North Carolina
Division of Water Quality

Identification Methods for the Origins of Intermittent and Perennial streams

Version 3.1

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"Streams are gutters down which flow the ruins of continents."
Luna Leopold

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. Section 1 pertains details on the field method and rating form that can be used to identify intermittent or perennial streams. Version 3.1 of the manual replaces Version 2.0 (January 19, 1999) and reflects five years of additional regulatory and academic experience. Changes are limited to organization and clarification and do not result in any changes in interpretation of scores. Section 2 provides details on the procedure and information needed to determine if a stream is perennial.

SECTION 1 – Stream Identification Method and Rating Form

Introduction

A stream can be described as flowing surface water in a channel resulting from:

- *Stormflow* – increased streamflow resulting from the relatively rapid runoff of precipitation from the land as interflow (rapid, unsaturated, subsurface flow), overland flow, or saturated flow from raised near surface water tables close to the stream, or
- *Baseflow* – low flow resulting from delayed discharge of ground water into the stream between rainfall events, or
- A combination of both stormflow and baseflow, and
- Contributions of discharge from upstream tributaries as stormflow or baseflow, if present.

Streams may exhibit both stormflow and baseflow characteristics as they flow from their origins to their destinations. 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 (stormflow, or baseflow plus tributary discharge, if present) 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 (stormflow 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.

Initially, the earliest versions of this manual and form were used to distinguish ephemeral, intermittent and perennial features of streams no matter where in the landscape the stream segment under consideration was located. Accordingly, the form and manual could conceivably be used on high order (e.g. 3^{rd}, 4^{th}, 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 (1^{st}, 2^{nd}) 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

The main purpose of the first version of the stream identification manual and scoring form was to derive a relationship between a score and the persistence of water or the size of a stream or river. The method has been used to distinguish ephemeral, intermittent, or perennial streams in low order (1^{st} or 2^{nd}) streams. However, characteristics found more commonly (but not exclusively) in higher order streams such as braided channels and stream levees remain in the manual.

This stream evaluation method is intended to distinguish (identify) ephemeral streams from intermittent streams and intermittent streams from perennial streams. 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. A score of 30 or more points is one factor that may be used to determine the presence of a perennial stream (see Section 2 – Guidance for the Determination of the Origin of Perennial Streams, page 29).

Definitions

The definitions of ephemeral, intermittent and perennial streams are found in North Carolina's administrative code and are also provided below. Complete language for the rules can be found at: (http://ncrules.state.nc.us/ncadministrativ_/title15aenviron_/default.htm) The definition of an intermittent stream refers to a stream channel only containing water for part of the year (typically winter and spring). Therefore the term "water table" that was used in the intermittent stream definition refers to the seasonal high water table in the riparian zone soil adjacent to the stream.

Ditch – 'Ditch or canal' means a man-made channel other than a modified natural stream constructed for drainage purposes that is typically dug through inter-stream divide areas. A ditch or canal may have flows that are perennial, intermittent, or ephemeral and may exhibit hydrological and biological characteristics similar to perennial or intermittent streams. 15A NCAC 02B .0233(2)(c)

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. 15A NCAC 02B .0233(2)(d)

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. 15A NCAC 02B .0233(2)(g)

Modified Natural Stream – 'Modified natural stream' means an on-site channelization or relocation of a stream channel and subsequent relocation of the intermittent or perennial flow as evidenced by topographic alterations in the immediate watershed. A modified natural stream must have the typical biological, hydrological, and physical characteristics commonly associated with the continuous conveyance of water. 15A NCAC 02B .0233(2)(h)

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. 15A NCAC 02B .0233(2)(i)

Groundwaters – "Groundwaters" means those waters occurring in the subsurface under saturated conditions. 15A NCAC 02L .0102 (11)

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. 15A NCAC 02L .0102 (27)

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. 15A NCAC 18A .1935 (29)

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. 15A NCAC 02H .1002 (15)

Sources of Variability

Spatial and temporal variations in stream attributes occur within and among stream systems. Perhaps the most predominate sources of variation within a stream system are the downstream changes in stream attributes related to increasing persistence and volume of flow and the temporal variation of flow related to precipitation variability and seasonal changes in evapotranspiration. 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) with interactions due to precipitation and climate. 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.

Ditches and Modified Natural Streams

In North Carolina it may be difficult to differentiate between a man-made ditch and a natural stream that has been modified (e.g. straightened or relocated). There are a variety of techniques that can be employed to help with this distinction. The topographic lines depicted on a USGS topographic map may indicate a natural valley in which a natural stream could be present. Generally topographic crenulations (the ‘folding’ of contour lines) with angles 90^o or less can be indicative of the presence of streams. In addition an NRCS county soil survey may show the presence of linear (i.e. parallel to a stream channel) soil series, which are indicative of alluvial deposits.

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

When the evaluator and landowner agree that the feature under investigation is a man-made ditch, then scoring is not necessary. In addition, the evaluator may determine scoring is not necessary when best professional judgment leads the evaluator to conclude that the feature is a man-made ditch and not a modified natural stream.

Identification of stream type is accomplished by evaluating 29 different attributes of the stream and assigning a numeric score to each attribute. A scoring sheet (last page of this manual) is used to record the score for each attribute and determine the total numeric score for the stream under investigation. The sheet specifically requests information for Date, Project, Evaluator, Site, County, Other (Quad Name), and Latitude and Longitude. However any other pertinent observations should also be recorded on this sheet. These may include the amount and date of the last recent rain, hydrologic unit codes, or evidence of stream modifications. The scoring sheet is an official record, so all pertinent observations should be recorded on it.

Scores should reflect the persistence of water with higher scores indicating intermittent and perennial streams. A four–tiered, weighted scale used for evaluating and scoring each attribute addresses the variability of stream channels. The scores, "Absent", "Weak", "Moderate", and "Strong" are applied to sets of geomorphic, hydrologic and biological attributes. The score given to an attribute reflects the evaluator's judgment of the average degree of development of the attribute along a reach of the stream at least 100 ft long. 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.

Previous versions of this form used a "yes" / "no" format and was found by NC Division of Water Quality staff and by the regulated community to be inadequate to properly encompass and assess the natural variability encountered when making stream identifications in the field. "Moderate" scores are intended as an approximate qualitative midpoint between the two extremes of "Absent" and "Strong." The remaining qualitative description of" Weak" represents gradations that will often be observed in the field.

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, its watershed, and physiographic region.

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. Continuous Bed and Bank

Throughout the length of the stream, is the channel clearly defined by having a discernable bank and streambed?

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. This indicator will lessen and may diminish or become fragmented upstream as the stream becomes ephemeral.

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

Is the stream channel sinuous throughout the reach being evaluated?

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

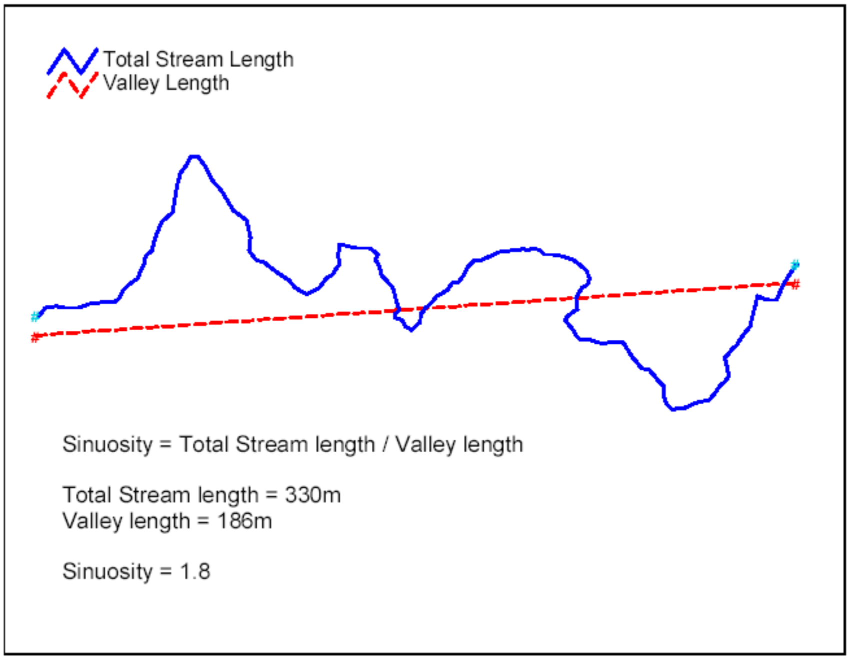

Figure 1. Stream sinuosity

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 than farther downstream in the perennial stream. While ranking, take into consideration the size of the stream and its watershed, which may also influence the stream wavelength. Sinuosity should be visually estimated or measured in the field. Sinuosities of small headwater streams approximated from maps or aerial photos are usually not of sufficient accuracy. 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.

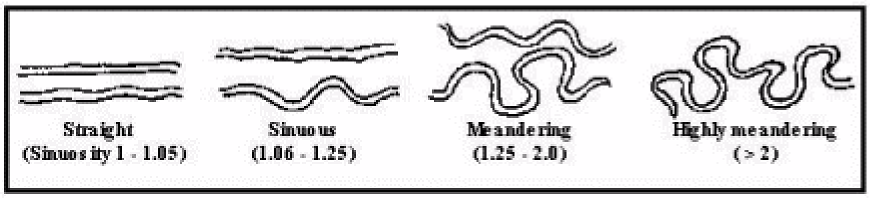

Figure 2. Examples of stream sinuosity

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

Is there a regular sequence of riffles and pools or other erosion/deposition structural features in the channel indicative of frequent high flows?

A repeating sequence of riffle/pool (riffle/run in lower-gradient streams, ripple/pool in sand bed 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 (or ripple-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 woody 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 zone with relatively high channel slope gradient, shallow water, and high flow velocity and turbulence. In smaller streams, riffles are defined as areas of a distinct change in gradient where flowing water can be observed. The bottom substrate material in riffles contains the largest sedimentary particles that are moved by bankfull flow (bedload). A pool is a zone with relatively low channel slope gradient, deep water, and low velocity and turbulence. Fine textured sediments generally dominate the bottom substrate material in pools. Along the stream reach, take notice of the spacing and frequency of the riffles and pools or other types of instream structures. 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.

4. Soil Texture or Stream Substrate Sorting

Has channel erosional downcutting penetrated through the soil profile? Is the texture of the bottom substrate different (i.e. much coarser) than that of the soil in the adjacent floodplain? Is there evidence of sorting of the bottom substrate materials, indicative of frequent high flows?

This feature can be examined in two ways. The first is to determine if the soil texture in the bottom of 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 down cut 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. Accelerated stormflow resulting from development may produce deep, well-developed ephemeral or intermittent channels but which have little or no coarse bottom materials indicative of upstream erosion and downstream transport. The bottom substrate of intermittent or perennial streams often have accumulations of coarse sand and larger particles.

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? In the coastal plain one may need to look for size variations among sand grains – for instance, coarse versus fine sand. 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.

Table 2. Standard USDA particle sizes

	Diameter	
Description	millimeters (mm)	inches (in.)
fine sand	0.1-0.25	.004-.01
medium sand	0.25-0.5	.01-.02
coarse/very coarse sand	0.5-2.0	.02-.08
pebbles (gravel)	2-75	.08-3.0
cobbles	75-250	3.0-9.8
stones	250-600	9.8-23.6
boulders	> 600	> 23.6

Strong – There is a well-incised channel through the soil profile with relatively coarse-textured bottom sediments compared to riparian zone soils: coarse sand, gravel, or cobbles in the piedmont; gravel, cobbles, stones, or boulders in the mountain regions, and medium or coarse sand in the coastal plain. 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 – There is a well-developed channel but it is not deeply incised through the soil profile. Some coarse-textured bottom sediments are present that indicates downstream transport. Relatively little sorting of fine material from coarser materials. Small depositional features are present; small pools are accumulating some sediment.

Weak – The channel is poorly developed, and incised only part way through the soil profile. Some coarse textured bottom sediments are present, but substrate sorting is not readily observed. There may be some small depositional features present on the downstream side of obstructions (large rocks, etc.).

Absent – The channel is poorly developed, very little to no coarse textured bottom sediments are present, and substrate sorting is absent. There are few to no depositional features.

5. Active/Relic Floodplain

Is there an active floodplain at the bankfull elevation or is there evidence of recent channel incision with a relic floodplain above the current bankfull elevation?

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 (at current bankfull elevation) 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 the 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. Depositional Bars or Benches

Are there well-developed depositional benches or bars, the top of which at the transition to the bank is approximately at bankfull elevation?

When a stream channel conveys perennial flow, the forces of channel scouring and deposition create certain distinct physical erosional and depositional 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 and below which little or no vegetation is present. 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).

The presence of deposition bars or benches 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 these deposition features are throughout the reach, the higher the score should be. Depositional features are often absent on very small channels. Sometimes there may be depositional features along the side of the channel, the tops of which are significantly below bankfull elevation. These features should not receive as many points as well-developed bankfull benches, but should receive some points.

> *Bankfull benches: Experience has shown that this attribute may cause confusion among persons making stream geomorphology observations, thus this attribute was renamed to "Depositional bars or benches." Bankfull flow is the stormflow volume that forms the channel and transports the greatest quantity of sediment. 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.*

Strong – Depositional bars or benches 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 depositional bars or benches are completely lacking.

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

7. Braided Channel

Is there a reach with multiple channels present in a low gradient area of sedimentation?

Braided channels occur in shallow, low gradient areas where abundant sediment has a tendency to build up across the stream creating a braided pattern of channels and an extensive floodplain. Are there two or more 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

Are there fresh deposits of alluvial materials that have been transported and deposited on surfaces in the stream channel or on the floodplain by recent high flows?

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 are 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

Are well developed natural levees present on the active or relic floodplain?

Levees develop on the bank top adjacent to the stream when sand is deposited relatively parallel to the top of the bank from flood flows. These result from the deposition of heavier particles immediately adjacent to the channel as flood waters leave the channel. Natural levees are 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 stream reach.

It may be necessary to distinguish between natural levees and spoil piles. Spoil piles are created when a stream is ditched, when a ditch is created, or when sediment is removed from a stream. When natural levees are present, they will occur along both stream banks in generally equal heights. However spoil piles most often occur along only one stream bank. There may be times when it is difficult to distinguish between natural levees and spoil piles, and in these cases this must be noted on the field scoring sheet.

10. Head Cut

Is there a head cut at the upstream end of the reach being evaluated? Are there one or more head cuts within the reach being evaluated?

A head cut is an abrupt vertical drop in the bed of a stream channel that is an active erosion feature. It often resembles a small intermittent waterfall (or a miniature cliff) and will have a deep pool at the base resulting from the high energy, turbulent waterfall produced during high flows. Intermittent or perennial streams sometimes begin at a head cut in the piedmont and mountains. Head cuts are transient structures of the stream and often exhibit relatively rapid upstream movement during periods of high erosion rates. Groundwater seepage may also be present from the face or base of a head cut.

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

11. Grade Control Point

Are there grade control points within the reach being evaluated?

A grade control point is a structural feature in the channel that separates an abrupt change in grade of the stream bed or a point where erosional downcutting has been stopped by an obstruction. Grade controls may be caused by bedrock outcrops (nick points), large stones or large roots which extend across the channel, or accumulations of large woody debris. Stormwater or other discharges through pipes also serve as grade control points. These structures separate an abrupt change in grade of the stream bed.

12. Natural Valley or Drainageway

Is there a well-developed stream valley at the location of the reach being evaluated compared to the degree of valley development in the ephemeral reach of the stream?

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 v-shaped or u-shaped, thereby indicating a “draw” or valley? In other words, does the land have slopes that seem to drain to or indicate a natural valley or drainage way?

13. Second (or greater) Order Channel

Is the channel reach being evaluated second or greater in order, considering all channels, including ephemeral ones, that discharge to it?

The higher the channel order, the more likely the stream is to be perennial. Stream order is best evaluated in the field, since headwater streams are poorly depicted on maps. However for the purposes of this manual, a stream channel must be approximately shown on either the most recent version of the 1:24,000 USGS topographic map or Natural Resource Conservation Service (NRCS) county soil survey. In those unusual instances where a clearly defined intermittent or perennial stream channel is not shown on either map, the field evaluator may decide that the channel is second order or greater and provide clear documented evidence.

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

Does the presence of baseflow, and indicators of groundwater presence and groundwater discharge indicate a significant period of groundwater discharge to the stream ?

Baseflow Presence: Water flowing in the channel more than 48 hours after significant rainfall is clear evidence of groundwater discharge from saturated soils below the water table adjacent to the stream. Even when there is no visible flow above the channel bottom, there may likely be slow groundwater discharge into and downstream flow in the ***hyporheic zone***. *The hyporheic zone is the accumulation of coarse textured sediments in the bottom of the channel that may be up to 2-3 ft deep in small streams. A functioning part of the stream, the hyporheic zone is the site of much groundwater discharge to the stream, downstream flow, and biological and chemical activity associated with aquatic functions of the stream.*

Groundwater Table: The presence of a seasonal high water table or groundwater discharge (i.e. seeps or springs) from the bank, both above the elevation of the channel bottom indicates a relatively reliable source of baseflow to a stream. Indicators of a current water table can be observed by digging a bore hole in the adjacent floodplain approximately two feet away from the streambed. The presence of water standing in the hole above the elevation of the channel bottom after waiting for at least 30 minutes (longer for clayey soils) indicates the presence of a water table. The presence of hydric soil indicators above the elevation of the channel bottom in floodplain soils adjacent to the channel indicates the presence of a seasonal high water table that can provide a significant period of base flow. The presence of hydric soils should be determined in accordance with methods in the "*Corps of Engineers Wetlands Delineation Manual"* (1987 online ed., http://www.wes.army.mil/el/wetlands/pdfs/wlman87.pdf) or "*Field Indicators of Hydric Soils in the United States* (http://soils.usda.gov/use/hydric/).

Note that hydric soil indicators may be poorly developed at the seasonal high water table elevation in young, coarse textured, alluvial soil materials with low concentrations of clay, iron and manganese, or floodplain soils where moving water fails to become reduced.

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 except during a period of drought. Score this category based on the abundance of these features observed within the reach.

Strong – Significant base flow is present. Spring, seep or groundwater table is readily observable throughout reach.

Moderate – Some base flow is present. Springs, seeps or groundwater table are present, but not abundant throughout reach.

Weak – Water is standing in pools and the hyporheic zone is saturated, but there is not visible flow above the channel bottom. Indicators of groundwater discharge are present, but require considerable time to locate.

Absent – Little to no water in the channel. No springs or seeps present and no indication of a high groundwater table.

15. Water in Channel and > 48 Hours Since Last Rainfall, or Water in Channel During Dry Conditions or in Growing Season[1]

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

[1] The growing season varies geographically. Growing season dates are found in county soil surveys produced by the National Resources Conservation Service or may be found at the web page of the NRCS Water and Climate Center (http://www.wcc.nrcs.usda.gov/climate/wetlands.html).

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. Flow is often very hard to discern in small, shallow, very low gradient coastal plain streams.

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.

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.

16. 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.

17. Sediment on Plants or Debris

Is fine sediment deposited on plants or debris in the channel or on the active floodplain, indicative of recent high flows?

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 stable, vegetated watersheds is considerably less than in disturbed watersheds. Are plants in the stream, on the streambank, or in the floodplain covered 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.

18. Organic Drift Lines (Wrack lines)

Are there accumulations of organic debris in piles or lines in the channel or on the active floodplain indicative of recent high flows?

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 that 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.

19. Hydric Soils

Are there hydric soils present at the toe of the bank or base of head cuts above the stream bottom or well developed hydric indicators in the hyporheic zone?

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 during the growing season that results in extended periods of soil reduction. Thus the presence of well-developed hydric soil indicators in soils at the base of the bank or strongly reduced hyporheic zone materials provides strong evidence of extended annual periods of base flow.

Soils with sufficient periods of inundation or saturation and that contain significant amounts of clay or silt and significant amounts of iron and manganese will develop color features indicative of extended saturation and reduction. 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 persistent 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. Look for redoximorphic features several inches below the surface. Note that non-soil (i.e. relatively young) alluvial accumulations of coarse sand, gravel, and cobble in the stream bank or hyporheic zone, will not develop hydric soil indicators.

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

Table 3. 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 2.5 or greater.	0

Upland Soil

Hydric soil depicting gleying

Hydric soil depicting mottling

Figure 6. Photographs of hydric and nonhydric soils.

C. Biological Indicators

20. Fibrous Roots

Are fibrous roots present near the surface of the hyporheic zone in the thalweg of the stream?

Fibrous roots are non-woody, small diameter (< 0.25 in), shallow wide spreading roots that often form dense masses in the top few inches of the soil. Roots in the root mass consist of many roots with generally equal diameters. Fibrous roots of woody plants are those which function in water and nutrient uptake. Since oxygen is needed for respiration, fibrous roots are intolerant of water, unless they are roots of water tolerant plants. Thus, in areas of stream bottom substrates where water is persistent or frequent high energy flows disturb the bottom substrate, fibrous roots may be infrequent or even absent. 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. Note that during extended growing season, or dry periods, fast growing fibrous roots may grow across the bottom of a stream that would not be present during normal flow conditions. Note that this indicator refers to fibrous roots of upland plants rather than aquatic plants that may be growing in the channel.

21. Rooted Plants in Streambed

Are rooted plants growing in the hyporheic zone in the thalweg area of the stream?

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. 20 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. 29 – Wetland Plants in Streambed, page 27). Cases where rooted upland plants are present in the streambed may indicate ephemeral or intermittent flow.

Figure 7. Rooted plants in streambed

22. 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.

23. 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 8) 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 claims

24. Fish

Fluctuating water levels of intermittent streams provide unstable and stressful habitat conditions for fish communities.   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 the stream sampling reach, especially underneath undercut banks. In most cases, fish are indicators of perennial streams, since fish will rarely inhabit an intermittent stream.

25. 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.

Figure 9. Salamander

26. 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. Details on specific macroinvertebrate taxa that indicate perennial flow can be found in Section 2 – Guidance for the Determination of the Origin of Perennial Streams" (page 29).

Caddisfly: *Diplectrona sp*

Stonefly*:* *Eccoptera sp*.

Figure 10. Benthic macroinvertebrates

27. Presence of Filamentous Algae and Periphyton

These forms of algae are attached to the substrate. They 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.

28. 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 (Fe^{2+}) to the ferric form (Fe^{3+}). 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.

29. 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 4). This same system can be used to infer the duration of soil saturation in stream channels. Small, low gradient, low velocity intermittent and perennial streams with adequate sunlight will often have OBL and FACW wetland plants or submerged aquatic vegetation growing in the stream bed. All wetland designations are defined by *National List of Plant Species That Occur in Wetlands: Southeast Region 2*. 1988. U.S. Fish and Wildlife Service. (http://wetlands.fws.gov/plants.htm) Submerged Aquatic Vegetation (SAV) grows completely underwater (for instance Coontail -- *Ceratophyllum demersum*)

Table 4. 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.

History of the Stream Identification Manual and Forms.

Version 1.0 **–** Method was originally derived to correlate scores with the persistence of water. Low scores would indicate stream channels in the upper portions of watersheds (low order streams), and the highest scores would indicate major rivers (high order streams).

Version 2.0 **–** Effective January 19, 1999. The method was termed the NC Stream Classification Method and was adapted as a result of HB 1257 (Stream Identification for Buffer Rules); 2000-2001 Session of the NC General Assembly. The Stream Technical Advisory group evaluated Version 1.0 of the form and recommended the use of the modified form for use by the DWQ.

Version 3.0 **–** Added considerable amount of explanatory material and restructured the rating form. Issued for public comment: September 21, 2004. Version 3.0 was developed during the summer and fall of 2004. Version 3.0 was used in the development of Version 3.1.

Version 3.1 **–** Effective February 28, 2005. Minor editions and corrections resulting from a test of the Version 3.0 material during the Surface Water Identification Training and Certification (SWITC) Class; November 15-17, 2004 and December 8-9, 2004. Version 3.1 incorporated the "Guidance for the Determination of the Origin of Perennial Streams."

SECTION 2 – Guidance for the Determination of the Origin of Perennial Streams

Background

A Stream Technical Advisory Committee (TAC) was established by the DWQ in December 1998 to provide technical, scientific input related to the definitions of streams and waterbodies in the Neuse River basin. The TAC approved a stream classification methodology that evaluates the geomorphology, hydrology and biology of stream features to determine the origin of intermittent streams as well as narrative definitions for these stream types (NCDWQ 1999).

The DWQ utilizes a numerical cutoff of 19 points with this evaluation form as an appropriate value to classify a stream as at least “intermittent”. However, DWQ has not previously utilized a numerical cutoff for the perennial threshold. Currently, the DWQ relies on a policy to describe the thresholds between an intermittent and a perennial channel which suggests that investigators use the presence of biological indicators such as fish, crayfish (in channel), amphibians, mussels (clams) or large (multi-year) tadpoles as perennial stream indicators. This internal policy has proven to be effective in many instances such as intermittent/perennial determinations during unusual flow periods (such as extreme drought) and in some ecoregions of North Carolina (Triassic Basin and coastal plain streams). In addition, DWQ’s water supply watershed protection rules, which are implemented by local governments, and compensatory stream mitigation requirements are affected by whether a stream is perennial or intermittent. This provides another reason for DWQ to develop and utilize a more scientifically valid definition for perennial streams.

Recent and on-going Investigations

As part of a recent investigation for the City of Greensboro, personnel with Law Engineering and Environmental Services (now MacTec Environmental Services), with the support of DWQ personnel, used a modification of the DWQ stream classification method and recommend a numerical cutoff for a perennial stream origin in the piedmont of 30 points (Lawson, et al. 2002). In addition, DWQ biologists have been looking for the presence of long-lived aquatic species as reliable determinants for perennial channels. These investigations suggest that the presence of a select group of benthic macroinvertebrates that require water for their entire life cycles (rheophilic taxa) is a reliable method to determine the origins of perennial channels. A proposed list of these organisms is included with this policy revision (Tables 5 and 6). The DWQ is currently conducting an investigation of the ecological functions of intermittent stream channels. Results from this federally funded investigation also have corroborated the technique of using a suite of rheophilic aquatic insect taxa to determine perennial stream origins.

Revised DWQ Policy for the Definition of Perennial Stream Origins

A perennial stream is defined as a well-defined channel that contains water year round during a year of normal rainfall[2] with the aquatic bed located below the water table for most of the year (15A NCAC 2B.0100). This definition also notes that perennial streams exhibit the typical biological, hydrological, and physical characteristics commonly associated with the continuous conveyance of water.

A stream channel is perennial when any of the following criteria are met:

1. Biological indicators such as fish, crayfish (in channel), amphibians (larval salamanders and large, multi-year tadpoles), or clams are present. If only crayfish or fingernail clams are present, a numerical value of at least 18 on the geomorphology section of the most current version of the DWQ stream classification form is required.

OR

2. A numerical value of at least 30 points is determined from the most recent version of the DWQ stream identification form[3].

OR

3. More than one benthic macroinvertebrate that requires water for entire life cycles are present as later instar larvae[4]. A list of the benthic organisms commonly collected by DWQ biologists during perennial stream determinations are shown in Tables 5 and 6.

DWQ staff suggest that a stream be examined using these three criteria in the sequence above – namely, a field examination should first look for criterion 1 and then criterion 2. If the channel does not meet either of these two criteria and the field biologist believes the channel to be perennial, then the third criterion should be utilized – however identification by a well-trained aquatic entomologist is required for the proper use of this criterion. In most instances, the use of either of the first two criteria should be sufficient to make a stream determination.

[2] Normal Rainfall is defined as the 30 year average, provided by NOAA National Climatic Data Center, computed at the end of each decade. These data are available as annual and monthly means.
[3] Use of this form requires Division-based or approved training (or appropriate certification in accordance with GS 143-214.25
[4] Recognition and/or identification of these organisms will require Division-based or approved training.

Table 5. Ephemeroptera, Plecoptera and Trichoptera (EPT) perennial stream indicator taxa

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

Table 6. Additional indicators of perennial stream features.

	Megaloptera	**Odonata**	**Diptera**	**Coloptera**	**Mollusca**
Family:	Corydalidae	Aeshnidae	Ptychopteridae	Elmidae	Unionidae
	Sialidae	Calopterygidae		Psephenidae	Ancylidae
		Cordulegastridae			Planorbidae
		Gomphidae			Pleuroceridae
		Libellulidae			
Family & ***Genus:***			Tipulidae *Tipula* sp.	Dryopidae *Helichus* (adult)	

Special Provision for Coastal Plain Streams

Reduced topography, which causes fewer channel forming features, can make the geomorphology section of the stream form problematic in the Middle Atlantic Coastal Plain and Southeastern Plains (Griffith et. al. 2002) – approximately east of I-95. In this area, biology should take precedence over geomorphology for determining a stream. Therefore the criteria should be utilized in the following sequence: 1, 3, and then 2.

History of the *Guidance for the Determination of the Origin of Perennial Streams*

Version 1.0 – Developed in 1997/1998. Fish, salamanders, turtles, crayfish and multiyear (large) tadpoles were used as indicators.

Version 2.1 – Added Stoneflies, Mayflies and Caddisflies

Version 2.2 – Added section about the coastal plain

Version 2.3 – Added taxa lists (Tables 5 and 6)

Version 2.4 – Effective February 28, 2005. Added tables of macroinvertebrate taxa found in perennial streams. Issued for public comment October 13, 2004.

List of References

Griffith, G.E., Omernik, J.M., Comstock, J.A., Schafale, M.P., McNab, W.H., Lenat, D.R., MacPherson, T.M., Glover, J.B. and Shelburne, V.B. 2002. Ecoregions of North and South Carolina (color poster with map, descriptive text, summary tables and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,00).

Lawson, J., R. Darling, D. Penrose, and J.D. Gregory. 2002. Stream Identification and Mapping for Water-Supply Watershed Protection. In Proceedings, Watershed 2002, February 23-27, 2002, Fort Lauderdale, FL.

APPENDIX – Comparison Between Version 2.0 and 3.1 Scoring Forms.

VERSION 2.0 FORM	Versions 3.x Forms
Primary Field Indicators	
I. Geomorphology	
1) Is there a riffle-pool sequence?	3. In-channel structure: riffle-pool sequence
2) Is the USDA texture in streambed different from surrounding terrain?	4. Soil texture – Substrate sorting (Renamed attribute)
3) Are natural levees present?	9. Natural Levees
4) Is the channel sinuous?	2. Sinuosity
5) Is there an active (or relic) floodplain present?	5. Active/relic floodplain
6) Is the channel braided?	7. Braided channel
7) Are recent alluvial deposits present?	8. Recent alluvial deposits
8) Is there a bankfull bench present?	6. Depositional bars or benches
9) Is a continuous bed & bank present?	1. Continuous bed and bank
10) Is a 2nd order or greater channel (as indicated on topo map and/or in field) present?	13. Second or greater order channel on <u>existing</u> USGS or NRCS map
II. Hydrology	
1) Is there a groundwater flow/discharge present?	14. Groundwater flow/discharge
III. Biology	
1) Are fibrous roots present in streambed?	20. Fibrous roots in channel
2) Are rooted plants present in streambed?	21. Rooted plants in channel
3) Is periphyton present?	*27. Filamentous algae; periphyton (Version 2.0 items combined)
4) Are bivalves present?	23. Bivalves
Secondary Field Indicators	
I. Geomorphology	
1) Is there a head cut present in channel	10. Headcuts
2) Is there a grade control point in channel	11. Grade Control
3) Does topography indicate a natural drainage way?	12. Natural Valley and drainageway
II. Hydrology	
1) Is this year's (or last's) leaf litter present in streambed?	16. Leaflitter
2) Is sediment on plants (or debris) present	17. Sediment on plants
3) Are wrack lines present?	18. Organic debris lines or piles (Wrack lines)
4) Is water in channel and >48 hrs. since last known rain?	15. Water in channel and > 48 hrs since rain. or Water in channel – dry or growing season (Version 2.0 items combined)
5) Is there water in channel during dry conditions or in growing season?	
6) Are hydric soils present in sides of channel (or in headcut)	19. Hydric soils (redoximorphic features) present?
III. Biology	
1) Are fish present?	24. Fish
2) Are amphibians present?	25. Amphibians
3) Are aquatic turtles present?	DELETED (No aquatic turtles ever scored)
4) Are crayfish present?	22. Crayfish
5) Are macrobenthos present?	26. Macrobenthos
6) Are iron oxidizing bacteria/fungus present?	28. Iron oxidizing bacteria/fungus
7) Is filamentous algae present?	*27. Filamentous algae; periphyton
8) Are Wetland Plants in Streambed?	29. Wetland plants in streambed

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date:	**Project:**	**Latitude:**
Evaluator:	**Site:**	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30*	**County:**	**Other** *e.g. Quad Name*:

A. Geomorphology (Subtotal =_________)	Absent	Weak	Moderate	Strong
1[a]. 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 or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or 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	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = _________)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = _________)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch: