Physical Evaluation

This portion of the survey includes a wide variety of observations using all senses, making several judgments based on established rating descriptions, as well as some collection and measurement procedures. In this section we discuss general physical observations. These observations should be completed prior to or immediately following the water quality analysis. Table 3 provides a list of the conditions that are assessed as wells as some general guidelines regarding what certain characteristics indicate. Water observations are made in a run or riffles, sediment observations are also made in a run or riffle and benthic algae observations are made in a riffle. These observations should be made multiple times throughout the reach to make sure conditions are consistent. You should write comments on the survey data sheet if any notable differences within the reach are observed.

Table 1 - Stream physical condition characteristics.

Watercolors

Brown: Usually caused by sediment in the water. Some muddiness (brown color) is natural after storms, but if the condition persists look for an activity upstream that has disturbed the soil such as construction sites, logging, storm water runoff from roads or urban areas, or agricultural activities such as cattle in the stream.
Black: Usually caused by coalmine drainage, tar, or sometimes waste material from road construction.
Green: Usually due to an algae bloom caused by excessive nutrients in the water. The source could be sewage, fertilizers from farms, homes or golf courses or waste from animal feedlots.
Multi-colored sheen: Can occur naturally in stagnant waters, but a sheen that is moving or does not break up easily may be an indication of oil pollution. The source could be runoff from streets or parking areas or illegal dumping. In some areas the use of all-terrain (ATV's) vehicles may contribute to stream oil pollution.
Orange or **red**: Usually associated with mine drainage (high iron content in the stream).
Tea colored: Usually associated with wetlands.
White or **gray**: Can be caused by runoff from landfills, dumps, or sewage.

Sediment colors

Brown: An indication of silt deposits from sediment sources. Most stream bottoms are normally brown in color.
Black: This deposit can occur naturally in heavy organic soils but can also be due to fine coal particles, tars, ashes, sludge etc.
Green: Possible indication of excessive algae growth from organic (nutrient) enrichment sources.
Orange, **yellow** or **red**: A coating of flocculates on the sediments is usually due to polluted coalmine drainage.
White or **gray**: A white cottony mass is a sewage fungus common to organic polluted waters. An even coating of white or gray flocculates may be metals (aluminum) precipitated out of solution from contamination due to mine drainage.

Water/sediment odors

Collect your sediment and water sample separately to assess the odors.
Rotten eggs: This strong sulfur-like odor can be an indication of sewage pollution or polluted coalmine drainage.
Musky: This slight organic odor is often natural, but in some cases may indicate nutrient enrichment from organic waste products or sewage contamination.
Oily: This odor may indicate pollution from oil and gas wells.
Chemical: There are a wide variety of chemical odors usually the result of industrial discharges, solvents, and detergents.

Algae color

Algae color varies from brown to dark green in most streams and rivers; although color is a noticeable condition of the algae it is not a particular indicator of the types or of the condition represented by the algal community.

Algae abundance

Coverage in a riffle is estimated based upon the following: none, scattered, moderate or heavy. A heavy coating of matted and floating algae is often an indication of nutrient rich conditions caused by excess nitrogen and phosphorous.

Algae growth habit

The growth habit characteristics are critical to understating the algae. Most stream algae will be evenly coated on the rocks and have a smooth or slimy texture; other types will be filamentous and have a hairy texture; and others will be matted. Matted algae are easily removed from the surfaces by slowly scraping with your fingers. If the algal community is mostly matted pieces will come off in junks like carpet when it has been removed from flooring.

Foam occurs naturally due to the decomposition of leaves (this foam is generally less than three inches high and cream colored). Excessive white foam may be due to detergent pollution.

Habitat Assessment

The habitat assessment process involves rating and scoring many different **habitat conditions** as optimal, suboptimal, marginal or poor based upon criteria (descriptions and a rating scale) included on the survey data sheets. The optimal category is a description of conditions that meet natural expectations; suboptimal includes descriptions of criteria that are less than desirable but satisfies expectations under most circumstances; marginal is a description of moderate levels of degradation with severity at frequent intervals throughout the reach; and poor are descriptions of criteria for streams that have been substantially altered with severe degradation characteristics.

Descriptions of the habitat conditions are provided below. For additional information refer to Chapter 5 of the US EPA's Rapid Bioassessment Protocols Manual. The conditions here should be applied when describing the habitats of rocky-bottom streams and rivers.

Embeddedness refers to the extent to which rocks (gravel, cobble, and boulders) are surrounded by, covered, or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, fewer living spaces are available to macroinvertebrates and fish for shelter, spawning and egg incubation. To estimate the percent of embeddedness, observe the amount of silt and sand sediments overlying and surrounding the larger gavel and cobble size particles. You should base your embeddedness assessment on the composition of the materials that you observe. Embeddedness is always evaluated in the riffles used for your BMI collections. In most cases the best person(s) to comment about this condition is the person(s) collecting BMIs. If cobble and gravel are easy to remove from the riffle and there is little sand or silt either in the net or suspended during collections, embeddedness is minimal. In some cases, chemicals can cement (armoring) the substrate together and cause severe embeddedness.

Sediment deposition is an estimate of the amount of sediment that has accumulated and the changes that have occurred to the stream channel because of deposition. Deposition occurs from large-scale movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals or result in the filling of runs and pools. Usually, deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms. Sediment deposition should be rated throughout your reach and should not be confused with embeddedness. Sediment deposition is probably the most difficult condition to assess. It is a natural process and bars often form in streams that are very stable and have little sediment from the surrounding land or few problems with erosion. When assessing this condition look for indicators that are unusual or beyond what is expected to be normal for the stream. The most effective way to learn is to view many different stream types representing both degraded and natural conditions. In most cases island formation, especially in small streams (1^{st} through 3^{rd} order), is an indication of excessive deposition. The most common cause for unusual or un-natural deposition in most streams is human encroachment (i.e., structures such as bridges, roads, culverts etc. to close to the stream or built so that the stream is narrowed) and bank erosion. Steep sloping banks with exposed surfaces are more likely to erode. Undercut banks can often erode but are sometimes very stable if covered with vegetation, tree roots and rocks. Look for deposition around eroding banks, especially if they show bare soils consisting mostly of fine materials (fine gravel, sand, and silt). Hard surfaces no matter how steep or undercut are less likely to erode.

The remaining conditions are assessed on the left and right sides. Note: The **LEFT** and **RIGHT** sides are determined by looking downstream.

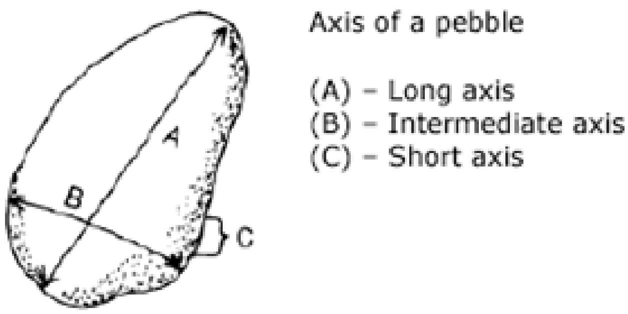
The **bank stability** condition evaluates whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are therefore considered to be unstable. Signs of erosion include crumbling, un-vegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition and suggest a scarcity of cover and organic input to streams.

Riparian buffer width is an estimate of the width of natural vegetation from the edge of the stream bank out through the riparian zone. A relatively undisturbed riparian zone supports a robust stream system; narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. Residential developments, urban centers, golf courses, and rangeland are the common causes of anthropogenic degradation of the riparian zone. Conversely, the presence of old fields, paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores. Riparian buffers are the most valuable protection a stream system has against outside influences. In most cases healthy riparian directly reflects upon the condition of the stream unless the source of the insult is a specific pollutant. Enhancement of the riparian buffer by re-planting native grasses, forbs, shrubs and trees is the first step in the recovery of the stream back to a more natural condition. Below is a list of just a few of the many benefits a healthy riparian buffer provides.

1. Provides organic material as food for macroinvertebrate, fish and wildlife.
2. Supplies large and small pieces of woody debris that provide habitat for fish, macroinvertebrates and amphibians.
3. Alters how sunlight reaches the stream and is an important temperature moderator.
4. Stabilizes stream banks and reduces erosion.
5. Filters sediment and materials from overland runoff and roots of many plants traps and holds the sediments.
6. Absorbs nutrients from overland and sub-surface flows.
7. Reduces the impacts of flooding through temporary storage, interception/diversion and slow releases (especially wetlands) from heavy rains.

Pebble count

The composition of the streambed and banks is an important facet of stream character, influencing channel form and hydraulics, erosion rates, sediment supply, and other parameters. Observations tell us that steep mountain streams with beds of boulders and cobbles act differently from low-gradient streams with beds of sand or silt. You can document this difference by collecting representative samples of the bed materials using a procedure called a Wolman pebble count. This method requires a person with a metric ruler who walks through the stream and a note taker who remains on the bank with the field book or survey data sheet. The note taker records the count is recorded by size classes or categories like those shown in Table 4. Pebble counts can be made using grids, transects, or a random step-toe procedure.



Select the portion of the reach that you wish to measure (this may be the entire reach or riffles only). For stream characterization, sample pools, runs, and riffles in the same proportions as they occur in the study reach. For other purposes, it may be more appropriate to use a more random method. The professional SOP recommends a minimum of 100 particles to obtain a valid count. WV Save Our Streams ask that volunteers using this procedure collect a minimum of 50 particles.

Table 2 - Pebble count size classes.

Categories	**Description** (size)	**Size range** (mm)	**Categories**	**Description** (size)	**Size range** (mm)
Silt/clay	Slick/smooth	Determined by feel	Cobble	Tennis ball - basketball	65 - 256
Sand	Very small grainy	< 2	Boulder	Basketball – car size	> 257
Fine gravel	Pea – golf ball	2 - 24	Bedrock	Large solid surface	NA
Coarse gravel	Golf ball – tennis ball	25 - 64	Woody debris	Sticks, leaves etc.	NA

Pebble count collection procedure

Start at a randomly selected point near the downstream end of the reach. Start on the shoreline and take steps across the stream. Averting your gaze, pick up the first particle touched by the tip of your index finger at the toe of your wader. Measure the intermediate axis (neither the longest nor shortest of the three mutually perpendicular sides of each particle picked up). Measure embedded particles or those too large to be moved in place. For these, measure the smaller of the two exposed axes. Call out the measurement. The note taker tallies it by size class, repeats it back for confirmation and keeps count. Continue across the channel slightly upstream in the direction of the opposite bank and repeat the process, continuing to pick up particles until you have the requisite number (100 or more) of measurements. Traverse across the stream perpendicular to the flow or in a zigzag pattern.