Summary of Stream Channel Classification Inventories on the George Washington & Jefferson National Forests, Virginia, 2017-2020

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Project Type
Stream channel classification.

Goal
Provide information needed to provide adequate stream channel protection in timber management units.

Objective
Classify stream channels in timber management units in 2017, 2018, 2019, and 2020.

Approach
Forest provides list of timber units with pending harvest. CATT works with Forest and district staff to develop standardized classification system. CATT deploys field teams to classify stream channel. CATT supplies project GIS to Forest.

Accomplishments
Submitted maps of classifications to district and Forest personnel 2017-2020.
2017: Classified stream channels in 64 timber stand sale units across 2 districts.
2018: Classified stream channels in 46 timber stand sale units within 9 sale areas across 2 districts.
2019: Classified stream channels in 111 timber stand sale units within 22 sale areas across 3 districts.
2020: Classified stream channels in 324 timber stand sale units across 5 districts.

Partners and Contacts
Forest Contacts: Dawn Kirk, Forest Fisheries Biologist; Pauline Adams, Forest Hydrologist; Jesse Overcash, District Biologist; Chuck Lane, District Biologist


Assessing riparian characteristics


Classifying a headwater channel

Project Summary
Functioning riparian areas are important in all aquatic habitats. The George Washington and Jefferson National Forest seeks to retain, restore, or enhance ecological and physical processes and functions of riparian areas along all perennial, intermittent, and ephemeral streams and wetlands by identifying, classifying, and delineating all stream channels within the project areas of timber management units. Central to this goal is the ability to accurately and efficiently identify perennial, intermittent, and channeled ephemeral streams. The Forest has partnered with the CATT to develop and apply a standardized approach for stream channel classification. We developed a field guide to channel classification and then hired, trained, and deployed field teams to classify channels in timber management units across the George Washington and Jefferson National Forests. The Forest uses the classifications to lay out Riparian Corridors and Channeled Ephemeral Zones in timber management units, as prescribed in the Forest plan.

Field Methods
Appendix A: Guide to Stream Channel Classification on the George Washington & Jefferson National Forests

Appendix A:

Guide to Stream Channel Classification on the George Washington & Jefferson National Forests

Guide to Stream Channel Classification on the George Washington & Jefferson National Forests

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Background

Determining whether a small mountain stream is perennial, intermittent, or ephemeral can be difficult given the dynamic seasonal nature of drainage networks and watershed conditions. No one indicator can be used exclusively, and given high variability in streams during stormflow runoff periods and droughts, inconsistent stream classification can occur. In 2017, staff from the George Washington & Jefferson National Forests (GWJNF) partnered with the Forest Service Southern Research Station Center for Aquatic Technology Transfer (CATT) to refine and document the GWJNF stream channel classification approach and to test the classification system in a variety of channel types across the national forests.

Riparian areas are three-dimensional ecotones of interaction that include terrestrial and aquatic ecosystems, that extend down into the groundwater, up above the canopy, outward across the floodplain, up the near-slopes that drain into the water, laterally into the terrestrial ecosystem, and along the watercourse at a variable width[1]. Riparian areas sustain the aquatic environment by influencing water temperature, light, habitat diversity, channel morphology, food webs and productivity, and the species diversity of stream and lake systems. Intact riparian areas are important in all aquatic habitats.

A Riparian Corridor is a management prescription area designated in the Forest Plans for the GWJNF. Riparian Corridors are managed to retain, restore, and/or enhance the inherent ecological processes and functions of the associated aquatic, riparian, and upland components within the corridor. As a management prescription area, this includes corridors along all defined perennial and intermittent stream channels that show signs of scour, and around natural ponds, lakeshores, wetlands, springs, and seeps.

The width of the Riparian Corridor is determined from a combination of waterbody type (perennial or intermittent) and the average slope of the landform perpendicular to the waterbody (hereafter referred to as ‘side slope’). For perennial waterbodies, including streams, lakes, ponds, and wetlands, there is a core area within the Riparian Corridor that extends 100 feet from the edge of the channel or the normal high water mark. For intermittent streams, the core area within the riparian corridor extends 50 feet from each side of the channel. When side slope exceeds ten percent in perennial or intermittent waterbodies, the Riparian Corridor is extended beyond the core area (Table 1).

Ephemeral streams are hydrologically connected to perennial and intermittent streams. Channeled Ephemeral Stream Zones, as designated in the Forest Plans for the GWJNF, include and are directly adjacent to all scoured ephemeral streams. The primary purpose of this zone is to maintain the

ability of the land to filter sediment from upslope disturbances while achieving the goals of the adjacent management prescription area. In addition, the emphasis along ephemeral streams is to maintain channel stability and sediment control by keeping vehicles away from stream banks and maintaining, restoring, or enhancing large wood loading. The width of the Channeled Ephemeral Stream Zone is 25 feet regardless of side slope (Table1).

Central to the designation of Riparian Corridors and Channeled Ephemeral Stream Zones is the ability to accurately and consistently identify perennial, intermittent, channeled ephemeral streams and changes in side slopes. This field guide is provided to improve accuracy, consistency and efficiency in stream channel classification and to ultimately assist in the proper protection of stream channels and riparian areas as they relate to project planning and implementation.

[1]Verry, E. S., J. W. Hornbeck, and C. A. Dolloff. 2000. Riparian management in forests of the continental Eastern United States. Lewis Publishers, Boca Raton, Fla.

Table 1. Riparian Corridor and Channeled Ephemeral Zone Minimum Widths (feet) per each side of a stream channel or around the perimeter of other waterbodies such as wetlands, as measured perpendicular from the edge of the channel or bank for streams and normal high water mark for wetlands. Ephemeral streams that are not channeled (e.g. swales) are not assigned a riparian corridor or a channeled ephemeral zone width.

	Side slope 0-10%	**Side slope 11-45%**	**Side slope 45%+**
Perennial	100 ft. (core area)	125 ft.	150 ft.
Intermittent	50 ft. (core area)	75 ft.	100 ft.
Channeled ephemeral	25 ft.	25 ft.	25 ft.
Ephemeral (Swale)	NA	NA	NA

Side Slope Measurement

Side slope is the average slope of the landform adjacent to the waterbody and is recorded in 1 of 3 categories (0 – 10%, 11 – 45%, and greater than 45%).

Measure the side slope as follows:

1. Stand with your feet at the top of the bank or at the edge of the normal high water mark.

2. Have your partner go to the edge of the riparian corridor core area, a distance of 100 feet for perennial waterbodies (including lakes, ponds, and wetlands) and 50 feet for intermittent channels.

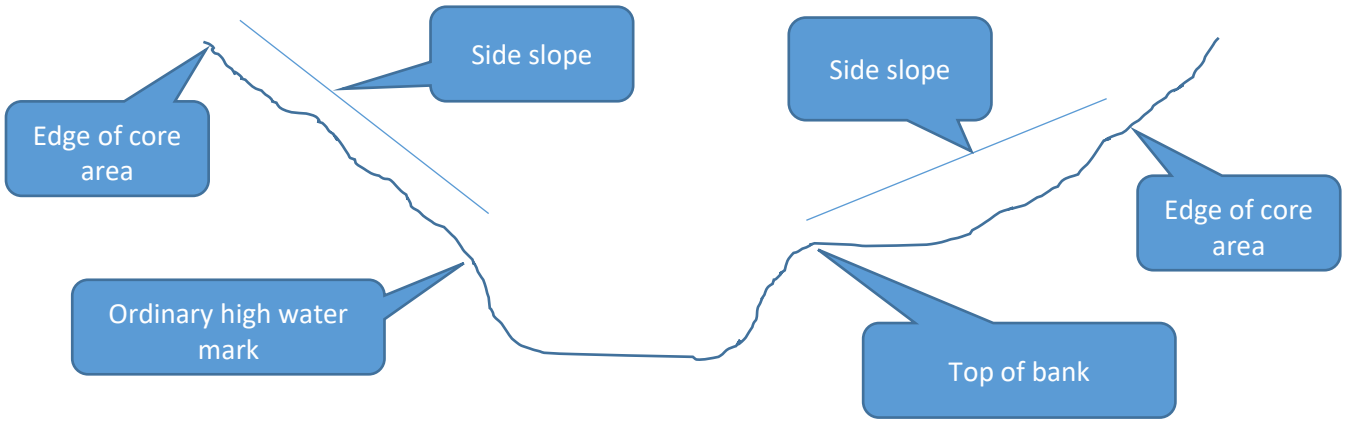
3. Measure the slope by sighting to your partner with a clinometer.

4. Record a slope class for right bank and left bank separately (right and left as facing downstream).

Visual estimation of side slope is acceptable, however the field team should calibrate their visual estimates by making measurements at the beginning of each day and wherever there is question as to the side slope class.

Our objective is to document the side slope within particular channel types (see next section for channel type descriptions) and to identify the point where side slope transitions from one category to another. This transition may occur gradually. When in doubt, assign the higher of the two side slope categories.

Note that side slope should be viewed in the context of the larger landform that contains the riparian corridor. There may be undulations within the riparian corridor, but we are interested in capturing the average slope of the landform containing the riparian corridor. The place you select to measure the side slope should be representative of the average side slope for as far up and downstream as you can see from the point of measurement. Be sure the place you select to measure the slope represents the average and not an outlier.



Channel Types

Perennial – Lakes, ponds and wetlands are considered perennial waterbodies, as is any watercourse that is below the water table and generally flows most of the year.

Intermittent – A watercourse that flows in response to a seasonally-fluctuating water table.

Channeled ephemeral – A watercourse above the water table that flows for short periods of time in direct response to storm precipitation or snowmelt runoff with enough energy to remove soil, organic matter, and leaf litter down to mineral soil.

Ephemeral – A watercourse above the water table that flows for short periods of time in direct response to storm precipitation or snowmelt runoff, but lacking the energy to remove soil, organic matter, and leaf litter down to mineral soil. Often manifested as a natural swale or depression with vegetation and organic material covering the bottom.

In the following section we describe hydrological, physical and biological indicators that can be used to assign stream channel types.

Tips for Determining Stream Channel Type

Determining whether a small mountain stream is perennial, intermittent, channeled ephemeral or ephemeral can be difficult. Applying the following suggestions will be helpful:

- Rely on observations from District field personnel who are familiar with the area. The indicators provided in this manual will vary in effectiveness depending on local conditions.

- Check the USGS stream real-time flow data for stream flows in the area of your watershed. The flow on the day of the visit should be close to the long-term median and at least in the 25% to 75% range.

- Check the NWS precipitation analysis for the area. Classification should not proceed if more than ¼ inch of rain has fallen in the past 48 hours.

- The entire length of the channel within the project area needs to be assessed in order to identify transitions between ephemeral, intermittent, and perennial streams.

- Streams may alternate between perennial and intermittent, or intermittent and channeled ephemeral, or channeled ephemeral and ephemeral in transitional reaches. Extend the classification type that provides the largest riparian corridor to the upstream end of the transitional reach.

- It is rare to obtain 100% agreement among indicators, and no one indicator can be used exclusively. For example, baseflow and stream bed continuity may indicate intermittent, but biological indicators may point to perennial. When in doubt, classify a channel as the type that provides the largest riparian corridor.

- We provide a variety of indicators that require a wide range of expertise to use. It is unlikely that any one person will have expertise in all areas, so select the indicators that you are most comfortable with when classifying the stream channels. Indicate on the datasheet which indicators were used, and which were not used.

- If the channel type is short enough that it will be completely protected by the immediate downstream buffer, then it may be ommited from classification. For example if a channeled ephemeral is less than 25 ft in length it may be ommitted.

- Not all channel types are present in all drainages. For example, a channel may begin as perennial spring or seep without any evidence of contributing intermittent or channeled ephemeral channels.

- In addition to marking transitions between channel types field teams should mark the location of wetlands within the project area. Wetlands are perennial waterbodies but are recorded separately from stream channels.

Datasheet Example:

Project:
Date:
Crew:
District:

Coordinates (lat/long in decimal degrees):

Coordinate type: Transition Coordinate Observation Coordinates

Right Side Slope Category: 0-10% 11-45% 45%+

Left Side Slope Category: 0-10% 11-45% 45%+

Indicator	Perennial	Intermittent	Channeled Ephemeral	Ephemeral
Hydrological				
Baseflow				
Groundwater				
Physical				
Stream order				
Stream bed continuity				
Substrate size				
Soil				
Biological				
Roots				
Plants				
Algae				
Macroinvertebrates				
Crayfish				
Snails				
Fish				
Amphibians				
Birds				

Field classification (circle one):

Wetland Feature Perennial Intermittent Channeled Ephemeral Ephemeral

Photo ID looking downstream:

Photo ID looking upstream:

Notes:

Summary of typical indicators for each channel type

PERENNIAL

Hydrological Indicators

Baseflow: Flowing through riffles/Residual pools only/Seasonally dry

Perennial channels are often characterized by ample flowing water in comparison to other channel types (see Photo 8). Water is typically present and flowing through riffles, rather than being isolated to small residual pools. However, perennial channels in the absence of recent rain, or in low flow or drought conditions may be reduced to residual pools or almost completely dry. Complete seasonal drying can occur in some hydrologies. In these conditions other criteria such as substrate, stream bed and bank, roots, macroinvertebrates, amphibians, and soil redox are crucial to classifying a channel as perennial.

Groundwater: Springs and seeps present/Springs and seeps absent

Springs and/or seeps may or may not be present in perennial channels. If present, springs and seeps bolster the classification of perennial channels, but may still be indicative of intermittent channels. If springs and seeps have a strong active flow and other perennial criteria are present, typically the channel is perennial. However, a channel can still be perennial without springs or seeps, as the springs or seeps may not be detected or may be present higher in the watershed, either outside the timber stand or outside of the perennial channel.

Physical Indicators

Substrate: Continuous coarse sediment

Perennial channels are characterized by the presence of continuous coarse sediment that is well sorted or scoured to bedrock. Sands, silts, gravels, cobbles, boulders, and even bedrock are often present in perennial channels. In some situations, perennial channels may not have large material, but a thick coating of sand, silt, or clay substrate. Often this is near an active spring or seep.

Stream bed and bank: Well developed bed and bank

The bed and bank of perennial channels is well developed. Obvious signs of scour and high water marks are often present. With the exception of submerged aquatic vegetation (SAV) (i.e fontinalis), higher gradient perennial channels have little to no plants growing in stream bed. However perennial channels may go subsurface for short distances, and/or have little to no bank at the beginning of an active seep or spring (See Photo 9). Make sure to record what is typical of the entire reach, and make notes about changes if necessary.

Soil redox: Abundant/Not abundant/Absent

Obvious signs of soil redox may or may not be present in perennial channels. If present, it may or may not be abundant. Soil redox is characterized by redox bacteria, (reddish grainy-like coating on stream bottom, sometimes with oily sheen on water's surface) gleying (soil is mottled in burnt orange/bluish gray color), or depleted matrix (soil shows evidence of fluctuating baseflow).

Biologic Indicators

Roots: No roots across stream bed

Generally, roots will not grow across the stream bed of perennial channels. Because of the power of the water that consistently moves through perennial channels, most roots cannot persist. The occasional large, woody root of a water tolerant tree may be present in perennial channels, but fibrous and small diameter woody roots should not be present.

Obligate or Facultative wetland plants: Abundant/Not abundant

Wetland plants are often present in or along the sides of perennial channels, particularly in flattened areas adjacent to the stream channel. They may be abundant or not abundant, or present in high or low diversity. Good evidence for perennial channels include the presence of rushes, sedges, some grasses, or fontinalis (submerged aquatic moss). Cinnamon fern, cardinal flower, or thick rhododendron may also be present.

Algae: Abundant/Not abundant/Absent

Abundant algae is typically observed throughout the reach in a perennial channel but may be not abundant or absent where water quality is poor.

Macroinvertebrates: Abundant/Not abundant/Absent

Generally, macroinvertebrates are present within perennial channels. They may be abundant with high diversity, or not abundant with low diversity. A channel may be perennial even in the absence of macroinvertebrates, but in this instance other criteria will need to bolster classification.

Crayfish: Abundant/Not abundant/Absent

Crayfish are typically abundant in perennial channels, either in the form of burrows or actually present in the water, or both. Channels may still be classified as perennial in the absence of crayfish. A channel may be perennial even in the absence of crayfish, but in this instance other criteria will need to bolster classification.

Snails: Abundant/Not abundant/Absent

Gilled or lunged snails (with operculum, right handed shell) can be present.

Fish: Abundant/Not abundant/Absent

An abundant or diverse fish assemblage indicates a perennial channel. However, fish may be present in low numbers or absent altogether where habitat or water quality are poor or following periods of extended drought. A channel may be perennial even in the absence of fish, but in this instance other criteria will need to bolster classification.

Amphibians: Abundant/Not abundant/Absent
Amphibians are often present in perennial channels. Larval forms of amphibians, amphibians with gills, or amphibian eggs are evidence of a perennial channel. A channel may be perennial even in the absence of amphibians, but in this instance other criteria will need to bolster classification.

Acadian Flycatcher, Louisiana Waterthrush, or Willow Flycatcher: Abundant/Not abundant/Absent
Presence of these bird species indicates perennial waters are nearby. They will be absent where terrestrial habitat is unsuitable. A channel may be perennial even in the absence of these birds, but in this instance other criteria will need to bolster classification.

	
Typical perennial channel with water flowing through riffles	Head of a perennial seep. Note that although there is little flow or sorting of substrate immediately downstream this feature is still considered perennial.

INTERMITTENT

Hydrological Indicators

Baseflow: Residual pools only/Dry
In intermittent channels, water is often only found in residual pools when surveying under base flow conditions. Recent rain or prolonged rainy season can cause the water table to rise and water to flow continuously in intermittent channels. Intermittent channels can also be dry depending on seasonality and most recent rain event. Classification should not proceed if more than ¼ inch of rain has fallen in the past 48 hours

Groundwater: Springs and seeps present/Springs and seeps absent
Seeps/springs may or may not be present in an intermittent channel. However, signs of springs/seeps indicate either a perennial or intermittent channel.

Physical Indicators

Substrate: Continuous coarse sediment/Discontinuous coarse sediment
Intermittent channels are characterized by an increase in coarse sediment in the channel relative to channeled ephemerals. Because there is typically more water (and therefore more power) moving through intermittent channels than channeled ephemeral channels, more sand, gravel, cobble, and even boulders are present. Coarse sediment in intermittent channels may still be discontinuous but is typically well sorted and of a larger class size than that present in channeled ephemeral channels (top photo).

Stream bed and bank: Well developed bed and bank/Interruptions in bed and bank
Intermittent channels often possess well developed beds and banks, especially in comparison to channeled ephemeral channels. The bank is often clearly defined and signs of scour are obvious. However, it is common for intermittent channels to have interruptions in the bed in bank or go subsurface for short distances (middle photo).

Soil redox: Absent/Not abundant
Soil redox may or may not occur in intermittent channels. Typically, if present, it is not abundant. Soil redox is characterized by redox bacteria, (reddish grainy-like coating on stream bottom, sometimes with oily sheen on water's surface) gleying (soil is mottled in burnt orange/bluish gray color), or depleted matrix (soil shows evidence of fluctuating baseflow).

Biological Indicators

Roots: Small diameter woody roots across stream bed/No roots across stream bed
Oftentimes intermittent channels have some woody roots across the channel, but typically no fibrous roots. Because of higher energy flow events that occur in intermittent channels, scour and course sediment prevents fibrous roots from persisting. Thus, typically small diameter woody roots can be found in intermittent channels.

Obligate or Facultative wetland plants: Not abundant/Abundant
Wetland plant species may occur around intermittent channels, but usually not in high numbers or great diversity. Some moss, cinnamon fern, or thick rhododendron may be present in or near intermittent streams. A good indicator that a stream is changing from ephemeral or channeled ephemeral to intermittent or perennial is a noticeable change in understory. Ephemeral/channeled ephemeral channels typically possess an open understory, while intermittent/perennial channels can be surrounded by thick rhododendron stands. An abrupt change is indicative of a seep or spring (see bottom photo). Sedges may also be present where adequate sunlight reaches the channel.

Algae: Not abundant/Abundant
Some algae is observed in a few locations in the reach, though algae can become abundant during wet periods in the spring.

Macroinvertebrates: Absent/Not abundant
Macroinvertebrates may or may not be present in intermittent channels. They are often absent. When present, there is typically minimal diversity and they are not abundant. Species that have shorter lifecycles (one year vs two year) are more likely to be present. See appendix C.

Crayfish: Not abundant/Abundant/Absent
Crayfish may be abundant, not abundant or absent in intermittent channels. When crayfish are observed in intermittent channels, they are present in the form of crayfish burrows, not observed in the water. Aquatic crayfish are typically more indicative of a perennial channel. Channels can still be classified as intermittent if crayfish (or their burrows) are absent.

Snails: Absent/Not abundant
Lunged aquatic (no operculum, left handed shell) may be present; gilled snails rare.

Fish: Absent/Not Abundant/Abundant
When present, fish are restricted to residual pools, except during extended wet periods.

Amphibians: Absent/Not abundant/Abundant
Often in intermittent channels amphibians are present but not abundant. They are often found in damp areas under rocks in or near the channel. Typically, those found are terrestrial. Larval forms are absent from intermittent channels as they indicate perennial conditions with long term water for development to occur. A channel may still be classified as intermittent even if amphibians were not observed.

Acadian Flycatcher, Louisiana Waterthrush, or Willow Flycatcher: Absent

	
Intermittent (right channel) vs. channeled ephemeral (left channel).	Intermittent channels may have discontinuous coarse substrate and interrupted banks as shown above.

CHANNELED EPHEMERAL

Hydrological Indicators

Baseflow: Dry

Channeled ephemeral streams are dry with no water present, if surveyed under protocol conditions. Classification should not proceed if more than ¼ inch of rain has fallen in the past 48 hours.

Groundwater: Springs and seeps absent

Channeled ephemeral streams do not contain springs or seeps.

Physical Indicators

Substrate: Discontinuous coarse sediment

Channeled ephemeral streams should have signs of sediment transport. Oftentimes sporadic or discontinuous portions of the reach have sands, gravels, and cobbles while other portions may have minute scour only just past the mineral soil (see left photo).

Stream bed and bank: Interruptions in bed and bank

Rudimentary channel formation is characteristic of channeled ephemeral streams. Often the channel possesses signs of scour in discontinuous sections of the reach (see right photo). It is common for bed and bank in these channels to be discontinuous as energy dissipates over a small flat area only to channelize again a short distance away. Therefore, it is crucial when classifying channeled ephemeral to thoroughly check that the stream has indeed fully transitions to a different type.

Biological Indicators

Roots: Small diameter woody roots across stream bed/woody and fibrous roots across stream bed

Roots are prevalent across channeled ephemeral streams. Typically, there are many small diameter woody roots and some fibrous roots in patchy areas across the stream bed. These roots are indicative of channeled ephemeral streams as they could not persist if the channel was wet and heavily scoured for an extensive period of time.

Obligate or Facultative wetland plants: Absent

Algae: Absent

No Algae is observed through the reach

Macroinvertebrates: Absent

Channeled ephemeral streams do not hold enough water year-round to support the life history requirements of aquatic macroinvertebrates.

Crayfish: Absent

Channeled ephemeral streams do not hold enough water year-round to support life history requirements of crayfish.

Snails: Absent

No aquatic snails are observed. Terrestrial snails may be present.

Fish: Absent
Channeled ephemeral streams do not hold enough water year-round to support life history requirements of fish.

Amphibians: Not abundant/Absent
Larval (gilled) amphibians are absent from channeled ephemeral streams. Terrestrial forms of some salamanders can be found walking in these areas if leaves are wet or may be found sheltering beneath wood or stones during dry periods.

Acadian Flycatcher, Louisiana Waterthrush, or Willow Flycatcher: Absent

	
Typical channeled ephemeral stream	Channeled ephemeral with discontinuous substrate and channel

EPHEMERAL (SWALE)

Hydrological Indicators

Baseflow: Dry

Ephemeral streams if surveying under protocol conditions should be completely dry. Classification should not proceed if more than ¼ inch of rain has fallen in the past 48 hours.

Groundwater: Springs and seeps absent

Springs and seeps are absent from ephemeral streams.

Physical Indicators

Substrate: No coarse sediment

Soil looks relatively undisturbed and closely resembles surrounding area. Another good indicator of an ephemeral stream is if the leaf litter layer is still intact and there is no evidence of movement by water.

Stream bed and bank: Bed and bank absent

Ephemeral streams should have no bed or bank present. Ephemeral streams should resemble a swale on the landscape, rather than an actual channel (See photos 1 and 2). Once scour occurs past the mineral soil layer, stream has transitioned to channeled ephemeral.

Biological Indicators

Roots: Woody and fibrous roots across stream bed

Roots of all sizes, but particularly fibrous roots, can be found in ephemeral streams and are generally unexposed (buried under soil/leaf litter).

Obligate or Facultative wetland plants: Absent

Algae: Absent

Algae is not present in ephemeral streams.

Macroinvertebrates: Absent

Ephemeral streams do not hold enough water year-round to support the life history requirements of aquatic macroinvertebrates.

Crayfish: Absent

Ephemeral streams do not hold enough water year-round to support life history requirements of crayfish.

Snails: Absent

No aquatic snails are observed. Terrestrial snails may be present.

Fish: Absent

Ephemeral streams do not hold enough water year-round to support life history requirements of fish.

Amphibians: Not abundant/Absent

Larval (gilled) amphibians are absent from ephemeral streams. Terrestrial forms of some salamanders can be found walking in these areas if leaves are wet or may be found sheltering beneath wood or stones during dry periods.

Acadian Flycatcher, Louisiana Waterthrush, or Willow Flycatcher: Absent

	
Typical ephemeral stream swale.	Another example of an ephemeral stream swale.

Appendix A: Riparian Corridor Description from Forest Plan

Our working definition for riparian corridor comes from the 2014 Revised Land and Resource Management Plan for the George Washington National Forest, Appendix A, accessed 6/4/2018 at: https://www.fs.usda.gov/main/gwj/landmanagement/planning

DEFINITION OF RIPARIAN CORRIDOR

RIPARIAN CORRIDORS VERSUS RIPARIAN AREAS

Riparian Areas are functionally defined as areas with three-dimensional ecotones of interaction that include both terrestrial and aquatic ecosystems. They extend down into the groundwater, up above the canopy, outward across the floodplain, up the near-slopes that drain into the water, laterally into the terrestrial ecosystem, and along the watercourse at a variable width (Ilhardt et al. 2000). A **Riparian Corridor**, on the other hand, is a management prescription area designed to include much of the Riparian Area. Within the riparian corridor management prescription area, management practices are specified to maintain riparian functions and values. As a management prescription area, this includes corridors along all defined perennial and intermittent stream channels that show signs of scour, and around natural ponds, lakeshores, wetlands, springs, and seeps.

DETERMINATION OF RIPARIAN CORRIDOR

Due to their spatial extent, riparian corridors are not identified on the Forest Plan map of prescription allocations. Estimated acreages of the Riparian Prescription allocations are based on the widths described in Tables in A-1 and A-2. For project planning and implementation, the following process will be used to determine the extent of site-specific riparian corridors.

Riparian corridor widths are designed to encompass the riparian area defined on the basis of soils, vegetation and hydrology and the ecological functions and values associated with the riparian area. The widths in Tables A-1 and A-2 shall be used to define the riparian corridor if the corridor is not site-specifically determined as described below.

If a site-specific field investigation determines the need to vary the widths in Table A-1 and A-2, that width shall become the project level riparian corridor. This corridor shall be determined by an interdisciplinary analysis using site-specific information to ensure that riparian values and functions are maintained.

The slope-dependent riparian corridor widths are measured in on-the-ground surface feet perpendicular from the edge of the channel or bank (stream, water body, etc.) and extend out from each side of a stream. For ponds, lakes, sloughs, and wetlands (including seeps or springs associated with wetlands) the measurement would start at the ordinary high water mark and go around the perimeter. For braided streams, the outermost braid will be used as the water's edge. An interrupted stream (a watercourse that goes underground and then reappears) will be treated as if the stream were above ground. (An acceptable level of error for on-the-ground measurements of these widths is $\pm$ 10%.) The riparian corridor includes human-created reservoirs, wildlife ponds, wetlands, and waterholes connected to or associated with natural water features. In addition, those areas not associated with natural water features, but support riparian flora or fauna, will have a riparian corridor designation. The riparian corridor management direction does not apply to constructed ponds developed for recreation uses; or to human-made ditches, gullies, or other features that are maintained or in the process of restoration. For these areas, site-specific analysis will determine appropriate protective measures. (See also the Forest-wide Standards in Chapter 4.)

Tables A-1 and A-2 do not apply to constructed ponds developed for recreation uses; or to human-made ditches, gullies, or other features that are maintained or in the process of restoration. For these areas, site-specific analysis will determine the appropriate protective measures.

Table A.1 Riparian Corridor Minimum Widths for Perennial Streams, Lakes, Ponds, Wetlands, Springs or Seeps

Slope Class	0-10% Core Area	11-45% Core + Extended Area	45%+ Core + Extended Area
Minimum width in feet (as described above)	100	125	150*

Table A.2 Riparian Corridor Minimum Widths for Intermittent Streams

Slope Class	0-10% Core Area	11-45% Core + Extended Area	45%+ Core + Extended Area
Minimum width in feet (as described above)	50	75*	100*

* The Extended Area is the outer 25 feet (on 11-45 % slopes) and 50 feet (on 45% and greater slopes).

OVERVIEW OF RIPARIAN CORRIDORS

The figure below is a simplified representation of the Riparian Corridor that demonstrates its extension on both sides of a watercourse, down into the water table, and laterally around wetlands and other surface water sources. The Riparian Corridor may fall within or beyond the true Riparian Area.

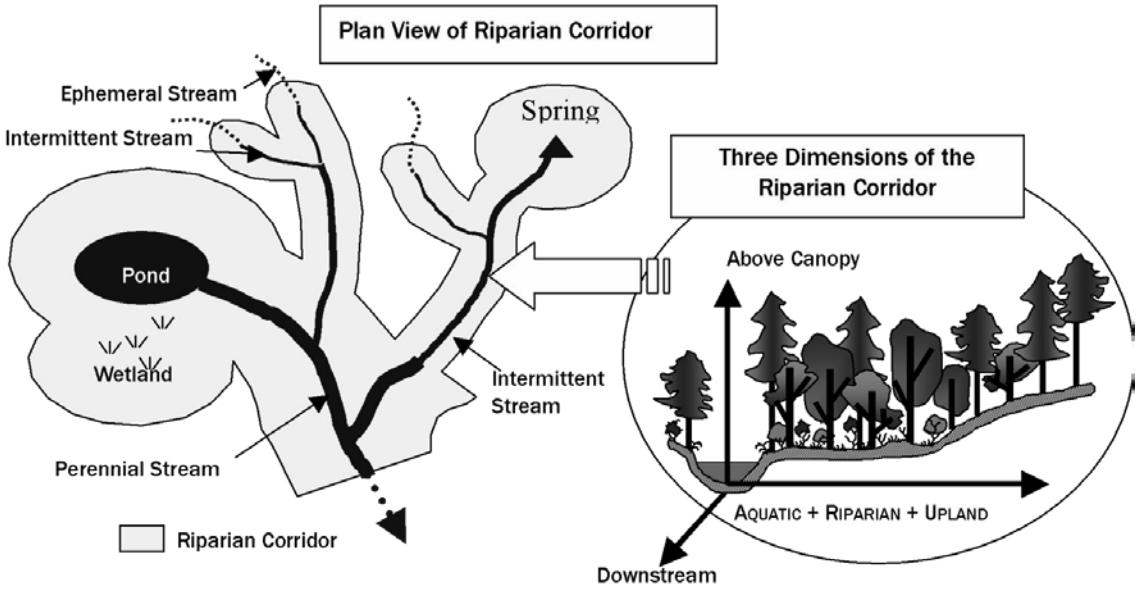


Figure A.1 Simplified Representation of a Riparian Corridor

OPERATIONAL DEFINITION FOR A RIPARIAN AREA

Riparian Areas are areas associated with the aquatic ecosystem and that portion of the terrestrial ecosystem that is substantially affected by the presence of surface and groundwater. Riparian areas consist of perennial streams, natural ponds, lakes, wetlands, and adjacent lands with soils, vegetation and landform indicative of high soil moisture or frequent flooding. Riparian areas have variable widths that are determined by ecologically significant boundaries rather than arbitrary distances. The extent of riparian areas is determined on-the-ground using features of soil, landform, and vegetation. No feature is used alone to delineate these ecosystems. Characteristics indicative of these areas are:

- Soils – dark colored Entisols, Inceptisols, and Mollisols;
- Landform – the 100-year floodplain;
- Vegetation – the presence of wetland plants classified as obligates or facultative wetland species as defined by the U.S. Fish and Wildlife Service in the National List of Plants that Occur in Wetlands: Northeast (Region 1). (Reed, P.B., Jr., 1988).

RELATIONSHIP WITH OTHER MANAGEMENT PRESCRIPTIONS

The Riparian Corridors overlap with other management prescription allocations. In order to establish precedence, the following rules apply:

Where the Riparian Corridor management prescription area overlaps with lands that have been allocated to the following Management Prescriptions, then whichever management direction is the most restrictive will apply:

- 1A or 1B – Wilderness and Recommended Wilderness Study,
- 2C2 or 2C3 – Eligible Scenic and Recreational Rivers,
- 8E7 – Shenandoah Mountain Crest
- 8E4a – Indiana Bat Primary Cave Protection Area,
- 12D - Backcountry Recreation Areas

For lands allocated to any of the other management prescriptions, where the riparian corridor overlaps with these allocations, the direction in the Riparian Corridor Management Prescription will take precedence.

RELATIONSHIP WITH BEST MANAGEMENT PRACTICES

This Forest Plans meets or exceeds State Best Management Practices. Current State BMP handbooks or manuals are incorporated as direction in the Forest Plan and are implemented for those resource management activities that are covered by the handbooks/manuals. Standards for activities not included in BMP handbooks/manuals are included in Chapter 4 of this Forest Plan.

The Streamside Management Zones (SMZ) recommended in State BMPs are designated areas directly adjacent to streams and water bodies where land management activities are controlled or regulated to primarily protect water quality and aquatic organisms from upslope land uses. Provisions within the SMZ typically contain sediment filter strips, a base shade level, restriction on ground disturbance and protection of stream banks and streambeds. As described, Riparian Corridors are management prescription areas that maintain ecological processes and functions. SMZs may be the same width or smaller than the riparian corridor, however, in some cases they may extend beyond the corridor.

RELATIONSHIP WITH CHANNELED EPHERMERAL STREAMS

Ephemeral streams do not have true riparian areas but are hydrologically connected to perennial and intermittent streams. Channeled Ephemeral Stream Zones include and are directly adjacent to all scoured ephemeral channels. Standards for the Channeled Ephemeral Zone are found in Chapter 4 of this Forest Plan. The primary purpose of this zone is to maintain the ability of the land to filter sediment from upslope disturbances while achieving the goals of the adjacent management prescription area. In addition, the emphasis along ephemeral streams is to maintain channel stability and sediment control by keeping vehicles away from stream banks and maintaining, restoring, or enhancing large woody debris. The management direction in this zone reflects the adjacent management prescription and may be modified as a result of watershed analysis.

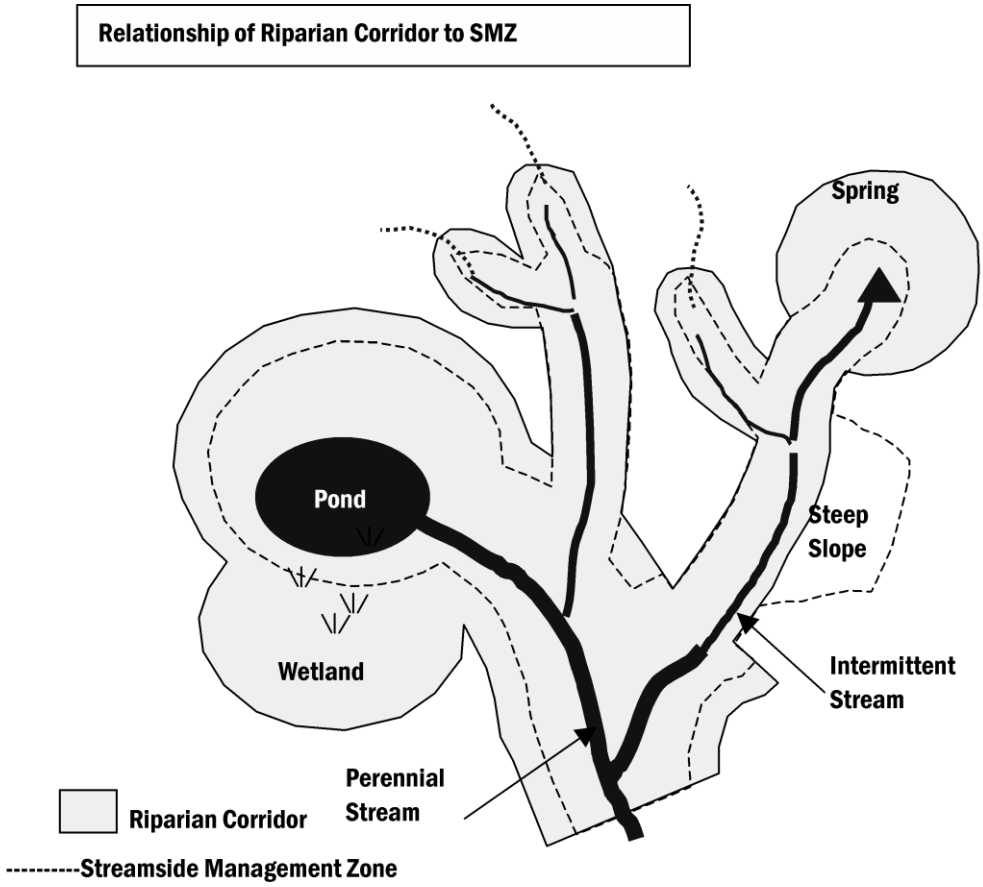


Figure A.2 Relationship of Riparian Corridor to Streamside Management Zone

Appendix B: Comprehensive Synopsis of Channel Type Indicators

The indicators on the following pages are largely adapted from:

NC Division of Water Quality. 2010. Methodology for Identification of Intermittent and Perennial Streams and their Origins, Version 4.11. North Carolina Department of Environment and Natural Resources, Division of Water Quality. Raleigh, NC.

Hydrological Indicators

Hydrological indicators are best observed at least 48 hours since the last runoff producing rainfall (minimum ¼" precipitation event), during periods of average flow.

Baseflow: Water flowing in the channel more than 48 hours after rainfall that produces runoff is evidence of baseflow supplied by 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 be slow groundwater discharge into, and downstream flow through the coarse-textured sediments in the bed and sides of the channel, up to 2-3 feet below the surface in small streams. Obvious subsurface flow (e.g. sound of running water below stream bed) is an indicator or perennial waters even when there is no water above the elevation of the stream bed.

Perennial	Water is present and flowing in the thalweg region of the channel throughout the evaluation reach and there is baseflow through the riffles or other shallow zones during periods of normal to low flows. During drought conditions riffles and other shallow areas may become dry.
Intermittent	Channel may be completely dry, or water may be standing in pools and the hyporheic zone may be saturated, but there is not visible flow through the riffles or other shallow zones of the thalweg during periods of low flow. Water may flow through riffles during periods of high flow.
Channeled ephemeral	There is no visible water in the channel.
Ephemeral	There is no visible water (and no discernable channel).

Groundwater: The presence of a seasonal high water table or groundwater discharge (e.g., seeps or springs) from the bank above the elevation of the channel bottom indicates a relatively reliable source of baseflow to a stream.

Perennial	Evidence of groundwater discharge (springs, seeps) into or above the elevation of the channel or a groundwater table above the thalweg is readily observable in several areas of the reach.
Intermittent	Evidence of groundwater discharge may be present during wet periods, particularly in spring or winter, but may become less obvious during dry periods. The groundwater table as evidenced by springs or seeps is at or slightly above the level of water in the pools.
Channeled ephemeral	There is no evidence of groundwater discharge into the channel.
Ephemeral	There is no evidence of groundwater discharge into the channel.

Physical Indicators

Stream order: In general, the higher the channel order, the more likely a stream is to be perennial. Determine the order of the reach being evaluated in accordance with the Strahler Stream Order method (Strahler 1952), considering all intermittent and perennial stream segments that discharge to the evaluation reach. Due to inaccurate depiction of headwaters streams on maps, ground reconnaissance of the stream upstream of the reach being evaluated is preferred, when feasible.

Perennial	Generally, stream is second order or greater, but lower order channels may be perennial where springs or seeps are present.
Intermittent	Streams are generally 1st – 3rd order, though higher order streams may be included in some geologies.
Channeled ephemeral	Stream is 1st order or cannot be determined.
Ephemeral	Stream is 1st order or cannot be determined.

Stream bed continuity: The bed of a stream is the channel bottom and the physical confine of the "normal" baseflow or low water flow. Streambanks are vertical or sloped areas rising from the bed of the channel and are the lateral constraints (channel margins) of flow during all stages but flood stage. Flooding occurs when a stream overflows its banks and partly or completely fills its floodplain. As a general rule, the bed is that part of the channel at or near "normal" flow, and the banks are that part above the water line. However, because discharge varies, this differentiation is subject to local interpretation. Usually the bed is clear of terrestrial vegetation, while the banks are subjected to water flow only during high 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.

Perennial	Generally, the stream has a well-developed channel with continuous bed and bank present throughout the length of the reach. However, streambed and bank may become discontinuous in areas where streams are prone to subterranean flow. In these cases, the upstream most occurrence of perennial channel type marks the upstream extent of a perennial reach even where portions may flow beneath the surface.
Intermittent	Stream may have a well-developed channel with continuous bed and bank present throughout the length of the reach, or streambed and bank may become discontinuous.
Channeled ephemeral	The majority of the channel has obvious interruptions in the continuity of bed and bank.
Ephemeral	Bed and bank are absent altogether. Often times described as a swale.

Substrate size: Well developed streams that have eroded through the soil profile often have substrate materials dominated by larger sediment sizes (e.g., gravel, cobble, and boulder) relative to floodplain sediments and adjacent soils. Similar sediment sizes in the stream bed and the adjacent stream side area indicate that stream forming processes have not been consistent enough to cut into the soil profile and form an intermittent or perennial stream. Whereas the bed in channeled ephemerals may have substrates that are coarser than surrounding soils, the bed in ephemeral streams is typically soil. The bed of intermittent or perennial streams is often comprised of coarser sediment relative to the adjacent bank area or floodplain due to consistent stream-forming flows that have transported finer particles downstream as the channel has eroded downward; finer particles may be deposited on adjacent stream banks during floods leading to markedly finer sediments in adjacent floodplains.

Perennial	The channel is well-developed through the soil profile with relatively coarse streambed sediments compared to riparian zone soils. Particle size differs greatly between the stream substrate and adjacent land.
Intermittent	There is a well-developed channel but it is not as deeply incised through the soil profile as adjacent perennial channels. Coarse sediment is present in the streambed in a continuous layer. Particle size differs somewhat between the stream substrate and adjacent land.
Channeled ephemeral	The channel is scoured to bare mineral soil, but poorly developed through the soil profile. Some coarse sediment may be present in the streambed but can be discontinuous.
Ephemeral	The channel is not scoured to bare mineral soil. Particle size is the same in the channel and adjacent land.

Soil: The presence of a seasonal water table in the soil above the thalweg elevation is evidence of groundwater discharge into the channel that sustains an annual extended period of baseflow. In soils with fluctuating water tables near the surface, the level of the seasonal high water table is routinely estimated from soil color variation in soils with silts and clays that have iron and manganese oxides. When the soil is unsaturated and aerobic, chemically oxidizing conditions in the soil water produce oxidized forms of iron and manganese that are precipitates that coat soil particles and produce brown, yellow, and red colors. When the soil is saturated and anaerobic, chemically reducing conditions in the soil water produce reduced forms of iron and manganese that are colorless ions in solution. Gray or neutral low chroma soil colors result because the colors of the soil particles are visible. In sandy soils with very low clay content, long periods of saturation result in accumulation of organic matter that coats the sand grains and produces dark low chroma colors.

In soils with frequent, long periods of saturation the oxidation/reduction reactions of iron and manganese produce color variations called redoximorphic features (formerly called mottles). The degree of development of redoximorphic features is indicative of the frequency and duration of periods of soil saturation. Weakly developed redoximorphic features in the soil at the toe of the bank above the channel bed are common in intermittent streams and indicate the level of the seasonal high water table. Strongly developed redoximorphic features are common in the soils at the toe of banks and in the

streambed sediments of perennial streams. Ephemeral streams have oxidized soils in the bed and bank. Types of redoximorphic features are: (1) depleted matrix – matrix color has chroma ≤ 2; (2) depletions – zones of low chroma (≤ 2) within a matrix of higher chroma; (3) concentrations - soft masses or pore linings; zones of accumulation of oxidized iron and manganese, bright yellow, orange, or red colors (Figure 16).

Soil colors are identified with Munsell soil color charts. The matrix color of a soil ped is the color of more than 50% of the face of a broken ped. Use a soil auger to obtain at least three 6-8 inch cores in the toe of the bank above the thalweg elevation in a riffle or shallow zone of the channel. Look for redoximorphic features below by breaking open chunks of soil (peds). Note that non-soil such as relatively young alluvial accumulations of coarse sand, gravel, and cobble in the stream bank or hyporheic zone will not have redoximorphic features or other hydric soil indicators.

Is there evidence of a seasonal high water table in the soil at the toe of the stream bank, or the base of a head cut above the elevation of the thalweg of the evaluation reach?

YES – In the soil of the stream bank or base of a headcut within at least six inches above the average elevation of riffles or other shallow zones in the thalweg is found a soil layer at least two inches thick that has at least one indicator of a seasonal high water table.

NO – In the soil of the stream bank or base of a headcut within at least six inches above the average elevation of riffles or other shallow zones in the thalweg is found no indicator a seasonal high water table.

Common indicators of a seasonal high water table include but are not limited to:

- More than 60% of the ped face is gleyed, i.e. color is on a gley page of the Munsell
- More than 60% of the ped face is chroma ≤ 2 with or without concentrations
- In streams with floodplains, more than 60% of the ped face is chroma ≤ 4 with 10% or more redox concentrations
- More than 60% of the ped face is chroma ≤ 2 with 10% or more of redox depletions
- In a sandy soil, more than 70% of the sand grains are coated with organic matter
- In a sandy soil, there is streaking or splotches of organic matter
- The soil has mucky mineral texture

16a. Upland Soil (chroma >3) (NC DWQ)

16b. Hydric soil depicting gleying (chroma<2) (NC DWQ)

16c. Low chroma soil with redox concentrations (NC DWQ)

16d. Redox concentrations in sandy soil. (NC DWQ)

Perennial	Evidence of a seasonal high water table (e.g. 16b, 16c above) may be present. See text above for detailed description.
Intermittent	Evidence of a seasonal high water table (e.g. 16b, 16c above) may be present. See text above for detailed description.
Channeled ephemeral	There is not evidence of a seasonal high water table.
Ephemeral	There is not evidence of a seasonal high water table.

Biological Indicators

Roots: Fibrous roots are non-woody, small diameter (< 0.10 in), shallow, wide-spreading roots that often form dense masses in the top few inches of the soil. Fibrous roots of plants are those which function in water and nutrient uptake. The persistent presence of water would not allow for oxygen exchange in the roots of water-intolerant plants, limiting the growth of fibrous roots. Frequent high-energy flows that disturb the substrate will also limit their growth. Observe the streambed in or near the thalweg of the stream and determine if very small (fibrous) roots or small diameter woody roots are present. Note that during an 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.

Perennial	No fibrous or small diameter woody roots are present in the streambed.
Intermittent	Few fibrous roots or small diameter woody roots are present in the streambed.
Channeled ephemeral	A discontinuous network of fibrous roots is present in the streambed. Intact small diameter woody roots are visible in areas where fibrous roots are scoured away.
Ephemeral	A strong network of fibrous roots obscures visibility of small diameter woody roots (no scour).

Plants: The U.S. Army Corp of Engineers wetland delineation procedure can be used to infer the duration of soil saturation in streams. Small, low gradient, low velocity intermittent and perennial streams, springs and seeps with adequate sunlight will often have OBL (obligate wetland) and FACW (facultative wetland) plants, aquatic bryophytes such as *Fontanalis*, or submerged aquatic vegetation growing in the stream bed, though higher-gradient headwater streams may lack OBL or FACW vegetation. All wetland designations are defined by *National List of Vascular Plant Species that Occur in Wetlands: 1996 National Summary* (U.S. FWS 1997).

Perennial	Obligate or facultative wetland plants may be present along the stream banks or riparian area, or submerged aquatic vegetation may be present within the water feature, particularly in low gradient reaches.
Intermittent	Obligate or facultative wetland plants may be present along the stream banks or riparian area, particularly in low gradient reaches.
Channeled ephemeral	No obligate or facultative wetland plants are present.
Ephemeral	No obligate or facultative wetland plants are present.

Algae: Benthic algae are photosynthetic organisms that live on substrates in the stream. Benthic algal abundance is strongly influenced by the amount of sunlight reaching the stream, relative rate of stream discharge, availability of appropriate substrates, and level of nutrient enrichment. Look for green or blue-green filaments or mats, or golden brown "crusts" on appropriate substrates within the wetted channel. Also feel submerged rocks, plants, leaves, sticks, or other available substrates; a "slimy" coating can indicate a biofilm consisting of a mix of diatoms, other algae, bacteria, and fungus that is collectively referred to as periphyton, and should also be considered when rating this indicator.

Perennial	Abundant algae may be observed throughout the reach.
Intermittent	Some algae may be observed in a few locations in the reach, though algae can become abundant during wet periods in the spring.
Channeled ephemeral	No algae is observed through the reach.
Ephemeral	No algae is observed through the reach.

Macroinvertebrates: “Benthic macroinvertebrates” is a broad term applied to many different types of invertebrates that live on or within the stream substrate. Crayfish and snails are assessed separately in this method, so this indicator is meant to assess primarily aquatic insects (i.e., mayflies, stoneflies, caddisflies, hellgrammites, midges), amphipods, isopods, and annelids (worms and leeches). The larval stages of many aquatic insects are well-established indicators of flow duration since a continuous aquatic habitat is required for these species to mature. In general, caddisflies, mayflies, stoneflies, dragonflies and damselflies are very good indicators of at least intermittent (and in many cases, perennial) flow. Examine rocks and sticks in the stream and use a small net to sample a variety of habitats including riffles, pools, roots, undercut banks, leaf packs and the substrate. Note both the quantity as well as the diversity of the macroinvertebrate sample on the field form when scoring.

Perennial	An abundant or diverse assemblage, or the presence of larval stages that require multiple years to develop (Appendix C) indicates perennial channel. May be present in low numbers or absent in areas with poor water quality.
Intermittent	Macroinvertebrates may be present in low numbers. Amphipods and isopods may be abundant. May be absent where water quality is poor or after extended drought periods
Channeled ephemeral	No aquatic macroinvertebrates are present.
Ephemeral	No aquatic macroinvertebrates are present.

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 or "chimneys" in the muddy streambank or floodplain may be indicators of wet soils (wetlands) rather than streams.

Perennial	Several or very large crayfish may be present.
Intermittent	Crayfish may be present and may dominate relative to other macroinvertebrates.
Channeled ephemeral	No crayfish are present.
Ephemeral	No crayfish are present.

Snails: Though aquatic snails are not often found in higher-elevation headwater streams, their presence can be indicative of perennial or intermittent streams. Snails (mollusks with a coiled shell, Class Gastropoda) can have either gills (and therefore more dependent on the presence of well-oxygenated water) or primitive lungs (and therefore are "air breathers" that are more tolerant of drier conditions). Gilled snails can be identified by the presence of an operculum (somewhat hardened plate) that closes off the opening of the snail's shell, and generally the shells are "right-handed", i.e., the opening is on the right when held facing you and the point of the shell is up. Lunged snails will never have an operculum and they are generally "left-handed".

Perennial	Gilled or lunged snails (with operculum, right handed shell) may be present.
Intermittent	Lunged aquatic (no operculum, left handed shell) may be present; gilled snails rare.
Channeled ephemeral	No aquatic snails are observed. Terrestrial snails may be present.
Ephemeral	No aquatic snails are observed. Terrestrial snails may be present.

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. In small streams, the majority of species usually inhabit pools and runs. Fish should be easily observed within a minute or two. 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, though fish may occupy residual pools in intermittent streams as well.

Perennial	An abundant or diverse assemblage indicates perennial channel. May be present in low numbers or absent in areas with poor water quality or following extended droughts.
Intermittent	Fish may be present, but typically in low abundance and restricted to residual pools. Abundance may increase seasonally, particularly during spawning season or during extended wet periods. Fish may be absent.
Channeled ephemeral	No fish are observed.
Ephemeral	No fish are observed.

Amphibians: Amphibians such as salamanders, frogs, and toads require water, or at least moist conditions, for egg laying and larval development. Many salamander species' immature, gilled larvae require aquatic environments until they transform to adults. All frogs and toads lay their eggs in fresh water and tadpoles (the larval form of toads and frogs) require water for development. Older (>1 year old) salamander larvae can be a very good indicator of relatively permanent waters. Abundance of one species (Southern Two-Lined Salamanders, *Eurycea cirrigera*) is positively correlated with watershed area in headwater streams, and the presence of >1 year-old larvae is an indicator of perennial water (Johnson et al. 2009). Johnson et al. (2009) did not find any larval salamanders in any ephemeral streams, suggesting that their presence, regardless of age, suggests at least intermittent flow. The tadpoles of many species of frogs and toads require 2-3 months before final metamorphosis to adult occurs. However, the very large tadpoles of the American Bullfrog (*Lithobates catesbeianus*), and require a year or more before metamorphosis to adults. When large specimens of these species are found, it is a strong indicator of the presence of water over several seasons. Seasonality may have to be considered when assessing this indicator. Many tadpoles develop from egg to adult over the summer, suggesting that their presence during this time of year is a strong indicator of perennial flow, as this is usually the driest portion of the year.

Perennial	An abundant or diverse assemblage indicates perennial channel. May be present in low numbers or absent in areas with poor water quality or following extended droughts.
Intermittent	A few adult amphibians may be present; no gilled larval forms
Channeled ephemeral	No amphibians are present
Ephemeral	No amphibians are present

Reference: Johnson, Brent R., K.M. Fritz, K.A. Blocksam, D.M. Walters. 2009. Larval salamanders and channel geomorphology are indicators of hydrologic permanence in forested headwater streams. Ecological Indicators. 9 (2009) 150-159.

Birds: Some bird species are strongly associated with perennial waters. Presence of Acadian Flycatcher, Louisiana Waterthrush, or Willow Flycatcher indicates perennial waters nearby.

Perennial	Presence of Acadian Flycatcher, Louisiana Waterthrush, or Willow Flycatcher indicates perennial waters nearby. May be absent where terrestrial habitat is unsuitable.
Intermittent	Acadian Flycatcher, Louisiana Waterthrush, or Willow Flycatcher absent.
Channeled ephemeral	Acadian Flycatcher, Louisiana Waterthrush, or Willow Flycatcher absent.
Ephemeral	Acadian Flycatcher, Louisiana Waterthrush, or Willow Flycatcher absent.

Appendix C: Common Biological Indicators of Channel Type

Taxonomic Guide to Perennial Streams

Common aquatic macroinvertebrates that indicate perennial streams:

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

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

Source: NC Division of Water Quality. 2010. Methodology for Identification of Intermittent and Perennial Streams and their Origins, Version 4.11. North Carolina Department of Environment and Natural Resources, Division of Water Quality. Raleigh, NC.

Stonefly and Dragonfly

*Examples of macroinvertebrates commonly associated with **Perennial** Streams*

Gomphidae, dragonfly	Gomphidae, dragonfly
	

Perlidae, stonefly	Perlidae, stonefly
	

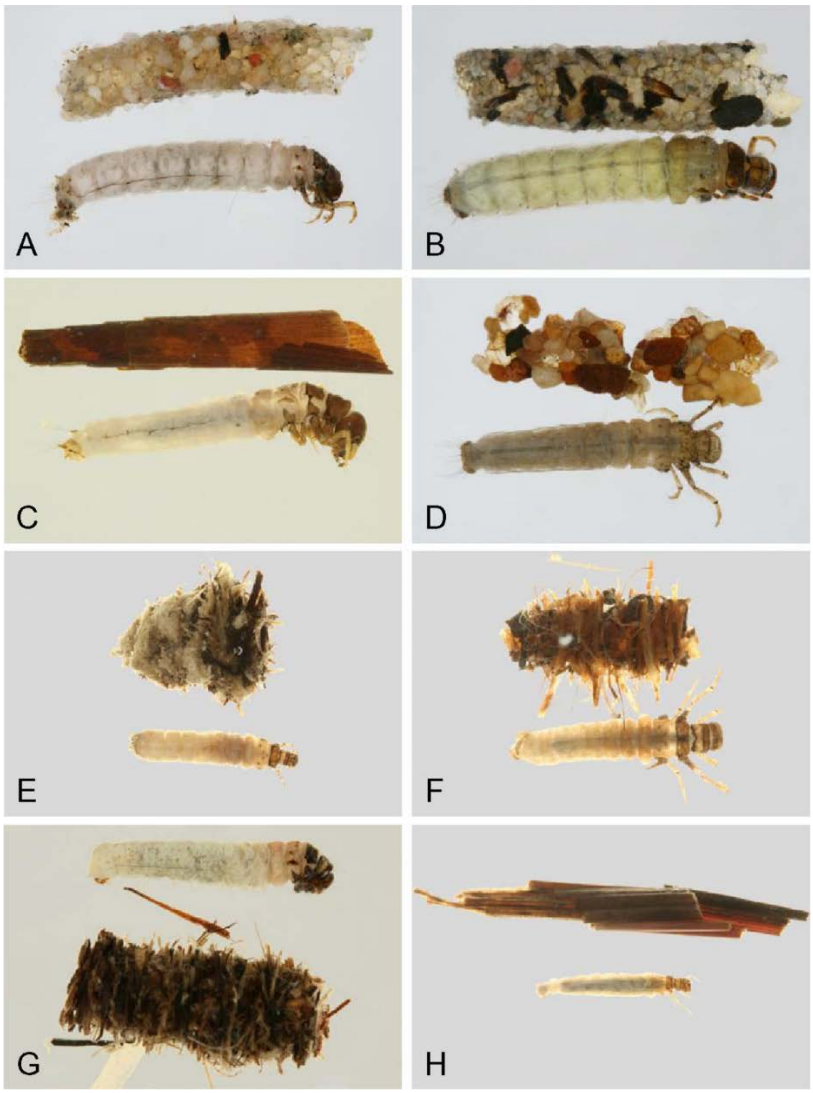
Pteronarcyidae, stonefly	Pteronarcyidae, stonefly
	

Heptagenia, mayfly *Baetidae, mayfly*

Note: Baetids can also be found in intermittent streams due to 1 year life cycle.

Photo credits: https://aquaticinsectsofcentralvirginia.blogspot.com/

Trichoptera - Caddisfly



http://media.springernature.com/full/springer-static/image/art%3A10.1186%2F1472-6785-13-5/MediaObjects/12898_2012_Article_240_Fig22_HTML.jpg

Snails

Gilled snails are indictors of **perennial** streams, lunged snails are not.

Gastropoda, Gilled snails	Gastropoda, Lunged snails
	
Shell opening generally to right Operculum covers shell opening	Shell opening generally to left in spiral shell forms No operculum

Drawings from: http://www.vasos.org/wp-content/uploads/ModifiedBugIDCardoct2004.pdf

Frogs

Bullfrog tadpoles

Large bullfrog tadpoles are indicators of **perennial** streams.

Salamanders

*Common salamanders associated with **perennial** streams:*

Adult Salamanders

Spring Salamander, *Gyrinophilus porphyriticus*	Spring Salamander, *Gyrinophilus porphyriticus*
	
Southern Two-lined Salamander, *Eurycea cirrigera*	Northern Two-lined Salamander, *Eurycea bislineata*
	
Seal Salamander, *Desmognathus monticola*	Blackbelly Salamander, *Desmognathus quadramaculatus*
	

Photo credits:
http://www.virginiaherpetologicalsociety.com/amphibians/salamanders/salamanders_of_virginia.htm

Larval Salamanders

Larval forms of salamanders (**note external gills in front of legs**) are indicators of **perennial** streams:

Larval Spring Salamader (left) and Two-lined Salamander (right)


Larval Spring Salamander	Larval Two-lined Salamander
	

Photo credits:
http://www.ohio.edu/people/brune/ohio-16/ohio-16.html

Crayfish

Crayfish are indicators of **perennial or intermittent** channels when directly observed within a stream or evidence of crayfish are observed adjacent to the stream channel.

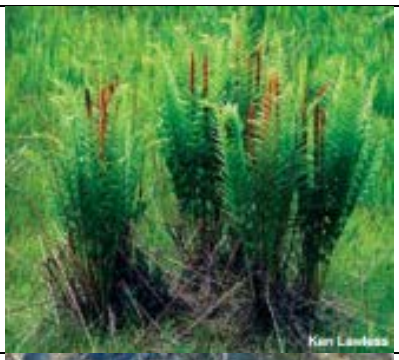
Crayfish chimneys are constructed in order to reach the water table in times of drought or when a streams channel has dried. Chimneys are also common in seep wetlands and isolated areas of moist soil. When observing crayfish chimneys look closely at the excavated soil as this is a key indicator of soil horizons below, often a depleted or gleyed matrix is observed.

Note: Not all crayfish species burrow and some species are only burrowers such as the Blue Crayfish found in the mountains of Virginia and West Virginia.

Crayfish Burrow	***Cambarus monongalensis***
	
Crayfish burrow showing distinct "chimney" from soil excavation.	*Cambarus monongalensis a burrowing species found in mountainous area in VA, WV, and PA.*
Appalachian Crayfish (*Cambarus bartonii*)	**Rock Crayfish (*Cambarus carinirostris*)**
	
*Mature Appalachian Crayfish commonly found within **perennial** streams.*	*Rock crayfish, secondary burrower found in cool streams and pools fed by **springs or non-permanent waters**.*

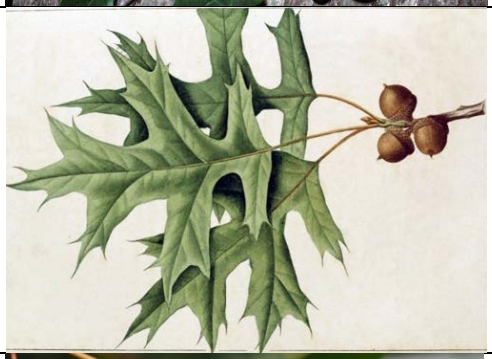
Obligate/Facultative Wetland Vegetation Guide

In **intermittent** streams, obligate (OBL) or facultative wetland (FACW) plants may be present along the stream banks or riparian area, particularly in low gradient reaches. In **perennial** streams, obligate or facultative wetland plants may be present along the stream banks or riparian area, or submerged aquatic vegetation may be present within the water feature, particularly in low gradient reaches. The ability to identify these plants may assist in channel classification.

Common Name (Species):	**Wetland Indicator Status:**	**Image:**
Cinnamon Fern (*Osmunda cinnamomea*)	FACW	
Fontinalis (*Fontinalis antipyretica*)	OBL, flowing water	
Sensitive Fern (*Onoclea sensibilis*)	FACW	
Cardinal Flower (*Lobelia cardinalis*)	FACW+	

Jewelweed, (*Impatiens capensis*)	FACW	
Sedges (*Carex spp.*) (Species vary)	FACW-OBL	
Rushes (*Scirpus cyperinus*) (*Scirpus Validus*) (*Eleocharis spp.*) (*Juncus effuses*)	FACW-OBL	
Sphagnum Moss (*Sphagnum L.*)	FACW-OBL	
Rhododendron, maximum	FAC	

Spicebush (*Lindera benzoin*)	FACW-FAC	 *Photo by: Nonenmac*
Common Greenbriar (*Smilax rotundifolia*)	FAC	
Smooth Alder (*Alnus serrulata*)	OBL	
Black Willow (*Salix nigra*)	FACW	 *Photo: S.B. Johnny*

Red Maple (*Acer rubrum*)	FAC	
Sycamore (*Platanus occidentalis*)	FAC-FACW	
Swamp white oak (*Quercus bicolor*)	FACW+	
Pin Oak (*Quercus palustris*)	FACW	
Black Gum (*Nyssa sylvatica*)	FAC	 *Photo: David Stang*

Green Ash (*Fraxinus pennsylvanica*)	FACW	

Photo Credit: https://plants.usda.gov/core/wetlandSearch

Information gathered from: Piedmont Environmental Council's "Common Wetland Plants of Northern Virginia's Piedmont: A Field Guide" https://www.pecva.org/library/documents/Resources-Publications/Publications/Plant-Wildlife/WetlandPlantGuide.pdf

Birds

*Woodland birds associated with **perennial** streams.*

Species:	Image:	Call:
Acadian Flycatcher: • Small flycatcher • Prominent eyering & wingbars • Greenish colored back		"Peet-Sah" Or "Flee-Sick" Calls can be found at: https://www.allaboutbirds.org/guide/Acadian_Flycatcher/sounds
Louisiana Waterthrush: • Small songbird • Brown back • White underside with dark stripes • White eyestripe • Constantly bobs its tail.		"Clear whistled notes followed by a complex jumble of short, rapid phrases. Sharp metallic "chip" Calls can be found at: https://www.allaboutbirds.org/guide/Louisiana_Waterthrush/sounds
Willow Flycatcher: • Brownish olive overall, with a slight yellow wash to the belly. • 2 whitish wingbars and a white throat that contrasts with the brownish olive breast. • White eyering is very and nearly absent.		Call with a soft dry "whit" Calls can be found at: https://www.allaboutbirds.org/guide/Willow_Flycatcher/sounds

All images and information collected from: https://www.allaboutbirds.org/guide/search