



## **Determinations of Water Bodies with Perennial Flow**

### **Guidance on the Chesapeake Bay Preservation Area Designation and Management Regulations**

*September 2003; Revised December 10, 2007 and June 21, 2010*

#### **Purpose:**

This document provides guidance on requirements of the Chesapeake Bay Preservation Area Designation and Management Regulations (Regulations) for determining the extent of Resource Protection Areas (RPAs) based on the presence of water bodies with perennial flow. The purpose is to provide methods for evaluating stream flow that may be used for determining whether a stream is perennial. It provides guidance as to whether such methods can be used for generally determining the extent of RPA boundaries pursuant to 9 VAC 10-20-80 D, or as a site-specific determination pursuant to 9 VAC 10-20-105, or both.

The methods presented in this guidance reflect various options that are approved by the Division of Chesapeake Bay Local Assistance (DCBLA). DCBLA recognizes that other valid methods may exist for making determinations of stream flow. Local governments wishing to use methods other than those presented herein should consult with the Department and obtain the Department's review and approval of alternate methods. Alternative methods used to make site-specific perennial stream flow determinations must be scientifically defensible. The purpose of the site-specific determination is to accurately determine whether there is perennial flow present and, in some cases, the location of the boundary between perennial and intermittent or ephemeral flows.

#### **Regulations:**

The Regulations require counties, cities, and towns in Tidewater, Virginia, to determine the extent of the Chesapeake Bay Preservation Areas (CBPA) within their jurisdictions. The RPA component of the CBPA is comprised "of lands adjacent to water bodies with perennial flow that have an intrinsic water quality value due to the ecological and biological processes they perform or are sensitive to impacts, which may result in significant degradation to the quality of state waters" (9 VAC 10-20-80 A). Only certain activities are permitted within designated RPAs, and encroachments within these areas must comply with specified performance standards. Included among several specified RPA features are nontidal wetlands connected by surface flow and contiguous to water bodies with perennial flow and a 100-foot buffer located along both sides of such water bodies or landward of any other RPA land feature. Thus, the presence or absence of water bodies with perennial flow is key to the designation of RPAs.

The designation and delineation of RPAs is a two-stage process under the Regulations. The first stage requires that localities provide a map depicting the general location of Chesapeake Bay Preservation Areas, including RPAs. The second stage requires a site-specific determination of the actual RPA boundaries at the time site plans are developed. The Regulations allow the use of the USGS maps to generally depict where perennial streams occur. If the USGS map indicates an entire stream on a site is perennial and the owner/developer of the subject property agrees the stream is perennial, then the USGS map could be used as the basis for RPA designation on a plan of development (POD) for the site, and no further determination of perennial flow would be necessary.

However, there may be sites where only part of a stream on a property is depicted as perennial on the USGS map, and a site-specific evaluation would be appropriate to determine the extent of perennial flow.

The determination of perennial flow does not constitute the final determination of RPA boundaries, given that this determination would not necessarily show RPA features such as nontidal wetlands contiguous and connected to other RPA features. Therefore, a site-specific determination of the extent of the RPA would still be required through the plan-of-development process when the proposed development activity would occur in close proximity to a water body with perennial flow or mapped RPA. The Regulations do not preclude localities or property owners from conducting site-specific evaluations prior to the plan-of-development process or prior to the preparation of a Water Quality Impact Assessment (WQIA). Further guidance regarding mapping-related matters is available in the document entitled *Administrative Procedures for the Designation and Refinement of Chesapeake Bay Preservation Area Boundaries*.

- For the purpose of generally determining whether water bodies have perennial flow, Section 9VAC 10-20-80 D of the Regulations allows local governments to use “one of the following methods, as long as the methodology is adopted into the local program and applied consistently: (i) designation of water bodies depicted as perennial on the most recent U.S. Geological Survey 7½ minute topographic quadrangle map (scale 1:24,000); or (ii) use of a scientifically valid system of in-field indicators of perennial flow. However, site-specific determinations shall be made or confirmed by the local government pursuant to 9 VAC 10-20-105.”
- Section 9 VAC 10-20-105 of the Regulations requires local governments (as part of their plan-of-development review process pursuant to 9 VAC 10-20-231 1 e or during their review of a water quality impact assessment pursuant to 9VAC 10-20-130 6) to ensure or confirm that “(i) a reliable site-specific evaluation is conducted to determine whether water bodies on or adjacent to the development site have perennial flow, and (ii) Resource Protection Area boundaries are adjusted, as necessary, on the site, based on this evaluation of the site. Local governments may accomplish this by either conducting the site evaluations themselves or requiring the person applying to use or develop the site to conduct the evaluation and submit the required information for review.”

### **Definition**

The Chesapeake Bay Preservation Area Designation and Management Regulations do not include a definition for the term “water body with perennial flow”. However, for the purposes of this document (as adapted in part from program guidance offered by Fairfax County), the term has the following meaning.

***Water Body with Perennial Flow:*** *A body of water that flows in a natural or man-made channel year-round during a year of normal precipitation. This includes, but is not limited to streams, estuaries, and tidal embayments and may include drainage ditches or channels constructed in wetlands or from former natural drainageways, which convey perennial flow. Lakes and ponds, with perennial streams flowing into, out of, or through them, are a part of the perennial stream. Generally, the water table is located above the streambed for most of the year and groundwater is the primary source for stream flow.*

## **Mapping and Regulation of Ditches as RPAs**

The Resource Protection Area includes drainage ditches or channels constructed in wetlands or from former natural drainageways, which convey perennial flow. Ditches are constructed for many purposes and occur in many different settings, including agricultural ditches, roadside ditches, ditches constructed for purposes of flood control or as part of a stormwater management BMP, and ditches constructed specifically for purposes of draining wetlands (i.e., Tulloch ditches). The following provides guidance on how ditches in these four settings should be regulated.

Section 9 VAC 10-20-150.B.1 exempts the “. . . construction, installation, operation, and maintenance of . . . public roads, and their appurtenant structures . . .” from compliance with the Regulations as long as review of the facilities are in accordance with the ESC law, the SWM law, a ESC plan and SWM plan approved by DCR or local water quality criteria at least as stringent as the above state requirements. A roadside ditch, within the right-of-way of a public road that is exempted as noted above, is considered to be an appurtenant structure and, therefore, maintenance of the roadside ditch is also exempted from the Regulations. A buffer is not required for such ditches. *This provision was not changed by the 2002 amendments of the Regulations.*

Section 9 VAC 10-20-130.5.b(3) addresses agricultural drainage ditches, which may be water bodies with perennial flow, but which are not required to have the buffer requirements applied if “. . . at least one best management practice which, in the opinion of the local Soil and Water Conservation District Board, addresses the more predominant water quality issue on the adjacent land . . .” Necessary maintenance of such ditches can also be performed. Therefore, when the above conditions are met, no buffer is required. *This provision was not changed by the 2002 amendments of the Regulations.*

9 VAC 10-20-130.1.e allows for flood control and stormwater management BMPs to be placed in the RPA, providing certain conditions are met. This section further allows for maintenance of those structures. Therefore, ditching associated with flood control or BMP construction, as well as the maintenance of such ditches, may be permitted under this provision. A buffer is not required for such ditches.

## **Lakes, Ponds and Other Impoundments as RPAs**

The Resource Protection Area includes ponds, lakes, or other impoundments with perennial streams flowing either into or out of them with exceptions as noted below. Impoundments (lakes and ponds) developed as stormwater management facilities to address stormwater quality and/or quantity requirements may be required to be designated as RPAs. If the size of the impoundment exceeds that which is necessary to provide flood control, stormwater water quality treatment or both, then they should be considered amenities and treated as RPA features. In order for existing stormwater management facilities to be exempted from inclusion as a required RPA feature, they must have been designed and installed in accordance with the locality's standards for stormwater management facilities in effect at the time of plan approval. In order for new stormwater management facilities to be exempt from inclusion as a required RPA feature, they must meet all of the criteria outlined under Section 9 VAC 10-20-130 1 e of the Regulations.

# METHODS FOR DETERMINING PERENNIAL FLOW

## Field Indicator Protocols

The use of field indicator protocols entails the evaluation of observations made of stream geomorphology, hydrology, and biology. DCBLA has reviewed and found three field indicator protocols, field-tested in Virginia and North Carolina, to be acceptable for making site-specific determinations.

The first method was developed by the North Carolina Division of Water Quality (Version 3.1, February 28, 2005) and is the combination of two previous stream classification protocols, one of which was initially developed for making distinctions between intermittent and ephemeral streams, and a version that was later adapted for use in making distinctions between perennial and intermittent streams. Version 3.1 of the North Carolina method reflects five years of additional regulatory and academic experience in both North Carolina and Virginia. The second is a modification of the North Carolina method developed by Fairfax County, Virginia (2003). The Fairfax Method defines procedures for making field determinations between perennial and intermittent streams for the geography of northern Virginia. The third is a modification of the North Carolina method developed by James City County in (March, 2010). The James City County method was developed to create a more accurate and reliable predictor of perennial flow in James City County. This protocol has been tested in James City County as well as York County, City of Williamsburg, Gloucester County, New Kent County and the City of Newport News and found to be an accurate tool for identifying perennial water bodies in all of these specific localities within the upper Coastal Plain. These protocols and data sheets are available through the Department or as downloaded documents from the Internet (see links at [http://www.dcr.virginia.gov/chesapeake\\_bay\\_local\\_assistance/perstream.shtml](http://www.dcr.virginia.gov/chesapeake_bay_local_assistance/perstream.shtml)). Department staff can provide additional information and training regarding these protocols and encourages the review of each individual protocol manual prior to use.

The North Carolina, Fairfax County and James City County protocols, through extensive testing, have recorded a range of scores, representative of the perennial stream transition points. Based upon field-testing of these methods, a stream should be assumed to be perennial if the score equals or exceeds 30 for the North Carolina protocol, 25 for the Fairfax County protocol, or 14 for the James City County protocol. However, field-testing has indicated that perennial streams can have a score as low as 21 for the North Carolina method or 12 for the James City County method. While general consistency of application of the protocol among individuals has been noted, it is recommended that there be field verification for any determination where the score is within 3 points of either 30 for the North Carolina method, or 25 for the Fairfax County method or 2 points of 14 for the James City County method. Field verification procedures might include documentation of other supportive data such as the presence of biological indicators (fish, crayfish, amphibians, mussels or clams, or large, multi-year tadpoles or benthic macroinvertebrates) that require water for entire life cycles. These organisms include, but are not limited to, Ephemeroptera (mayflies), Plecoptera (stoneflies) or Trichoptera (caddisflies). Field verification procedures might also include revisiting the site when low flow is expected in the summer or early fall months.

Due to expected geologic and physiographic differences, the average scoring threshold representing the breakpoint between perennial and intermittent stream reaches or perennial and ephemeral stream reaches may be different from that developed for the North Carolina and Fairfax County protocols by as much as 8 to 10 points. For the James City County protocol, the differences may be between

2 to 4 points. For this reason, localities are encouraged to test the protocol to refine the scoring and thresholds for determining perenniality in their jurisdictions or regions. As noted above, where a score is within 2 to 3 points of an established threshold score depending on the protocol used, closer field verification should be conducted. Any modifications in the protocols or threshold numbers should be reviewed and approved by the Department. If modifications are made, the locality should provide supporting documentation to demonstrate why such modifications are warranted.

These methods are applicable for use as “a reliable, site-specific evaluation” pursuant to 9 VAC 10-20-105 or, if such methods are used to evaluate all streams within a jurisdiction, it could form the basis for designation of RPAs pursuant to 9 VAC 10-20-80 (D)(ii). The James City County protocol is also applicable for evaluation pursuant to 9 VAC 10-20-105, but only for the localities listed above.

### **Ground Water Monitoring**

The base flow of a stream is that portion of flow supported by groundwater seepage into a channel that is not attributable to storm runoff. The water table of perennial streams is generally located above the streambed for most of the year. The water table of intermittent streams may fluctuate above and below the streambed depending on the time of year.

Therefore, another method for determining the flow conditions of a stream includes monitoring of groundwater elevations relative to streambed. This information should be evaluated in the context of recent and seasonal climatic data (i.e., normal/wet/dry season or year). When using this method it is particularly important to conduct the investigation during the drier months of the year.

Piezometers and monitoring wells can be used to determine the depth of shallow water tables, and are well suited for the purposes of determining groundwater table elevations relative to streambed elevations. The soil profile should be evaluated to determine whether to install either groundwater monitoring wells or piezometers and to determine the elevation/depth of the screen and the design of the screen and backfill or sand pack.

For the purposes of determining groundwater table elevations in the vicinity of stream channels, piezometers should be placed proximate to the stream channel (at a minimum 3 feet away from the channel and at a maximum 10 feet from the channel). The location of the piezometer should be at a relatively low point within the riparian zone not in higher topographic relief that might occur along the channel. The objective is to intercept the most likely pathway of groundwater migration. Elevations of the streambed and piezometers should be surveyed in to the nearest tenth of a foot. Only survey grade GPS systems or land survey equipment will provide this level of accuracy. Guidance about construction and installation of shallow monitoring wells and shallow piezometers is available through the Department. U.S. Army Corps of Engineers’ document “Installing Monitoring Wells/Piezometers in Wetlands” (WRP Technical Note HY-IA-3.1, August 1993) is a good guide to installing shallow piezometers. The depth of the piezometer should not exceed 3 feet below the elevation of the streambed elevation. At least two piezometers should be installed along the subject watercourse. The total number and spacing of piezometers along a watercourse will depend on the stream length in question and the desire for more or less precision in determining the point at which a stream transitions from perennial to intermittent.

Piezometers should be monitored at periodic intervals particularly during the drier months, when the



presence or absence of persistent flow will become a more determining factor. Caution should be exercised in evaluating results if monitoring occurs within 48 hours of a rainfall event. However, monitoring soon after a rainfall, particularly when the channel exhibits dry conditions, may present compelling evidence that the stream does not convey perennial flow, provided that this does not occur during drought conditions. Regardless, it is important to interpret the data in the context of meteorological conditions and trends.

The depth of groundwater in each piezometer should be measured with an electric water level indicator or weighted tape. The depth of groundwater below ground surface should be recorded and compared to the surveyed elevation of the streambed.

In interpreting the results, several factors should be considered particularly where differentially permeable soil strata are present. For example, a deep well that traverses several horizons might miss a perched water table. Special note should be made when installing the piezometer where obvious signs of a perched water table might be present. If there is some reason to believe that an adjacent wetland provides a sustaining source of water to the stream, care should be taken not to bypass the ground water data of the perched wetland. For soils with uniform permeability this should not be a concern. The field observations and recorded data should be correlated to recent, seasonal and yearly precipitation data. The recorded data would be most reliable during periods of normal precipitation. The recorded data will be less reliable in periods of precipitation extremes (extremely wet or extremely dry years). Although, water table data and stream flow observations in dry or drought conditions would provide compelling evidence of perennial flow and conversely, data and observations indicating no flow during periods of higher than normal precipitation would provide compelling evidence that a stream is intermittent. When it is determined that a stream is not perennial based upon data from a particular piezometer, it should be assumed that the channel upstream of this point is intermittent or ephemeral and additional in-field surveys are not required upstream.

This method is applicable for use as “a reliable, site-specific evaluation” pursuant to 9 VAC 10-20-105. If this method were used to evaluate all streams within a jurisdiction, this method can be used as the basis of definitive mapping of RPAs pursuant to 9 VAC 10-20-80 D. In the latter case, this might only be practical for localities where there are few and/or short stream reaches.

### **Surface Water Monitoring**

Stream flow can also be determined by monitoring surface water where an existing weir or flume is in place or can be installed and measured at intervals for a period of time, particularly during the low flow season. The calculated discharge (using various weir equations) should be provided for the monitoring events and corroborated with recent and seasonal climatic (precipitation) data and photographs of the stream and impounding structure. It is important to periodically inspect the structure for leaks and/or undercutting, which could affect monitoring results.

When it is determined that a stream is not perennial based upon data from a particular weir, it should be assumed that the channel upstream of this point is intermittent or ephemeral. Flow meters are not an acceptable method for purposes of determining the uppermost extent of perennial flow because of insufficient depths of water during low flow conditions. Collapsible flumes are generally unacceptable due to problems with installing them and imprecision when not properly installed.

This method is applicable for use as “a reliable, site-specific evaluation” pursuant to 9 VAC 10-20-105. If this method were used to evaluate all streams within a jurisdiction, this method could be used as the basis of definitive mapping of RPAs pursuant to 9 VAC 10-20-80 D. In the latter case, this might only be practical for localities where there are few and/or short stream reaches.

### **Drainage Area Based on Sampling**

Using a threshold watershed size for generally determining the upstream extent of streams subject to RPA designation is acceptable provided that the approach is based upon a statistically valid random sampling of stream flow in a particular watershed. Using this threshold watershed size would also be acceptable in adjacent or nearby watersheds that share similar geologic and watershed characteristics. While using such a method is acceptable for generally mapping the upstream extent of RPA streams, it should be understood that such a method would not definitively determine the precise beginning of perennial flow. It is likely that this method would include some intermittent stream sections and exclude some perennial stream sections. While it is recognized that this does not offer absolute precision in all circumstances, the differences are expected to be minimal and the occurrences few. This method would provide for ease of use, predictability, and consistency in application and, to some extent, less cost for localities.

Data used for establishing watershed thresholds should be based upon stream data collected using an acceptable field indicator protocol (i.e., NC Protocol, Fairfax County Protocol) or based upon actual stream flow monitoring data in the local watershed. At least one watershed per physiographic region should be selected to represent other watersheds within the local jurisdiction. The subwatershed study area should be 5 square miles or greater in size or to the lower end of a fourth order stream (order based upon USGS map). This data set should yield at least 20 break points (transition points from intermittent to perennial or ephemeral to perennial). The median drainage area of this dataset (the drainage area of approximately 20 or more breakpoints where the streams become perennial) should be selected as the threshold watershed size. At least 20% of these streams should be resurveyed during drought conditions or the extreme low flow period of the year in order to validate the dataset and the threshold watershed size. In addition, this data should be evaluated in the context of seasonal climatic conditions and whether conditions represent normal, wet or dry years. For example, if stream flow monitoring data were collected in an extremely dry year, the threshold drainage area would tend to be larger than for a normal precipitation year, because the point where a stream flow becomes perennial would be further downstream. And conversely, the drainage area would be smaller in wetter years.

This method is applicable for use in determining the upstream extent of water bodies with perennial flow pursuant to 9 VAC 10-20-80 D in jurisdictions where a subwatershed(s) study has been conducted. It should be a reasonably accurate representation of the drainage area of the upper extent of perennial streams within the same physiographic region of adjacent or nearby jurisdictions. However, it is recommended that localities require a site-specific survey be performed as part of the site development process to determine the true extent of water bodies with perennial flow.

### **Documented Observation**

Photographs of stream flow conditions should always be taken when making a determination of whether a stream conveys perennial or intermittent flow. The use of photo-documentation of stream flow conditions as the only means of making a stream flow determination may be appropriate in certain circumstances. For example, photographs documenting dry channel conditions during the

wetter seasons of the year or in some cases following a rainfall event in a normal rainfall year may be sufficient to document intermittent or ephemeral flow conditions. Conversely, photographs of wet channel conditions during drier seasons of the year or during periods of drought would strongly indicate perennial flow conditions. However, if photo-documentation alone is used for purposes of documenting stream flow or lack of stream flow, it should always be corroborated with precipitation data (see discussion of climate data on page 8), which documents climatic conditions at the time the photograph was taken. Photographs should not be taken within two (or preferably three) days following a substantial rainfall. An exception to this might be if the channel is dry following a substantial rainfall event in a normal precipitation year. Documented observations of no flow when the Palmer Drought Severity Index indicates a condition wetter than a classification of -2.0 (moderate drought), unless local government approved rainfall data indicates wetter conditions, should be considered definitive confirmation that the stream is not perennial.

Photographs used for purposes of documenting stream flow must have a visible date stamp or certification (by landowner/applicant or his/her designated representative) of the date the photograph(s) were taken. The date stamp feature is available with most digital cameras and some battery-operated cameras. Care should be taken to obtain photographs that are close enough to see the channel characteristics (i.e., banks, substrate) and that are unobstructed by vegetation (vegetation may need to be clipped to obtain a clear view). Photographs of the channel should include identifiable stationary landmarks in the field, so that the point of observation can be later verified, if necessary. Identifiable landmarks might include survey flagging (marked with some identification) or structural objects (i.e., culverts, bridges, nearby buildings, unique natural features, etc.).

The location and view direction of the photographs should be marked on a map or plat. A minimum of two photographs should be provided (upstream and downstream view). However, stream segments greater than 200 feet in length should include additional photographs (upstream/downstream views for each 200-foot length segment).

This method is applicable for use as a “reliable site-specific evaluation” pursuant to 9 VAC 10-20-105. If this method were used to evaluate all streams within a jurisdiction, this method can be used as the basis of definitive mapping of RPAs pursuant to 9 VAC 10-20-80 D.

### **Additional Corroborative Information**

Regardless of which method is used for determining stream flow, the determination should always be made in the context of the current weather conditions and precipitation trends. Other information may be useful as well, but should be used cautiously depending on the source(s).

Stream flow determinations should be made at least 48 hours after the last known rainfall. This will ensure that observations are made of conditions more representative of base flow conditions that are not influenced by recent precipitation events. However, monitoring soon after a rainfall, particularly when the channel exhibits dry conditions, may present compelling evidence that the stream does not convey perennial flow, provided that this does not occur during extreme drought conditions. The occurrence of recent precipitation events prior to site investigation should be taken into consideration (i.e., the amount of rainfall, the number of days lapsed since the last precipitation event occurred). The month-to-date and year-to-date precipitation data is helpful in evaluating whether the conditions at the time of observation are above, below, or near normal for the season or year. This information is readily available from a variety of sources including the National Weather Service websites, the



Nation Climatic Data Center, the Virginia Climatology Office, and daily newspapers. Similarly, the lack of rainfall should be noted both for recent conditions and over the previous year or more. Because the underlying soils and geology are, in a sense, the reservoirs of ground water that is slowly released to streams, a sense of whether these reserves are expected to be normal or are experiencing a deficit is valuable in putting the current conditions in context. The following sources of data should be consulted for recent and longer-range climatic data:

- Dulles airport <http://weather.noaa.gov/weather/current/KIAD.html>
- Reagan National Airport <http://weather.noaa.gov/weather/current/KDCA.html>
- Virginia State Climatology Office <http://climate.virginia.edu/>
- Virginia DEQ Drought Monitor: <http://www.deq.state.va.us/waterresources/drought.php>
- U.S. Drought Monitor <http://www.drought.unl.edu/dm/index.html>
- The National Weather Service <http://www.weather.gov>

Evaluating field observations in the context of prevailing weather conditions and trends requires a basic understanding of the terms “normal precipitation” and “drought”. Normal precipitation is typically considered to be a 30-year mean. Prevailing climate conditions of the preceding two to three months as well as the preceding 12 months should be compared to the normal precipitation for the corresponding periods of time over the period of record. Deviations exceeding 20% normal precipitation should be considered noteworthy. Of the various measures of drought that have been developed, the most frequently used indicators are those developed by Wayne Palmer in the 1960s. Palmer defined drought as a prolonged and abnormal moisture deficiency. The Palmer Drought Severity Index (PDSI), standardized to local climates, is a tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. It takes into account several factors including precipitation totals, temperature, evapotranspiration, soil runoff and soil recharge. The PDSI varies between -6.0 and +6.0 and from these values, 11 categories of wet and dry conditions have been defined and are shown in the table below. Conditions drier than a Palmer Classification of -2.0 (moderate drought) or wetter than 2.0 (moderately wet) should be considered particularly noteworthy in evaluating stream data in the context of prevailing climate conditions.

### **Palmer Classifications**

4.0 or more	extremely wet
3.0 to 3.99	very wet
2.0 to 2.99	moderately wet
1.0 to 1.99	slightly wet
0.5 to 0.99	incipient wet spell
0.49 to -0.49	near normal
-0.5 to -0.99	incipient dry spell
-1.0 to -1.99	mild drought
-2.0 to -2.99	moderate drought
-3.0 to -3.99	severe drought
-4.0 or less	extreme drought

Discussions with long-term residents and local professionals (hydrologists, VDOT staff, county extension agents, NRCS technicians, surveyors, foresters, field engineers) may reveal further information about the permanence of flow in a particular stream channel. However, caution should be exercised with respect to the reliability of anecdotal information. This information is strictly supplemental and final stream determinations should not rely solely on anecdotal information.

### **Expertise Required for Making Determinations**

Professional disciplines required for making field determinations of stream perenniality may vary depending on the protocol or method used. Those using an ecologically based method should have an educational background, training and experience in stream ecology or the appropriate training and experience in the particular protocol employed. Experience and training in civil engineering, particularly river mechanics or hydrology/hydraulics is more applicable for techniques that employ the measurement and calculation of surface water flow through a weir or flume. Persons holding professional geologist (P.G.) certifications or those with considerable experience and training in hydrogeology would be more knowledgeable or better trained in using groundwater-monitoring techniques. No particular experience is required for people who use simple photographic documentation corroborated with meteorological data.