 | | | | | | Y N |
| 61 | | | | | | Y N | 86 | | | | | | Y N |
| 62 | | | | | | Y N | 87 | | | | | | Y N |
| 63 | | | | | | Y N | 88 | | | | | | Y N |
| 64 | | | | | | Y N | 89 | | | | | | Y N |
| 65 | | | | | | Y N | 90 | | | | | | Y N |
| 66 | | | | | | Y N | 91 | | | | | | Y N |
| 67 | | | | | | Y N | 92 | | | | | | Y N |
| 68 | | | | | | Y N | 93 | | | | | | Y N |
| 69 | | | | | | Y N | 94 | | | | | | Y N |
| 70 | | | | | | Y N | 95 | | | | | | Y N |
| 71 | | | | | | Y N | 96 | | | | | | Y N |
| 72 | | | | | | Y N | 97 | | | | | | Y N |
| 73 | | | | | | Y N | 98 | | | | | | Y N |
| 74 | | | | | | Y N | 99 | | | | | | Y N |
| 75 | | | | | | Y N | 100 | | | | | | Y N |

**FORM 13 PARTICLE SIZE DISTRIBUTION (Pebble Counts) and BF WIDTH**

| Stream Name: | | | | | Reach ID: | | | | Date: | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T # BF Width | Particle Number | B-Axis Diam. (mm) | Bed (BD) or Bank (BK) | T # BF Width | Particle Number | B-Axis Diam. (mm) | Bed (BD) or Bank (BK) | T # BF Width | Particle Number | B-Axis Diam. (mm) | Bed (BD) or Bank (BK) |
| 1 | 1 | | BD BK | 9 | 41 | | | 17 | 81 | | BD BK |
| | 2 | | BD BK | | 42 | | | | 82 | | BD BK |
| | 3 | | BD BK | | 43 | | | | 83 | | BD BK |
| | 4 | | BD BK | | 44 | | | | 84 | | BD BK |
| | 5 | | BD BK | | 45 | | | | 85 | | BD BK |
| 2 | 6 | | BD BK | 10 | 46 | | | 18 | 86 | | BD BK |
| | 7 | | BD BK | | 47 | | | | 87 | | BD BK |
| | 8 | | BD BK | | 48 | | | | 88 | | BD BK |
| | 9 | | BD BK | | 49 | | | | 89 | | BD BK |
| | 10 | | BD BK | | 50 | | | | 90 | | BD BK |
| 3 | 11 | | BD BK | 11 | 51 | | | 19 | 91 | | BD BK |
| | 12 | | BD BK | | 52 | | | | 92 | | BD BK |
| | 13 | | BD BK | | 53 | | | | 93 | | BD BK |
| | 14 | | BD BK | | 54 | | | | 94 | | BD BK |
| | 15 | | BD BK | | 55 | | | | 95 | | BD BK |
| 4 | 16 | | BD BK | 12 | 56 | | | 20 | 96 | | BD BK |
| | 17 | | BD BK | | 57 | | | | 97 | | BD BK |
| | 18 | | BD BK | | 58 | | | | 98 | | BD BK |
| | 19 | | BD BK | | 59 | | | | 99 | | BD BK |
| | 20 | | BD BK | | 60 | | | | 100 | | BD BK |
| 5 | 21 | | BD BK | 13 | 61 | | | 21 | 101 | | BD BK |
| | 22 | | BD BK | | 62 | | | | 102 | | BD BK |
| | 23 | | BD BK | | 63 | | | | 103 | | BD BK |
| | 24 | | BD BK | | 64 | | | | 104 | | BD BK |
| | 25 | | BD BK | | 65 | | | | 105 | | BD BK |
| 6 | 26 | | BD BK | 14 | 66 | | | 22 | 106 | | BD BK |
| | 27 | | BD BK | | 67 | | | | 107 | | BD BK |
| | 28 | | BD BK | | 68 | | | | 108 | | BD BK |
| | 29 | | BD BK | | 69 | | | | 109 | | BD BK |
| | 30 | | BD BK | | 70 | | | | 110 | | BD BK |
| 7 | 31 | | BD BK | 15 | 71 | | | 23 | 111 | | BD BK |
| | 32 | | BD BK | | 72 | | | | 112 | | BD BK |
| | 33 | | BD BK | | 73 | | | | 113 | | BD BK |
| | 34 | | BD BK | | 74 | | | | 114 | | BD BK |
| | 35 | | BD BK | | 75 | | | | 115 | | BD BK |
| 8 | 36 | | BD BK | 16 | 76 | | | 24 | 116 | | BD BK |
| | 37 | | BD BK | | 77 | | | | 117 | | BD BK |
| | 38 | | BD BK | | 78 | | | | 118 | | BD BK |
| | 39 | | BD BK | | 79 | | | | 119 | | BD BK |
| | 40 | | BD BK | | 80 | | | | 120 | | BD BK |

If a tertiary channel is present at a transect, note the total bankfull width (including tertiary channel's width) followed by tertiary channel's width. For example: If the total bankfull width is 10m, and the bankfull width of the tertiary channel is 1m, you will enter "10, 1" in the space provided.

## FORM 1 - DESIGNATED MONITORING AREA REACH

| Group: | Order: | Reach Type: | Crew: |
|---|---|---|---|
| Stream Name: | | | Sample Date: |

| Stream Flow (circle one) | Stream Flow Comments: |
|---|---|
| 1) Flow (whole reach) | |
| 2) Flow (part of reach) | |
| 3) No flow (water in pools) | |
| 4) No flow (dry) | |
| 5) Other (make comment) | |
| | |

### Reach Information

| | | | |
|---|---|---|---|
| Width Category: 6 m | Reach Length (m): | Elev. Change 1 (cm): | Elev. Change 4: |
| Random Start Distance (m): | Straight Length (m): | Elev. Change 2: | Elev. Change 5: |
| | | Elev. Change 3: | Elev. Change 6: |

| Bottom of Reach Site Marker | |
|---|---|
| Bearing to BR: | Dist. to BR (m): |
| Description of Marker Location: | |
| | |

| Top of Reach Site Marker | |
|---|---|
| Bearing to TR: | Dist to TR (m): |
| Description of Marker Location: | |
| | |

Reach Length = (((# of transects – 1) * width category) + random distance for 1st transect + distance from last transect to top of reach)

Reach Length = (((_____ - 1) * _____) + _____ + _____) = _____

**UTM Coordinates for Bottom of Reach, Top of Reach, and Site Markers**

| | | Accuracy | Zone | UTM Easting | | | | | | | UTM Northing | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bottom of Reach | 1st | | | | | | | | | | | | | | | | |
| | 2nd | | | | | | | | | | | | | | | | |
| | Avg | | | | | | | | | | | | | | | | |
| Top of Reach | 1st | | | | | | | | | | | | | | | | |
| | 2nd | | | | | | | | | | | | | | | | |
| | Avg | | | | | | | | | | | | | | | | |
| BR Site Marker | 1st | | | | | | | | | | | | | | | | |
| | 2nd | | | | | | | | | | | | | | | | |
| | Avg | | | | | | | | | | | | | | | | |
| TR Site Marker | 1st | | | | | | | | | | | | | | | | |
| | 2nd | | | | | | | | | | | | | | | | |
| | Avg | | | | | | | | | | | | | | | | |

### Completion Check List: Fill Out and Initial Before Leaving Reach

| Attribute | Inform. Collected | Inform. Entered | Entered on Summary | Explanation if Answer "N" |
|---|---|---|---|---|
| Reach Map | Y N | Y N | | |
| Pools | Y N | Y N | | |
| Cross-Sections | Y N | Y N | | |
| BF Widths | Y N | Y N | | |
| Transect Measurements | Y N | Y N | | |
| Change in Elevation | Y N | Y N | | |
| GPS Readings | Y N | Y N | | |
| Photos | Y N | Y N | Y N | |
| Backup Logger Data | | | | Performed Y N |

**FORM 1 - DESIGNATED MONITORING AREA REACH (backside)**

Measuring elevation change: starting from Bottom of Reach, shooting upstream

BR → TR

| | Shot 1 | | Shot 2 | | Shot 3 | | Shot 4 | | Shot 5 | | **Elevation Change** Sum of Dif (Dif 1+Dif 2…) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | Dif 1 **A - B** | B | A | Dif 1 **A - B** | B | A | Dif 1 **A - B** | B | A | Dif 1 **A - B** | B | |
| Elev 1 | | | | | | | | | | | | | |
| Elev 2 | | | | | | | | | | | | | |
| Elev 3 | | | | | | | | | | | | | |

Measuring elevation change: starting from Top of Reach, shooting downstream

TR → BR

| | Shot 1 | | Shot 2 | | Shot 3 | | Shot 4 | | Shot 5 | | **Elevation Change** Sum of Dif (Dif 1+Dif 2…) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | Dif 1 **B - A** | B | A | Dif 1 **B - A** | B | A | Dif 1 **B - A** | B | A | Dif 1 **B - A** | B | |
| Elev 1 | | | | | | | | | | | | | |
| Elev 2 | | | | | | | | | | | | | |
| Elev 3 | | | | | | | | | | | | | |

**Continue measuring reach elevation until 2 reach elevations are within 10%**

lower limit upper limit

Elevation_____ * 0.9 =_____, Elevation_____ * 1.1 =_____

Elevation_____ * 0.9 =_____, Elevation_____ * 1.1 =_____

Elevation_____ * 0.9 =_____, Elevation_____ * 1.1 =_____

**DO NOT erase on this form. If more than 5 shots are required, continue on additional sheet(s)**

# FORM 15: Beaver Impacted Reaches

Site Name: _____ Date: _____

Stream Name:

A. Original reach length: (m) _____

B. Total length of reach un-impacted by beaver: (m) _____

C. Longest continuous length of reach un-impacted by beaver: (m) _____

D. Length of original reach impacted by beaver: (m) = A - B = _____

E. % reach impacted by beaver: = D / A *100 = _____

**This section should be filled out by scouts**

Scout: _____

Are beaver dams active? Yes No

If 'No' crew will sample reach using normal procedures
If 'Yes' fill out the 2 questions below

Is C < 80m? Yes No

Is E > 50%? Yes No

If either question is 'Yes', don't send crew to site. Technicians will take photos, sample bugs & measure water chemistry during temp. probe retrieval

**This section should be filled by crews**

Crew: _____

Is C < 80m? Yes No

Is E > 50%? Yes No

If either question is 'Yes', sample using scenario A
If both questions are 'No', sample using scenario B

**Additional Photos for Beaver Impacted Reaches**

| Photo # | Beaver Pool # * | Photograph of: | |
|---|---|---|---|
| | 1 | Beaver Dam: Looking Upstream | Reach Overview |
| | 1 | Beaver Dam: Looking Downstream | Reach Overview |
| | 1 | Top of Beaver Pool: Looking Upstream | Reach Overview |
| | 1 | Top of Beaver Pool: Looking Downstream | Reach Overview |
| | 1 | Beaver Pool Overview | Reach Overview |
| | 2 | Beaver Dam: Looking Upstream | Reach Overview |
| | 2 | Beaver Dam: Looking Downstream | Reach Overview |
| | 2 | Top of Beaver Pool: Looking Upstream | Reach Overview |
| | 2 | Top of Beaver Pool: Looking Downstream | Reach Overview |
| | 2 | Beaver Pool Overview | Reach Overview |
| | 3 | Beaver Dam: Looking Upstream | Reach Overview |
| | 3 | Beaver Dam: Looking Downstream | Reach Overview |
| | 3 | Top of Beaver Pool: Looking Upstream | Reach Overview |
| | 3 | Top of Beaver Pool: Looking Downstream | Reach Overview |
| | 3 | Beaver Pool Overview | Reach Overview |
| | | | Reach Overview |
| | | | Reach Overview |

* the most downstream beaver pool / impacted area is #1, the next beaver pool upstream is # 2, etc.
Use additional sheets if you have > 3 beaver pools.

Scout/Crew_____

# Site Revisit Information

**Site Name (Group-Order-Type):**_____ **Stream:** _____

BR Marker Found? Y N BR Relocation confidence: Perfect High Moderate None

TR Marker Found? Y N TR Relocation confidence: Perfect High Moderate None

**Comments:**

| Scout Use Only | | | | | |
|---|---|---|---|---|---|
| **Temperature Probe Placed** | Y | N | | | |
| **BR Flagged** Y N | **Sampling Scenario:** | BR Flag to TR Flag | BR Flag Upstream | | |
| **TR Flagged** Y N | | | | | |
| **Degree of Overlap:** | Perfect | High | Moderate | None | |
| **Comments:** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| DMA Location: | Good | Seems Good | Bad | Seems Bad | Not Sure |
| Comment: | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |