Athens-Clarke County
Manual for Identification of Streams

November 3, 2004

Purpose

The purpose of this manual and accompanying field form is to identify and score geomorphic, hydrological and biological stream features that distinguish between ephemeral, intermittent and perennial streams. Athens Clarke County has evaluated the Stream Identification Protocol developed by the State of North Carolina Division of Water Quality and found it use appropriate for identification of streams within Athens-Clarke County. The Department of Transportation and Public Works has made some minor modifications within the document, but has maintained the scoring procedures and forms necessary for identifying streams.

Introduction

A stream can be described as flowing surface water resulting from the direct runoff (overland flow) of precipitation, or groundwater discharging into the stream (baseflow) or a combination of both. Streams may exhibit both overland flow and baseflow characteristics as they flow from their origins to their destinations. Generally, headwater (upper) portions of watersheds have streams with flow resulting primarily from runoff and lower portions of watershed have stream segments are represented predominately by groundwater. This manual and accompanying field form can be used to identify points on the landscape that represent stream origins as well as stream, channel and flow characteristics resulting from these varying sources of water.

Streams are drainage features that often change from ephemeral to intermittent and intermittent to perennial along a gradient or continuum—sometimes with no single distinct point demarcating these transitions. In order to distinguish ephemeral streams from intermittent ones or intermittent streams from perennial ones using the information presented in this guide, the field evaluator should have experience making geomorphic, hydrological and biological observations in headwater streams. Determinations must not be made at one point without first walking up and down the channel. This initial examination allows the evaluator to examine and study the nature of the channel, observe characteristics of the watershed, and observe characteristics that indicate what source of water (overland flow or baseflow) may predominately or solely contribute to flow. Once these observations are made, the investigator can determine the areas along the stream channel where these various sources of water (overland or groundwater) predominate flow and the constancy of flow, i.e. ephemeral, intermittent and perennial. As a general rule of thumb, several hundred feet (sometimes more) of channel should be walked to make these determinations. These initial observations aid in determining the magnitude (absent, weak, moderate or strong) of specific parameters.

All stream systems are characterized by interactions among hydrologic, geomorphic (physical) and biological processes. Variations in these characteristics along the length of a stream can help distinguish what source of water predominately contributes to flow. Thus, attributes of these three processes (geomorphic, hydrologic and biologic) are used in this stream identification methodology to produce a numeric score. The score is then used to assign a stream type such as “ephemeral” “intermittent” or “perennial” to the stream reach being evaluated.

Accordingly, the form and manual could conceivably be used on high order (e.g. 3rd, 4th, or higher) streams. However, these higher order streams are always perennial. Therefore, the persistence of water and flow has never been debated in these high order streams. Attributes of stream channels in headwaters or low order (1st, 2nd) streams can be subject to debate, thus this form and manual are best applied to these smaller streams. Beginning users of this manual and form should visit a variety of headwater streams, look for the geomorphic, hydrologic and biologic features discussed here, and gain experience observing the magnitude and variability of these features.

Background

This stream evaluation method is intended to distinguish (identify) ephemeral channels from intermittent channels. The numerical rating system format was developed based on requests from the regulated community in North Carolina for an objective method of stream identification. In addition, this method has served as the basis of similar endeavors elsewhere e.g. Fairfax County, Virginia: (http://www.co.fairfax.va.us/dpwes/watersheds/perennial.htm) .Results from over 300 individual field trials conducted in the Piedmont and Coastal Plain portions of the Neuse River Basin, North Carolina during May, June, July and August of 1998, as well as field testing conducted during December 1998 and January 1999 have supported a minimum score of 19.0 to distinguish ephemeral channels from intermittent streams. Scores less than 19.0 indicate ephemeral channels, whereas scores 19.0 or greater indicate that at least an intermittent channel is present. Given that Athens-Clarke County is located in the Piedmont region of Georgia, this stream identification protocol is appropriate for identification of local streams.

Definitions

The definitions of ephemeral, intermittent and perennial streams are provided for clarification in this manual:

Ephemeral Stream – Ephemeral (stormwater) stream means a feature that carries only stormwater in direct response to precipitation with water flowing only during and shortly after large precipitation events. An ephemeral stream may or may not have a well-defined channel, the aquatic bed is always above the water table, and stormwater runoff is the primary source of water. An ephemeral stream typically lacks the biological, hydrological, and physical characteristics commonly associated with the continuous or intermittent conveyance of water.

Intermittent Stream – Intermittent stream means a well-defined channel that contains water for only part of the year, typically during winter and spring when the aquatic bed is below the water table. The flow may be heavily supplemented by stormwater runoff. An intermittent stream often lacks the biological and hydrological characteristics commonly associated with the conveyance of water.

Perennial Stream – Perennial stream means a well-defined channel that contains water year round during a year of normal rainfall with the aquatic bed located below the water table for most of the year. Groundwater is the primary source of water for a perennial stream, but it also carries stormwater runoff. A perennial stream exhibits the typical biological, hydrological, and physical characteristics commonly associated with the continuous conveyance of water.

Groundwaters – “Groundwaters" means those waters occurring in the subsurface under saturated conditions.
Water Table -- "Water table" means the surface of the saturated zone below which all interconnected voids are filled with water and at which the pressure is atmospheric.

Perched Water Table -- "Perched water table" means a saturated soil horizon or horizon subdivision, with a free water surface periodically observed in a bore hole or shallow monitoring well, but generally above the normal water table, or may be as identified by drainage mottles or redoximorphic features, and caused by a less permeable lower horizon.

Seasonal High Water Table -- "Seasonal High Water Table" means the highest level that groundwater, at atmospheric pressure, reaches in the soil in most years. The seasonal high water table is usually detected by the mottling of the soil that results from mineral leaching.

Sources of Variability

Variations occur within and among stream systems. Perhaps the most predominate sources of variation within a stream system are precipitation and seasonally induced changes in vegetative cover. The rate and duration of flow in stream channels is influenced by climate and by recent weather. Recent (within 48 hours) rainfall can influence scoring; therefore it is strongly recommended that field evaluations be conducted at least 48 hours after the last known rainfall. However, please note that the identification method has been designed with redundancy to allow for reasonably accurate ratings even after a recent rainfall.

Sources of variation among stream systems are due primarily to geology or soils (physiographic province). For example, riffles and pools result from in-channel structures and these structures can vary between rocks and boulders in the mountains and roots and wood debris in the coastal plain. Other examples of variability include the magnitude (height) of head cuts, which are greater in watersheds with greater relief.

Suggested Field Equipment

Soil auger – used to determine if hydric soils are present.
Small net – used to catch aquatic insects.
Global Positioning System (GPS) – used to determine latitude and longitude.
Camera – used to photograph and document site features.

Scoring

Scores should reflect the persistence of water with higher scores indicating intermittent and perennial streams. A four tiered weighted scale used for this system addresses the variability of stream channels. The tiers “Absent”, “Weak”, “Moderate”, and “Strong” are applied to sets of geomorphic, hydrologic and biological attributes. These categories are intended to allow the evaluator flexibility in assessing variable features or attributes. In addition, the small increments in scoring between gradations will help reduce the range in scores between different evaluators. The score ranges were developed in order to better assess the often gradual and variable transitions of streams from ephemeral to intermittent.

Definitions of Absent, Weak, Moderate and Strong are provided in Table 1. These definitions are intended as guidelines and the evaluator must select the most appropriate category based upon experience and observations of the stream under review and its watershed.

Table 1. Guide to scoring categories

Category	Description
Absent	The character is not observed
Weak	The character is present but you have to search intensely (i.e., ten or more minutes) to find it
Moderate	The character is present and observable with mild (i.e., one or two minutes) searching
Strong	The character is easily observable

A. Geomorphic Indicators

1. Bed and Bank

Throughout the length of the stream, is the channel clearly defined by having a discernable bank and streambed? This indicator will lessen and may diminish or become fragmented upstream as the stream becomes ephemeral.

The bed of a stream or river or creek is the physical confine of the normal water flow. The lateral constraints (channel margins) during all but flood stage are known as the stream banks. In fact, a flood occurs when a stream overflows its banks and partly or completely fills its flood plain. As a general rule, the bed is that part of the channel below the "normal" water line, and the banks are that part above the water line; however, because water flow varies, this differentiation is subject to local interpretation. Usually the bed is kept clear of terrestrial vegetation, whereas the banks are subjected to water flow only during unusual or infrequent high water stages, and therefore can support vegetation much of the time.

Strong - There is a continuous bed and bank present throughout the length of the stream channel.

Moderate - The majority of the stream has a continuous bed and bank. However, there are obvious interruptions.

Weak - The majority of the stream has obvious interruptions in the continuity of bed and bank. However, there is still some representation of the bed and bank sequence.

Absent - There is little or no ability to distinguish between the bed and bank.

2. Sinuosity

Sinuosity is a measure of a stream's "crookedness." Specifically, it is the total stream length divided by the valley length (Figure 1). The greater the number, the higher the sinuosity. Sinuosity is related to slope. Natural undisturbed streams with steep slopes have low sinuosities, and streams with low slopes typically have high sinuosities.

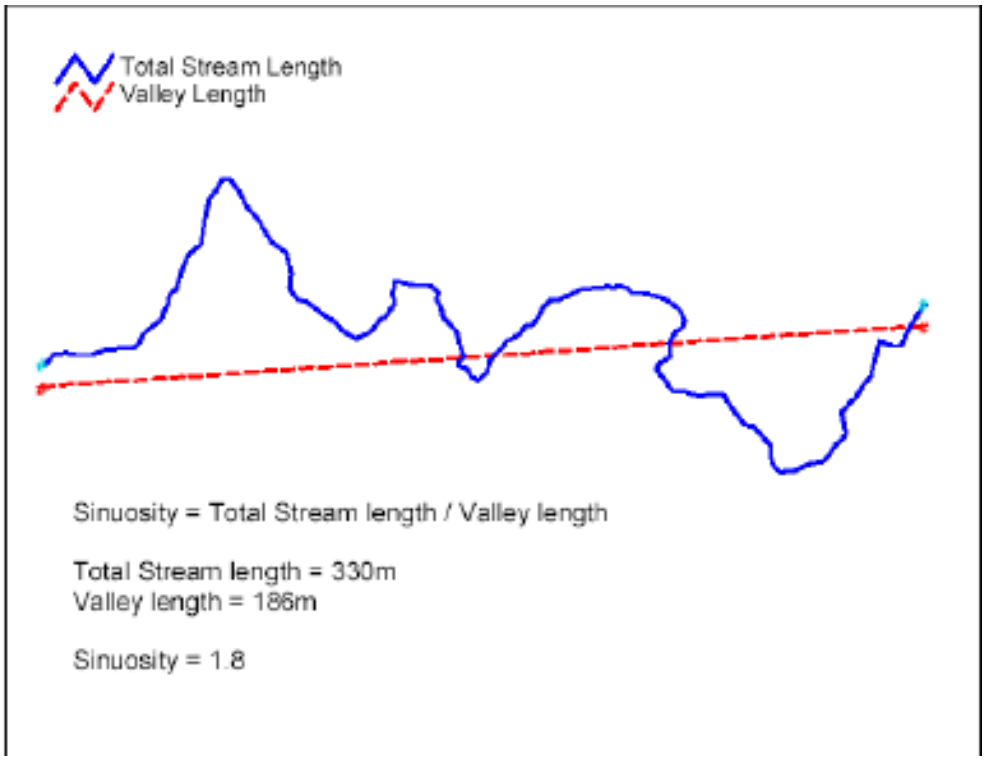

Figure 1. Stream sinuosity

Sinuosity is the result of the stream naturally dissipating its flow forces. Intermittent streams don't have a constant flow regime, and as a result generally exhibit a significantly less sinuous channel. While ranking, take into consideration the size of the stream and its watershed, which may also influence the stream wavelength. Sinuosity may be visually estimated, or approximated using a map and a map-wheel; examples are provided in Figure 2.

Strong – Ratio > 1.4. Stream has numerous, closely-spaced bends, very few straight sections.

Moderate – 1.2 < Ratio < 1.4. Stream has good sinuosity with some straight sections.

Weak - 1.0 < Ratio < 1.2. Stream has very few bends and mostly straight sections.

Absent - Ratio = 1.0. Stream is completely straight with no bends.

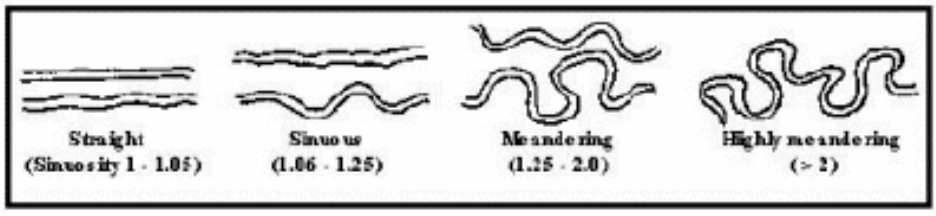

Figure 2. Examples of stream sinuosity

3. In-channel Structure -- Riffle-Pool Sequences

A repeating sequence of riffle/pool (riffle/run in lower-gradient streams or step/pool in higher gradient streams) can be observed readily in perennial streams. This morphological feature is almost always present to some degree in higher gradient streams such as piedmont and mountain streams. Riffle-run sequences in low gradient streams, such as those in the coastal plain are often created by in-channel woody structure (such as roots) and debris. When present, these

characteristics can be observed even in a dry stream bed by closely examining the local profile of the channel.

A riffle is a relatively shallow turbulent area along narrower portions of a stream where the water has a tendency to churn and flow rapidly. In smaller streams, riffles are defined as areas of a distinct change in gradient where flowing water can be observed. A pool is an area of slow moving water, where the stream widens and deepens. Along the stream reach, take notice of the frequency between the riffles and pools. Riffles are more frequent in the mountain and piedmont physiographic provinces than in the coastal plain and many parts of the Triassic Basin.

Strong - Demonstrated by an even and frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.

Moderate - Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.

Weak - Streams show some flow but mostly have areas of pools or mostly areas of riffles.

Absent - There is no sequence exhibited, or there is no flow in the channel.

4. Soil Texture

This feature can be examined in two ways. The first is to determine if the soil texture in the stream channel is similar to the soil texture outside the channel. If this is the case, then there is evidence that erosive forces have not been active enough to downcut the channel and support an intermittent or perennial stream. Soils in the bed of ephemeral channels typically have the same or comparable soil texture as areas close to but not in the channel.
The second way this feature can be examined is to look at the distribution of the soil particles in the substrate in the stream channel. Is there an even distribution of various sized substrates throughout the reach or does partitioning or sorting occur? The occurrence of depositional features will be infrequent in intermittent streams. Perennial streams, on the other hand, tend to exhibit correspondingly larger depositional features, with cobble/gravel/boulders being localized in riffles and runs, and with accumulations of fine sediments settling out in pools.

Note, however, the usefulness of this attribute may vary among physiographic provinces. For instance, in the coastal plain or sandhills, the variability in the size of soil particles is less than in the piedmont and mountains.

Strong - There is a clear distribution of various sized substrates. Depositional features are present, finer particles are absent or accumulate in pools, and larger particles are located in the riffles/runs.

Moderate - Various sized substrates are present but represented by a higher ratio of larger particles (cobble/gravel/rock). Small depositional features are present; small pools are accumulating some sediment.

Weak - Substrate sorting is not readily observed. There may be some small depositional features present on the downstream side of obstructions (large rocks, etc…)

Absent – Substrate sorting is absent. There are few depositional features.

5. Active/Relic Floodplain

Floodplains are relatively flat areas usually located outside of or adjacent to the stream bank that accumulate organic matter and inorganic alluvium deposited during flooding. An active floodplain shows characteristics such as drift lines, sediment deposited on the banks or surrounding plants, which may also be flattened by flowing water. In cases of severe channel incision (down-cutting) the stream's new floodplain may be restricted to within the channel itself and the previous but now disconnected (relic) floodplain will be harder to see (outside of channel). In these instances, look for indicators along the sides and within the incised channel. Floodplains on smaller order, incised streams may not be continuous but rather may be present in some locations and absent in others. In many cases there should be evidence of a floodplain if the stream has perennial flow.

Strong - The area displays all of the aforementioned characteristics.

Moderate - Most of the characteristics are apparent.

Weak - The floodplain is not obvious, however some of the indicators are present.

Absent - The characteristics are not present.

6. Bankfull Bench

Experience has shown that this attribute may cause confusion among persons not trained or have little experience making stream geomorphology observations. The bankfull (sometimes spelled as "bankful") stage can be defined as the point at which the flow just begins to enter the active floodplain. Thus there are a variety of indicators that can be used to identify this point.

When a stream channel conveys perennial flow, the forces of channel scouring and deposition create certain distinct physical features, which can be readily observed. One of these features includes scoured areas along the bank above which the stream banks are much less eroded. Another feature is accumulations of sand or silt creating a bar or "bench" which may or may not be covered with vegetation. The former should be fairly continuous along the length of the stream's banks and should be seen at roughly the same elevation as the top of any sediment bars (where the stream bank slope begins to increase dramatically).
Bankfull indicators imply that the channel experiences a relatively continuous hydrologic regime and is in dynamic equilibrium with the shaping forces of its water/sediment load. The flow regime, soils and grade determine the bankfull width and morphology of the conveyance channel. The more obvious and continuous the bankfull features are throughout the reach, the higher the score should be. Bankfull benches are often absent on very small channels.

Strong - Bankfull indicators are obvious throughout the sample reach.

Moderate - Indicators are present throughout most of the reach.

Weak - Indicators are infrequent along sampling reach.

Absent - Indications of a bank-full bench are completely lacking.

Figure 3. Bankfull bench (source: http://www.co.fairfax.va.us/dpwes/watersheds/ps_protocols.pdf)

7. Braided Channel

Braided channels occur in shallow, low gradient areas where abundant sediment has a tendency to build up, across the stream creating a braided pattern. Are there more than one small stream channels that cross or "braid" over one another? This usually occurs in areas where the land flattens significantly and where there is abundant sediment supply in a wide streambed with shallow water flow.

Strong - The stream displays a braided appearance with many crossings creating many "islands".

Moderate - The stream displays a braided pattern however; it does not cross many times and only has a few "islands".

Weak - The braided pattern is present but the stream only crosses one or two times creating only one or two "islands".

Absent - The gradient is too high such that the water is flowing too quickly in order to create a braided channel.

8. Recent Alluvial Deposits

Alluvium may be deposited as sand, silt, various sized cobble, and gravel. Observe whether or not there is any recent deposition or accumulation of these substrates within the stream channel (sand and point bars) or floodplain. The amount of alluvium deposited will indicate whether water is constantly pushing substrate downstream. Keep in mind that eroding stream channels influenced by stormwater drains/outfalls may score higher than undisturbed channels for this indicator.

Strong - Large amounts of sand, silt, cobble, and/or gravel alluvium present in the channel and in the floodplain.

Moderate - Large to moderate amount of sand, silt, cobble, and/or gravel mostly present in the stream channel.

Weak - Small amounts of sand, silt, and/or small cobble present within the channel.

Absent - There is no sand or point bars present within the stream channel and no indication of overbank deposition within the floodplain.

Figure 4. Recent alluvial deposits.

Striped stick is 1.0 m long, painted in decimeters and lying on the streambed
Note: rooted herbaceous plants in streambed

9. Natural levees

Levees develop when sand or silt is deposited relatively parallel to the top of the bank. These result from the deposition of heaver particles immediately adjacent to the channel and also aid in the concentration of water to the channel during periods of high flow. They are represented as large, “hills”, or broad low “ridges” that may be covered by vegetation or remain as bare areas. Scoring is based on the presence and length of the levee through the streamreach.

10. Head Cut

A head cut is an abrupt vertical drop in the bed of a stream channel. It often resembles a small intermittent waterfall (or a miniature cliff). Intermittent streams sometime start at these areas. Headcuts are transient structures of the stream and often exhibit active erosion. Groundwater seepage may also be present.

Figure 5. Examples of headcuts (Striped stick is 1.0 m long, painted in decimeters)

11. Grade Control Point

Grade points may be distinguished by a large rock outcrop or large roots which extends across the channel. Stormwater or other discharges through pipes also serve as grade control points. These structures separate an abrupt change in grade of the stream bed. These features are relatively permanent structures in the channel.

12. Natural Valley and Drainageway

When looking at the local topography in the field (or on a U.S. Geological Survey Map) does the land slope towards the channel (or are the contour lines fairly close together and roughly sinuous in shape and thereby indicating a "draw"?). In other words, does the land have slopes that seem to drain to or indicate a natural drainage way?

13. Second (or greater) Order Channel

The higher the channel order, the more likely the stream is to be perennial. Stream order should be based on available information and evaluated in the field. Primary map sources to be used include any county soil surveys published by the Natural Resource Conservation Service (NRCS) or any USGS 7.5 minute quadrangle. Although second order and higher order streams are almost always perennial, conditions must be evaluated in the field in order to confirm this.
It is often difficult to evaluate stream order on channels starting at a stormwater outfall. Based on field observations, these channels are considered 1st order. However, a review of historic data such as the County Soil Survey may indicate that the order is greater.

YES - One or more first order channels are draining into the stream above sampling reach.

NO – There are only first order channels above sampling reach.

B. Hydrologic Indicators

14. Groundwater Flow/Discharge

Groundwater Table: The presence of a seasonal highwater table or discharge (i.e. seeps or springs) indicates a relatively reliable source of water to a nearby stream. Indicators of a seasonal high water table include visual observation of inundation or soil saturation in the floodplain. Indicators of at least a high water table can be observed by digging a hole in the adjacent floodplain approximately two feet away from the streambed. The presence of water seeping into the hole (usually a slow process) or the presence of hydric soils indicates the presence of at least a high water table.

The Munsell Soil Color Charts book can be used to determine the chroma of the soil matrix/mottles in the hole. Low chroma soils or mottled soils are good indicators of a seasonal high water table. Hydric soils in the sides of a channel or headcut are also indicators of groundwater discharge. Seasonal high water tables are commonly found in the Coastal Plain within areas with low relief. Seeps: Seeps have water dripping or slowly flowing out from the ground or from the side of a hill or incised stream bank. Springs: Look for "mushy" or very wet, and black decomposing leaf litter nearby in small depressions or natural drainage ways. Springs and seeps often are present at grade controls and headcuts. The presence of this indicator suggests that the stream is being recharged by a groundwater source unless during a period of drought. Score this category based on the abundance of these features observed within the reach.

Strong - Spring, seep or groundwater table is readily observable throughout reach.

Moderate - Springs, seeps or groundwater table are present, but not abundant throughout reach.

Weak - Indicators are present, but require considerable time to locate.

Absent - No springs or seeps present and no indication of a high groundwater table.

15. Leaflitter

Are leaves (freshly fallen or older leaves that may be "blackish" in color and/or partially decomposed) accumulating in the streambed? Perennial streams (with deciduous riparian vegetation) should continuously transport plant material through the channel. Leaves and lighter debris will predominate throughout the length of non-perennial stream channels, whereas there will be little to no leaves present in the stronger flowing areas (riffles) with small accumulations on the upstream side of obstructions. This indicator may be hindered during autumn sampling between rain events. This is a secondary hydrologic indicator in which strong evidence receives fewer points than absent.

Strong - Abundant amount of leaf litter is present throughout the length of the stream.

Moderate - Leaf litter is present throughout most of the stream's reach with some accumulation beginning on the upstream side of obstructions and in pools.

Weak - Leaf litter is present and is mostly located in small packs along the upstream side of obstructions and accumulated in pools.

Absent - Leaf litter is not present in the fast moving areas of the reach but there may be some present in the pools.

16. Sediment on Plants and Debris

The transportation and processing of sediment is a main function of streams. Therefore, evidence of sediment on plants or other debris in the stream channel may be an important indicator of the persistence of flow. Note that sediment production in watersheds streams is considerable less that disturbed watersheds. Are plants in the stream, on the streambank, or in the floodplain stained white, gray, red, or brown, with sediment? Look for silt/sand accumulating in thin layers on debris or rooted aquatic vegetation in the runs and pools. Be aware of upstream land-disturbing construction activities, which may contribute greater amounts of sediments to the stream channel, and can confound this indicator. Note these activities on the data sheet if these confounding factors are present.

Strong - Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.

Moderate - Sediment found on plants or debris within the stream channel although not prevalent along the stream. Mostly accumulating in pools.

Weak - Sediment is isolated in small amounts along the stream.

Absent - No sediment is present on plants or debris.

17. Organic Drift Lines (Wrack lines)

Organic drift lines are defined as twigs, sticks, logs, leaves, trash, plastics, and any other floating materials piled up on the upstream side of obstructions in the stream, on the streambank, in overhanging branches, and/or in the floodplain indicate high stream flows. (These lines of debris are also commonly referred to as "wrack lines") Ephemeral streams usually exhibit fewer or no drift lines within their channels unless downstream of a stormdrain or extensive urban runoff,. The magnitude of the accumulation of drift may be influenced by watershed characteristics and sources of debris. For example, streams in watersheds dominated by herbaceous vegetation may not exhibit drift lines.

Strong - Large drift lines are prevalent along the upstream side of obstructions within the channel and the floodplain.

Moderate - Large drift lines are dispersed mostly within the stream channel.

Weak - Small drift lines are present within the stream channel.

Absent - No drift lines are present.

18. Water in Channel and >48 Hours Since Last Rainfall

It is necessary to discern stormwater inflow (resulting from precipitation within the past 48 hours) and groundwater inputs. Flow observations preferably should be taken at least 48 hours after the last rainfall. Local weather data and drought information should be reviewed before evaluating flow conditions. Perennial streams will have water in their channels year-round in the absence of drought conditions. If a stream exhibits flowing water in the height of the dry season (mid-summer through early fall in a normal year), then it probably conveys water perennially. On the other hand, a stream that does not exhibit flow during periods of increased rainfall would indicate an

intermittent or ephemeral flow. Flow is more readily observed in the riffles and very shallow, higher-velocity areas of the stream. Dropping a floating object on the water surface will aid in determining if flow is present.

Strong - Flow is highly evident throughout the reach. Moving water is easily seen in riffles and runs.

Moderate - Moving water is easily seen in riffle areas but not as evident throughout the runs.

Weak - Flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.

Absent - Water present but there is no flow; dry channel with or without standing pools.

19. Water In Channel During Dry Conditions Or In growing Season

Intermittent streams do not always have water in them. Look for water in pool areas or in holes in the streambed. Another good rule of thumb for differentiating ephemeral streams from intermittent ones is if they have water in them during dry (drought) conditions or during the growing season. The presence or type of plants and fauna as well as the dampness of the soil in the channel (look under rocks) are also good indications of the presence of water during the growing season[2 1]

20. Hydric Soils

(A good technical reference is "Field Indicators of Hydric Soils" available from: http://soils.usda.gov/use/hydric/)

Hydric soils are defined as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part of the soil (Federal Register, July 13, 1994). Nearly all hydric soils exhibit characteristic morphologies that result from repeated periods of saturation or inundation, or both, for more than a few days. Soils with sufficient periods of inundation or saturation will develop features indicative of the duration of water. These features are commonly referred to as redoximorphic features and include mottling and gleying (low chroma). Soils immediately adjacent to the stream bed along the stream bank may have redoximorphic features if groundwater discharge is present. Use a Dutch auger or Oakfield probe to obtain a 12 to 14-inch deep core and examine the soil pedon for mottles and low chroma. These features indicate that a seasonal water table is commonly present and that the channel is at least intermittent.

Mineral soils which are exposed to atmospheric oxygen in the soil profile will have some degree of oxidation occurring and as a result will have bright red, orange, or yellow matrix colors (Figure 6). Saturated soils, such as those found in the streambeds of perennial streams, have limited or no contact with oxygen, will remain reduced and subsequently have a very dull color chroma or may be gleyed completely (dull gray hues or chroma throughout the soil ped (Figure 6). The soil sample should be representative of the major stream bed/bank soil type observed throughout the sample reach. If necessary, use the Munsell Color Charts book to determine the chroma of the soil matrix. The soil matrix is defined as the dominant soil constituent (>50%). Low chroma values (< 2) or gleyed soils indicate continual saturation, while brightly colored soils or mottles (> 2)

[1] The growing season varies geographically and is often described in county soil surveys produced by the National Resources Conservation Service.

indicate only short periods of wetting, typical of intermittent or ephemeral streambed soils or upland soils. Table 2 provides a key for scoring.

Table 2. Scoring redoximorphic features

Redoximorphic feature	Score (see form)
Strong - Gleyed soils	1.5
Moderate - Matrix chroma of 1	1.5
Weak - Matrix chroma of 2.	1.5
Absent - Matrix chroma of 2 or greater.	0

Upland Soil

Hydric Soil depicting gleying

Hydric Soil depicting mottling

Figure 6. Photographs of hydric and nonhydric soils.

C. Biological Indicators

21. Fibrous Roots

Fibrous roots are shallow wide spreading root that often form root masses. Roots in the root mass consist of many roots with generally equal diameters. Fibrous roots do not include roots larger than half the thickness of a finger and are not generally "woody" in appearance or consistency. Since oxygen is needed for respiration, roots are intolerant of water. Thus, in areas where water is persistent, roots may not be frequent or even present. A higher score is given for the absence of fibrous roots. Observe the bottom (or edge) of the stream and determine if very small (fibrous) roots are present.

22. Rooted Plants In Streambed

This attribute relates flow to the absence of rooted plants, since flow will often act as a deterrent to plant establishment by removing seeds or preventing aeration to roots (see No. 21 Fibrous Roots above). A higher score is given for the absence of rooted plants. Focus should be on the presence of plants in the bed or thalweg of the stream and plants growing on any part of the bank of the

stream should not be considered. Note, however, there will be exemptions to this attribute. For example rooted plants can be found in shaded perennial streams with moderate flow but in all cases these plants will be water tolerant (OBL, FACW; see No. 32 – Wetland Plants in Streambed). Cases where rooted upland plants are present in the streambed may indicate ephemeral or intermittent flow.

Figure 7. Rooted plants in streambed

23. Crayfish

Most species of crayfish are associated with aquatic or wet environments such as streams and wetlands. A small net can be used to examine small pools, under rocks, under logs, sticks or within leaf packs in the stream for crayfish. Crayfish associated with small holes in the muddy streambank or "chimneys" (roughly cylindrical chimneys) on the muddy bank or floodplain may be indicators of wet soils (wetlands) rather than streams.

24. Bivalves

Clams cannot survive outside of water, thus one should examine the streambed or look for them where plants are growing in the streambed. Also, look for empty shells washed up on the bank. Some bivalves (e.g., Fingernail clams; Figure 7) can be pea-sized or smaller. Since clams require a fairly constant aquatic environment in order to survive the search for bivalves can be conducted while looking for other benthic macroinvertebrates. A small net may be useful.

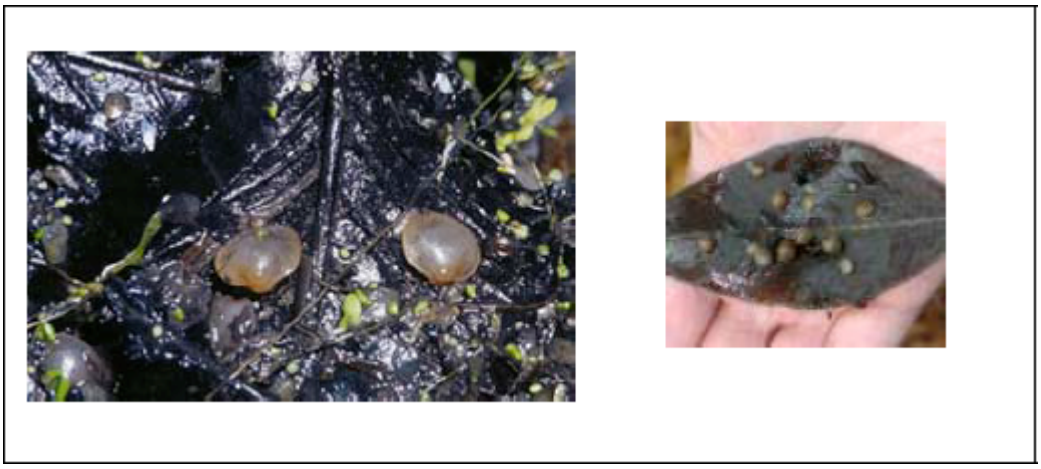

Figure 8. Fingernail clams

25. Fish

Fluctuating water levels of intermittent streams provide unstable and stressful habitat conditions for fish communities. Only a rarely will a fish inhabit an intermittent stream. When looking for fish, all available habitats should be observed, including pools, riffles, root clumps, and other obstructions (to greatly reduce surface glare, the use of polarized sunglasses is recommended). In small streams, the majority of species usually inhabit pools and runs. Fish should be easily observed within a minute or two. Also, fish will seek cover once alerted to your presence, so be sure to look for them slightly ahead of where you are walking along the stream. Check several areas along stream sampling reach, especially underneath undercut banks.

26. Amphibians

Salamanders and tadpoles can be found under rocks, on streambanks and on the bottom of the stream channel. They may also appear in the benthic sample. Frogs will alert you of their presence by jumping into the water for cover, usually following an audible “squeak”. Frogs and tadpoles typically inhabit the shallow, slower moving waters of the pools and near the sides of the bank. Amphibian eggs, also included as an indicator, can be located on the bottom of rocks and in or on other submerged debris. They are usually observed in gelatinous clumps or strings of eggs.

27. Benthic Macroinvertebrates

The larval stages of many aquatic insects are good indicators that a stream is perennial because a continuous aquatic habitat is required for these species to mature. Use a small net and sample a variety of habitats including water under overhanging banks or roots, accumulations of organic debris (e.g. leaves) and the substrate. Note both the quantity as well as the diversity of your macroinvertebrate sample on the field form when scoring.

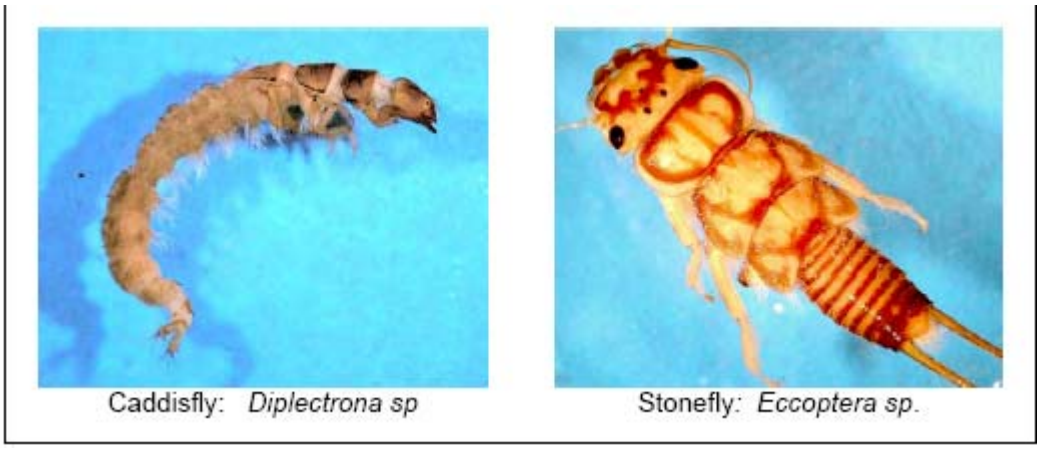

Figure 9. Benthic macroinvertebrates

Table 3. Common families of benthic macroinvertebrates found in perennial streams.

Ephemeroptera (Mayflies)	Plecoptera (Stoneflies)	Trichoptera (Caddisflies)
Baetidae	Peltoperlidae	Hydropsychidae
Caenidae	Perlidae	Lepidostomatidae
Ephemerellidae	Perlodidae	Limnephilidae
Ephemeridae		Molannidae
Heptageniidae		Odontoceridae
Leptophlebiidae		Philopotamidae
Siphlonuridae		Polycentropidae
		Psychomyiidae
		Rhyacophilidae

28. Presence of Periphyton/Green Algae

These forms of algae and aquatic mosses are attached to the substrate, and are visible as a pigmented mass or film, or sometimes hairlike growths on submerged surfaces of rocks, logs, plants and any other structure within the stream channel. These life forms require an aquatic environment to persist. Periphyton growth is influenced by chemical disturbances such as increased nutrient (nitrogen or phosphorus) inputs and physical disturbances such as increased sunlight to the stream from riparian zone disturbances.

29. Iron Oxidizing Bacteria/Fungus

In slow moving (or stagnant) areas of the stream, are there clumps of "fluffy" rust-red material in the water? Additionally, on the sides of the bank (or in the streambed) are there red or rust colored stains (usually an "oily sheen" or "oily scum" will accompany these areas) on the soil surface? These features are often (although not exclusively) associated with groundwater. Iron oxidizing bacteria/fungus in streams derives energy by oxidizing iron, originating from groundwater, in the ferrous form (Fe2+) to the ferric form (Fe3+). In large amounts, iron-oxidizing bacteria/fungus discolors the stream substrate giving it a red appearance. In small amounts, it can be observed as

an oily sheen on the water's surface. This indicates that the stream is being recharged from a groundwater source, and these features are most commonly seen at seeps or springs.
Filmy deposits on the surface or banks of a stream are often associated with the greasy "rainbow" appearance of iron oxidizing bacteria. This is a naturally occurring phenomenon where there is iron in the groundwater. However, a sudden or unusual occurrence may indicate a petroleum product release from an underground fuel storage tank. One way to differentiate iron-oxidizing bacteria from oil releases is to trail a small stick or leaf through the film. If the film breaks up into small islands or clusters, it is most likely bacterial in origin, however if the film swirls together, it is most likely a petroleum discharge.

Figure 11. Iron oxidizing bacteria. Figure on right depicts iron bacteria on a twig.

30. Wetland Plants in Streambed

The U.S. Army Corp of Engineers wetland delineation procedure utilizes a plant species classification system upon which soil moisture regimes can be inferred (Table 3). This same system can be used to determine the duration of soil saturation in stream channels. All wetland designations are defined by 1988 National List of Vascular Plant Species That Occur in Wetlands, U.S. Fish and Wildlife Service. Indicator scores (0 through 3) corresponding to each class of vegetation are listed on field data sheet while SAV - (Submerged Aquatic Vegetation) grows completely underwater (for instance Coontail -- Ceratophyllum demersum)

Table 3. Indicator categories of wetland plants.

Code	Wetland Type	Comment
OBL	Obligate Wetland	Occurs almost always (estimated probability 99%) under natural conditions in wetlands.
FACW	Facultative Wetland	Usually occurs in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
FAC	Facultative	Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
FACU	Facultative Upland	Usually occurs in non-wetlands (estimated probability 67%-99%), but occasionally found on wetlands (estimated probability 1%-33%).
UPL	Obligate Upland	Occurs in wetlands in another region, but occurs almost always (estimated probability 99%) under natural conditions in non-wetlands in the regions specified. If a species does not occur in wetlands in any region, it is not on the National List.

Stream Identification Field Form

Date:	Project:	Latitude:
Evaluator:	Site:	Longitude:
Total Points: Stream is at least intermittent if ≥ 19	County:	Other e.g. Quad Name:

A. Geomorphology (Subtotal =_____)	**Absent**	**Weak**	**Moderate**	**Strong**
1. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Bankfull bench	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9. Natural Levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley and drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3 Written documentation in Notes is required for scoring 3 points.	
B. Hydrology (Subtotal = _____)				
14. Groundwater flow/discharge	0	1	2	3
15. Leaflitter	1.5	1	0.5	0
16. Sediment on plants	0	0.5	1	1.5
17. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
18. Water in channel and > 48 hrs since rain.	0	0.5	1	1.5
19. Water in channel -- dry or growing season	0	0.5	1	1.5
20. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	
C. Biology (Subtotal = _____)				
21. Fibrous roots in channel	3	2	1	0
22. Rooted plants in channel	3	2	1	0
23. Crayfish	0	0.5	1	1.5
24. Bivalves	0	1	2	3
25. Fish	0	0.5	1	1.5
26. Amphibians	0	0.5	1	1.5
27. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
28. Filamentous algae; periphyton	0	0.5	1	1.5
29. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
30. Plants in streambed	FAC = 0.5	FACW = 0.75	OBL = 1.5	SAV = 2.0

Notes:

Sketch: