Alliance for Aquatic Resource Monitoring

Visual Assessment Manual

February 2009

TABLE OF CONTENTS

Background on ALLARM:

The Alliance for Aquatic Resource Monitoring (ALLARM) is a project of the Environmental Studies Department at Dickinson College. Since its founding in 1986, ALLARM has become a nationally recognized technical and programmatic support center for community organizations interested in watershed assessment, protection, and restoration. ALLARM program goals are to:

1) Enhance local action for the protection and restoration of Pennsylvania watersheds by empowering communities with scientific knowledge and tools to implement watershed assessments;
2) Provide Dickinson College students with opportunities to participate in community-based participatory research thereby enhancing the quality of undergraduate science education; and
3) Be the leader in volunteer monitoring in Pennsylvania and a national model for college-community partnerships.

Through the work of student and professional staff, ALLARM offers comprehensive services to enable groups to use critical scientific tools to enhance environmental quality and fully participate in community decision-making. The program staff includes a Director, an Assistant Director, a faculty Science Director, and 12-14 undergraduate student staff.

For more information on please visit: www.dickinson.edu/allarm or email: allarm@dickinson.edu

Background on the USDA Visual Assessment Protocol:

The USDA Visual Assessment Protocols, or "streamwalks," allow watershed groups to evaluate stream sites based on the physical conditions of the stream. This is very useful in the early stages of the study design process, as the streamwalk can be used as a reconnaissance tool to evaluate the condition of the aquatic ecosystem within the stream. Streamwalks can help identify problem areas and allow you to narrow the scope of your monitoring sites. It is important to conduct streamwalks in addition to chemical and biological monitoring, as stream ecosystems are based on interactions of physical, biological, and chemical processes.

ALLARM uses this protocol to train volunteers on physical monitoring. This manual is a culmination of tools and resources ALLARM has developed to complement training workshops using the USDA protocol.

Project funding provided by the Foundation for Pennsylvania Watersheds.

Quantifying Your Results:

The assessment portion of the streamwalk is divided into twelve categories that evaluate different aspects of stream habitat. Each category is rated with a value between 1 and 10. Remember to rate only those categories appropriate to the stream reach, as some may not apply (i.e. manure presence and sewage). Record the score that best fits your observations based on the description provided. At the end, the scores are summed, averaged, and assigned a rating of:

Rating	Condition
≤ 6.0	Poor
6.1 – 7.4	Fair
7.5 – 8.9	Good
≥ 9.0	Excellent

Site Description and Diagram:

The first step in conducting a streamwalk is to identify the boundaries of the **reach** to be evaluated. A reach is a length of the stream that has consistent or representative conditions. The end of a reach is determined by a change in the ecosystem (primarily due to land use), such as a change from farmland to a parking lot. *Remember: There is an area in your forms for problem diagrams within your reach, so you do not need to change forms for every little change. Large bridges or overpasses are examples of what constitutes a new form.*

The site description section includes basic information about the stream, including the evaluator's name, location of reach, and surrounding land uses. If you do not know the longitude and latitude of your reach, write down road names or defining characteristics of your reach so you can locate the site later

on. For *Dominant Substrate*, choose the rock type that is dominant in the stream and approximate the percentage of the total substrate that it makes up.

In the *Site Diagram* space, sketch out the reach of your stream and make sure to note the direction of flow, riffles, pools, large woody debris, and trees. You should illustrate potential problem areas, such as road crossings, discharge pipes, bank erosion, etc. We recommend that you sketch your diagram after you have walked the entire reach and have evaluated it.

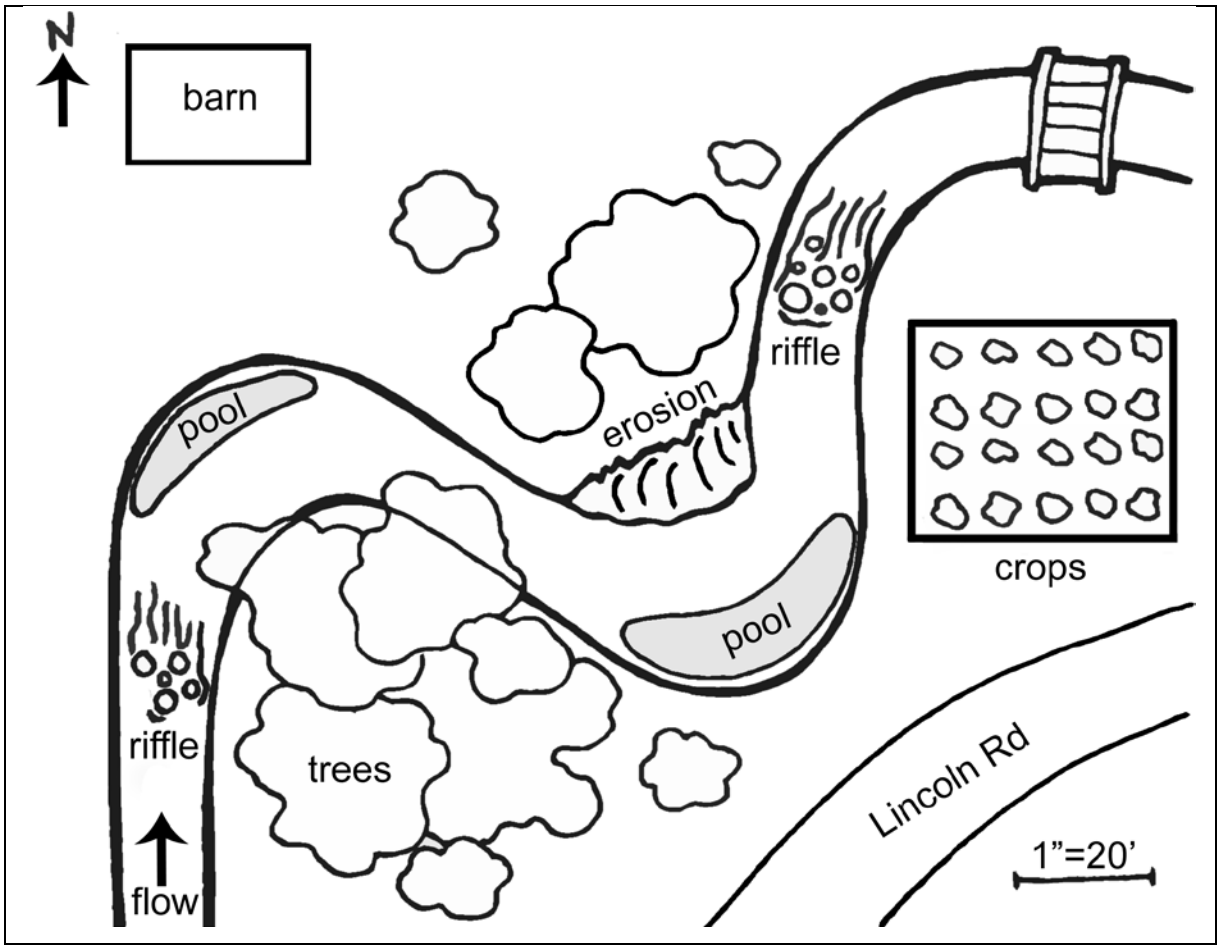


Figure 1. Site diagram example.

Monitor's name: _____ **Date:** _____

Stream name: _____ **Owner's name:** _____

Reach location: Latitude_____ Longitude_____

Land use (%): Row crop_____ Grazing/pasture _____ Forest _____

Residential_____ Conservation Reserve_____ Park _____

Industrial_____ Commercial_____ Other _____

Weather conditions: Today_____ Past 2-5 days_____

Active channel width (bankfull): _____ **Approximate reach length:** _____

Dominant substrate: Boulder _____ (>10 in) Cobble _____ (2.5-10 in) Gravel _____ (0.5-2.5 in) Sand _____ (<0.5 in) Silt _____ Mud_____

Site Diagram:

Notes:

CATEGORIES:

Assessment Tip: This manual refers to different portions of the stream channel as **baseflow**, **bankfull**, and **floodplain** (Figure 2). In order to conduct a successful visual assessment, it is important to understand these terms. **Baseflow** is the water flowing over the stream bottom under normal low-flow conditions. The **bankfull** stage, or "**active channel width**," forms and controls the shape of the active channel as larger volumes of water move through the channel during large storm events. Look for a break in the slope of the bank, changes in vegetation, substrate, debris, or signs of raised water flow as indicators of the bankfull stage. When the stream level rises above bankfull, water spills out into the surrounding **floodplain**.

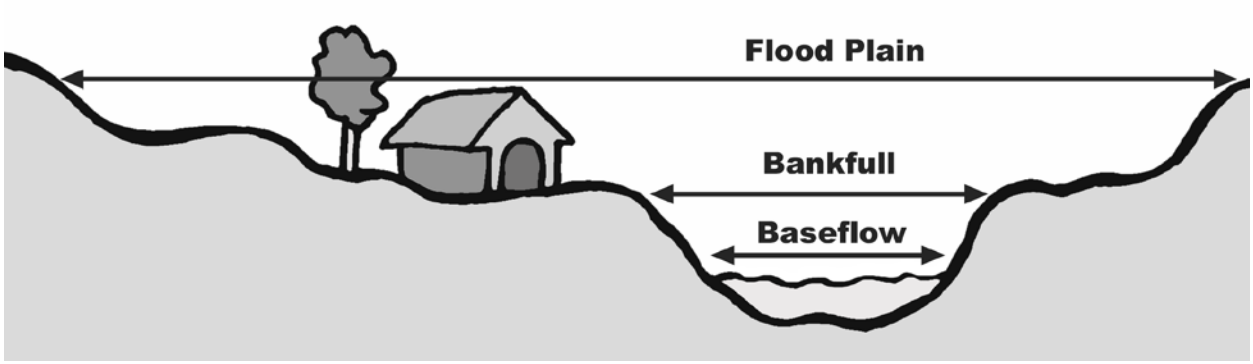


Figure 2. Stream cross-section identifying baseflow, bankfull, and floodplain.

CHANNEL CONDITION

Channel condition helps to understand historic and current uses as well as alteration of the stream. Indicators of **channelization** (man-made alteration) or straightening of the stream can include unnaturally straight sections of the stream, high banks, dikes, or a lack of flow diversity. Look for signs of down cutting (a deepening of the channel), lateral cutting (a widening of the channel), or aggradation (the stream bottom is raised in multiple locations by deposited sediments). You also want to look for artificial banks – man-made rock walls built to stabilize the bank, called **riprap**. Channelized streams are common but do not allow natural stream mobility or vegetation growth for the **riparian zone**. Other signs of channelization include drop structures (such as check dams), **culverts**, and irrigation diversions.

Example of lateral cutting.

Natural channel: • No man-made influences • No evidence of downcutting or excessive lateral cutting	• Evidence of past channel alteration, but with significant recovery of channel and banks • Stream-control structures are set back to provide access to a *floodplain*	Altered channel: • <50% of the reach has *riprap* and/or *channelization* • Excess *aggradation* o braided channel • Dikes or levees restrict *floodplain* width	• Channel is actively downcutting or widening • >50% of the reach has *riprap* or channelization • Dikes or levees prevent access to the *floodplain*
10	7	3	1

Keys: Look for down cutting, lateral cutting, altered or widened sections, dikes, levees or other obstructions.

BANK STABILITY:

Areas with degraded riparian zones, channel alteration, or changes in hydrology and sediment load can undergo excessive bank erosion. The roots of trees and woody vegetation in the riparian zone help to stabilize banks by holding the soil together. Look for areas of exposed soil on the banks, as well as high and steep banks which are more susceptible to erosion or collapse. As water flows around bends in the stream, the velocity is higher on the outside of the bend, and causes erosion.

Banks are stable: • Banks are low (at elevation of active floodplain) • 33% or more of eroding surface area of banks in outside bends is protected by roots that extend to the *baseflow* elevation	Moderately stable: • Banks are low (at elevation of active floodplain) • Less than 33% of eroding surface area of banks in outside bends is protected by roots that extend to the *baseflow* elevation	Moderately unstable: • Banks may be low, but typically are high (flooding occurs 1 year out of 5, or less frequently) • Outside bends are actively eroding (overhanging vegetation at top of bank, some mature trees falling into the stream • Some slope failures apparent	Unstable: • Banks may be low, but typically are high • Some straight reaches and inside edges of bends are actively eroding as well as outside bends (overhanging vegetation at top of bare bank • Numerous mature trees falling into the stream • Numerous slope failures apparent
10	7	3	1

Keys: Even the most stable streams may have 50% of the outside bend banks bare and eroding.

RIPARIAN ZONE:

Riparian zones are the vegetated areas adjacent to streams and are important for maintaining a healthy ecosystem and stabilizing streambanks. These zones act as a buffer between the stream and nearby lands, and should contain a variety of natural woody vegetation such as sedges or rushes, tall grasses, shrubs, understory trees, and overstory trees. Lawns are not considered part of the riparian zone, as mowed grass is rather impervious and will not absorb surface runoff as readily as natural vegetation. If one side of the stream is lacking a healthy riparian zone, the entire reach of the stream will be affected.

A healthy riparian zone:

- Absorbs and slows surface runoff and reduces the amount of pollutants entering the stream.
- Helps to control erosion by holding the soil together with root systems.
- Provides habitat and food for macroinvertebrates.

Natural vegetation extends at least two *bankfull widths* on each side	Natural vegetation extends one *bankfull width* on each side or If less than one width, covers entire floodplain	Natural vegetation extends half of the *bankfull width* on each side	Natural vegetation extends one third of the *bankfull width* on each side or Filtering function is moderately compromised	Natural vegetation less than one third of the *bankfull width* on each side or Lack of regeneration or Filtering function is severely compromised
10	8	5	3	1

Healthy Riparian Zone – 10

Unhealthy Riparian Zone - 1

WATER APPEARANCE:

This category accounts for the turbidity, color, and visual characteristics of the water. Water clarity is a measure of the ability of sunlight to penetrate the water. Degraded water clarity is usually caused by soil particles, organic matter, or algae suspended in the water. Keep in mind that many streams will not be deep enough to evaluate water clarity as described in the box below.

Some streams are naturally tea-colored from tannins in leaves, greenish due to algae communities, or orange from acid mine drainage. Excess nutrients can cause a thick algal film to coat the stream bottom. In degraded streams, surface scum, floating algal mats, and oil may be present.

• Very clear, or clear but tea-colored • Objects visible at depths of 3 to 6 ft (less if slightly colored) • No oil sheen on surface • No noticeable film on submerged objects or rocks	• May have slight green color • Occasionally cloudy, especially after storm events, but clears rapidly • Objects visible at depths of 1.5 to 3 ft • No oil sheen on water surface	• Considerable cloudiness most of the time • Objects visible to depths of 0.5-1.5 ft • Slow sections may appear pea-green • Bottom rocks or submerged objects covered with heavy green or olive-green film or moderate odor of ammonia or rotten eggs	• Very turbid or muddy appearance most of the time • Objects visible to depths <0.5 ft • Slow moving water may be bright-green • Other obvious water pollutants present • Floating algal mats, surface scum, sheen or heavy coat of foam on surface or strong odor of chemicals, oil, sewage, or other pollutants
10	7	3	1

Tip: *It can be difficult to determine the color of the water due to algae coating the rocks or glare on the water surface. Take a sample of water in a clear bottle and hold it up to the light.*

NUTRIENT ENRICHMENT:

Low levels of nutrients are essential to support aquatic ecosystems, but an abundance can cause problems. High levels of nutrients, particularly phosphorus and nitrogen, can cause an overgrowth of aquatic algae and **macrophytes** (floating and rooted aquatic plants). Excessive algae growth can hurt stream life as it can block the sun from penetrating the water, preventing other plants from producing dissolved oxygen through photosynthesis. Dissolved oxygen is also lowered as bacteria decompose dead plant matter. These low oxygen conditions can stress and even kill fish and other aquatic life. Evidence of nutrient enrichment includes a greenish water color, thick mats of algae, and a low diversity of aquatic plants.

• Clear water along entire reach • Diverse aquatic plant community • Little algal growth present	• Fairly clear or slightly greenish water along entire reach • Moderate algal growth	• Greenish water along entire reach • Abundant algal growth, especially during warmer months	• Pea green, gray or brown water along entire reach • Severe algal blooms create thick algal mats in stream
10	7	3	1

Keys: Look for algae and other aquatic vegetation. A little is good, but should not be excessive.

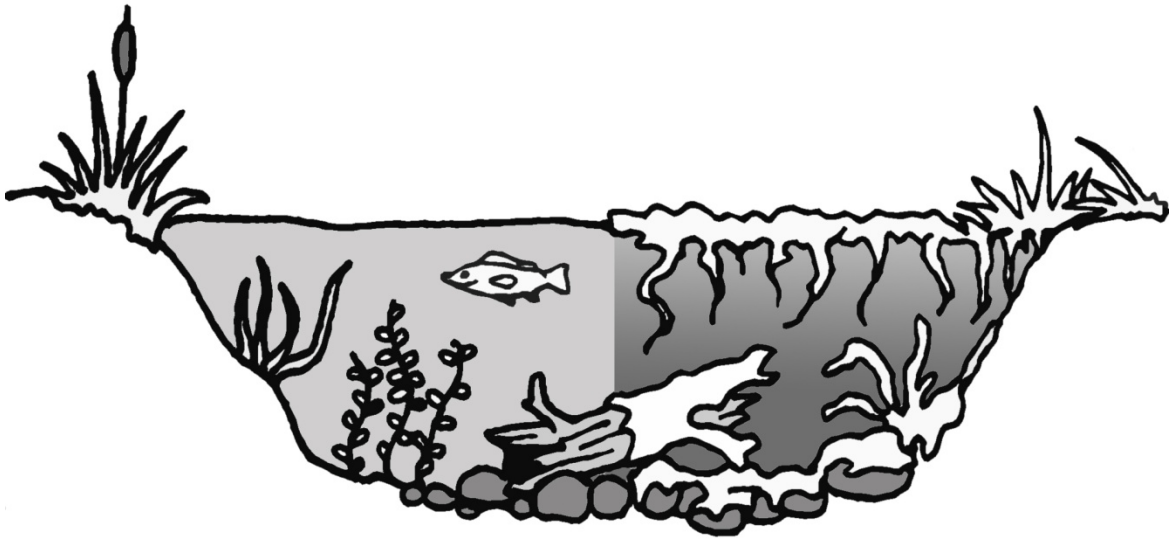


Figure 3. The left side has clear water and diverse aquatic plants, while the right side shows a degraded environment due to thick algal mats and green-brown water.

FISH BARRIERS:

Barriers, both natural and manmade, can prevent the movement of fish and other aquatic organisms. These barriers can prevent migrations, block access to important breeding and feeding areas, and isolate populations of fish and other organisms. Barrier types include waterfalls, boulder dams, small or sloped **culverts**, concrete drop structures, or any other obstacle that would impair the movement of aquatic organisms.

No barriers	Seasonal water withdrawals inhibit movement within the reach	Drop structures, culverts, dams or diversions (<1ft drop) within the reach	Drop structures, culverts, dams or diversions (>1ft drop) within 3 miles of reach	Drop structures, culverts, dams or diversions (>1ft drop) within the reach
10	8	5	3	1

Keys: Look for withdrawals, culverts, dams and diversions. Anything that is imposed or constructed by humans that would impede fish passage is considered a barrier.

IN-STREAM FISH COVER:

Fish need a variety of different habitat and cover types in order to maintain a healthy population. Cover types include:

- **Logs/large woody debris:** Fallen trees or parts of trees that provide structure and attachment for macroinvertebrates and hiding places for fish.
- **Deep pools**: Characterized by a smooth undisturbed surface, generally slow current, and deep enough to provide breeding areas for fish (deeper than the prevailing stream depth).
- **Overhanging vegetation:** Trees, shrubs, vines, etc. that hang over the stream surface providing shade and cover.
- **Boulders/cobble:** Boulders are rounded stones more than 10 inches in diameter; cobbles are stones 2.5 – 10 inches in diameter.
- **Undercut banks:** Eroded areas extending horizontally beneath the surface of the bank forming underwater pockets used by fish for hiding and protection.
- **Thick root mats:** Dense mats of roots (generally from trees) at or beneath the water.
- **Dense macrophyte beds:** Thick beds of emergent, submerged aquatic vegetation.
- **Riffles:** Area characterized by broken water surface, moderate or swift current, and relatively shallow depth (usually less than 18 inches).
- **Isolated/backwater pools:** Areas disconnected from the main channel or connected as a "blind" side channel, characterized by a lack of flow except in periods of high water.

>7 cover types available	6 to 7 cover types available	4 to 5 cover types available	2 to 3 cover types available	None to 1 cover type available
10	8	5	3	1

Cover types (check when present)**:**

(B) Logs/large woody debris _____ (A) Deep pools _____ (D) Overhanging vegetation _____

(B,C) Boulders/cobbles _____ (C) Riffles _____ Isolated/backwater pools _____

(A) Thick root mats _____ (A) Undercut banks _____ (E) Dense beds of aquatic plants _____

Other _____

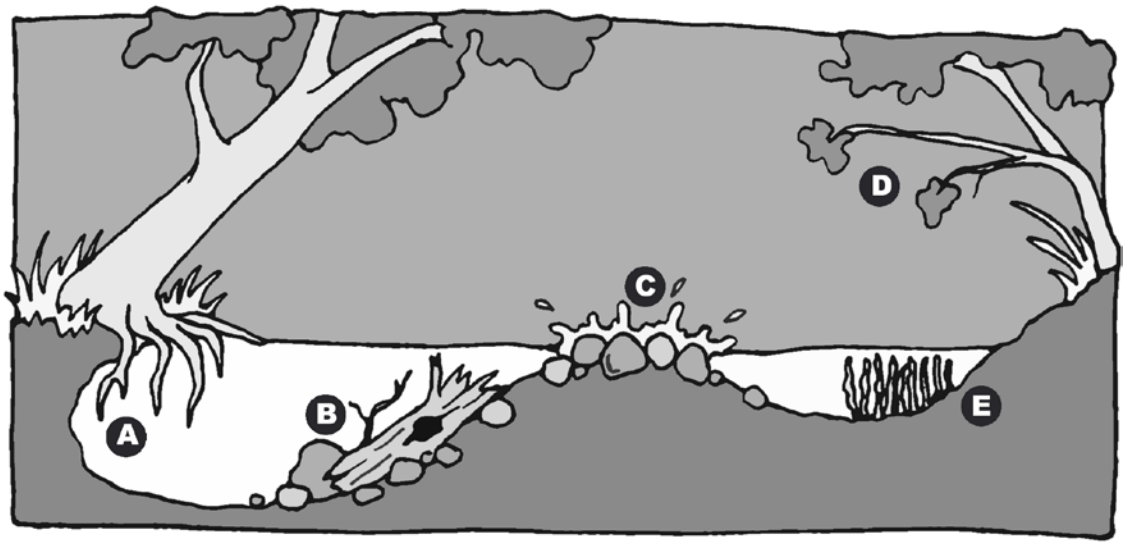


Figure 4. Stream cross-section with types of in-stream fish cover.

INSECT/INVERTEBRATE HABITAT:

Macroinvertebrates need a variety of substrates to have an optimal habitat for colonization. These substrates include fine woody debris, submerged logs, leaf packs, undercut banks, cobble, boulders, and coarse gravel.

• At least 5 types of habitat available • Habitat is at a stage to allow full insect colonization (woody debris and logs not freshly fallen)	• 3 – 4 types of habitat • Some potential habitat exists, such as overhanging trees, which will provide habitat, but have not yet entered the stream	• 1 – 2 types of habitat • The substrate is often disturbed, covered, deposited, or removed by high stream velocities	0 – 1 types of habitat
10	7	3	1

Habitat Examples (check when present):

Fine woody debris _____ Submerged logs _____ Leaf packs _____ Cobbles _____

Boulders _____ Coarse gravel _____ Undercut banks _____ Other _____

EMBEDDEDNESS:

Embeddedness measures the extent to which rocks are sunken into the stream bottom or buried by fine sediments (Figure 6). The less embedded a cobble, the more habitat variety for fish, macroinvertebrates, and other stream biota. The substrates that make up the stream bottom are classified by size:

Substrate	Size (in.)	Particle Size Description
Silt/Clay/Mud		Fine, sticky feeling
Sand	< 0.2	Gritty, pea
Gravel	0.1 – 2	Pea to marbled
Cobble	2 – 10	Tennis to basketball
Boulder	> 10	Basketball to car
Bedrock		Solid rocks bigger than a car

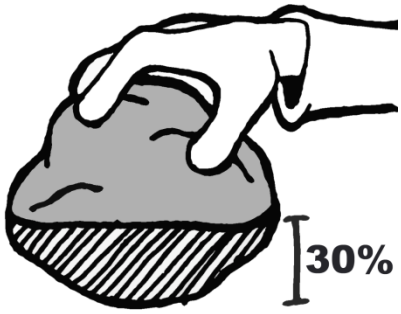


Figure 5. Estimating embeddedness.

How to measure: Remove a cobble from the stream, retain it spatial orientation, and estimate the height that is embedded, often a visible line on the rock (Figure 5). Repeat this for several cobbles and record the estimate.

Gravel or cobble particles are <20% embedded	Gravel or cobble particles are 20 - 30% embedded	Gravel or cobble particles are 30 - 40% embedded	Gravel or cobble particles are >40% embedded	Completely embedded
10	8	5	3	1

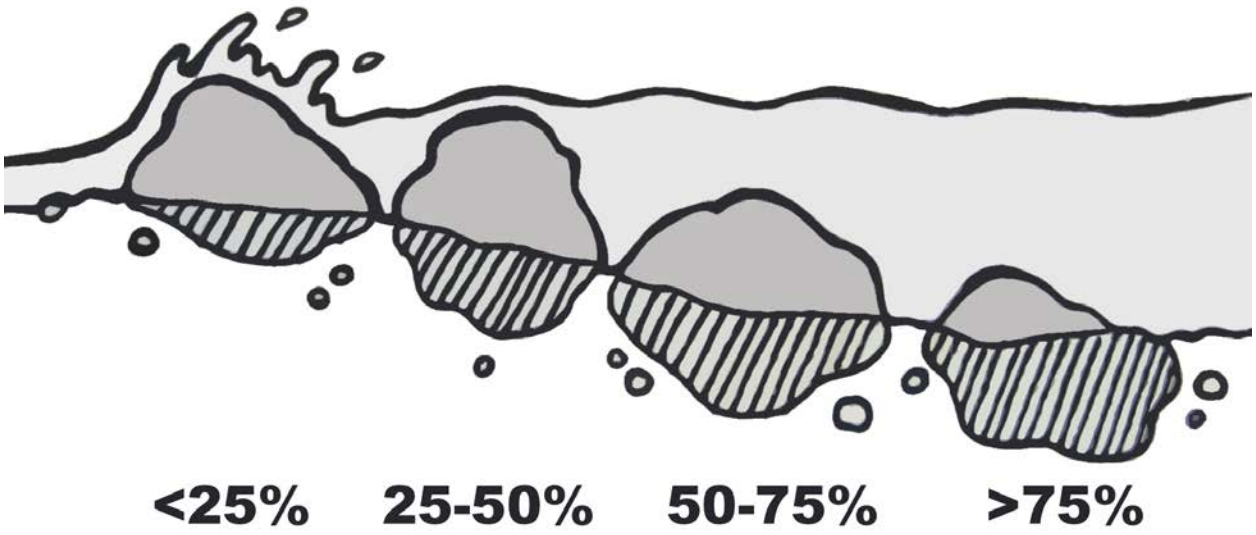


Figure 6. Cross-section of cobble embeddedness.

CANOPY COVER:

Large mature trees with overhanging branches provide canopy cover for streams. Shading of the stream is important because it keeps water cool, and limits algal growth by limiting the amount of sunlight available for photosynthesis. Cooler water has a greater oxygen holding capacity than warmer water, thus providing better conditions for aquatic life. Within the reach, estimate the portion of the water surface that is shaded by trees and vegetation in the riparian zone. As weather, time of day, and time of year can affect shading, assume that the vegetation is fully leaved and the sun is directly overhead.

• >75% of water surface shaded • 2 – 3 miles upstream generally well shaded	50% shaded in reach or >75% in reach, but upstream 2 to 3 miles poorly shaded	20 to 50% shaded	<20% of water surface in reach shaded
10	7	3	1

Keys: This category only pertains to waterways where channel is 50 feet wide or less.

MANURE PRESENCE (if applicable):

Livestock manure can enter the water from runoff of grazing lands or if livestock have access to the stream. Manure can increase the nutrient load, increase **biological oxygen demand**, and cause **eutrophication**. Well-worn livestock paths near the stream suggest manure presence in the water.

(Intentionally blank)	Livestock have access to riparian zone	Occasional manure in stream or Waste storage structure located on the floodplain	Extensive amount of manure on banks or in stream or Untreated human waste discharge pipes present
	5	3	1

SEWAGE (if applicable):

(Intentionally blank)	• Noticeable odor • Excess plant growth • Siltation	• Noticeable odor • Excess plant growth • Questionable pipe • Black stream substrate	• Visible pipe with effluent • Heavy odor
	5	3	1

ASSESSMENT SCORES

CHANNEL CONDITION ❒

BANK STABILITY ❒

RIPARIAN ZONE ❒

WATER APPEARANCE ❒

NUTRIENT ENRICHMENT ❒

FISH BARRIERS ❒

INSTREAM FISH COVER ❒

EMBEDDEDNESS ❒

INSECT/INVERTEBRATE HABITAT ❒

CANOPY COVER ❒

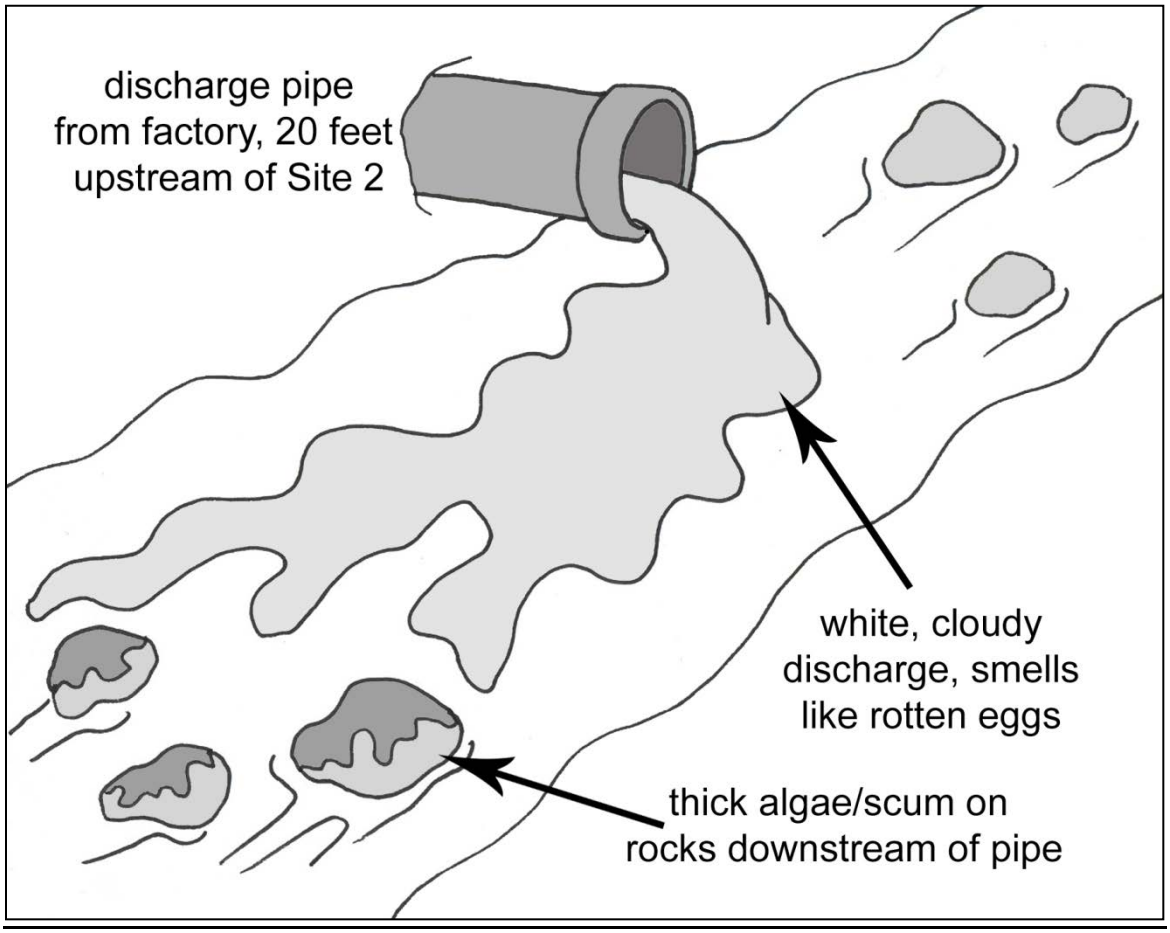
SEWAGE ❒
(If applicable)

MANURE PRESENCE ❒
(If applicable)

Overall Score
(Total divided by number scored) _____

< 6.0	**Poor**
6.1 – 7.4	**Fair**
7.5 – 8.9	**Good**
> 9.0	**Excellent**

PROBLEM DIAGRAM SAMPLE:



PROBLEM DIAGRAM

Type of problem: _____

Pictures: Y / N **Where are the pictures stored?** _____

Should this site be sampled? Y / N

If yes, why? _____

_____

GLOSSARY

Active Channel Width: Elevation of bank marking the normal maximum water flow before flooding occurs.
Aggradation: The stream bottom or floodplain is raised in elevation by the deposition of material.
Algae: A chlorophyll-containing plant ranging from one to many cells in size that lives in fresh or salt water.
Bankfull width: The width of the stream that is formed by the bankfull discharge (flow rate, such as cubic feet per second), which occurs once every 1.5 years on average.
Baseflow: The portion of stream flow that is derived from groundwater; average stream discharge during low flow conditions.
Benthic (Bottom-dwelling)**:** The plant and animal life whose habitat is the bottom of a sea, lake, or river.
Biological Oxygen Demand: A measure of the amount of oxygen used by microorganisms to decompose waste.
Channelization: Straightening of a stream channel to make water move faster.
Channelized: The straightening and deepening of streams. Channelization reduces the ability of the stream to assimilate waste and disturbs fish breeding areas.
Cover: Overhanging or instream structures (such as tree roots, undercut stream banks, or boulders) that offer protection from predators, shelter from strong currents, and/or shading.
Culvert: A channel used for draining water, often enclosed in steel, concrete, or plastic; can be used to allow water to pass underneath a road or embankment.
Current: The velocity (speed) of the flow (of water).
Ecosystem: The interacting system of a biological community (plants, animals) and its non-living environment.
Effluent: The wastewater from a municipal or industrial source that is discharged into the water.
Embeddedness: The degree to which objects in the stream bottom are surrounded by sediment.
Erosion: The wearing away of the land surface by wind or water.
Eutrophication: A process where water bodies receive excess nutrients that stimulate excessive plant growth.
Floodplain: The flat area of land adjacent to a stream that is formed by flood processes.
Gradient: The slope or steepness of the stream.
Macrophytes: Aquatic plants, growing in or near water that are either emergent, submergent, or floating.
Macroinvertebrate: Organisms found attached to rocks or within the sediments of the stream bed, often larval stages of insects, and are indicative of stream health.
Non-Point Source Pollution: "Diffuse" pollution, generated from large areas with no particular point of pollutant origin, but rather from many individual places. Urban and agricultural areas generate non-point source pollutants.
Nutrient: Any substance, such as fertilizer, phosphorus, and nitrogen compounds, which enhances the growth of plants and animals.
Point Source Pollution: A discharge of water pollution to a stream or other body of water, via an identifiable pipe, vent, or culvert.
Pool: An area of relatively deep slow water in a stream that offers shelter to fish.
Quality Control (QC): The system of checks that are used to generate excellence, or quality, in a program, such as a monitoring program.

Quality Assurance (QA): Quality Assurance is the larger system to see that QC is maintained. QA asks if we are doing the right things (in our case are we monitoring the right things to detect changes in water quality).
Reach: A stream section with fairly similar characteristics.
Riffle: A shallow, gravely area of streambed with swift current where water is breaking over rocks, wood, or other partly submerged debris and producing surface agitation.
Riprap: A sustaining wall built of rocks.
Riparian Zone: An area, adjacent to and along a watercourse, which is often vegetated and constitutes a buffer zone between the nearby lands and the body of water.
Run: A stretch of fast smooth current, deeper than a riffle.
Runoff: The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually returns to streams. Runoff can pick up pollutants from the air or the land and carry them to streams, lakes, and oceans.
Sediment: Fine soil or mineral particles that settle to the bottom of the water or are suspended in the water.
Stormwater Runoff: Water that washed off the land after a rainstorm. In developed watersheds it flows off of roofs and pavement into storm drains which may feed directly into the stream; often carries concentrated pollutants.
Substrate: The material that makes up the bottom layer of the stream, such as gravel, sand, or bedrock.
Suspended Sediments: Fine material or soil particles that remain suspended by the current until deposited in areas of weaker current. They create turbidity and, when deposited, can smother fish eggs or early plant growth.
Topographic: The configuration of a surface area including its relief, or relative elevations, and the position of its natural and man-made features.
Turbidity: Cloudiness of the water, caused by suspended sediments or excess organic matter.

REFERENCES & ACKNOWLEDGEMENTS

This protocol is a modified version of the USDA Stream Visual Assessment Protocol: Tier 1. The visual assessment worksheet consists of two main sections: site description and assessment.

The original version of the USDA Visual Assessment Protocol is available from:
http://www.nrcs.usda.gov/technical/ECS/aquatic/svapfnl.pdf

Figures were illustrated by Matthew Freedman, ALLARM, 2008.

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