pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Clean Water

Chapter 102 Erosion Potential Analysis

Frequently Asked Questions (FAQ)
Revised, March 6, 2025
Version 1.2

Background

Any person conducting or proposing to conduct an earth disturbance activity must design, implement and maintain erosion and sediment control (E&S) best management practices (BMPs) to minimize the potential for accelerated erosion and sedimentation during construction (see 25 Pa. Code § 102.11(a)). After earth disturbance is complete, the site must be permanently stabilized and protected from accelerated erosion and sedimentation (see 25 Pa. Code § 102.22(a)). When stormwater runoff concentrates and forms channelized flow, the runoff can cause accelerated erosion unless the channel or other conveyance is adequately stabilized. Channelized or concentrated flow frequently occurs below the outlets or overflows of BMPs and post-construction stormwater management (PCSM) stormwater control measures (SCMs) and the use of outlet protection is expected to minimize accelerated erosion.

The Department of Environmental Protection (DEP) requires an "Erosion Potential (EP) Analysis" as a component of applications and Notices of Intent (NOIs) for certain permits under Chapter 102 when the potential for accelerated erosion during or following construction exists. The focus of this analysis is on the anticipated stability of a flow path to resist accelerated erosion and is not related to a stormwater analysis that compares pre- to post-construction conditions for rate, volume, and water quality. The EP Analysis was previously named "Off-Site Discharge Analysis" (and this FAQ was formerly named "Chapter 102 Off-Site Discharges of Stormwater to Non-Surface Waters") but was changed because the analysis is needed for all concentrated flows whether on or off the project site.

The purpose of this document is to clarify DEP's expectations for completing an EP Analysis. Nothing in this document affects regulatory requirements. The interpretations herein are not an adjudication or a regulation. There is no intent on the part of DEP to give the interpretations in this document that weight or deference. This document provides a framework within which DEP and the delegated county conservation districts (CCDs) will exercise administrative discretion in the future. DEP reserves the discretion to deviate from the interpretations in this document if circumstances warrant.

FAQ #1: What is an EP Analysis?

An EP Analysis is a technical evaluation of the stability of a flow path from a discharge point (DP) to a surface water or storm sewer that directly discharges to a surface water. A DP is a location where concentrated flow on a project site originates both during and following earth disturbance activities. Most often a DP will be located at the outlet of an E&S BMP or PCSM stormwater control measure or SCM. Surface waters are defined as perennial and intermittent streams, rivers, lakes, reservoirs, ponds, wetlands, springs, natural seeps, and estuaries, excluding water at facilities approved for wastewater treatment such as wastewater treatment impoundments, cooling water ponds, and constructed wetlands used as part of a wastewater treatment process (25 Pa. Code § 102.1). An EP Analysis should result in a quantitative demonstration that the flow path will be stable (i.e., will not experience accelerated erosion) up to and including the 10-year/24-hour storm event.

FAQ #2: Why was the term "Off-Site Discharge Analysis" replaced with "EP Analysis"?

Accelerated erosion can occur both on and off project sites due to concentrated stormwater flows. The term was changed to reflect that an analysis is needed to demonstrate a stable flow path both within and outside of the project site boundary when concentrated flows originating from the project site are likely. The term "stable" means "non-erosive." It does not mean uniform or laminar flow in a channel as described in Chapter 6 of DEP's Erosion and Sediment Pollution Control Program Manual (363-2134-008; E&S Manual).

FAQ #3: When is an EP Analysis necessary?

DEP has developed a standardized form to document EP Analyses (3800-FM-BCW0271h). The instructions accompanying this form identify the circumstances in which an EP Analysis should be completed.

FAQ #4: What is the difference between a stable flow path and an unstable flow path?

A stable flow path would be expected to remain unchanged and not erode during a 10-year/24-hour storm, while an unstable flow path would be expected to experience erosion during a 10-year/24-hour storm. To determine if an existing flow path will be stable, the calculated velocity or calculated shear stress on the surface of the flow path should be lower than the allowable velocity or allowable shear stress, respectfully, as described in Chapter 6 of the E&S Manual.

FAQ #5: When should the velocity or shear method be used for an EP Analysis?

The velocity method can be used to determine if a flow path will be stable for slopes less than 10%. The shear stress method can be used for all flow paths, regardless of the slope. For the purpose of an EP Analysis, the assumption of ground cover meeting a density of short grass pasture and lawns referenced in the EP Analysis form instructions corresponds to a vegetative cover that provides a permissible velocity of 3.0 feet per second (fps) or an allowable shear stress of 3.33 pounds per square foot (psf).

FAQ #6: My project will discharge post-construction stormwater to an on-site storm sewer that will discharge to a surface water; do I need to complete an EP Analysis?

An EP Analysis is unnecessary for a discharge from a storm sewer that outlets directly to a surface water if the storm sewer provides a stable conveyance to the surface water. However, the applicant has a responsibility to show the ultimate flow path of the storm sewer to a surface water on E&S and/or PCSM Plan Drawings. Arrows highlighting the flow path on a drawing can serve this purpose. Property owner information does not need to be shown on the plan drawings or the EP Analysis form if the discharge is conveyed through a storm sewer system directly to the surface water. If the storm sewer does not discharge directly to a surface water, an EP Analysis and affected property owner information would be necessary for the flow path to the surface water.

FAQ #7: How is an EP Analysis completed?

Use of the EP Analysis form (3800-FM-BCW0271h) is encouraged and may be required if specified in the Chapter 102 permit application or NOI instructions. The designer is expected to conduct a field evaluation of stormwater flow paths once the locations of site features, BMPs, and SCMs are determined and take photographs to document the evaluation. Photographs should be taken perpendicular to the ground surface and clearly portray the current existing conditions. If access to off-site properties is not possible, then verification from drone footage or similar means to obtain this information would need to be provided. Light Detection and Ranging (LIDAR) or other site-specific survey data should be used for gathering topographical data. USGS 7.5-Minute Quadrangle maps are not accurate enough to determine slopes and ground cover features to the degree needed for this analysis, so they are not an acceptable resource. The most important step in the EP Analysis is identifying the critical cross-section of the anticipated flow path, determining the maximum allowable velocity or shear stress at the critical section, and calculating the maximum velocity or shear stress expected at the critical section during the 10-year/24-hour storm event.

EXAMPLE 7.A: A site situated in an average county in PA contains pasture ground cover in good condition and slopes gently from the north to the south.

The soil underlying the site is comprised of Hagerstown silt loam, 3 to 8 percent slopes and is erosion resistant. A proposed rain garden will discharge a peak flow of 22.5 cfs from a 10-year/24-hour storm through the 70-foot wide emergency spillway and across an open field until it reaches the nearest surface water. See **Figure 1**.

The EP Analysis will begin at the discharge point from the basin. By observation, there are two steeper sections of slope with varying widths. The slope alone is not sufficient to accurately predict the critical section so the narrowest flow widths will also need to be checked.

The ground cover and subsoil conditions are consistent so the critical path will be either at the steepest slope (the 12.5% sloped segment 2) or the segment at the narrowest flow width (62 feet at segment 1). The topography of the drainage area as shown in the blue dashed lines was field verified and measured to be approximately 62 feet wide at segment 1 and 82 feet wide at segment 2. The pasture condition observed is shown in the photo above which was taken during the site investigation.

The allowable shear stress method will need to be utilized for segment 2, since its slope is greater than 10%, so the shear stress method will be used to check both segments for consistency. In order to determine the flow depth to compute shear stress, Manning's equation will be employed as follows:

$$Q = \frac{1.486(a)\left(r^{\frac{2}{3}}\right)\left(s^{\frac{1}{2}}\right)}{n}$$

where Q = peak flow rate (cfs)

n = Manning's roughness coefficient (0.24 for meadow)

a = cross-sectional area of flow (ft^2)

r = hyddraulic radius (area/wetted perimeter) (ft)

s = slope (ft/ft)

Segment 1: The measured flow width was found to be approximately 62 feet. The cross-sectional area of the flow (a) equals depth (d) multiplied by flow width (w). Setting w at 62 feet and substituting the flow area [a = (w)(d)] into the equation above results in the expression:

$$Q = \frac{1.486}{n}\ (62\ d)\left(d^{\frac{2}{3}}\right)\left(s^{\frac{1}{2}}\right)$$

where the hydraulic radius (r) = 62d / 62 (assuming planar flow for the wetted perimeter) which results in just d; and solving for d (where d will be an equivalent theoretical depth):

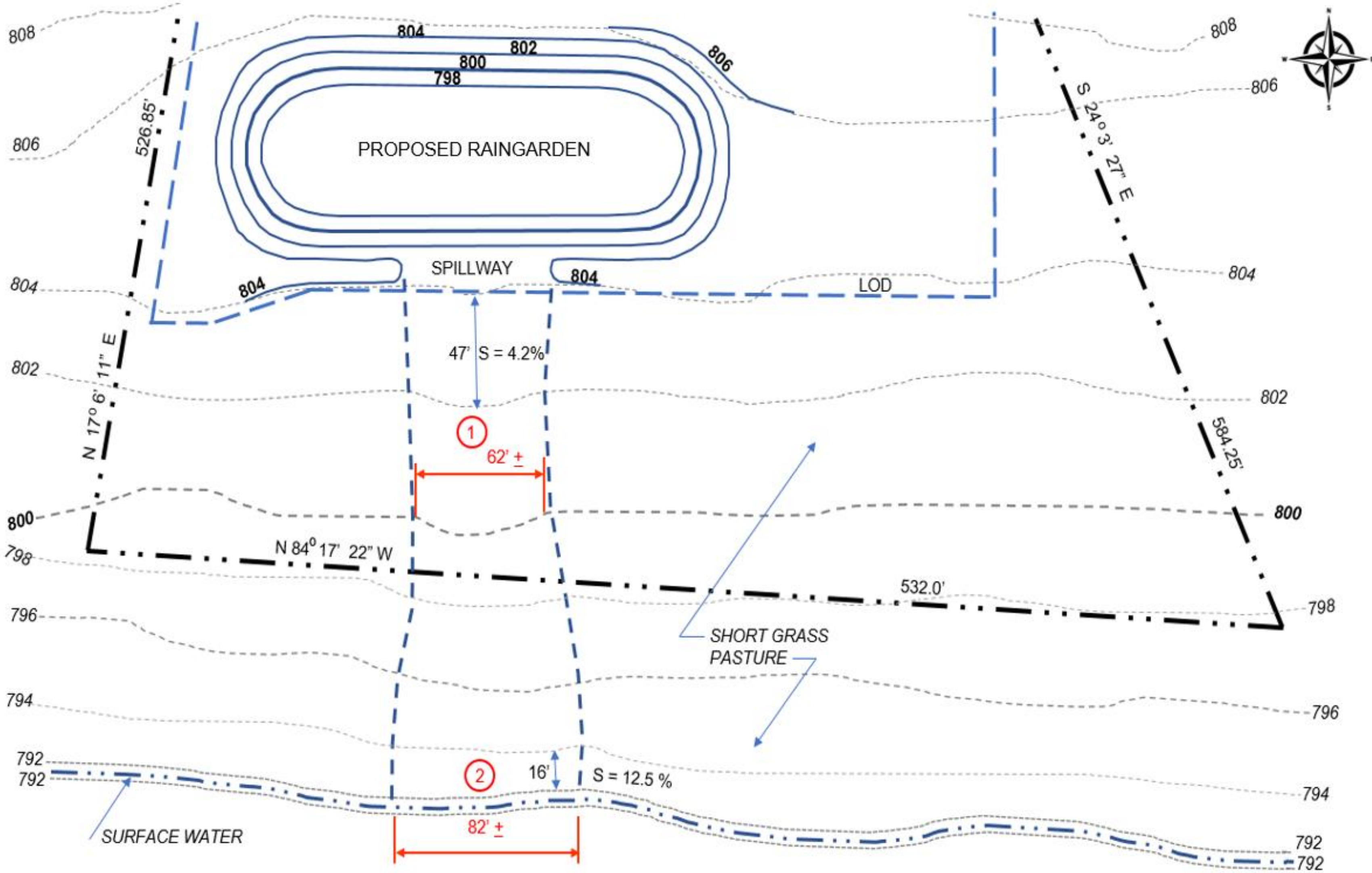
$$d = \left[\frac{Qn}{(62)(1.486)\left(s^{\frac{1}{2}}\right)}\right]^{\frac{3}{5}}$$

$$d = \left[\frac{(22.5)(0.24)}{(62)(1.486)\left(0.042^{\frac{1}{2}}\right)}\right]^{\frac{3}{5}}$$

d = 0.47 foot

The flow depth limit for shallow concentrated flow is 0.5 foot so we can proceed to compute the actual shear stress. If the flow depth had exceeded 0.5 foot, then a redesign would be recommended.

Figure 1: Example 7.A Illustration



Shear stress σ = 62.4 lbs/ft^3 (d) (s)
= 62.4 (0.47)(0.042)
= 1.23 psf

Segment 2: The equivalent flow depth is:

$$d = \left[\frac{(22.5)(0.24)}{(82)(1.486)\left(0.125^{\frac{1}{2}}\right)}\right]^{\frac{3}{5}}$$

d = 0.29 foot

Shear stress σ = 62.4 lbs/ft^3 (d) (s)
= 62.4 (0.29)(0.125)
= 2.24 psf

Segment 2 is the critical section of the flow path since it has the higher shear stress. The allowable shear stress across a pasture with Retardance D can be selected from information found in Chapter 7 (Grassed Waterways) of the USDA NRCS National Engineering Handbook Part 650 (NEH; figures and equations identified below are from this reference). The existing meadow cover was found to be equivalent to a Retardance Class D (see Figure 7-11 of the NEH).

The allowable vegetal stress is $\tau_{va} = 0.75\ C_1$ (see Equation 7-4) and the Retardance Curve Index is C_1 = 4.44 for retardance class D vegetation (see Figure 7-12, shown below).

Figure 7-12: Retardance Curve Index by Retardance Class

SCS retardance class	Retardance curve index, C_1
A	10.0
B	7.64
C	5.60
D	4.44
E	2.88

Therefore, τ_{va} = (0.75)(4.44) = 3.33 psf. The maximum anticipated shear stress (2.24 psf) is less than the allowable (3.33 psf), so the entire flow path should be stable and not erode.

EXAMPLE 7.B: This example uses Figure 1 in Example 7.A above, but only considers the discharge from the spillway and the subsequent flow across Segment 1. This time the flow path will be evaluated using the velocity method. The initial discharge from the rain garden can be determined from the continuity equation (V = Q/A) where the spillway width is 70 feet and the spillway invert is set at elevation 802.5 feet by design to provide a minimum of 1 foot of freeboard. The resultant flow depth is 0.5 foot, so the velocity can be computed as:

$$V = 22.5 \text{ cfs} / (70')(0.5') = 0.64 \text{ fps}$$

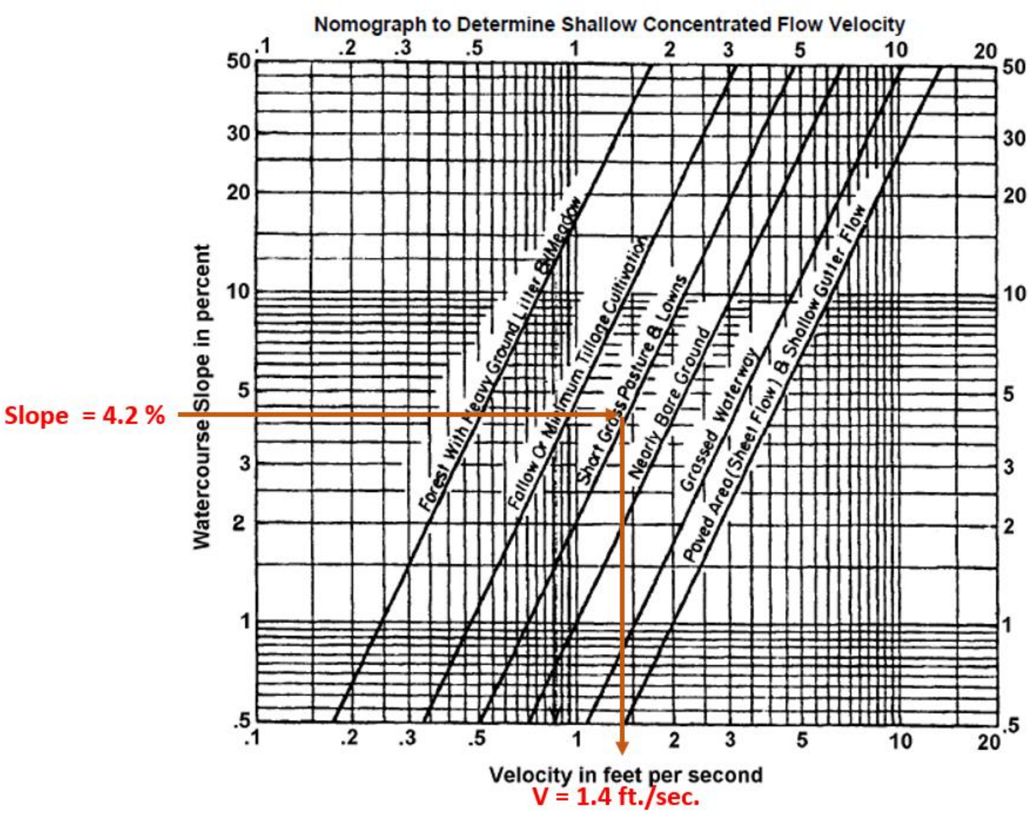
The receiving grass pasture will be able to resist a velocity of approximately 4.5 fps as seen from Table 6.4 in the E&S Manual as shown below.

TABLE 6.4
Maximum Permissible Velocities (ft/sec) for Channels Lined with Vegetation

Cover	Slope Range Percent	Erosion Resistant Soil[1]	Easily Eroded Soil [2]
Bermuda Grass	0 - 5%	6.0 [3]	5.0
Kentucky Bluegrass		5.5 [3]	4.5
Tall Fescue (endophyte-free)		5.5 [3]	4.5
Grass Legume Mixture		4.5	3.5
Bermuda Grass	5-10 %	5.5 [3]	4.5
Kentucky Bluegrass		5.0	4.0
Tall Fescue (endophyte-free)		5.0	4.0
Grass Legume Mixture		3.5	3.0

Modified from USDA-NRCS

The next step will be to evaluate Segment 1 with a 4.2% slope and the same pasture ground cover. Referring to Figure 5.1 from the E&S Manual:



The flow across Segment 1 will produce an approximate velocity of 1.4 fps, which is less than the allowable velocity of 4.5 fps, so the flow path across Segment 1 is expected to remain stable with respect to velocity (as well as shear stress as shown in Example 7.A above).

FAQ #8: I have completed an EP Analysis for a post-construction stormwater discharge that will flow through an off-site property to surface waters. The analysis demonstrated that the flow path will be stable. Is the applicant responsible for anything further?

Persons proposing to discharge stormwater to off-site property they do not own must have the legal authority to discharge either through a common law easement or an express easement. For sites that discharge to existing swales, ditches, storm sewers or similar structures where the new activities will not result in a change in volume or rate of stormwater runoff (for all storm events), the existing common law easement could be relied upon. An express easement may be necessary when there will be a change (increase or decrease) in volume or rate of stormwater (for all storm events). If an express easement is necessary, the easement should be in place before any new or increased stormwater discharges commence.

For the purposes of obtaining a permit under Chapter 102, the applicant need not provide or identify their legal right to discharge stormwater. However, a Chapter 102 permit does not convey property rights of any sort, nor any exclusive privileges, nor does it authorize any injury to private property, nor any infringement of federal, state or local laws or regulations.

FAQ #9: I have completed an EP Analysis for a post-construction stormwater discharge that will flow through an off-site property to surface waters. The analysis demonstrated that the existing flow path will not be stable. What options does the applicant have?

The applicant can evaluate whether there are other locations where stormwater could be routed to or the applicant can obtain authorization from the off-site property owner to make improvements to the flow path. In the latter case, a PCSM Plan Drawing should be prepared and submitted to DEP/CCD that illustrates the improvements to be made, including a sequence that specifies any off-site work to be completed before the discharge point is created. The project site boundary shown on the plan drawings should include any off-site improvements. DEP/CCD will not approve a Notice of Termination (NOT) until this work has been completed. Chapter 6 of DEP’s E&S Manual should be consulted when evaluating improvements to a flow path. The design of flow path improvements will need to consider site-specific information such as the expected velocity of runoff, flow depth, slope, soil erodibility, etc., which will guide the selection of vegetation, rip rap, or other materials or products that will prevent accelerated erosion.

FAQ #10: What if off-site improvements would be needed but an easement may not be apparent, or cannot be obtained, or the downslope landowner’s consent is not given? What options do applicants have?

The applicant will need to modify the proposed discharge (e.g., reduce velocity) until it becomes stable for the existing receiving ground cover conditions or discharge to a different location that will be suitable to receive the designed discharge.

EXAMPLE 10.A – A proposed stormwater discharge will traverse an existing agricultural cultivated field and, since the worst-case scenario will be bare earth, the calculated velocity or shear stress will need to be computed for bare earth conditions. If the allowable values are exceeded, then the proposed design needs to be revised, including the option of relocating the discharge point if necessary.

FAQ #11: Erosion currently exists at the location of a proposed stormwater discharge. Is the applicant responsible for making improvements to an existing condition?

If the point of discharge cannot be relocated, then improvements to the existing condition would be necessary. Any change in stormwater runoff characteristics could exacerbate an existing condition, so it is not advisable to discharge to an area that already shows signs of or has undergone erosion.

FAQ #12: The PCSM design of my site will manage the net change in stormwater rate, volume and water quality. Is an EP Analysis still necessary?

If any of the conditions identified in the instructions to the EP Analysis form (3800-FM-BCW0271h) will exist, an EP Analysis is necessary. These conditions are independent of the need for applicants to comply with the PCSM requirements of Chapter 102.

EXAMPLE 12.A – A site has been designed to manage the post-construction stormwater runoff such that there is no increase in the runoff volume from the 2-year/24-hour storm event and there is no increase in the peak rate from the 2-, 10-, 50-, and 100-year/24-hour storm events. The 2-year/24-hour stormwater volume is being managed by an infiltration basin, and the larger storms will discharge through a precast concrete outlet structure with a discharge pipe near a property line to an area that is not a surface water. The stormwater will flow through an off-site property before reaching the receiving surface water. An EP Analysis must be completed to evaluate the stability of the flow path from the infiltration basin discharge to the surface water.

FAQ #13: If the PCSM design will reduce the post-construction stormwater runoff rate to the pre-construction rate up to the 100-year/24-hour storm, is that a sufficient demonstration for preventing accelerated erosion?

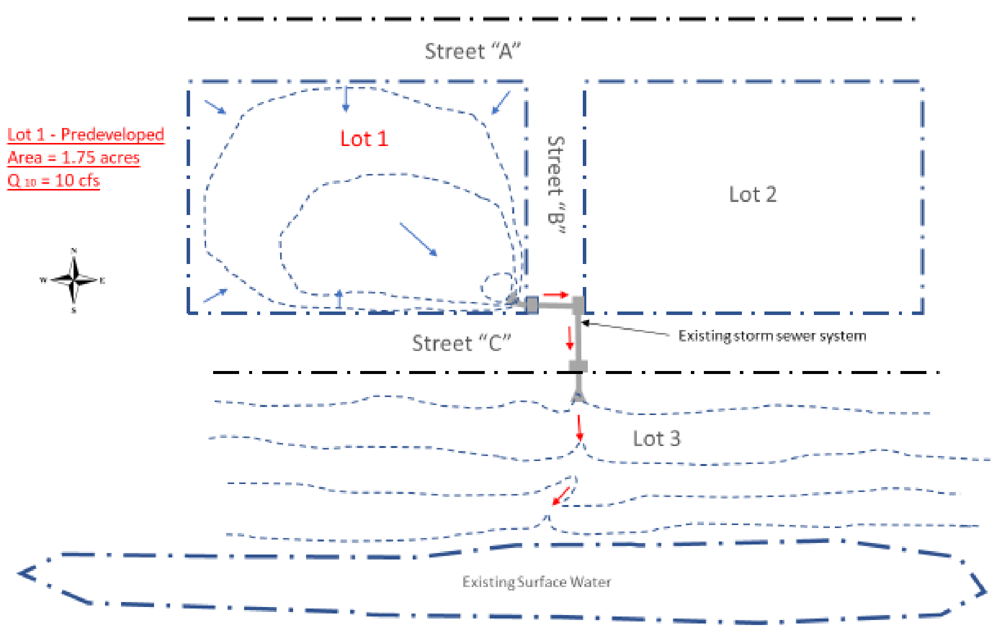
A demonstration of meeting pre-construction runoff rates would not be sufficient where post-construction runoff is concentrated in comparison to pre-construction conditions (see Example 13.A below).

A demonstration of meeting pre-construction runoff rates would be sufficient when the flow path characteristics will not change as a result of construction and calculations are provided to demonstrate that the 10-year/24-hour storm discharge rate will not increase (see Example 13.B below).

EXAMPLE 13.A – The pre-construction flow rate for the 2-year/24-hour storm event for a drainage area on a site is 10 cfs, spread across an area that is 100 feet wide in a shallow concentrated flow condition. The post-construction flow rate from the outlet of a PCSM SCM is 8 cfs for the 2-year/24-hour storm event (i.e., a reduction of the flow rate). However, the post-construction flow path will be only 15 feet wide, producing a more concentrated flow condition. The applicant should evaluate the flow path to ensure that it is stable.

EXAMPLE 13.B – Lot 1 consists of a grass field with no improvements. The entire lot flows into an existing conveyance system on the southeast corner of the property and eventually daylights on Lot 3 prior to discharging to an existing surface water. The 10-year/24-hour pre-construction discharge rate from Lot 1 is 10 cfs. See Figure 13.A below.

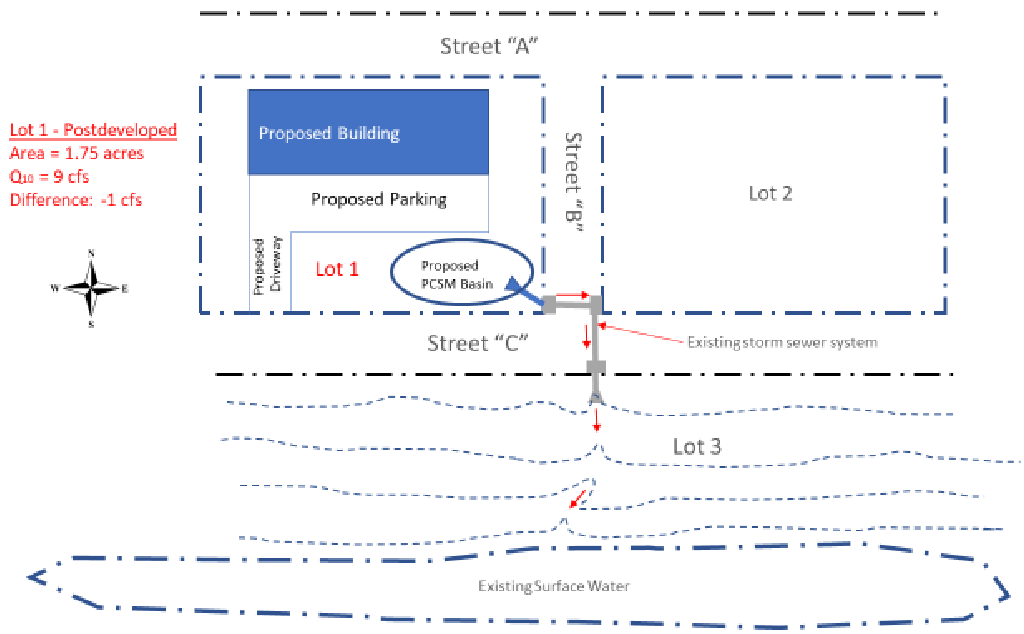
Figure 13.B.1 – Pre-Construction Condition



In the post-construction condition, a PCSM SCM will be constructed to manage the runoff from the proposed improvements. The 10-year/24-hour post-construction discharge rate from Lot 1 is 9 cfs, a reduction of one (1) cfs compared to the pre-construction condition.

Since the 10-year/24-hour post-construction discharge rate will not increase AND the flow path characteristics on Lot 3 will not change in the post-construction condition, a pre- and post-construction flow rate comparison at the 10-year/24-hour storm would be acceptable in lieu of an EP Analysis.

Figure 13.B.2 – Post-Construction Condition



FAQ #14: We are planning to collect and divert upgradient municipal runoff around our project site. Will an EP Analysis be required?

Yes, if the conditions in the EP Analysis Instructions apply.

FAQ #15: Storm sewers will collect runoff from a large area and there will be a discharge point along a new road on our project site. A new channel will be constructed to convey runoff from the discharge point to an infiltration basin. Must an EP Analysis be completed for this scenario?

An EP Analysis is unnecessary if a new channel will be designed and constructed in accordance with DEP's E&S Manual.

FAQ #16: We are planning a new channel to convey discharges from an SCM to the nearest surface water. However, the surface water is likely an intermittent or ephemeral stream. Do we need to analyze the intermittent or ephemeral stream as part of our project?

An intermittent stream is a body of water flowing in a channel or bed composed primarily of substrates associated with flowing water, which, during periods of the year, is below the local water table and obtains its flow from both surface runoff and groundwater discharges (see 25 Pa. Code § 102.1). Intermittent streams are surface waters.

Ephemeral streams are defined in DEP guidance (ID No. 386-2000-013) as follows:

A reach of stream that flows only during and for short periods following precipitation and flows in low areas that may or may not have a well-defined channel. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Some commonly used names for ephemeral streams include stormwater channel, drain, swale, gully, hollow, saddle, and routinely and incorrectly as "dry streams." The term is often used interchangeably with intermittent stream, but the difference is in length of time of continuous flow (less than one month per year for ephemeral streams).

Ephemeral streams are not surface waters. Therefore, DEP/CCD would expect that an EP Analysis be conducted on an ephemeral stream just as for any other existing drainage feature that is not a surface water if one or more of the conditions in the EP Analysis Instructions apply. The analysis should include the full ephemeral segment of the stream, as determined by a water quality biologist or other professional with experience in surface water characteristics.

It is noted that DEP/CCD may require a "stream stability analysis" for an intermittent stream or other stream with a small watershed area if DEP/CCD has concerns with the potential for stream bed scour and bank erosion due to a site's stormwater discharges. DEP has published draft guidance on conducting a stream stability analysis in the Pennsylvania Post-Construction Stormwater Management (PCSM) Manual (386-0300-001).

FAQ #17: What is the Soil Erodibility Factor (k) on the EP Analysis Form and where can I find it?

The slope erodibility factor "k" can be used to classify erodible soils and is typically used in the USDA RUSLE2 equation to analyze slope stability. K factors can be found through the NRCS Web Soil Survey website using the Soil Data Explorer > Soil Reports > Soil Erosion > RUSLE2 Related Attributes tabs. Refer also to Table 6.4 in the E&S Manual for classification of erosion resistant or easily erodible soil.

FAQ #18: Will the flow path for a structural level spreader require an EP analysis?

If a level spreader is proposed in which calculations are provided to demonstrate that the level spreader will produce sheet flow conditions (flow depth < 0.10 foot) immediately below the level spreader, an EP Analysis is not required. The weir equation can be used to determine the flow depth at the level spreader lip. Refer to page 175 of the E&S Manual for guidance on the weir equation. If calculations are not provided to demonstrate that the flow depth immediately below the level spreader is less than 0.1 foot, the discharge must be treated as concentrated flow and an EP Analysis must be performed.

Version History

Date	Version	Revision Reason
3/6/2025	1.2	Modified FAQ #1 to clarify that a DP is a location where concentrated flow on a project site originates both during and following earth disturbance activities.
10/7/2024	1.1	Revised FAQ #13 to clarify that it is not necessary to complete an EP Analysis when a flow path will not change due to construction and the post-construction peak rate is less than or equal to the pre-construction peak rate up to the 10-year/24-hour storm. Added FAQ #18 to explain that if calculations are provided that demonstrate the flow immediately below a level spreader will be sheet flow (i.e., < 0.1 foot), an EP Analysis is not necessary.
8/30/2024	1.0	Original