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Post Construction Stormwater Management/Site Restoration Plans Narrative

Atlantic Sunrise Project
Phase 1

Compressor Station 610
Orange Township
Columbia County
Pennsylvania

Prepared For:

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2800 Post Oak Blvd
Houston, TX, 77251

Issued: August 2015
Revised: October 2016

BL Project No. 14C4909

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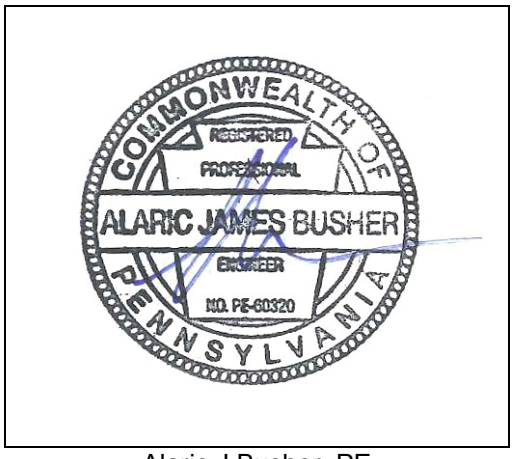

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APPENDICES

Appendix C United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Custom Soil Resource Report

1.0 GENERAL INFORMATION

The following narrative was prepared as a supplement to the Transcontinental Gas Pipe Line Company, LLC.'s (Transco's) Environmental Construction Plan (ECP) provided in Section 4 of the Erosion and Sediment Control General Permit 2 (ESCGP-2) Notice of Intent (NOI), which was prepared for the Atlantic Sunrise Project ("Project"). This narrative is intended to describe the post construction stormwater management/site restoration (PCSM/SR) design for the Compressor Station 610 ("Site") to be constructed as part of the Project, within Orange Township, Columbia County, Pennsylvania. Similar narratives were prepared, under separate cover, for facilities in other affected counties, as well as for the pipeline construction.

The facility proposed to be constructed as part of Phase 1 of the Atlantic Sunrise Project in Columbia County is the following:

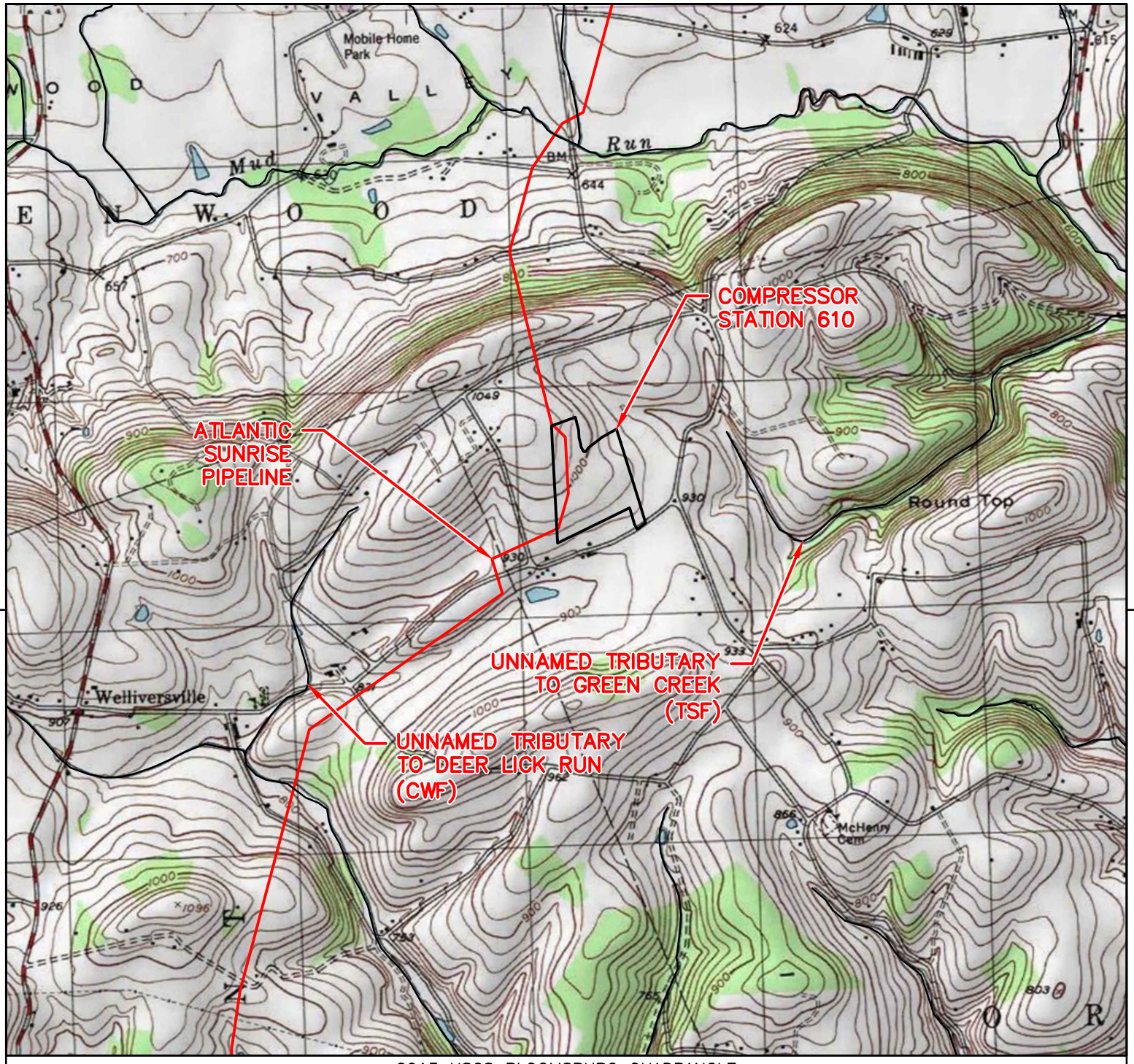
Facility Name	Facility Description	Facility Coordinates
Compressor Station 610	Compressor Station	N41°06'24.47", W76°26'57.38"

The Compressor Station 610 will be approximately 33.70 acres in area including a 1,526 linear foot new access road, 286,603 square feet (6.58 acres) of new gravel pad, and 261,861 square feet (6.01 acres) of impervious area. The Site will utilize existing public and private roads for access to the Site during and after construction. Best Management Practices (BMPs), in accordance with the standards and specifications in the Pennsylvania Department of Environmental Protection's (PADEP's) "Erosion and Sediment Pollution Control (E&S) Program Manual," Technical Guidance No. 363-2134-008, as amended and updated (E&S Manual) will be implemented to minimize and/or avoid potential adverse environmental impacts due to the construction, operation and maintenance activities associated with the Site. The proposed practices are designed to maximize volume reduction technologies, eliminate or minimize point source discharges to surface waters, preserve the integrity of stream channels, and protect the physical, biological, and chemical qualities of the receiving surface water. The intent is to keep the post construction runoff volume and flow rate no greater than the pre-construction conditions while maintaining water quality. Impervious areas, land clearing and soil compaction are minimized and natural drainage features and vegetation are protected wherever possible. Heavy equipment will be restricted from infiltration areas. E&SC and PCSM BMP measures will be installed and maintained as needed to control stormwater movement in the Site area.

Refer to the ECP (**Section 4 of the ESCGP-2 NOI**) for overall Project information.

There are no impacts to regulated wetlands associated with this proposed Site. Refer to the Wetland Delineation Report provided in **Section 5 of the ESCGP-2 NOI** for information supporting wetland mapping as shown on the Erosion and Sediment Control (E&SC) Plans (**Section 2 of the ESCGP-2 NOI**).

1.1 Topographic Features



2013 USGS BLOOMSBURG QUADRANGLE

N

GRAPHIC SCALE

2000 1000 0 2000

SCALE IN FEET

ATLANTIC SUNRISE PROJECT

COMPRESSOR STATION 610

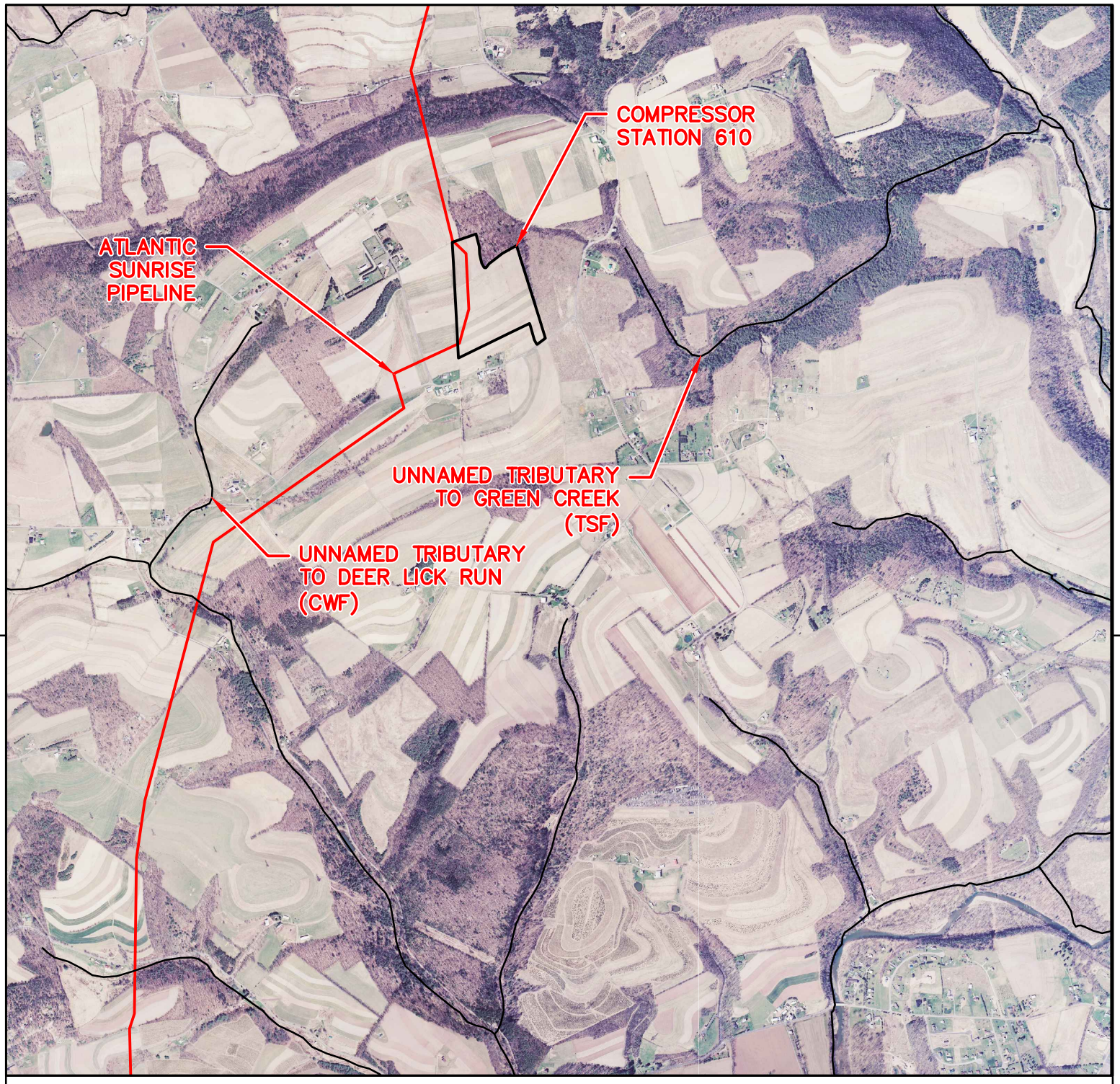
USGS LOCATION MAP

ORANGE TOWNSHIP
COLUMBIA COUNTY, PENNSYLVANIA

Williams

NO.	DATE	BY	REVISION DESCRIPTION	W.O. NO.	CHK.	APP.
0	08-28-15	BL	ISSUED FOR PADEP PERMIT SUBMITTAL	1161505	SMK	
1	12-02-15	BL	ISSUED FOR PADEP RESUBMITTAL	1161505	AJB	

DRAWN BY: JEC	DATE: 04/03/15	ISSUED FOR BID:	SCALE: 1"=2,000'
CHECKED BY: AOE	DATE: 04/03/15	ISSUED FOR CONSTRUCTION:	
APPROVED BY: AJB	DATE: 04/03/15	DRAWING NUMBER: CS 610 LOCATION	SHEET 1 OF 1
WO: 1161505			



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GRAPHIC SCALE

2000 1000 0 2000

SCALE IN FEET

ATLANTIC SUNRISE PROJECT

COMPRESSOR STATION 610

AERIAL LOCATION MAP

ORANGE TOWNSHIP
COLUMBIA COUNTY, PENNSYLVANIA

Williams

NO.	DATE	BY	REVISION DESCRIPTION	W.O. NO.	CHK.	APP.
0	08-28-15	BL	ISSUED FOR PADEP PERMIT SUBMITTAL	1161505	SMK	
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APPROVED BY: AJB	DATE: 04/03/15	DRAWING NUMBER: CS 610 LOCATION	SHEET 1 OF 1
WO: 1161505			

1.2 Soil Characteristics

In addition to the below use limitations and resolutions, refer to Appendix C for the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Custom Soil Resource Report for the Site.

Soil Type and Use Limitations

Map Symbol	Soil Name	Slope	Cut Banks Cave	Corrosive to Concrete or Steel	Droughty	Easily Erodible	Flooding	High Water Table	Hydric/Hydric Inclusions	Low Strength	Slow Percolation	Piping	Poor Source of Topsoil	Frost Action	Shrink-Swell	Potential Sinkhole	Ponding	Wetness
AeB2	Allenwood silt loam, moderately eroded	3-12%	X	C/S					X	X	X	X	X	X				
HhC3	Hartleton channery silt loam, severely eroded	12-20%	X	C	X					X	X	X	X	X				
HhB2	Hartleton channery silt loam,	3-12%	X	C	X					X	X	X	X	X				
WbB2	Watson silt loam, , moderately eroded	3-8%	X	C/S	X			X	X	X	X	X		X	X			
WcC2	Weikert channery silt loam, moderately eroded	12-20%	X	C/S	X				X	X	X	X	X	X				

Source: Appendix E, Table E-1, PADEP, *Erosion and Sediment Pollution Control (E&S) Program Manual* Technical Guidance Number 363-2134-008.

Soil Use Limitations Resolutions

Limitation	Resolution
Cut Banks Cave	Excavations will be properly supported by sheeting and shoring to prevent caves.
Corrosive to Concrete or Steel	No concrete or steel piping is proposed without appropriate coatings and protection.
Droughty	Existing suitable topsoil and soil amendments will be used during construction.
Easily Erodible	Temporary and permanent erosion control BMPs will be employed throughout the Site.
Flooding	Ensure that the Site has proper drainage.
High Water Table	A geotechnical investigation was conducted to minimize conflicts with saturated zones.
Hydric/Hydric Inclusions	A wetland investigation was completed to determine no wetlands are present in the development area.
Low Strength	A maximum of 3:1 slopes are proposed.
Slow Percolation	A field investigation of percolation rates at the infiltration areas was performed to verify the soils percolation capacity.
Piping	Watertight pipe, antiseep collars, clay cores through basin berms, and concrete endwalls will be used to minimize the danger of piping.
Poor Source of Topsoil	Existing topsoil, which has proven to be suitable, will be reused on the Site.
Frost Action	Pavement subbase will be provided to minimize frost effects.
Shrink-Swell	Stone base will be provided to prevent shrink-swell from effecting pavement.
Potential Sinkhole	Geotechnical engineer of record recommendations will be followed for any potential occurrences.
Ponding	Surface grading and drainage facilities will be provided to minimize ponding affects.
Wetness	Wet weather construction recommendations, per the geotechnical engineer's recommendations, will be employed to minimize the effects of wetness during construction, surface grading. Surface grading and drainage will be provided to minimize wetness affects after construction.

1.3 Earth Disturbance Activity Characterization

Proposed Improvements and Land Use

The proposed Compressor Station 610 will be constructed in Orange Township, Columbia County, Pennsylvania. The Project will involve the construction of a natural gas compressor station. The earthmoving activity will involve the stripping and stockpiling of top soil, Site grading, Site excavation, placement of fill, trenching and backfill, construction of buildings and equipment with gravel pad/parking lot, construction of an asphalt access drive, construction of a stormwater management system, finish grading, and stabilization of disturbed surfaces. Approximately 261,861 square feet (6.01 acres) of additional impervious area and 286,603 square feet (6.58 acres) of additional gravel surface will result on-site. Areas outside the Site LOD may be used for staging of equipment and materials, but no earth disturbance will occur in these areas.

Present/Past Land Use

This section identifies the land requirements for construction and operation of the proposed CPL North, CPL South, and Associated Facilities. Table 1.3.1 summarizes the land requirements for the proposed Compressor Station 610 associated with the CPL North and CPL South mainlines.

The characterization of land use within the proposed CPL North, CPL South, and Associated Facilities project areas is based on interpretation of aerial photographs taken in the spring of 2014 and information gathered from field surveys conducted during 2014 and 2015. Transco classified land uses within the proposed CPL North, CPL South, and Associated Facilities project areas into the following eight broad types:

- Agricultural Land – land associated with active cultivation of row and field crops; areas of grasses planted for livestock grazing or for the production of hay crops; orchards; and specialty crops, including vineyards, Christmas trees, and fruits and vegetables.

- Upland Forest/Woodland – includes upland deciduous forest, evergreen forest, and mixed (deciduous and evergreen) forest, but does not include forested wetlands.

- Industrial/Commercial Land – land used for mines or quarries and associated processing plants; manufacturing or other industrial facilities; and land developed for commercial or retail uses, including malls, strip plazas, business parks, and medical facilities.

- Transportation Land – land used for transportation purposes, including interstate highways; state, county, and local highways and roads; and railroad lines.
- Residential Land – residential areas, including yards of individual residences.
- Open Land – non-forested and undeveloped land not classified for another use, including land maintained as utility ROWs for overhead and underground electric transmission, natural gas transmission, and oil transmission facilities.
- Wetlands – includes wetlands covered with emergent, scrub-shrub, and forested vegetation.
- Open Water – include rivers, streams, creeks, canals, and other linear waterbodies, as well as lakes, ponds, and other non-flowing waterbodies.

New MLVs will be wholly located within the permanent ROWs for the proposed CPL North and CPL South mainlines. Construction will primarily occur within the proposed CPL North and CPL South construction ROWs. Land uses appear to have been similar over the past 50 years.

Table 1.3.1
Land Requirements for the New Aboveground Facilities[a]

Facility	Milepost	County	Agricultural Land (acres)		Upland Forest / Woodland (acres)		Open Land (acres)		Total (acres)	
			Cons	Op	Cons	Op	Cons	Op	Cons	Op
New Compressor Station 610	CPL South 112.5	Columbia	32.8	32.8	0.7	0.7	0.0	0.0	33.5	33.5
Compressor Station 610 Subtotal			**32.8**	**32.8**	**0.7**	**0.7**	**0.0**	**0.0**	**33.5**	**33.5**

Notes:
[a] Land use acreages for construction and operation are provided for reference only. Acreages provided were calculated by using kmz files and prepared as part of the June 8, 2015 FERC Supplement. Refer to plans and ESCGP-2 NOI for actual site conditions.

Key:
Cons = Construction
L = Leidy Line system milepost
Op = Operation

Please refer to the PCSM/SR Plans and Detail Sheets, as provided in **Section 3 of the ESCGP-2 NOI**, and Section 1.2 and Appendix C of this PCSM/SR Narrative for information on the Site soils.

1.4 Stormwater Management Calculation Methodology & Net Change in Volume and Rate of Runoff

Runoff volume and rate calculations have been performed for the Site are included in Appendix A.

Pre-development and Post Development runoff hydrographs were developed for the 1-, 2-, 10-, 25-, 50-, and 100-year storm events using the Soil Conservation Service's TR-55 Method. The PCSM/SR BMPs will meet the volume reduction and water quality requirements of Control Guideline 1 (CG 1). Water Quality Worksheet #4 was used to complete the CG 1 volume analysis for the 2-year storm event. Stormwater models were created using the HydroCAD Version 7.10 computer program produced by HydroCAD Software Solutions, LLC. Stormwater conveyance calculations were performed using Worksheet 11 of the Pennsylvania Erosion and Sediment Pollution Control (E&S) Program Manual. (Analysis of rates and flows at each point of interest (POI) were completed to meet CG 1 Requirements.) National Oceanic Atmospheric Administration (NOAA) Atlas 14 rainfall intensities were used in the calculations. See Appendix A for calculations and results.

Drainage Area Summary:

The proposed Compressor Station 610 will be located at a highpoint that drains into two primary drainage areas. The first drainage area is comprised of Drainage Area A and Drainage Area C, with a combined POI located at POI C. The combined drainage area flows to an unnamed tributary to Deer Lick Run. However, Drainage Areas A and C were analyzed separately to demonstrate that there will be no increase in discharge from the site to the roadside swale at the adjacent property line. The second drainage area discharges to POI B and drains to the east to an unnamed tributary of Green Creek. The peak rate discharges for all three drainage areas have been analyzed to demonstrate that there will be no increase in runoff from the site for the 1, 2, 5, 10, 25, 50 and 100 year storm events. A list of the POIs is given below:

POI Summary:

POI A: Roadside swale south of the Site; Combines with POI C.

POI B: Offsite point of convergence of roadside swales east of the Site.

POI C: Roadside swale south of the Site; Combines with POI A.

Overall Site: Susquehanna River Watershed

Volume Summary Table

WATERSHED	2- YR PRE (FT^3)	2- YR POST (FT^3)	2- YR VOLUME INCREASE (FT^3)	2- YR STRUCTURAL AND NONSTRUCTURAL CREDITS (FT^3)	REDUCTION (FT^3)
UNT. to Deer Lick Run	*17711*	*79745*	*62034*	*62156*	*122*
UNT. To Green Creek	*12395*	*8413*	*-3982*	*0*	*3982*

*See Appendix A for calculations.

Runoff Rate Summary Table

STORM EVENT	POINT OF INTEREST A			POINT OF INTEREST B			POINT OF INTEREST C		
	PRE (CFS)	POST (CFS)	REDUCTION (CFS)	PRE (CFS)	POST (CFS)	REDUCTION (CFS)	PRE (CFS)	POST (CFS)	REDUCTION (CFS)
1-yr	*0.44*	*0.40*	*0.04*	*2.41*	*2.28*	*0.13*	*0.54*	*0.44*	*0.10*
2-yr	*1.57*	*1.05*	*0.52*	*8.96*	*8.49*	*0.47*	*1.68*	*1.35*	*0.33*
5-yr	*4.46*	*2.61*	*1.85*	*24.74*	*23.45*	*1.29*	*4.59*	*3.69*	*0.90*
10-yr	*8.15*	*5.51*	*2.64*	*44.21*	*41.91*	*2.30*	*8.11*	*6.51*	*1.60*
25-yr	*14.70*	*11.10*	*3.60*	*78.97*	*74.85*	*4.12*	*14.11*	*11.33*	*2.78*
50-yr	*20.90*	*15.82*	*5.08*	*112.40*	*106.54*	*5.86*	*19.79*	*15.89*	*3.90*
100-yr	*28.09*	*21.13*	*6.96*	*151.36*	*143.47*	*7.89*	*26.37*	*21.17*	*5.20*

*See Appendix A.1 for Pre-Development Calculations with Mapping and Appendix A.2 for Post Development Calculations with Mapping.

Act 167 Summary

The Site is not located within a current, PADEP approved Act 167 Stormwater Management Watershed Plan. Therefore, the Site was designed to meet CG 1 requirements.

1.5 Surface Water Classification

The PCSM/SR drawings in **Section 3 of the ESCGP-2 NOI** depict the locations of the streams and wetlands in and near the LOD for the Site. The Site area surface water runoff drains in two directions. To the east runoff drains to an unnamed tributary (UNT) to Green Creek, which is designated as Trout Stocking (TSF) under PA Code 25

Chapter 93. To the south, runoff drains to an UNT to Deer Lick Run, which is designated as Cold Water Fishery (CWF) under PA Code 25 Chapter 93. Both of these receiving waters are part of the Fishing Creek Watershed. The Site's watersheds are not listed as impaired in the PADEP Chapter 93 Integrated List.

1.6 BMP Description Narrative

The structural PCSM BMPs listed below are to be used for this Site. The calculations used to design the PCSM BMPs are included in Appendix A. The locations of the PCSM BMPs are shown on the PCSM/SR Plans and Detail Sheets (**Section 3 of the ESCGP-2 NOI**).

Vegetated Swales with Earthen Check Dams: Three vegetated swales will be utilized to infiltrate post construction stormwater runoff from the proposed facilities. This BMP is proposed to meet both volume reduction and nitrate removal.

Infiltration Basin: An infiltration basin will be utilized to infiltrate post construction stormwater runoff volume and provide runoff rate control. This BMP is proposed to meet volume reduction requirements.

Infiltration Berms and Retentive Grading: Infiltration berms will be used to increase the surface area available for infiltration as well as increasing the volume infiltrated and providing rate control. This BMP is proposed to meet volume reduction requirements.

Protect Sensitive and Special Value Features: Sensitive and special value features will be protected to reduce stormwater impacts. Construction activities will be conducted in a manner that avoids affecting and encroaching upon areas with important stormwater functions or stormwater impact sensitivities wherever practical so that the valuable functions are preserved. This BMP is proposed to meet non-structural volume credits

Minimize Soil Compaction in Disturbed Areas: Soil compaction within the LOD will be minimized to the extent practicable in order to protect soil quality, preserve permeability and protect the soil from damage where possible. Minimum compaction areas will be surrounded by orange construction fence for the duration of construction activities to ensure minimum compaction. This BMP is proposed to meet volume reduction credits and nitrate removal.

Soil Amendment and Restoration: Soil amendments shall be added to infiltration areas after construction in order to restore soil porosity and enhance long term infiltration.This BMP is proposed to meet non-structural volume reduction credit.

Street Sweeping: Street Sweeping of the site impervious surfaces will be performed on a regular schedule. This BMP is being proposed to meet the nitrate removal credit.

Reduce parking impervious area: Impervious parking areas will be minimized to the maximum extent practicable. Overflow parking will be on gravel areas.

Disconnected Non-Roof Impervious Areas: Non-roof impervious areas will be directed to vegetated areas rather than being directly connected to storm sewers. This BMP is proposed to meet required volume reduction credits

1.7 BMP Installation Sequence Narrative

1. At least 7 days prior to starting any earth disturbance activities, including clearing and grubbing, the owner and/or operator shall invite all contractors, Environmental Inspectors, the landowner, appropriate municipal officials, the E&S plan preparer, the PCSM plan preparer, the licensed professional responsible for oversight of critical stages of implementation of the PCSM plan, and a representative from the local conservation district to an on-site preconstruction meeting.

2. At least 3 days prior to starting any earth disturbance activities, or expanding into an area previously unmarked, the Pennsylvania One Call System Inc. shall be notified at 1-800-242-1776 for the location of existing underground utilities.

3. Install orange construction fence around areas to be protected. These include woodland area at the north east corner of the site, minimum compaction area north of infiltration basin #1 and minimum compaction/soil amendment areas of infiltration basins and berms.

4. Locate staging areas and access points including construction entrances. Field locate limits of disturbance.

5. Install rock construction entrances (RCEs).

6. Remove brush to effectively install perimeter controls, level side cuts to grant access for vehicles and workers to safely perform the installation of sediment barriers on the Site as shown on the construction drawings.

7. The Compliance Manager shall provide PADEP and CCD at least three days' notice prior to bulk earth disturbance and upon completed installation of perimeter erosion controls.

8. Install compost filter sock 2, 3 and 4. Install swale 1 and immediately seed and stabilize.

9. *** Install Sediment Basin 1 berm including clay core, outfall structure, aprons, and antiseep collars immediately after installing compost filter sock 3 and 4 and prior to any other disturbance on site.**

10. Install CFS Sediment Trap 1.

11. *** Install remainder of Sediment Basin 1 including slope liners, cleanout stake, and associated improvements. Install Filter Sock Diversions 1 and 2 only after basin is completed.**

12. Install vegetated roadside swales, culverts and riprap outlet protection.

13. *** Install Earthen Check Dams and drainage channel aprons as soon as swale grading is complete.**

14. Begin construction staking for grading.

15. Begin grading and strip and stockpile topsoil within the area of improvements and install sediment barriers around stockpiles.

16. Upon temporary cessation of an earth disturbance activity or any stage of an activity where the cessation of earth disturbance activities will exceed four days, the site shall be immediately seeded, mulched, or otherwise protected from accelerated erosion and sedimentation pending future earth disturbance activities. For an earth disturbance activity or any stage of an activity to be considered temporarily stabilized, the disturbed areas shall be covered with one of the following: A minimum uniform coverage of mulch and seed, with a density capable of resisting accelerated erosion and sedimentation, or an acceptable BMP which temporarily minimizes accelerated erosion and sedimentation. Temporary stabilization will not occur on active vehicular travel ways within the ROW. The on-site Environmental Inspector will log daily activity within the LOD and notify the contractor of areas requiring temporary stabilization (i.e., areas where work has ceased for at least four days).

17. Grade the compressor station pads and access roads, including stormwater runoff conveyance features as shown on the E&SC and PCSM/SR Plans (**Sections 2 and 3 of the ESCGP-2 NOI**).

18. Immediately stabilize side slopes with erosion control matting when slopes are 3:1 or greater. See PCSM/SR Plans and Detail Sheets, as provided in **Section 3 of**

the ESCGP-2 NOI, (patterns differ by slope category). Install rip rap slope stabilization where shown on the PCSM/SR Plans.

19. Remove FSD 2. Maintain drainage to the sediment basin while placing fill.

20. Construct facility including access roads.

21. Establish final grade.

22. Spread topsoil and construct infiltration berm 2 including amended soil.

23. Surface Stabilization, apply permanent stabilization measures immediately to any disturbed areas where work has reached final grade.

24. Upon completion of all earthwork activities and permanent stabilization of all disturbed areas, the Owner and/or Operators shall contact the local CCD for an inspection prior to the removal/conversion of the E&SC BMPs.

25. * Install Vegetated Swale 3. Remove FSD 1.

26. * After all upslope disturbed areas are stabilized, remove accumulated sediments and *raise Basin 1 bottom to final grade,* convert sediment basin to proposed infiltration management basin 1, including construction of Infiltration Berm 1 and placement of amended soil. Remove temporary skimmer from permanent outlet structure and install watertight plug in orifice. Remove temporary plate over permanent 36”x6” orifice in outlet structure and install top grate.

27. All material removed from temporary basins, traps and infiltration berms to be removed from site.

28. After finish grading and topsoil placement is completed, disturbed areas shall be fertilized, seeded, and mulched. Seed mixtures, fertilizer and mulch applications rates and dates shall conform to the tables provided on the PCSM/SR Plans and Detail Sheets (**Section 3 of the ESCGP-2 NOI**), land owner agreements and/or the **ECP** (**Section 4 of the ESCGP-2 NOI**).

29. After seeding, fertilizing and mulching is complete, install ECBs as required or ordered or on slopes of than 3:1 or greater.

30. After the Site is permanently stabilized and upon PADEP or local CCD and Owner approval of stabilization and re-vegetation, remove temporary erosion and sediment control measures and stabilize areas disturbed by removal.

31. Complete Site stabilization. Including seed application, ECB and mulching.

32. Upon completion of all earth disturbance activities and permanent stabilization of all disturbed areas, the Owner and/or Operators shall contact the local CCD for a final inspection.

33. Maintain E&SC BMPs until Site work is complete and uniform 70% perennial vegetative cover is established.

34. Remove and properly dispose/recycle E&SC BMPs. Remove orange construction fence. Repair and permanently stabilize areas disturbed during E&SC BMP removal upon establishment of uniform 70% vegetative cover.

*** indicates a critical stage of PCSM installation to be observed by a licensed professional or designee. Contractor to provide three working days' notice to Design Engineer.**

1.8 Supporting Calculations

Supporting calculations are included in Appendix A.

1.9 Plan Drawings

PCSM/SR Plans, including sensitive resource mapping, are included in **Section 3 of the ESCGP-2 NOI**.

1.10 Long Term Operation and Maintenance Schedule

Monitoring

Transco's personnel (Operations) will perform visual inspections on an annual basis after permit closure, by qualified personnel, trained and experienced in PCSM/SR, to ascertain that the BMPs are functioning and operating effectively to ensure Compressor Station 610 is causing no undue burden on the property owner or adjacent owners. Repairs of deficiencies will be initiated within ten business days of discovery.

Maintenance

The Contractor will be responsible for the maintenance of the system during construction. After construction, the stormwater management facilities will be owned and maintained by Transco.

Where maintenance of the storm system after acceptance by the Owner will primarily consist of routine cleaning of accumulated sediment and debris by facility staff or private contractors, the specific maintenance steps and schedule are listed below:

1. Detention/Infiltration Facility

Inspect detention/infiltration facility annually and inspect soil, repair eroded areas and remove litter and debris as needed. Inspect twice a year for sediment buildup, erosion and vegetative conditions. Remove and replace dead and diseased vegetation. Any litter, debris, sediment, vegetation, or other items removed during maintenance activities will be disposed of in a manner consistent with the ESCGP-2 requirements. ***Compaction of the basin bottom shall be prevented.***

2. Vegetated Swales with ***Earthen*** Check Dams

Vegetated swales with Earthen Check Dams are to be inspected annually for sediment, build-up, erosion debris, and damage due to traffic. Ditches should be maintained to ensure that the specified design dimensions and vegetative lining are available at all times. No more than one-third of the shoot (grass leaf) shall be removed in any mowing. Grass height shall be maintained between 3 and 6 inches unless otherwise specified. Excess vegetation shall be removed from permanent channels to ensure sufficient channel capacity. Any litter, debris, sediment, vegetation, or other items removed during maintenance activities will be disposed of in a manner consistent with the ESCGP-2 requirements.

3. Infiltration Berms/Retentive Grading

All berms must be kept free of obstructions such as fill, fallen leaves & woody debris, accumulated sediment, and construction material/wastes. Any disturbance to the berms shall be immediately repaired and stabilized. Compaction of the berm bottoms shall be prevented.

4. Protect Sensitive/Special Value Features

Protected areas shall remain undisturbed after construction activities cease. Orange construction fence will be used to protect special value/sensitive areas during construction.

5. Minimize Soil Compaction

- ***Protected areas – restrict vehicle access, do not clear vegetation. Avoid earth disturbance.***

- ***Minimum disturbance areas – Restrict vehicle access.***

6. Soil Amendment and Restoration

Restrict vehicle access. Monitor water drawdown time in infiltration areas and replace amended soils if dewatering time increases to more than three days. Maintain Infiltration areas and vegetated swales as indicated on the PCSM/SR Plans.

7. Reduce Parking Area Imperviousness

Gravel areas will be maintained in good condition and will not be paved without obtaining prior approval from the PADEP or the County Conservation District.

8. Street Sweeping

Paved areas will be swept as required but at a minimum of annually.

9. Annual Records of Maintenance Procedures

The facility shall maintain a checklist whenever the storm system is inspected and cleaned. An annual list of inspections and major cleaning operations and repairs (pumping, sweeping parking lots, cleaning catch basin, etc.) shall be maintained. The local CCD or enforcement officials shall have access to those records.

10. ESCGP-2

The facility Owner and Operator shall ensure compliance with ESCGP-2 requirements by meeting all ongoing record, keeping maintenance, and other applicable ESCGP-2 and PADEP permit conditions.

1.11 Material Recycling and Disposal

The restoration of the temporary gravel will require the removal of the temporary materials. The temporary materials include, but may not be limited to, stone surface and associated geotextiles. The contractors are required to dispose of materials at suitable disposals or recycling sites and in compliance with local, state and federal regulations.

Transco has prepared a Spill Plan for Oil and Hazardous Materials to assist in prevention of any spills that may occur at the Site and to respond to any spills that do occur. The Contractor will be required to become familiar with the Spill Plan for Oil and Hazardous Materials and its contents prior to commencing any construction-related activities. The Spill Plan for Oil and Hazardous Materials is included as **Attachment 9 to the ECP** provided as **Section 4 of the ESCGP-2 NOI**.

Contractors are required to inventory and manage their construction site materials. The goal is to be aware of the materials on-site; ensure they are properly maintained, used, and disposed of; and to make sure the materials are not exposed to stormwater.

Silt, sediment, trash, construction wastes and all other wastes generated during operation and maintenance activities shall be properly managed and disposed of in accordance with local, state and federal requirements.

Materials Covered

The following materials or substances are expected to be present on-site during construction **(Note: this list is not an all-inclusive list and the Materials Management Practices can be modified to address additional materials used on-site)**:

- Acids
- Detergents
- Fertilizers (nitrogen/phosphorus)
- Hydroseeding mixtures
- Petroleum based products
- Sanitary wastes
- Soil stabilization additives
- Solder
- Solvents
- Other

These materials must be stored as appropriate and shall not contact storm or non-stormwater discharges. Contractor shall provide a weather proof container to store chemicals or erodible substances that must be kept on the Site. Contractor is responsible for reading, maintaining, and making employees and subcontractors aware of safety data sheets (SDSs).

Material Management Practices

The following are material management practices that will be used to reduce the risk of spills or other accidental exposure of materials and substances to stormwater runoff.

1. Good Housekeeping Practices

   The following good housekeeping practices will be followed on Site during construction:

   - Store only enough material required to do the job.
   - Store materials in a neat, orderly manner.
   - Store chemicals in watertight containers or in a storage shed, under a roof, completely enclosed, with appropriate secondary containment to prevent spill or leakage. Drip pans shall be provided under dispensers.
   - Substances will not be mixed with one another unless recommended by the Manufacturer.
   - Manufacturer's recommendations for proper use and disposal will be followed.
   - Inspections will be performed to ensure proper use and disposal of materials.
   - Cover and berm loose stockpiled construction materials that are not actively being used (i.e. Soil, spoils, aggregate, etc.).
   - Minimize exposure of construction materials to precipitation.
   - Minimize the potential for off-site tracking of loose construction and landscape materials.

2. Hazardous Products

These practices will be used to reduce the risks associated with hazardous materials. SDSs for each substance with hazardous properties that is used on the job site(s) will be obtained and used for the proper management of potential wastes that may result from these products. A SDS will be posted in the immediate area where such product is stored and/or used and another copy of each SDS will be maintained in a file at the job site construction trailer office. Each employee, who must handle a substance with hazardous properties, will be instructed on the use of SDS and the specific information in the applicable SDS for the product he/she is using, particularly regarding spill control techniques.

- Products will be kept in original containers with the original labels in legible condition.
- Original labels and SDSs will be produced and used for each material.
- If surplus product must be disposed of, manufacturers or local/state/federal recommended methods for proper disposal will be followed.

3. Hazardous Wastes

All hazardous waste materials will be disposed of by the Contractor in the manner specified by local, state, and/or federal regulations and by the manufacturer of such products. Site personnel will be instructed.

4. Concrete and Other Wash Waters

Prevent disposal of rinse, wash waters, or materials on impervious or pervious surfaces, into streams, wetlands or other water bodies.

Concrete trucks will be allowed to wash out or discharge surplus concrete or drum wash water on the Site, but only in either (1) specifically designated diked areas which have been prepared to prevent contact between the concrete and/or washout and soil and stormwater having the potential to be discharged from the Site; or (2) in locations where waste concrete can be poured into forms to make riprap or other useful concrete products.

The hardened residue from the concrete washout diked areas will be disposed of in the same manner as other non-hazardous construction waste materials or may be broken up and used on the Site as deemed appropriate by the Contractor and

Owner or Owner's representative. The Contractor will be responsible for seeing that these procedures are followed.

All concrete washout areas will be located in an area where the likelihood of the area contributing to stormwater discharge is negligible. If required, additional E&SC BMPs must be implemented to prevent concrete wastes from contributing to stormwater discharges. The location of the concrete washout area(s) must be identified, by the Contractor/Job Site Superintendent, on the job site copy of the E&SC Plans (**Section 2 of the ESCGP-2 NOI**) and in the E&SC Narrative.

5. Sanitary Wastes

All sanitary waste units will be located in an area where the likelihood of the unit contributing to stormwater discharges is negligible. Additional E&SC BMPs must be implemented, such as containment trays (provided by the rental company) or special containment created with 2" x 4" lumber, impervious plastic, and gravel. The location of the sanitary waste units must be identified on the job site copy of the E&SC Plans (**Section 2 of the ESCGP-2 NOI**), in the E&SC Narrative, by the Contractor/Job Site Superintendent.

6. Solid and Construction Wastes

All waste materials will be collected and stored in a securely lidded metal dumpster. The dumpster will comply with all local and state solid waste management regulations. The dumpster/container lids shall be closed at the end of every business day and during rain events. Appropriate measures shall be taken to prevent discharges from waste disposal containers to the receiving water.

7. Construction Access

A stabilized construction exit will be provided to help reduce vehicle tracking of sediments. The paved roads adjacent to the Site entrance will be inspected daily and swept as necessary to remove any excess mud, dirt, or rock tracked from the Site. Dump trucks hauling material from the construction site will be covered with a tarpaulin as necessary.

8. Petroleum Products

On-site vehicles will be monitored for leaks and receive regular preventative maintenance. Petroleum products will be stored in tightly sealed containers which are clearly labeled. Petroleum storage tanks on-site will have a dike or berm containment structure constructed around it to contain spills which may occur

(containment volume to be 110% of volume stored). The dike or bermed area shall be lined with an impervious material such as a heavy duty plastic sheet. Drip pans shall be provided for all dispensers. Any asphalt substances used on the Site will be applied according to the manufacturer's recommendations.

9. Fertilizers and Landscape Materials

   Fertilizers will be applied only in the minimum amounts recommended by the manufacturer. Once applied, fertilizer will be worked into the soil to minimize the potential for exposure to stormwater. Storage will be under cover. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to minimize the potential for spills. The bin shall be labeled appropriately.

   Contain stockpiled materials, such as but not limited to, mulches, top soil, rocks and gravel, and decomposed granite, when they are not actively being used.

   Apply erodible landscape material at quantities and application rates according to the manufacturer's recommendations or based on written specifications by knowledgeable and experienced field personnel. Discontinue the application of any erodible landscape material within two days prior to a forecasted rain event or during periods of precipitation.

10. Paints, Paint Solvents and Cleaning Solvents

    Containers will be tightly sealed and stored when not in use. Excess paint and solvents will be properly disposed of according to the manufacturer's recommendations or local, state, and/or federal regulations.

11. Contaminated Soils

    Any contaminated soils (resulting from spills of materials with hazardous properties) which may result from construction activities will be contained and cleaned up immediately in accordance with applicable local, state and federal regulations.

1.12 Soil Conditions and Geologic Formations

There are no naturally occurring geologic formations or soils on-site that are expected that may have the potential to cause pollution during earth disturbance activities. See E&SC Detail Sheets (**Section 2 of the ESCGP-2 NOI**) for Acid-Producing Soils and Bedrock Control Plan should any unexpected acid runoff producing soils be encountered.

1.13 Thermal Impacts

Thermal impacts associated with CPL North, CPL South, and Associated Facilities will be avoided to the maximum extent practicable. The following provisions related to thermal impacts are included in the **E&SC Plan** within **Section 2 of the ESCGP-2 NOI**:

- The minimum permanent changes in land cover, necessary to construct the required facilities are being proposed.

- Runoff from the permanent impervious areas will be collected as part of the Post Construction Stormwater Management/Site Restoration (PCSM/SR) Plan and routed to PCSM/SR BMPs. In addition, impervious areas will be gravel instead of asphalt wherever practical.

- PCSM/SR BMPs incorporate the use of infiltration facilities such as basins and vegetated swales with Rock Filter Check Dams.

- The removal of vegetation, especially tree cover, will be limited to only that necessary for construction.

- The amount of impervious surfaces will be limited to only that necessary to support the construction of CPL North, CPL South, and Associated Facilities and/or operation of the pipeline.

1.14 Riparian Forest Buffer Management Plan

There are no regulated riparian buffers within the Site area.

1.15 Antidegradation Requirements

The Site is not located in a special protection or siltation impaired watershed; therefore, no antidegradation analysis is necessary.

1.16 Preparedness Prevention and Contingency Plan

See Attachment 9 of the **ECP** within **Section 4 of the ESCGP-2 NOI** for the Preparedness Prevention and Contingency Plan provided.

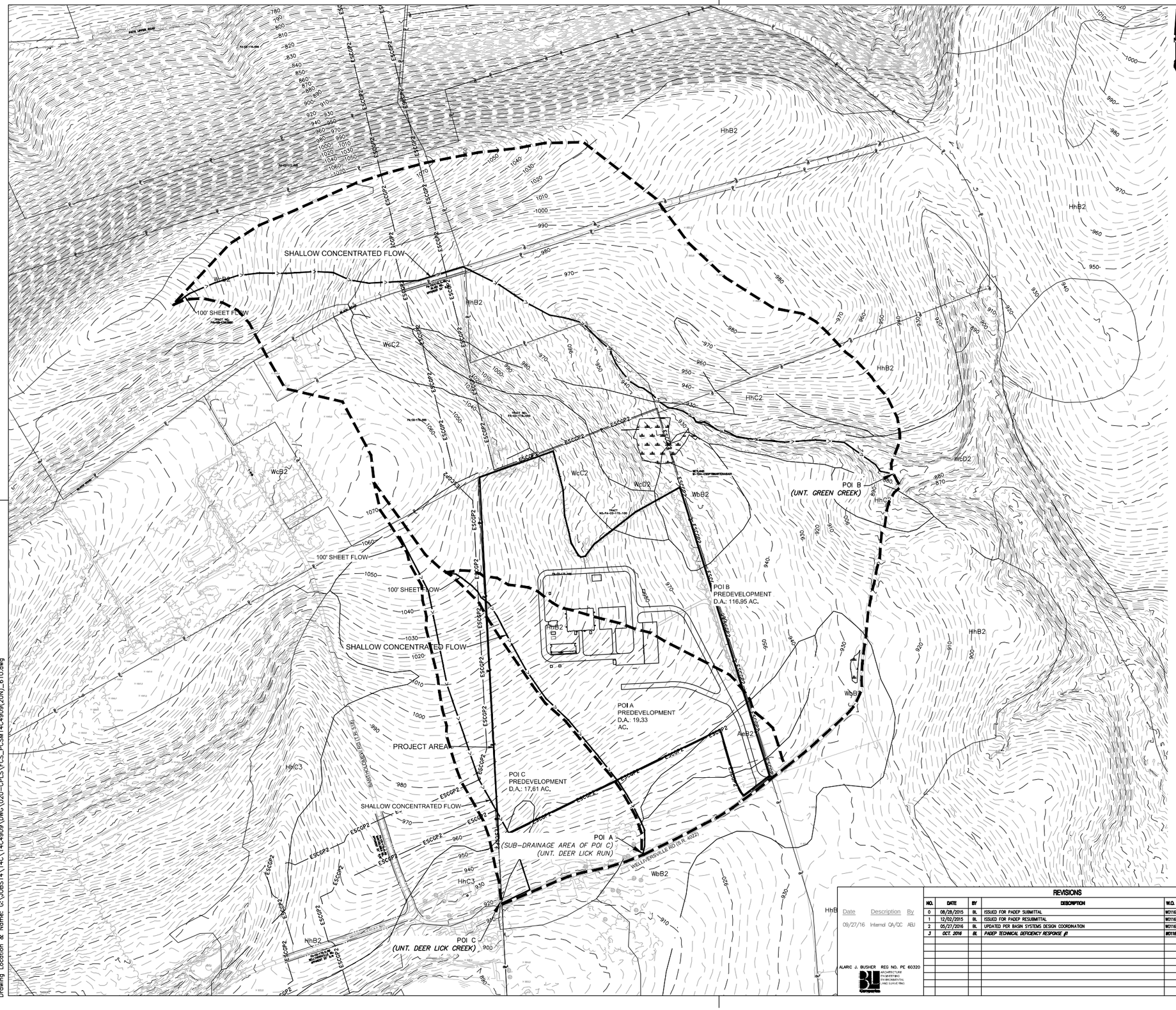
APPENDICES

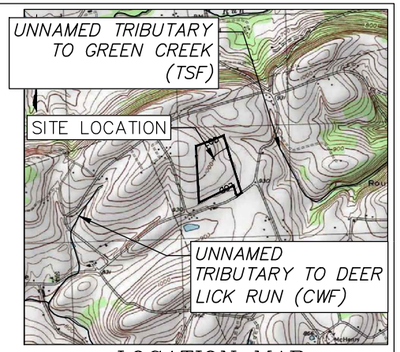
APPENDIX A

Compressor Station 610 Supporting Calculations

A.1 Pre-Development Calculations
A.2 Post Development Calculations
A.3 Conveyance Calculations
A.4 PCSM BMP Calculations
A.5 Water Quality Worksheets
A.6 Site Characterization Assessment
A.7 Supporting Documentation

A.1 Pre-Development Calculations





LOCATION MAP

USGS BLOOMSBURG QUADRANGLE
SCALE: 1"=2,000'

LEGEND

- PROPERTY BOUNDARY LINE (APPROXIMATE)
- MAJOR CONTOUR (10' INTERVAL)
- MINOR CONTOUR (2' INTERVAL)
- FENCE
- STONE ROW
- SOIL BOUNDARY
- TREELINE
- CENTERLINE STREAM/EDGE WATERBODY
- DELINEATED WETLANDS
- × 1353.0 — SPOT ELEVATION
- TREE OR BUSH
- UTILITY POLE AND UTILITY LINE
- GUY POLE
- GUY POLE OR ANCHOR
- POST
- SIGN
- WATER WELL
- UTILITY BOX
- MONUMENT (PROPERTY BOUNDARY MARKER)
- IRON PIPE OR PIN (PROPERTY BOUNDARY MARKER)
- WsB — SOIL TYPE DESIGNATION
- ESCGP2 — ESCGP-2 PERMIT BOUNDARY (SITE)
- LOD — LIMIT OF DISTURBANCE (COMPRESSOR STATION 610)
- LIMIT OF WORKSPACE (OVERALL PIPELINE PROJECT)
- PROJECT AREA
- EXISTING ROAD
- ROW
- DRAINAGE AREA BOUNDARIES

GRAPHIC SCALE
150 75 0 150
SCALE IN FEET
1 Inch = 150 ft.

Date	Description	By
09/27/16	Internal QA/QC	AEU

ALARIC J. BUSHER REG NO. PE 60320
BL companies — ARCHITECTURE, ENGINEERING, ENVIRONMENTAL AND SURVEYING

REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
0	08/28/2015	BL	ISSUED FOR PADEP SUBMITTAL	W01161505	DAK	AJB
1	12/02/2015	BL	ISSUED FOR PADEP RESUBMITTAL	W01161505	DAK	AJB
2	05/27/2016	BL	UPDATED PER BASIN SYSTEMS DESIGN COORDINATION	W01161505	AJB	AJB
3	*OCT. 2016*	*BL*	*PADEP TECHNICAL DEFICIENCY RESPONSE #1*	*W01161505*	*ABJ*	*ABJ*

TRANSCONTINENTAL GAS PIPELINE COMPANY LLC
ATLANTIC SUNRISE PROJECT– PROPOSED 42" NATURAL GAS PIPELINE
POST CONSTRUCTION STORMWATER MANAGEMENT PLANS
FOR COMPRESSOR STATION 610
ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA
PRE–DEVELOPMENT DRAINAGE AREA MAP

Williams

DRAWN BY:	AOE	DATE:	04/03/15	ISSUED FOR BID:	SCALE: AS NOTED
CHECKED BY:	AJB	DATE:	04/03/15	ISSUED FOR CONSTRUCTION:	REVISION: J
APPROVED BY:	AJB	DATE:	07/17/15	DRAWING NUMBER: (66–0610)F–1A–9	SHEET 1 OF 1
W.O.	1161505				

Drawn By & Date/Time: EPierdes Sep. 27, 2016 – 2:37pm
Drawing Location & Name: G:\JOBS\14_14C\14C4909\DWG\020-CPLS\FCS_PCSM14C4909(20N)_610.dwg

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Point of Interest A
Pre-Development Calculations

Summary for Subcatchment 1: PREDEVELOPMENT DRAINAGE AREA TO POI A

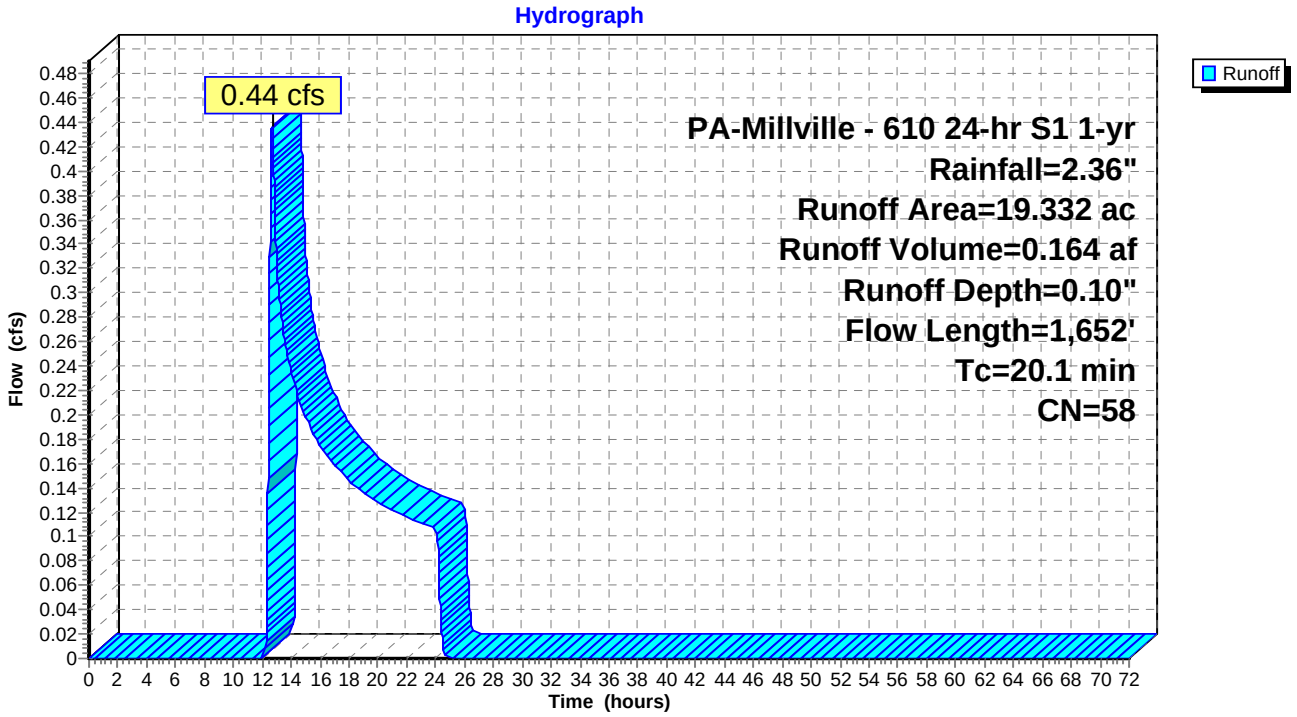
Runoff = 0.44 cfs @ 12.68 hrs, Volume= 0.164 af, Depth= 0.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
PA-Millville - 610 24-hr S1 1-yr Rainfall=2.36"

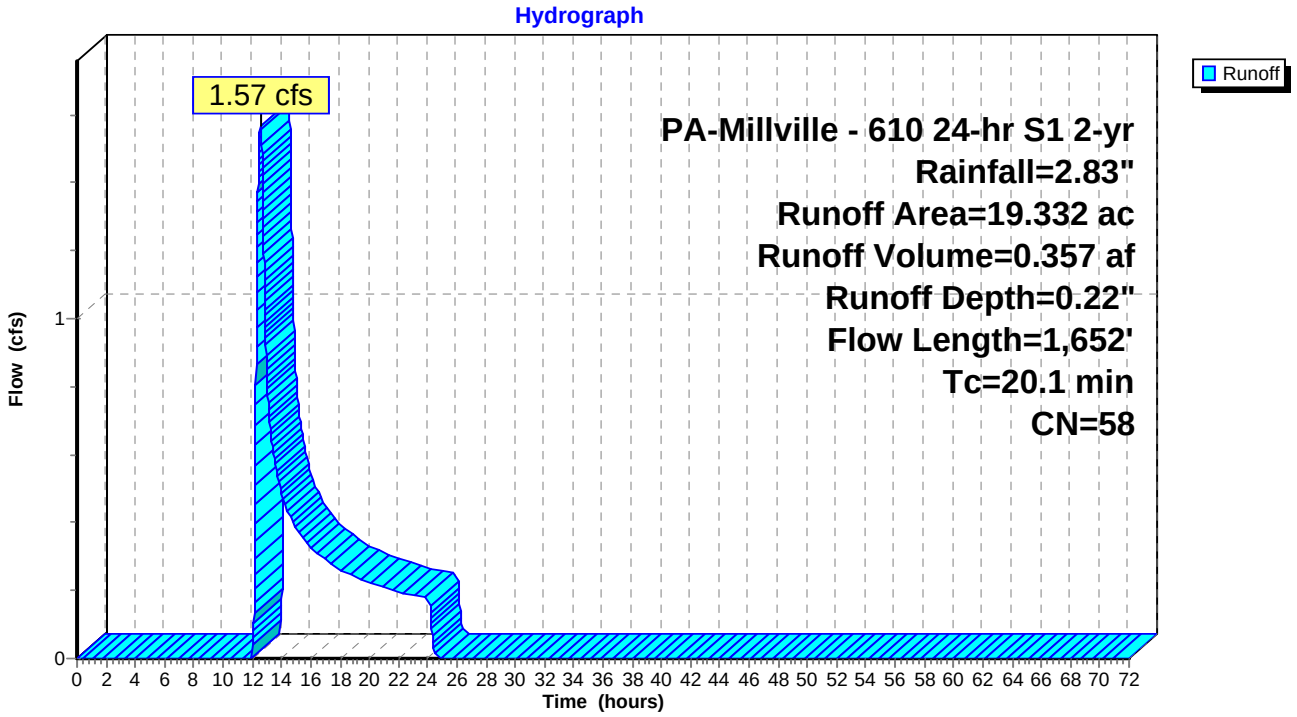
Area (ac)	CN	Description
19.332	58	Meadow, non-grazed, HSG B
19.332		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	100	0.0500	0.26		**Sheet Flow, SHT 1** Range n= 0.130 P2= 2.83"
1.1	111	0.0633	1.76		**Shallow Concentrated Flow, SCF 1** Short Grass Pasture Kv= 7.0 fps
4.6	561	0.0835	2.02		**Shallow Concentrated Flow, SCF 2** Short Grass Pasture Kv= 7.0 fps
3.2	363	0.0730	1.89		**Shallow Concentrated Flow, SCF 3** Short Grass Pasture Kv= 7.0 fps
2.1	230	0.0686	1.83		**Shallow Concentrated Flow, SCF 4** Short Grass Pasture Kv= 7.0 fps
1.5	177	0.0811	1.99		**Shallow Concentrated Flow, SCF 5** Short Grass Pasture Kv= 7.0 fps
1.2	110	0.0489	1.55		**Shallow Concentrated Flow, SCF 6** Short Grass Pasture Kv= 7.0 fps
20.1	1,652	Total			

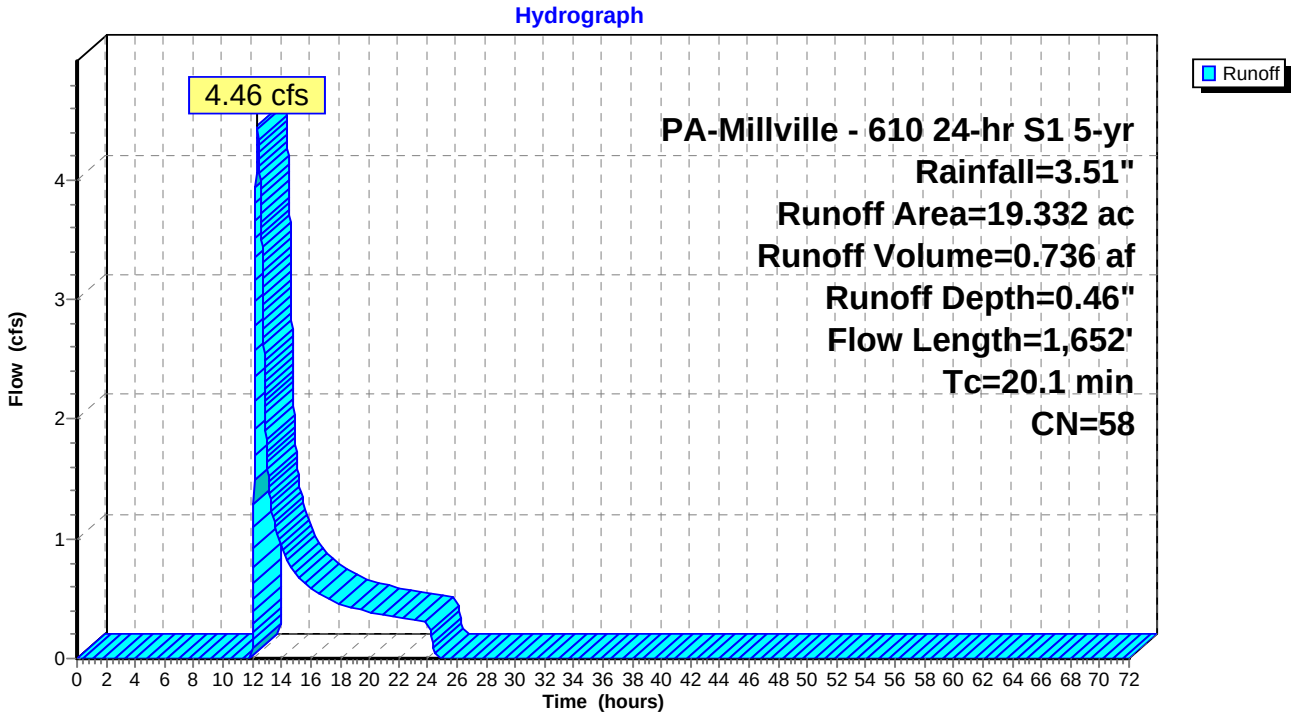
Subcatchment 1: PREDEVELOPMENT DRAINAGE AREA TO POI A



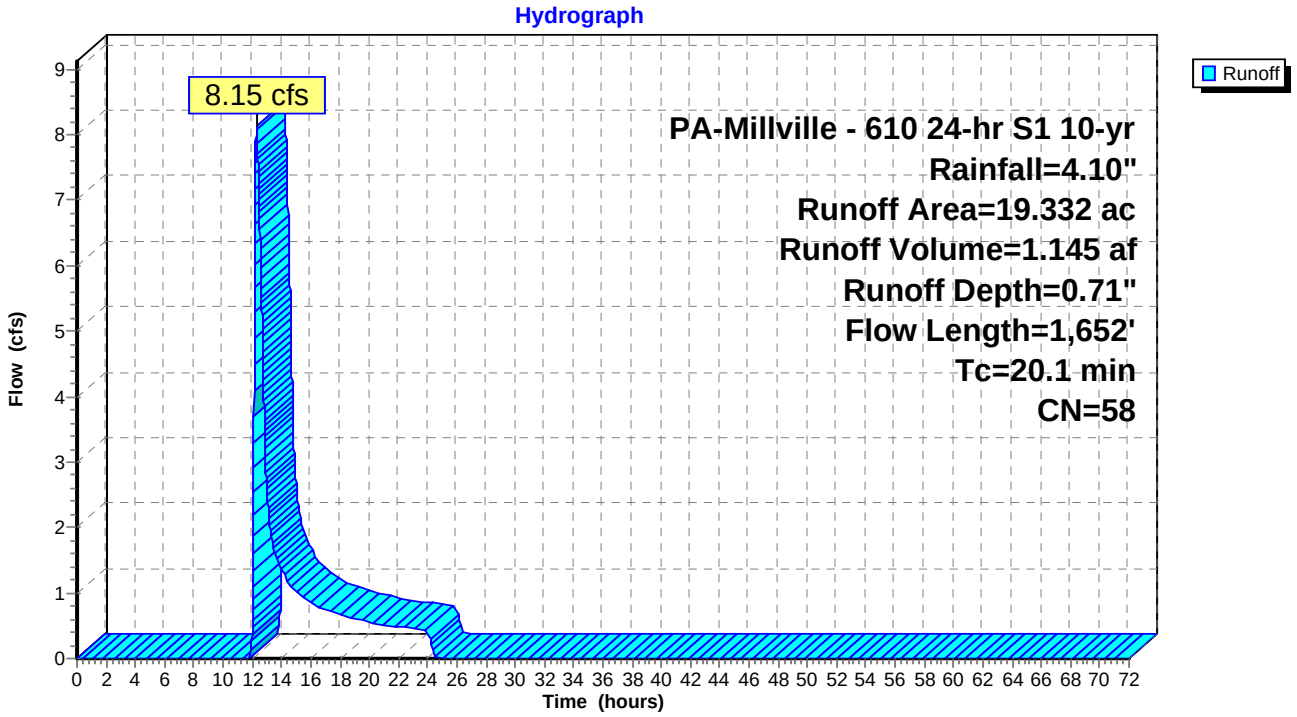
Subcatchment 1: PREDEVELOPMENT DRAINAGE AREA TO POI A



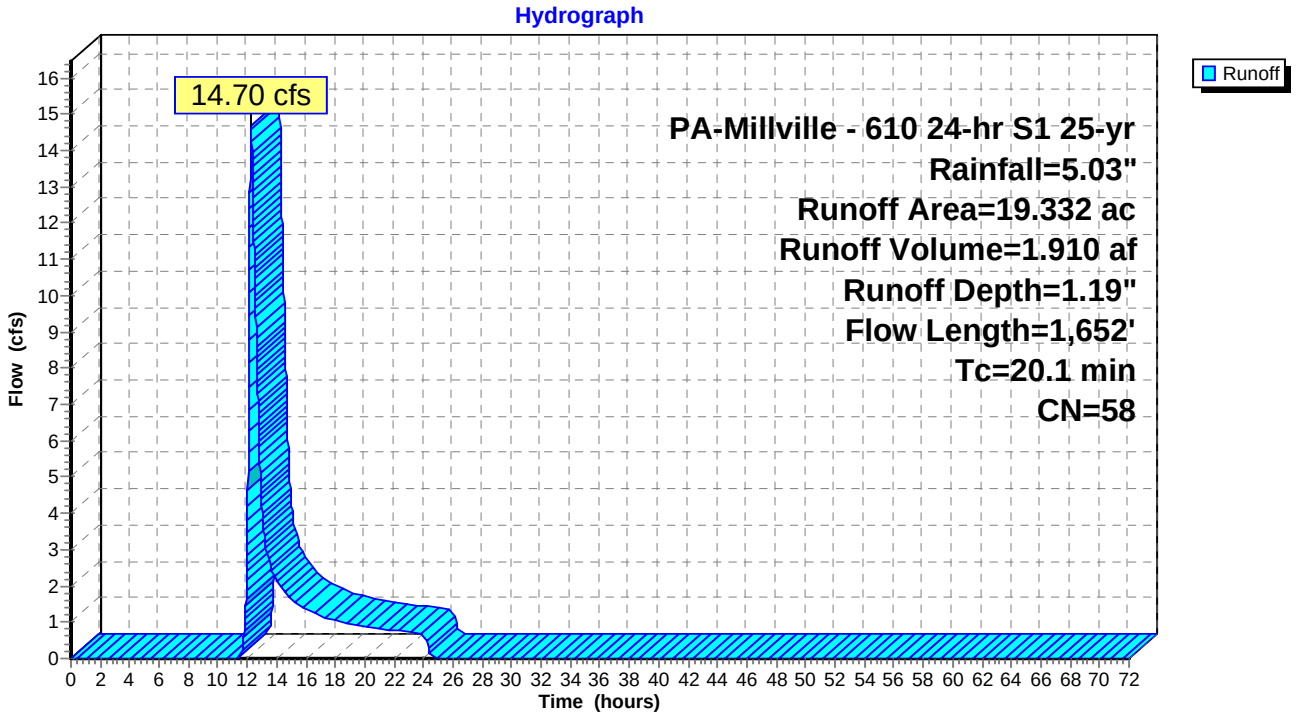
Subcatchment 1: PREDEVELOPMENT DRAINAGE AREA TO POI A



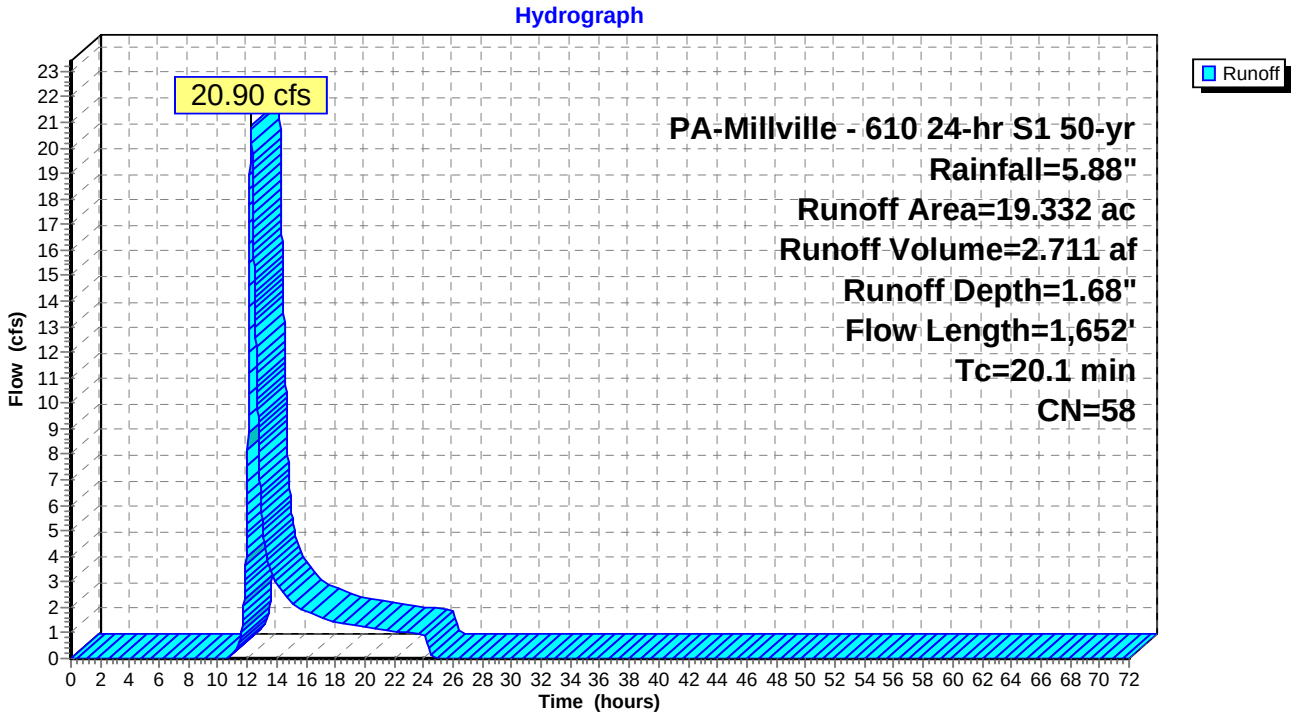
Subcatchment 1: PREDEVELOPMENT DRAINAGE AREA TO POI A



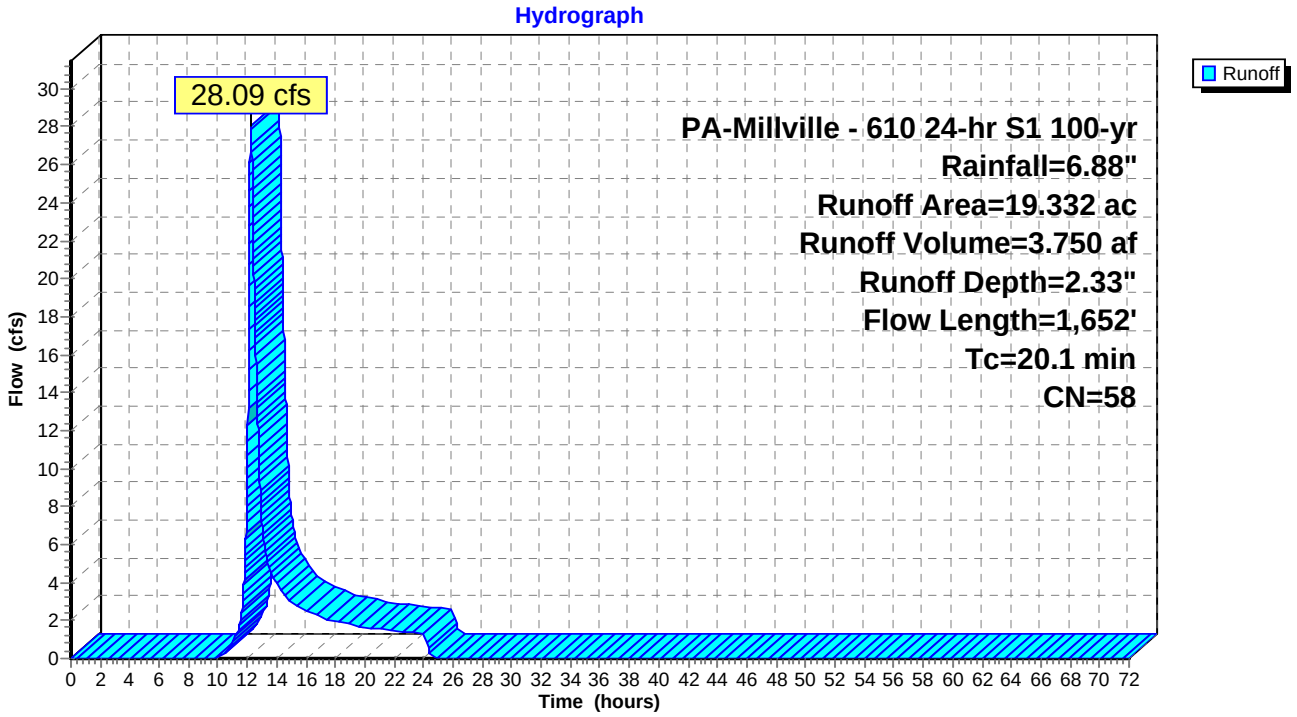
Subcatchment 1: PREDEVELOPMENT DRAINAGE AREA TO POI A



Subcatchment 1: PREDEVELOPMENT DRAINAGE AREA TO POI A



Subcatchment 1: PREDEVELOPMENT DRAINAGE AREA TO POI A



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Point of Interest B
Pre-Development Calculations

Summary for Subcatchment 7: PREDEVELOPMENT DRAINAGE AREA TO POI B

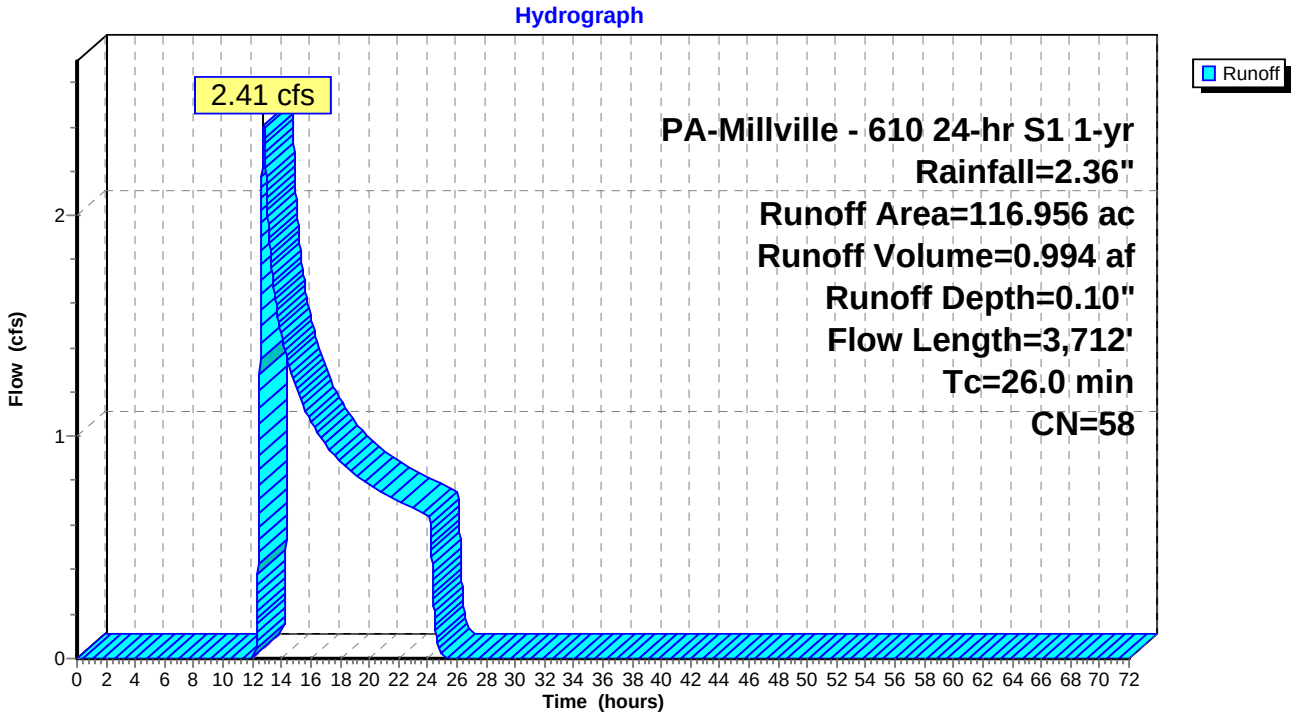
Runoff = 2.41 cfs @ 12.77 hrs, Volume= 0.994 af, Depth= 0.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
PA-Millville - 610 24-hr S1 1-yr Rainfall=2.36"

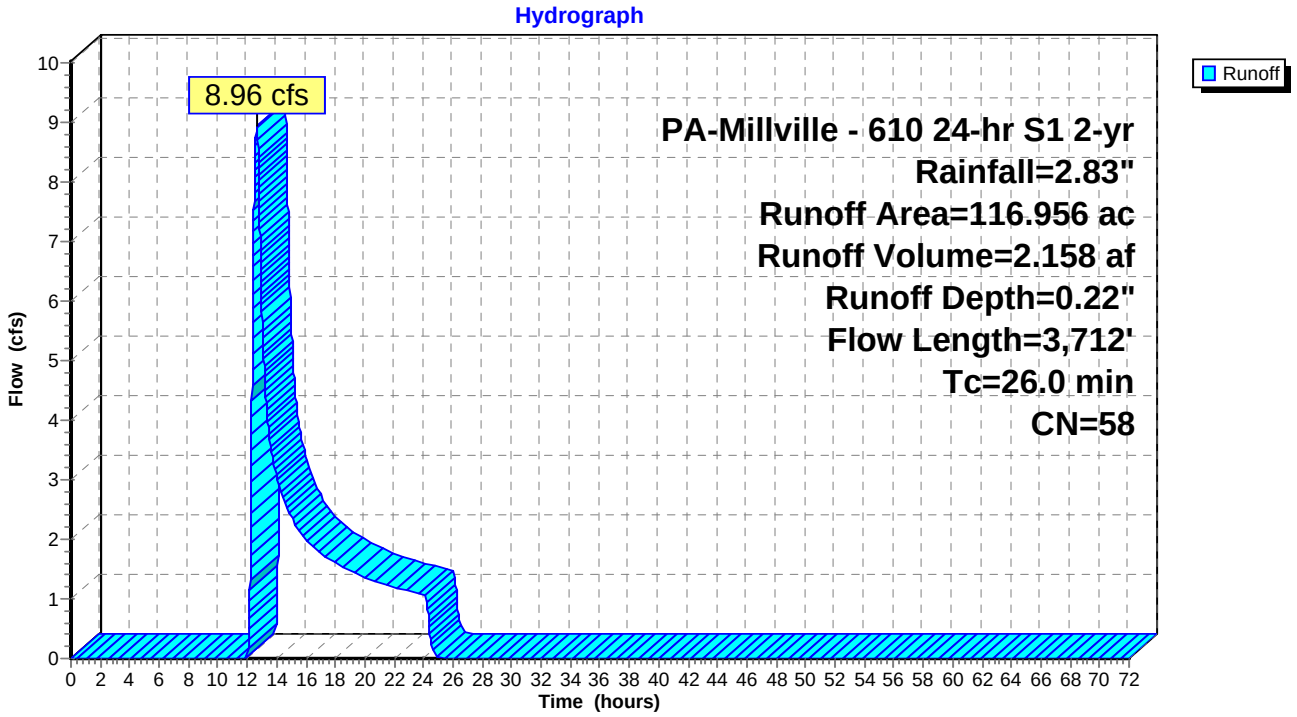
	Area (ac)	CN	Description
	1.818	55	Woods, Good, HSG B
	113.882	58	Meadow, non-grazed, HSG B
*	1.256	98	Impervious, HSG D
	116.956	58	Weighted Average
	115.700		98.93% Pervious Area
	1.256		1.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	100	0.0650	0.29		**Sheet Flow, SHT 1** Range n= 0.130 P2= 2.83"
8.2	1,084	0.0990	2.20		**Shallow Concentrated Flow, SCF 1** Short Grass Pasture Kv= 7.0 fps
1.6	262	0.0340	2.77		**Shallow Concentrated Flow, SCF 2** Grassed Waterway Kv= 15.0 fps
1.4	487	0.7000	5.86		**Shallow Concentrated Flow, SCF 3** Short Grass Pasture Kv= 7.0 fps
9.0	1,779	0.0480	3.29		**Shallow Concentrated Flow, SCF 4** Grassed Waterway Kv= 15.0 fps
26.0	3,712	Total			

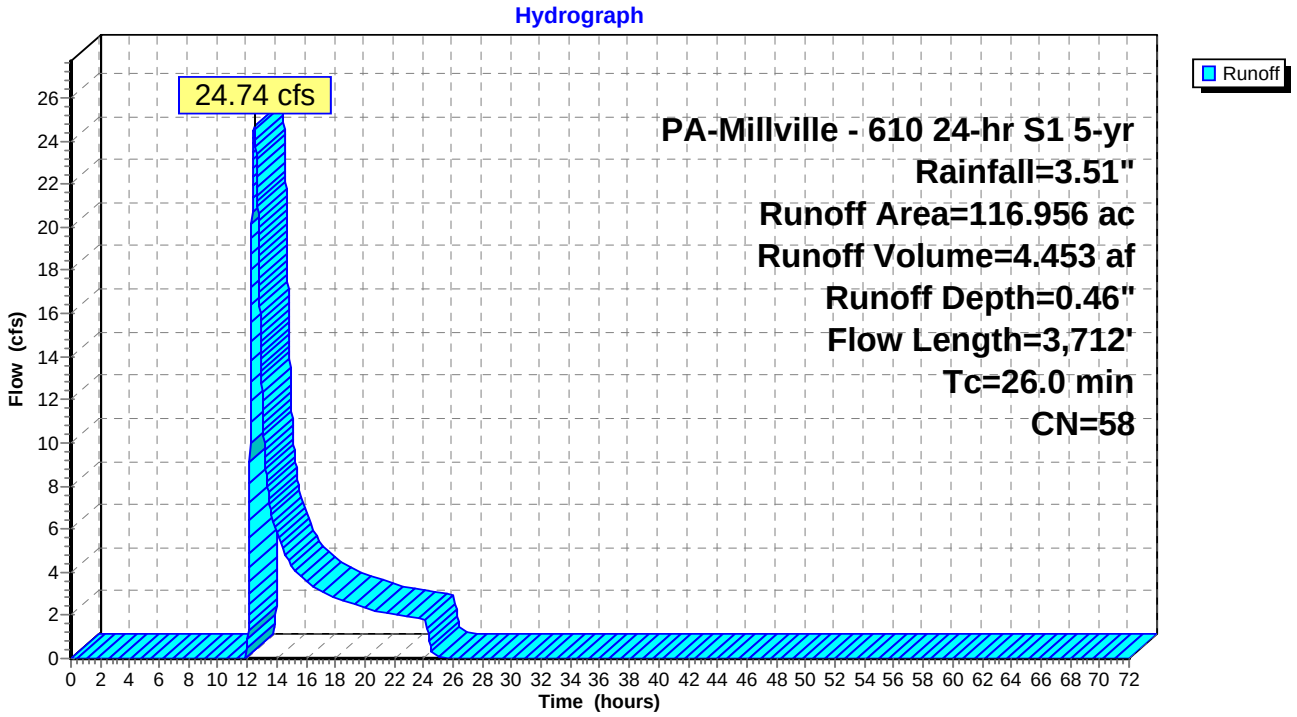
Subcatchment 7: PREDEVELOPMENT DRAINAGE AREA TO POI B



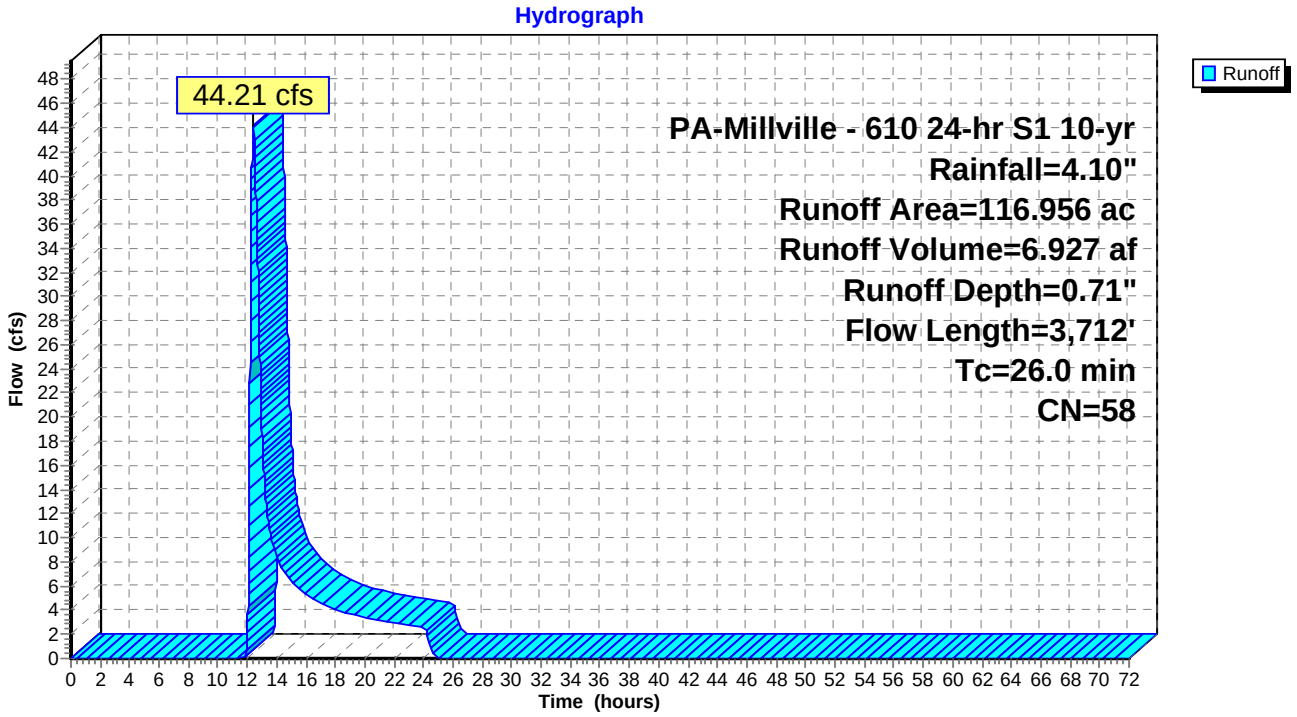
Subcatchment 7: PREDEVELOPMENT DRAINAGE AREA TO POI B



Subcatchment 7: PREDEVELOPMENT DRAINAGE AREA TO POI B



Subcatchment 7: PREDEVELOPMENT DRAINAGE AREA TO POI B



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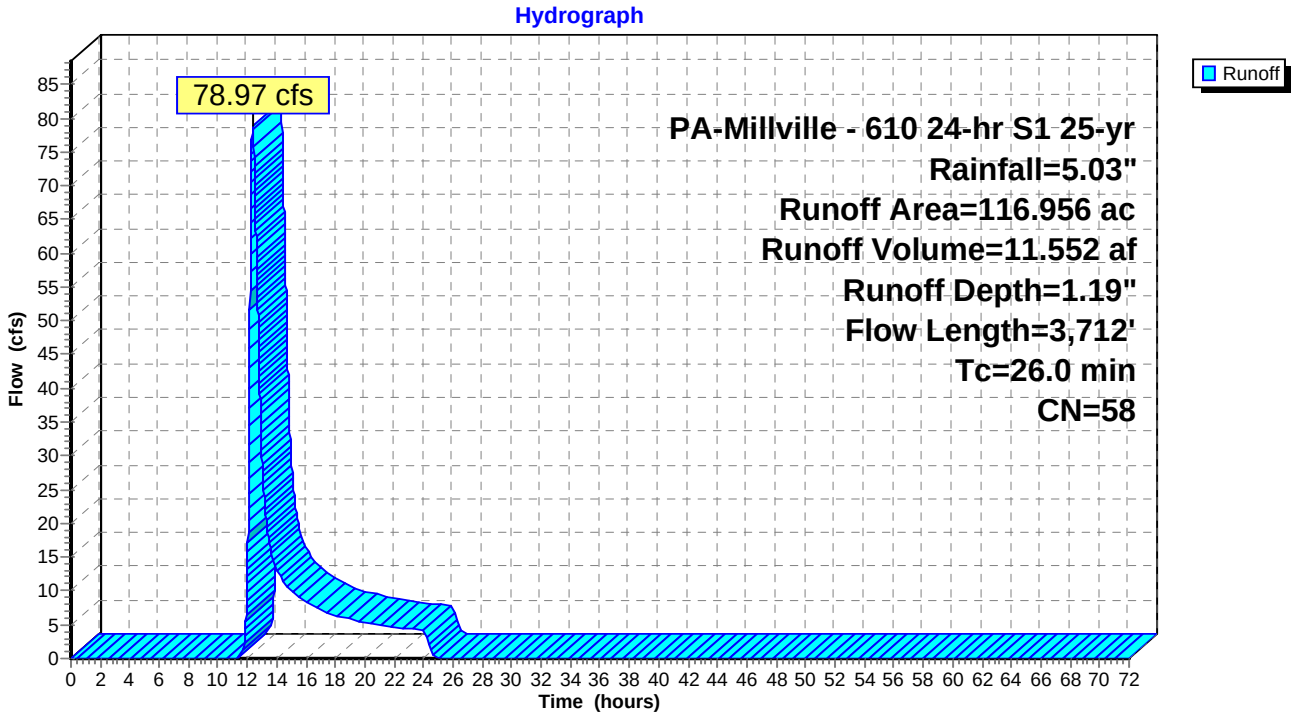

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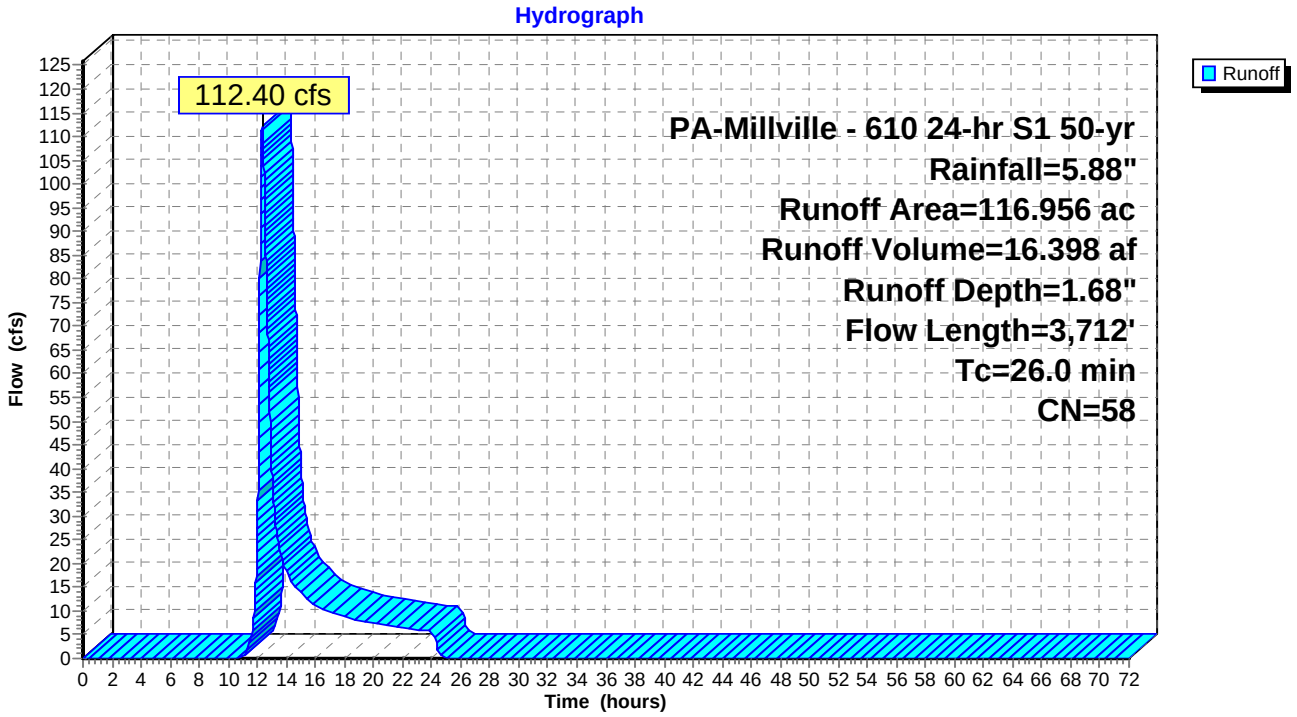

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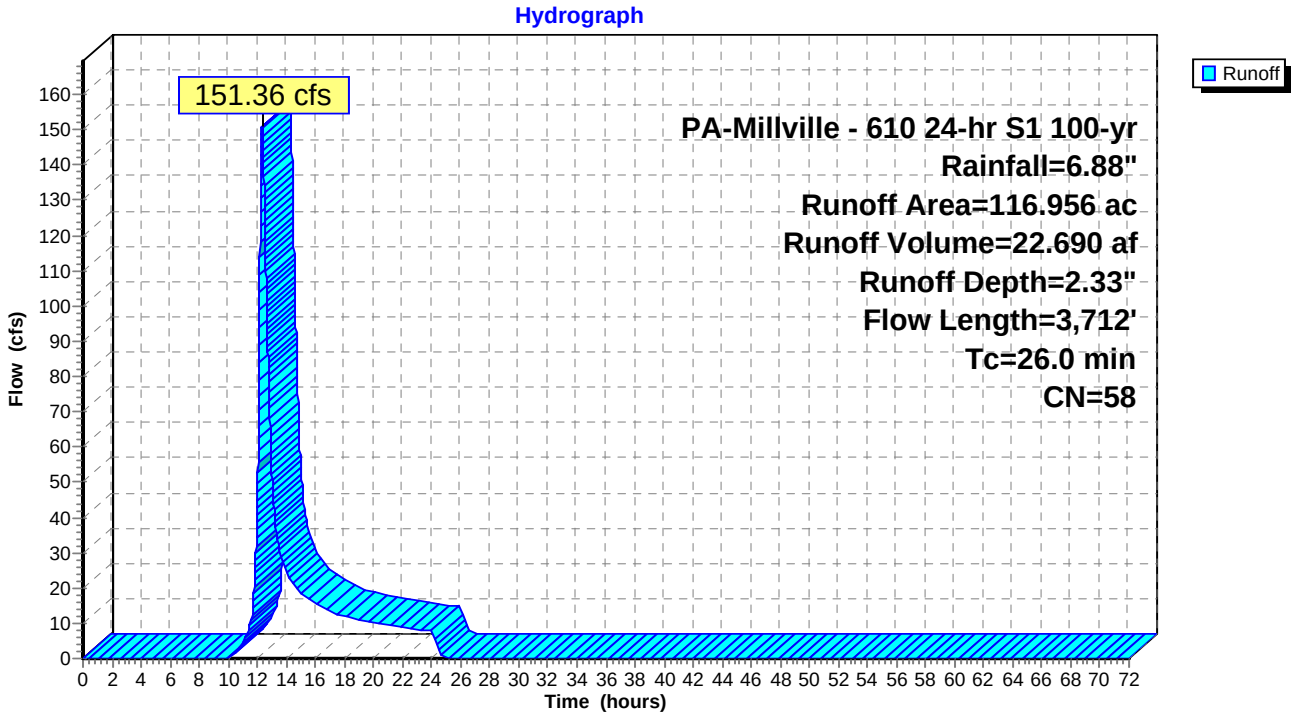

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Point of Interest C
Pre-Development Calculations

Summary for Subcatchment 11S: PREDEVELOPMENT DRAINAGE AREA TO POI C

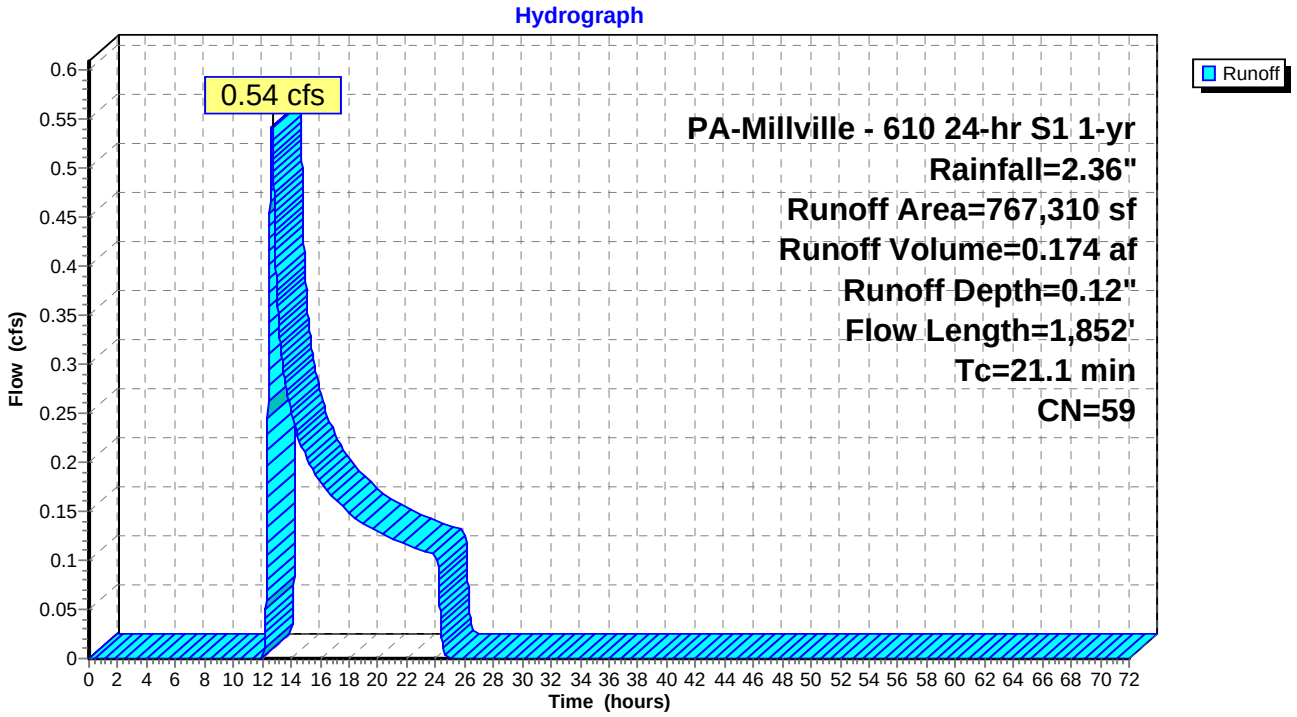
Runoff = 0.54 cfs @ 12.67 hrs, Volume= 0.174 af, Depth= 0.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
PA-Millville - 610 24-hr S1 1-yr Rainfall=2.36"

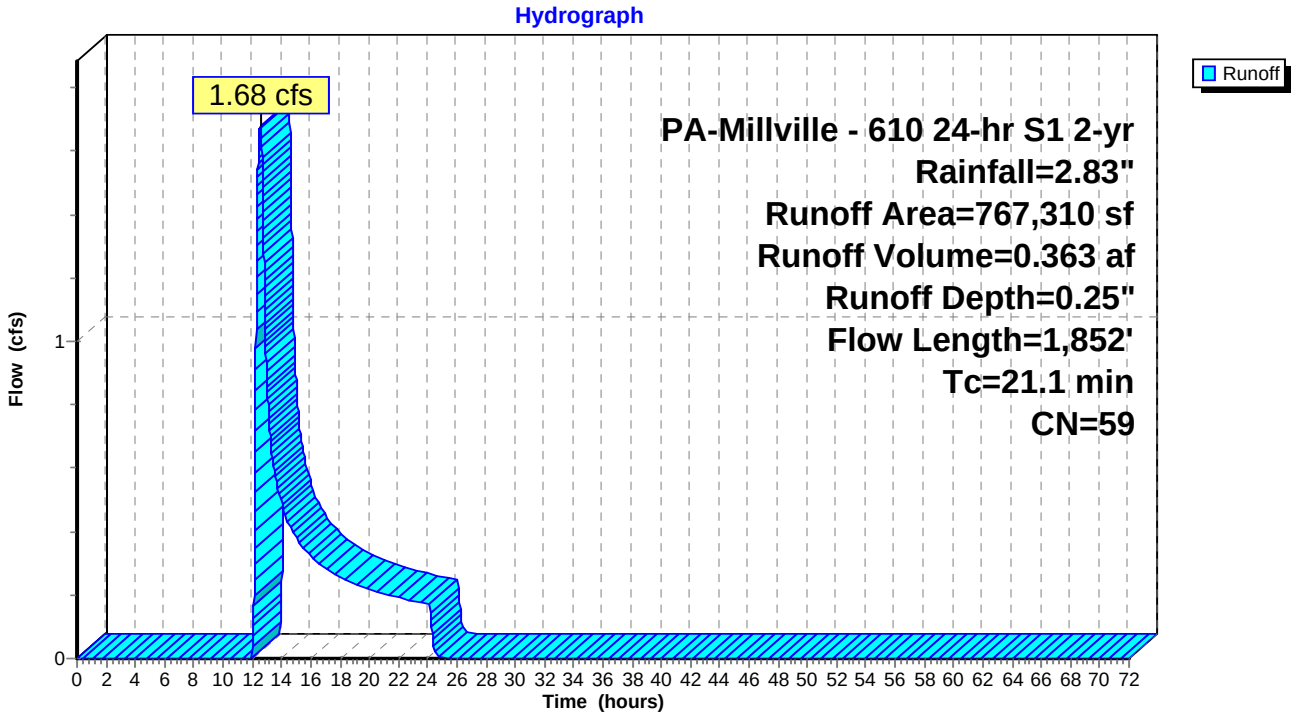
	Area (sf)	CN	Description
	757,073	58	Meadow, non-grazed, HSG B
*	10,237	98	Impervious, HSG B
	767,310	59	Weighted Average
	757,073		98.67% Pervious Area
	10,237		1.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.7	100	0.0450	0.25		**Sheet Flow, SHT 1** Range n= 0.130 P2= 2.83"
13.7	1,660	0.0830	2.02		**Shallow Concentrated Flow, SCF 1** Short Grass Pasture Kv= 7.0 fps
0.7	92	0.0200	2.12		**Shallow Concentrated Flow, SCF 2** Grassed Waterway Kv= 15.0 fps
21.1	1,852	Total			

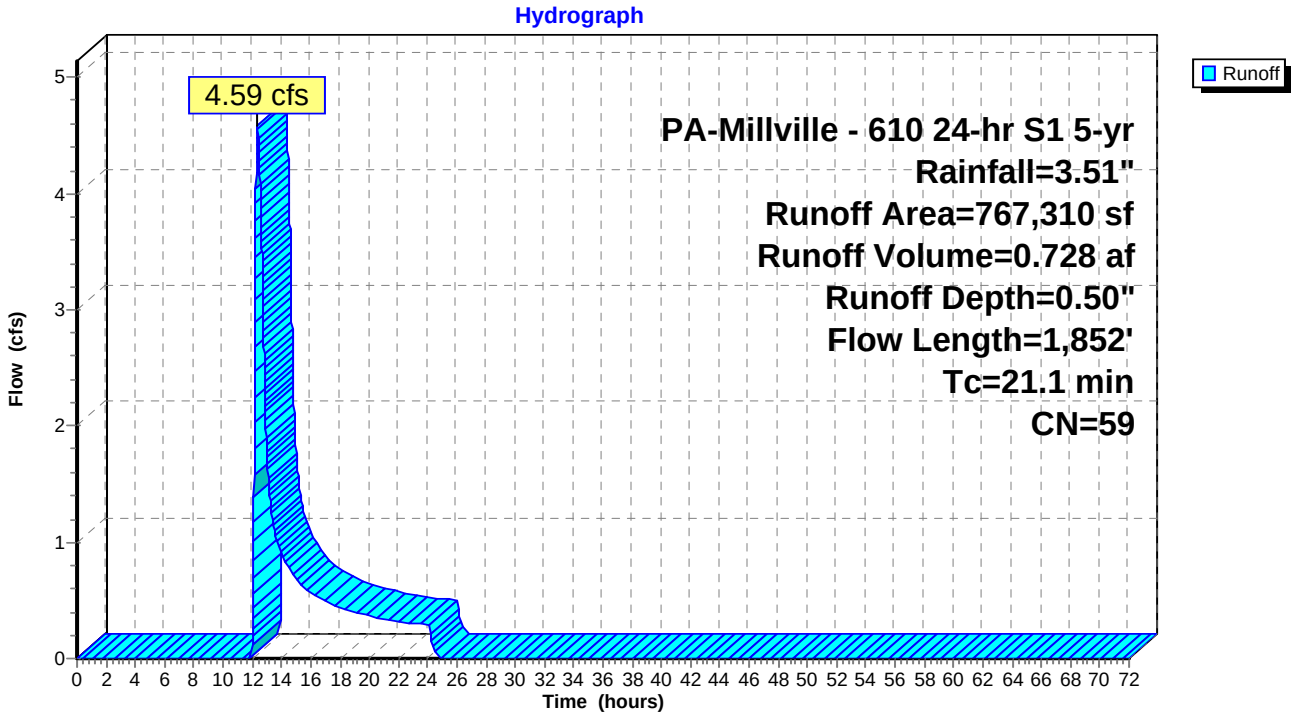
Subcatchment 11S: PREDEVELOPMENT DRAINAGE AREA TO POI C



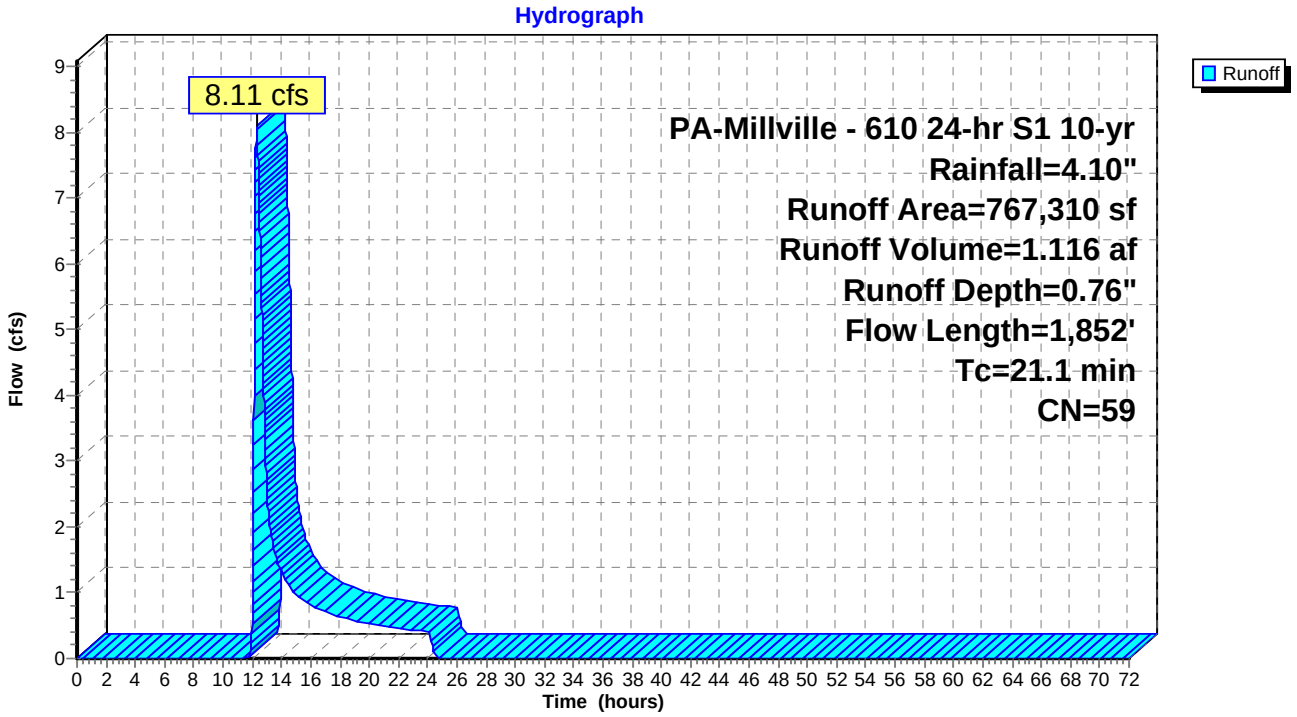
Subcatchment 11S: PREDEVELOPMENT DRAINAGE AREA TO POI C



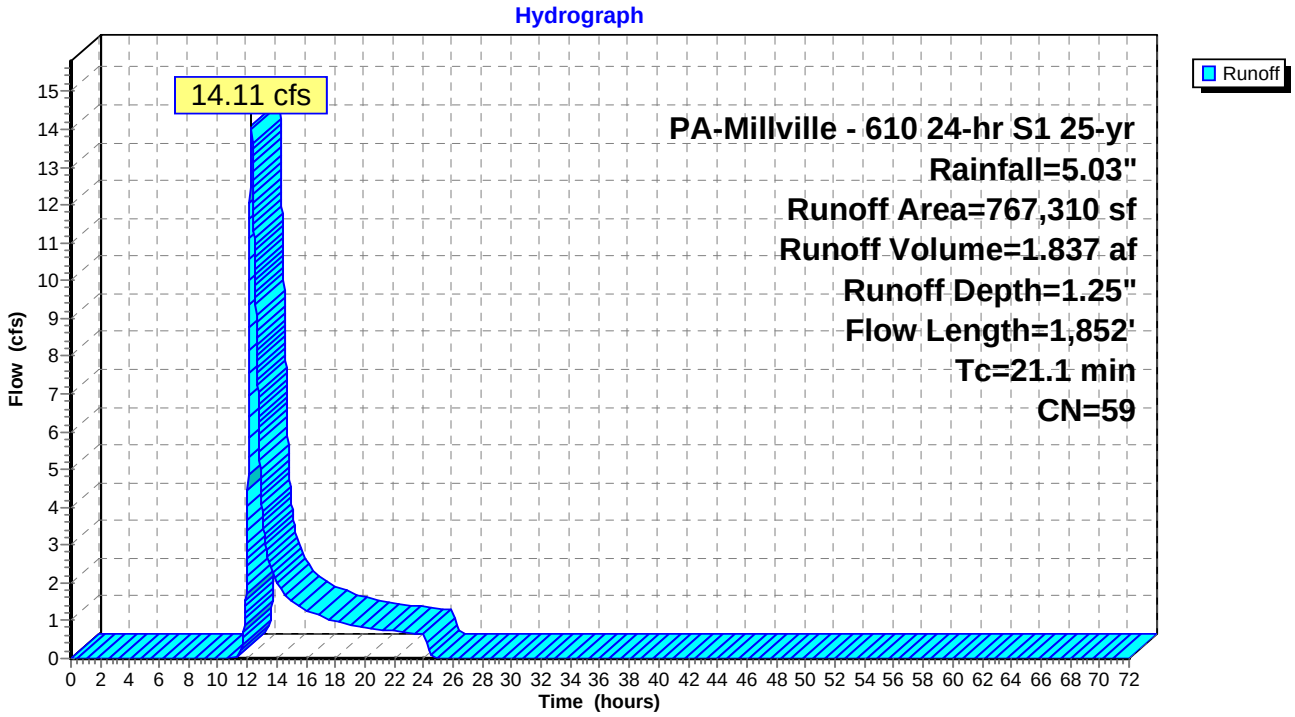
Subcatchment 11S: PREDEVELOPMENT DRAINAGE AREA TO POI C



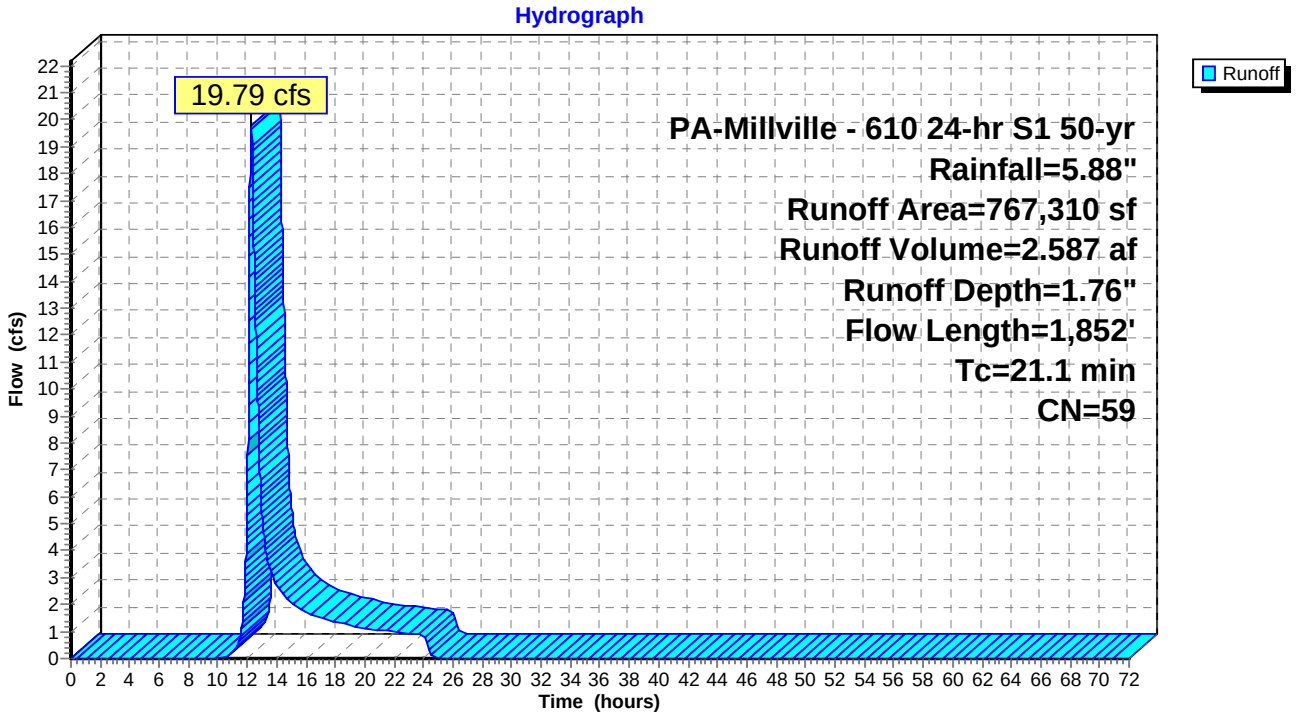
Subcatchment 11S: PREDEVELOPMENT DRAINAGE AREA TO POI C



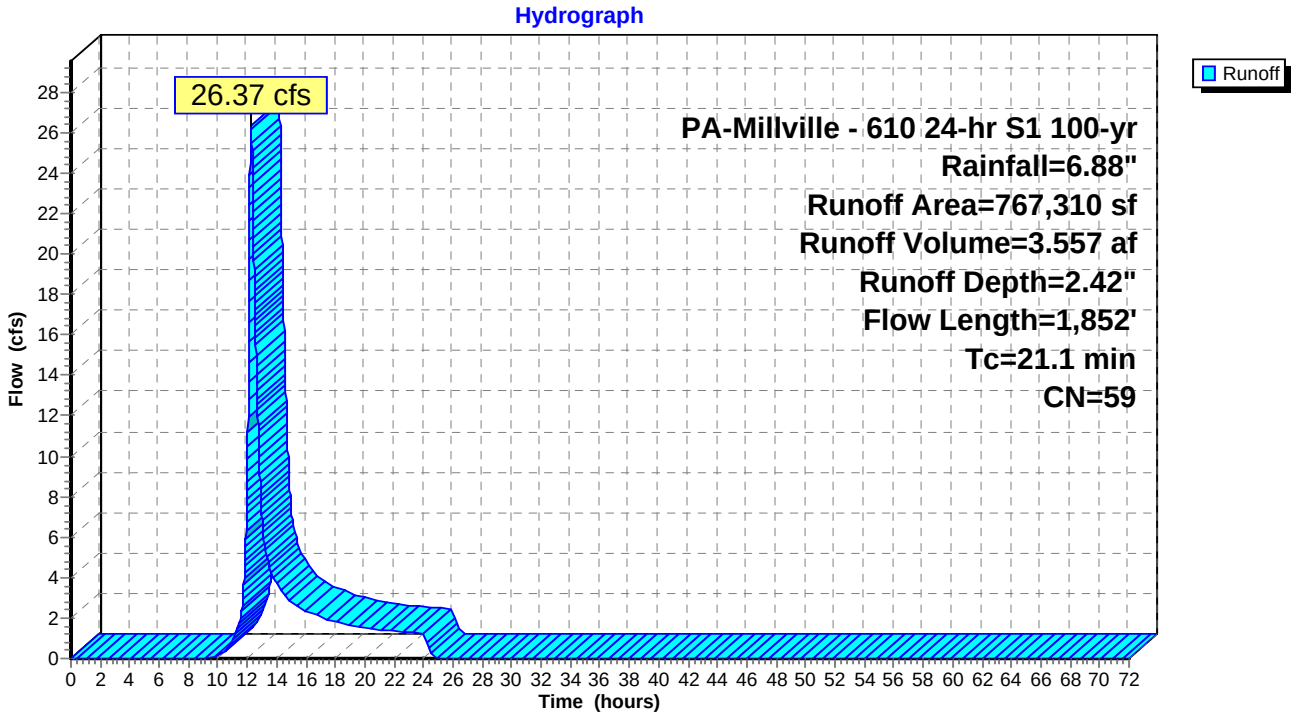
Subcatchment 11S: PREDEVELOPMENT DRAINAGE AREA TO POI C



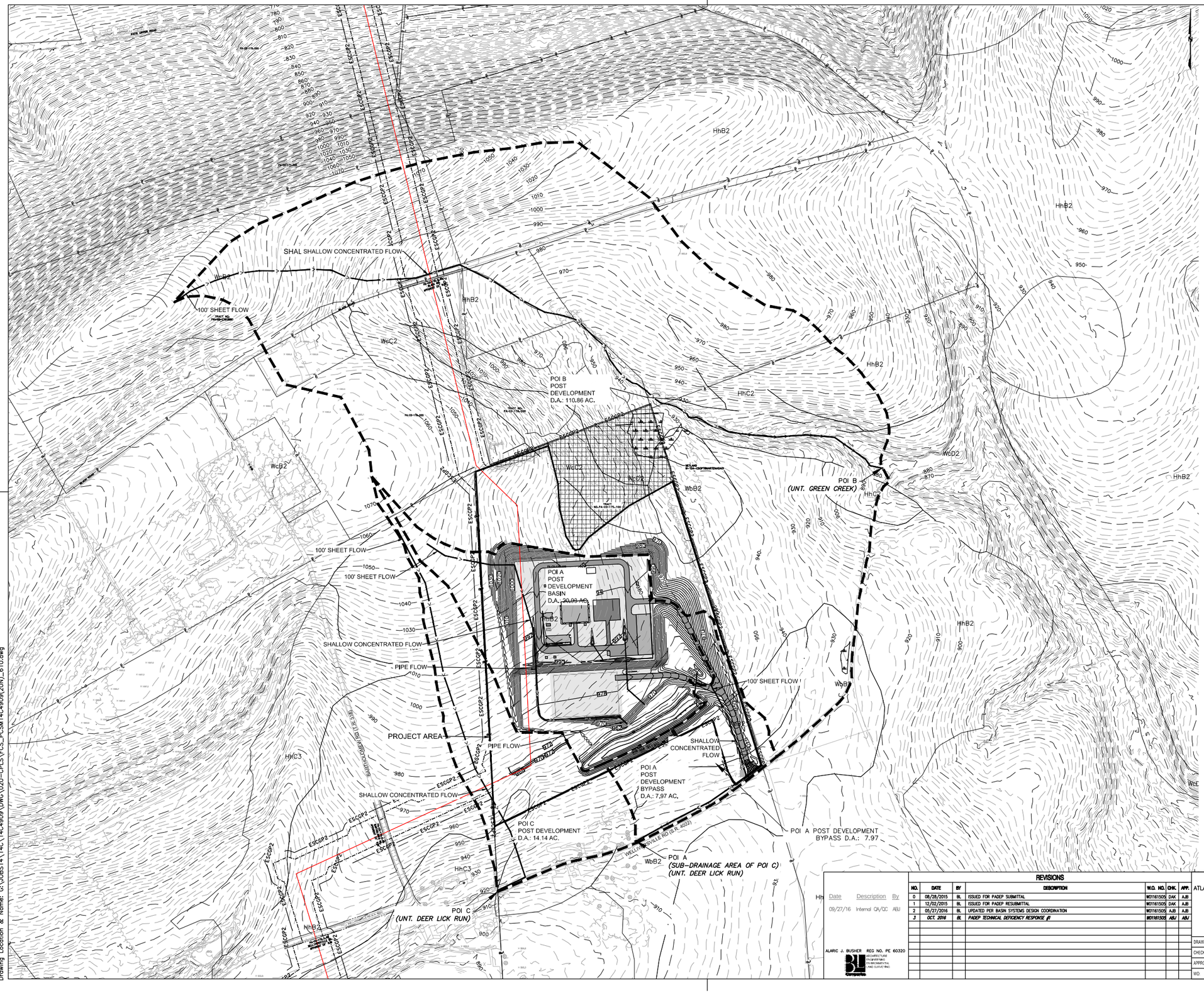
Subcatchment 11S: PREDEVELOPMENT DRAINAGE AREA TO POI C

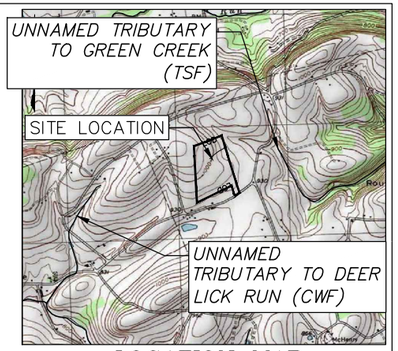


Subcatchment 11S: PREDEVELOPMENT DRAINAGE AREA TO POI C



A.2 Post Development Calculations





LOCATION MAP

USGS BLOOMSBURG QUADRANGLE
SCALE: 1"=2,000'

LEGEND

- PROPERTY BOUNDARY LINE (APPROXIMATE)
- 1460 MAJOR CONTOUR (10' INTERVAL)
- MINOR CONTOUR (2' INTERVAL)
- FENCE
- STONE ROW
- SOIL BOUNDARY
- TREELINE
- CENTERLINE STREAM/EDGE WATERBODY
- DELINEATED WETLANDS
- × 1353.0 SPOT ELEVATION
- TREE OR BUSH
- UTILITY POLE AND UTILITY LINE
- GUY POLE
- GUY POLE OR ANCHOR
- POST
- SIGN
- WATER WELL
- UTILITY BOX
- MONUMENT (PROPERTY BOUNDARY MARKER)
- IRON PIPE OR PIN (PROPERTY BOUNDARY MARKER)
- WsB SOIL TYPE DESIGNATION
- EXISTING ROAD
- ROW
- 1460 MAJOR CONTOUR (10' INTERVAL)
- MINOR CONTOUR (2' INTERVAL)
- MINOR CONTOUR (1' INTERVAL)
- LOD LIMIT OF DISTURBANCE (COMPRESSOR STATION 610)
- ESCGP2 ESCGP-2 PERMIT BOUNDARY
- CENTERLINE GAS PIPELINE
- LIMIT OF WORKSPACE (OVERALL PIPELINE PROJECT)
- PROJECT AREA
- PROPOSED ACCESS ROAD
- DRAINAGE AREA BOUNDARIES
- TRM LINING

GRAPHIC SCALE
200 100 0 200
SCALE IN FEET
1 Inch = 200 ft.

Date	Description	By
09/27/16	Internal QA/QC	AEU

ALARIC J. BUSHER REG NO. PE 60320
BL Companies ARCHITECTURE ENGINEERING CONSULTING AND SURVEYING

REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
0	08/28/2015	BL	ISSUED FOR PADEP SUBMITTAL	W01161505	DAK	AJB
1	12/02/2015	BL	ISSUED FOR PADEP RESUBMITTAL	W01161505	DAK	AJB
2	05/27/2016	BL	UPDATED PER BASIN SYSTEMS DESIGN COORDINATION	W01161505	AJB	AJB
J	OCT. 2016	BL	PADEP TECHNICAL DEFICIENCY RESPONSE #1	W01161505	AEU	AEU

TRANSCONTINENTAL GAS PIPELINE COMPANY LLC
ATLANTIC SUNRISE PROJECT– PROPOSED 42" NATURAL GAS PIPELINE
POST CONSTRUCTION STORMWATER MANAGEMENT PLANS
FOR COMPRESSOR STATION 610
ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA
POST DEVELOPMENT DRAINAGE AREA MAP

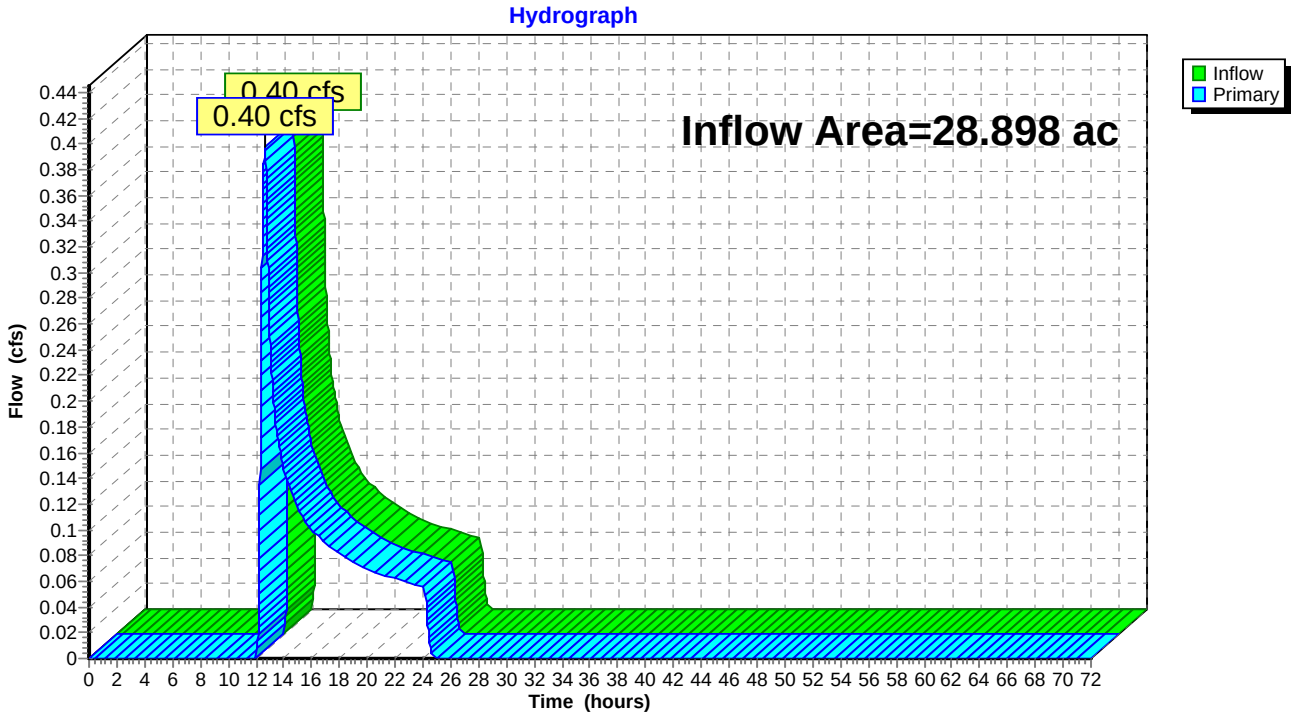
Williams

DRAWN BY:	AOE	DATE:	04/03/15	ISSUED FOR BID:	SCALE: AS NOTED
CHECKED BY:	AJB	DATE:	04/03/15	ISSUED FOR CONSTRUCTION:	REVISION: J
APPROVED BY:	AJB	DATE:	07/17/15	DRAWING NUMBER: (66–0610)F–1A–9	SHEET 1 OF 1
W.O.	1161505				

Drawn By & Date/Time: EPierides Sep 27, 2016 – 2:39pm
Drawing Location & Name: G:\Jobs\14_14C\14C4909\DWG\020-CPLS\YCS_PCSM14C4909(20N)_610.dwg

Point of Interest A

Link 6: POI A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0.40 cfs
0.40 cfs
Inflow Area=28.898 ac
Inflow
Primary
Flow (cfs)
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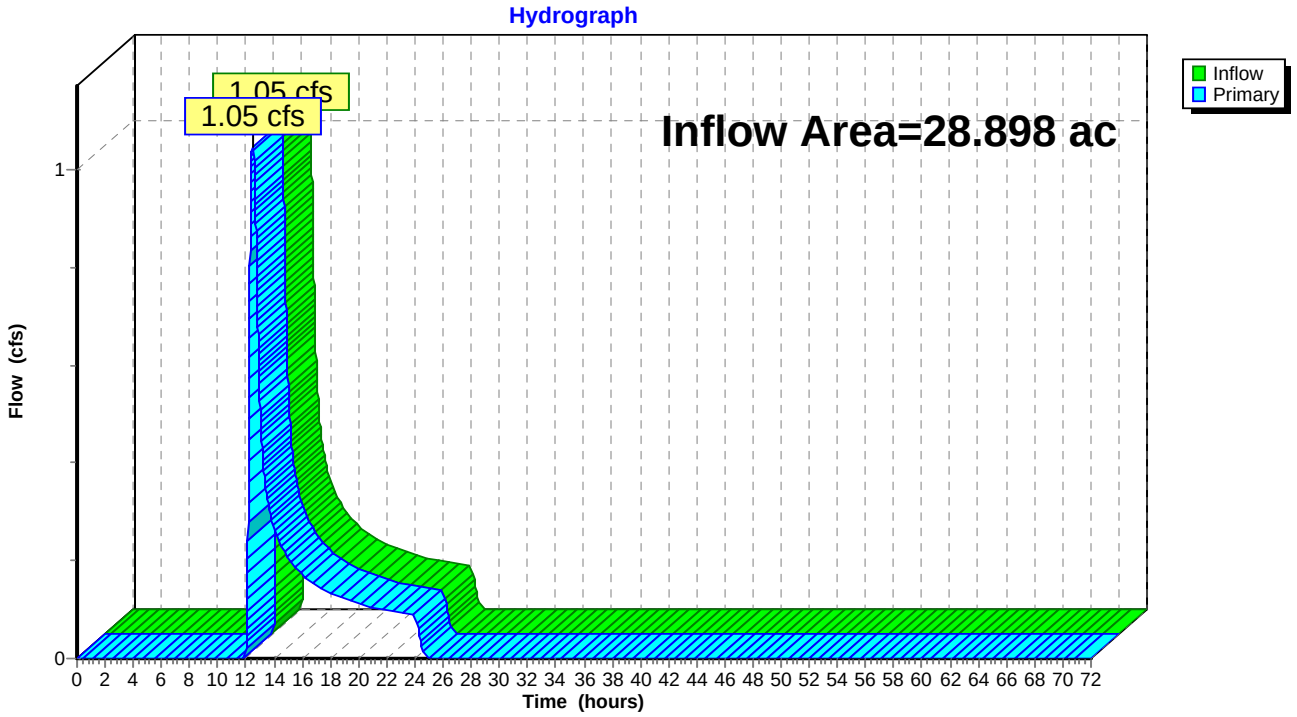
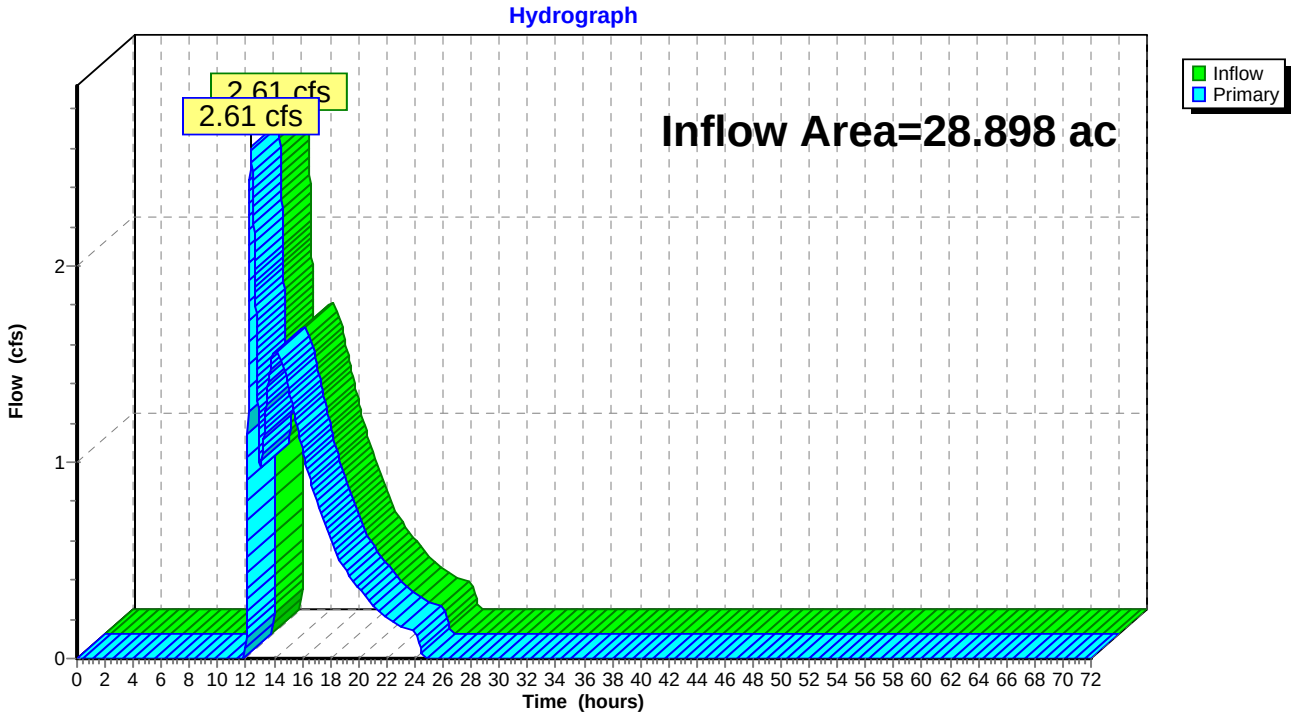
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72
Time (hours)

Link 6: POI A


Hydrograph
1.05 cfs
1.05 cfs
Inflow Area=28.898 ac
Inflow
Primary
Flow (cfs)
0
1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72
Time (hours)

Link 6: POI A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2.61 cfs
2.61 cfs
Inflow Area=28.898 ac
Inflow
Primary
Flow (cfs)
0
1
2
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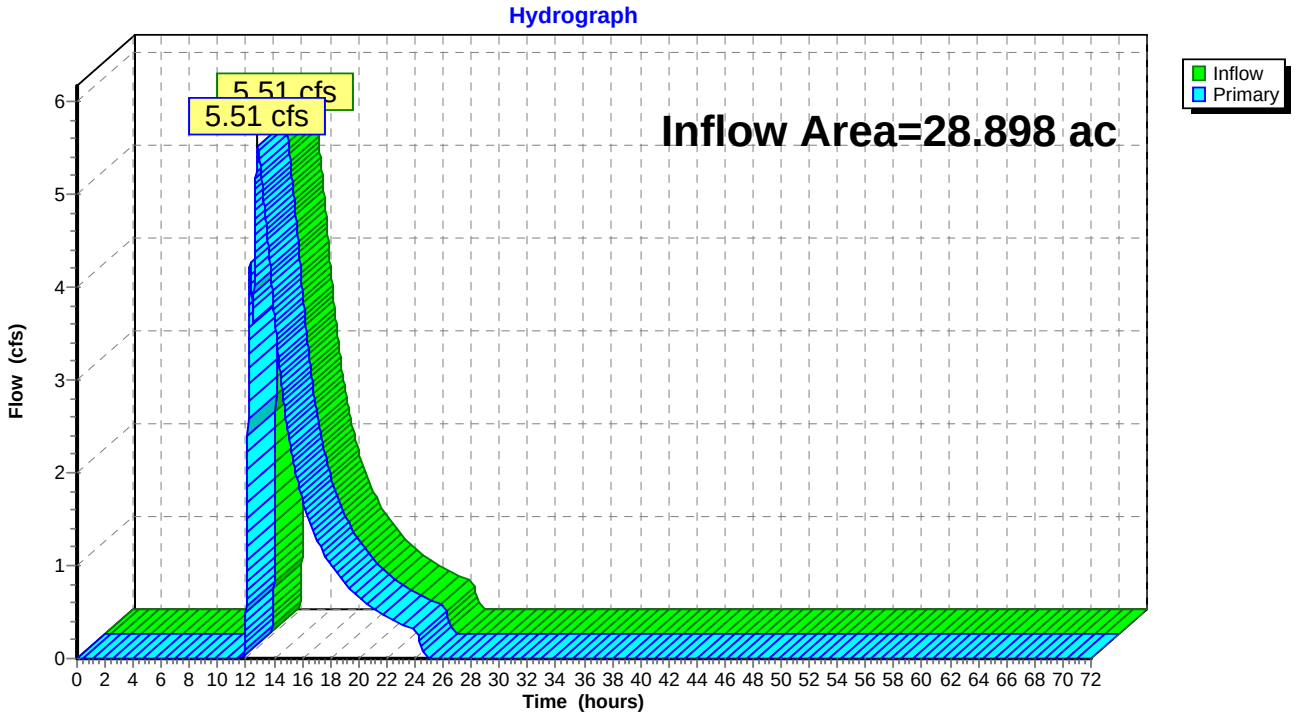
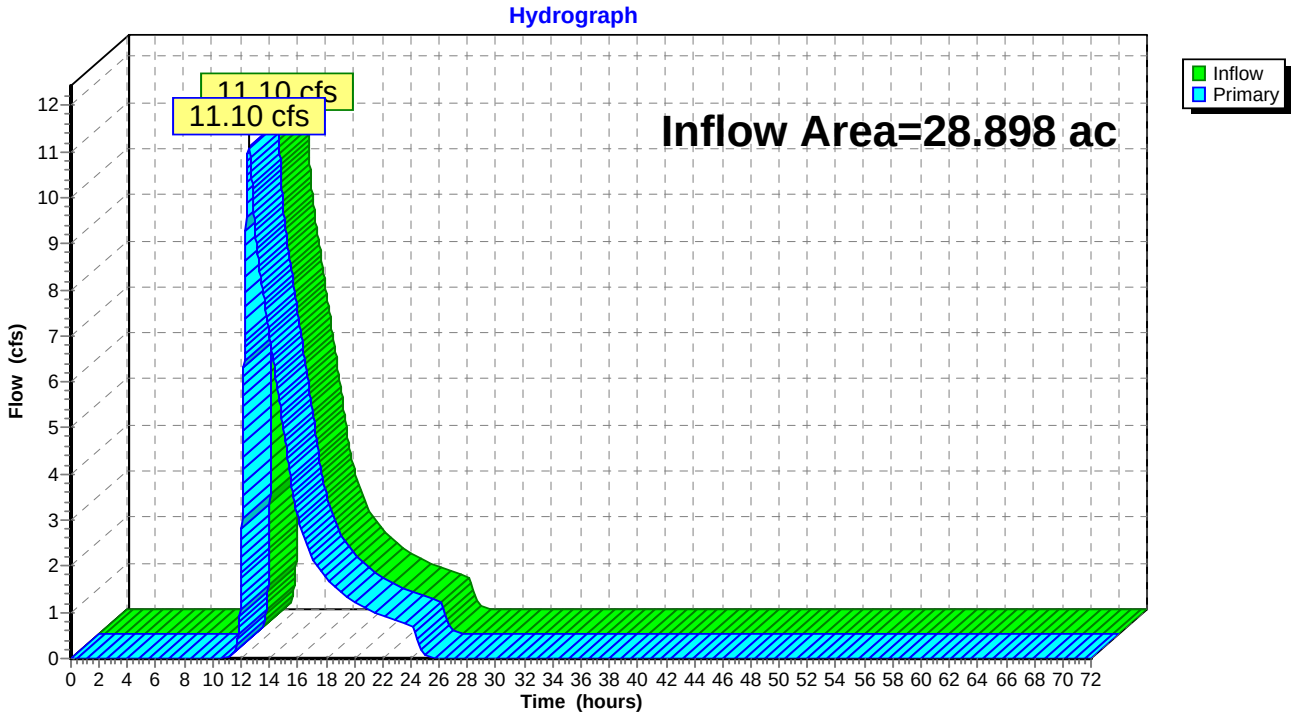
Time (hours)

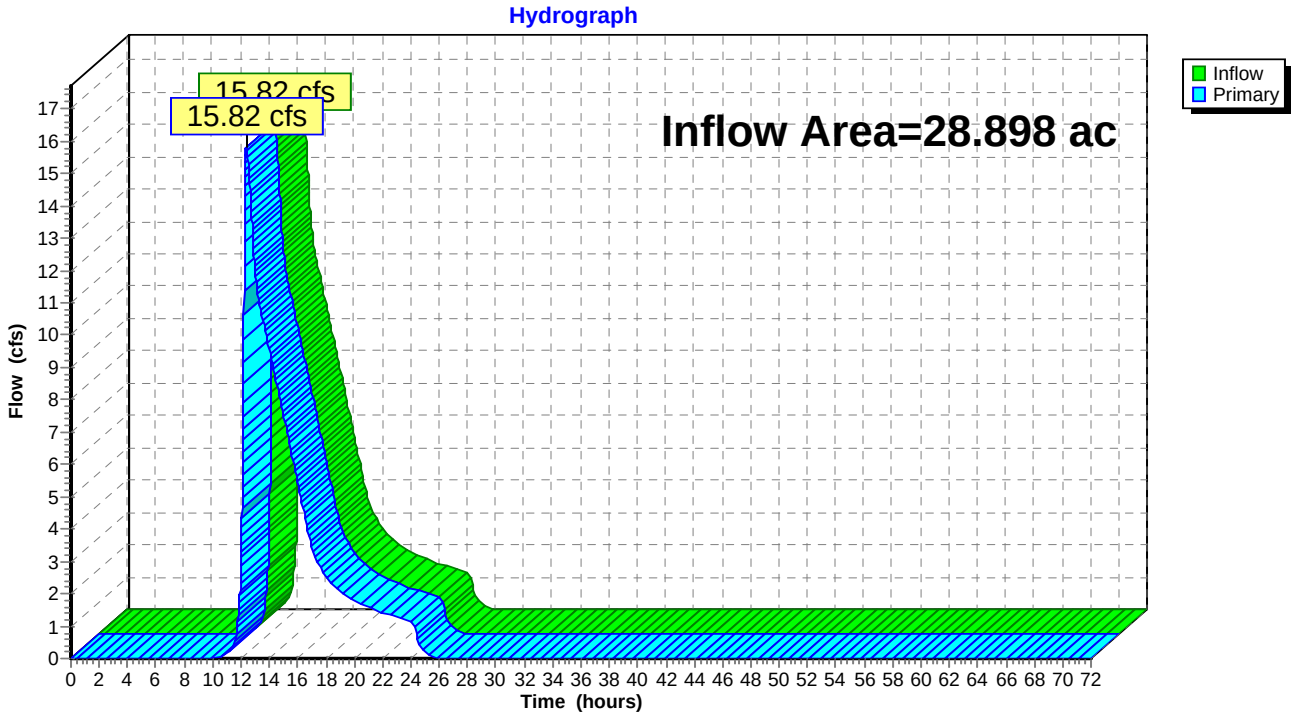
Link 6: POI A


Hydrograph
5.51 cfs
5.51 cfs
Inflow Area=28.898 ac
Inflow
Primary
Flow (cfs)
0
1
2
3
4
5
6
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72
Time (hours)

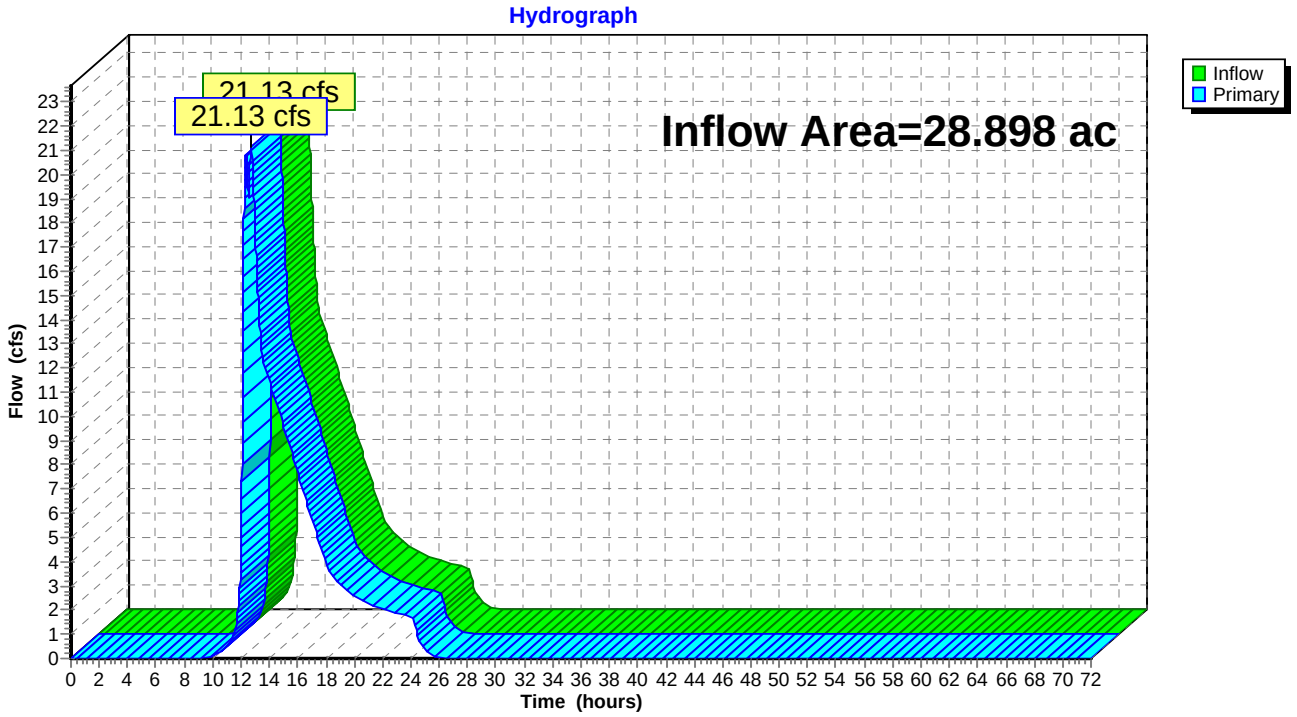
Link 6: POI A


Hydrograph
11.10 cfs
11.10 cfs
Inflow Area=28.898 ac
Inflow
Primary
Flow (cfs)
0 1 2 3 4 5 6 7 8 9 10 11 12
Time (hours)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72

Link 6: POI A


Hydrograph
15.82 cfs
15.82 cfs
Inflow Area=28.898 ac
Inflow
Primary
Flow (cfs)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Time (hours)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72

Link 6: POI A


Hydrograph
21.13 cfs
21.13 cfs
Inflow Area=28.898 ac
Inflow
Primary
Flow (cfs)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time (hours)
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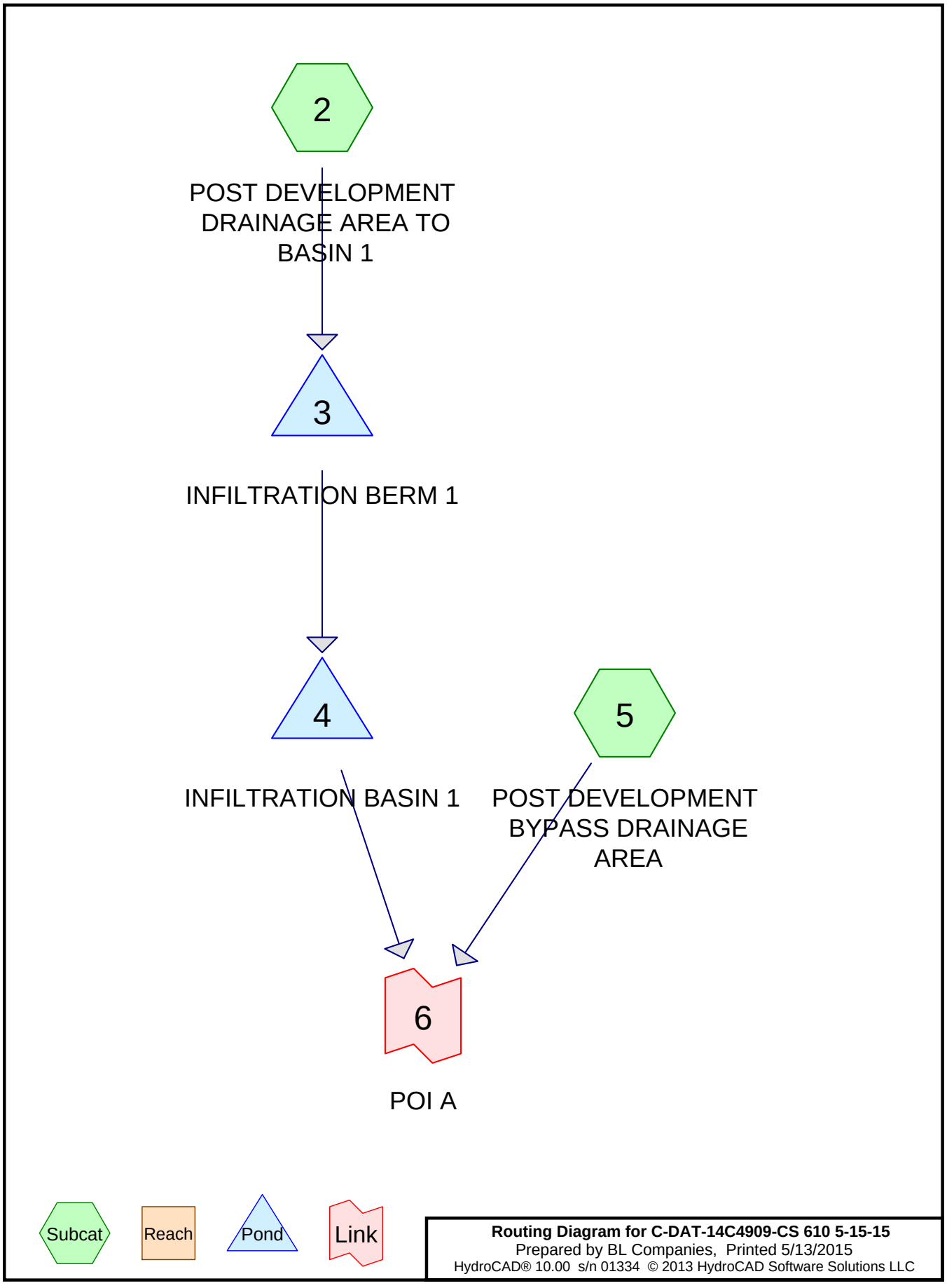

Routing Diagram for C-DAT-14C4909-CS 610 5-15-15
Prepared by BL Companies, Printed 5/13/2015

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Point of Interest A
Post Development Drainage Area to Basin 1

Summary for Subcatchment 2: POST DEVELOPMENT DRAINAGE AREA TO BASIN 1

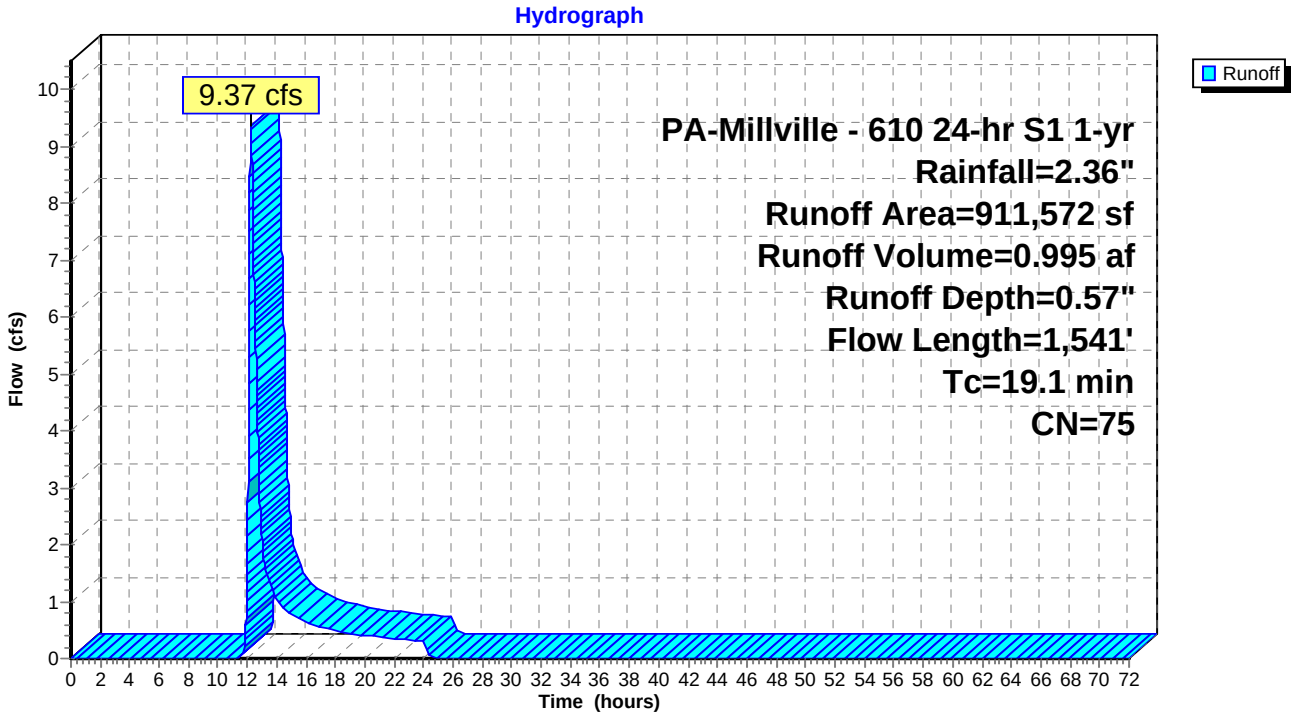
Runoff = 9.37 cfs @ 12.25 hrs, Volume= 0.995 af, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
PA-Millville - 610 24-hr S1 1-yr Rainfall=2.36"

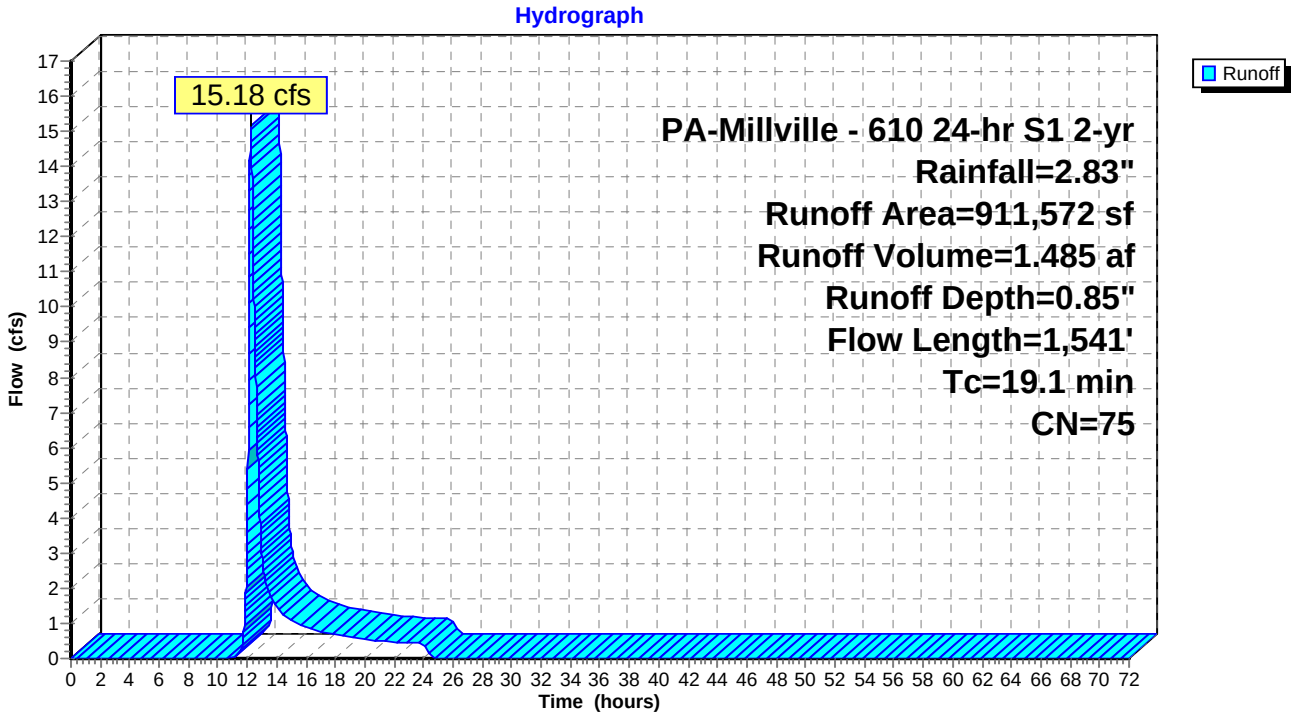
	Area (sf)	CN	Description
	290,973	61	>75% Grass cover, Good, HSG B
*	286,581	85	Gravel areas, HSG B
	179,293	98	Paved parking, HSG B
	154,725	58	Meadow, non-grazed, HSG B
	911,572	75	Weighted Average
	732,279		80.33% Pervious Area
	179,293		19.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.7	100	0.0453	0.25		**Sheet Flow, SHT 1** Range n= 0.130 P2= 2.83"
2.3	223	0.0549	1.64		**Shallow Concentrated Flow, SHT 1** Short Grass Pasture Kv= 7.0 fps
0.5	111	0.3000	3.83		**Shallow Concentrated Flow, SHT 2** Short Grass Pasture Kv= 7.0 fps
2.8	327	0.0150	1.97		**Shallow Concentrated Flow, SHT 3** Unpaved Kv= 16.1 fps
0.9	157	0.0300	2.79		**Shallow Concentrated Flow, SHT 4** Unpaved Kv= 16.1 fps
0.0	53	0.1480	30.01	94.28	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012
5.9	570	0.0100	1.61		**Shallow Concentrated Flow, SHT 5** Unpaved Kv= 16.1 fps
19.1	1,541	Total			

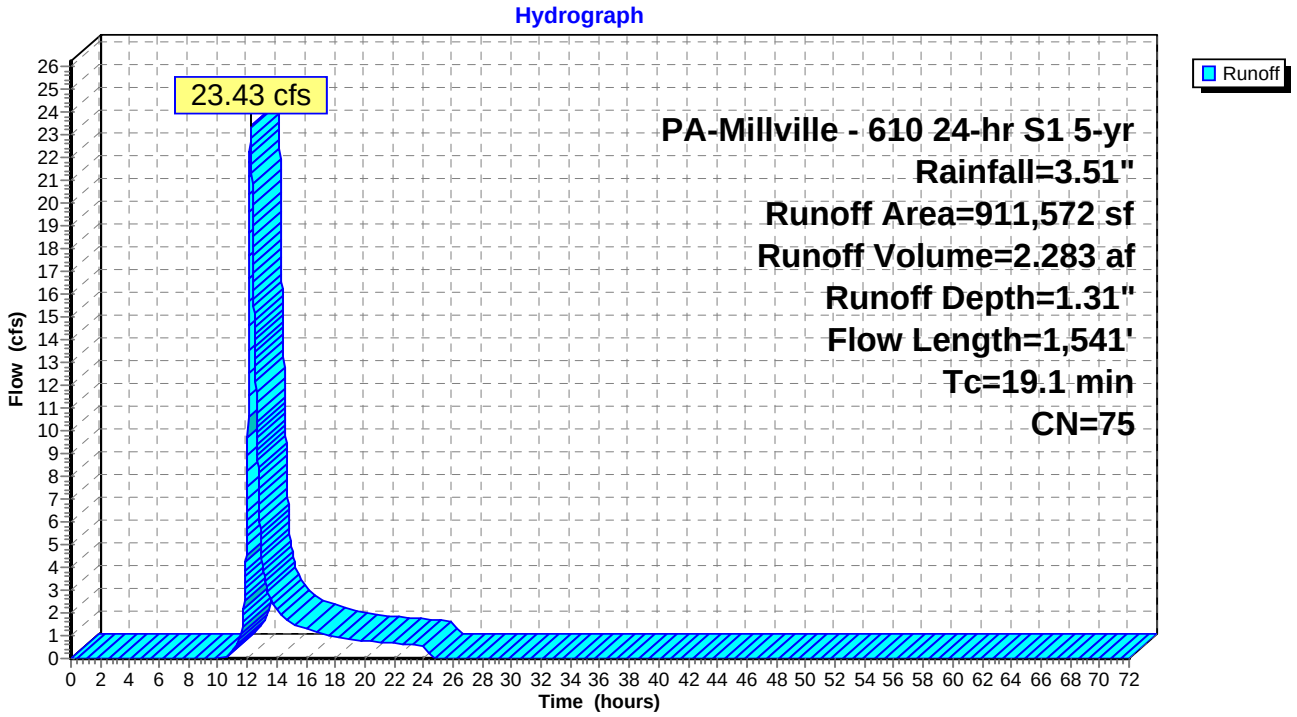
Subcatchment 2: POST DEVELOPMENT DRAINAGE AREA TO BASIN 1



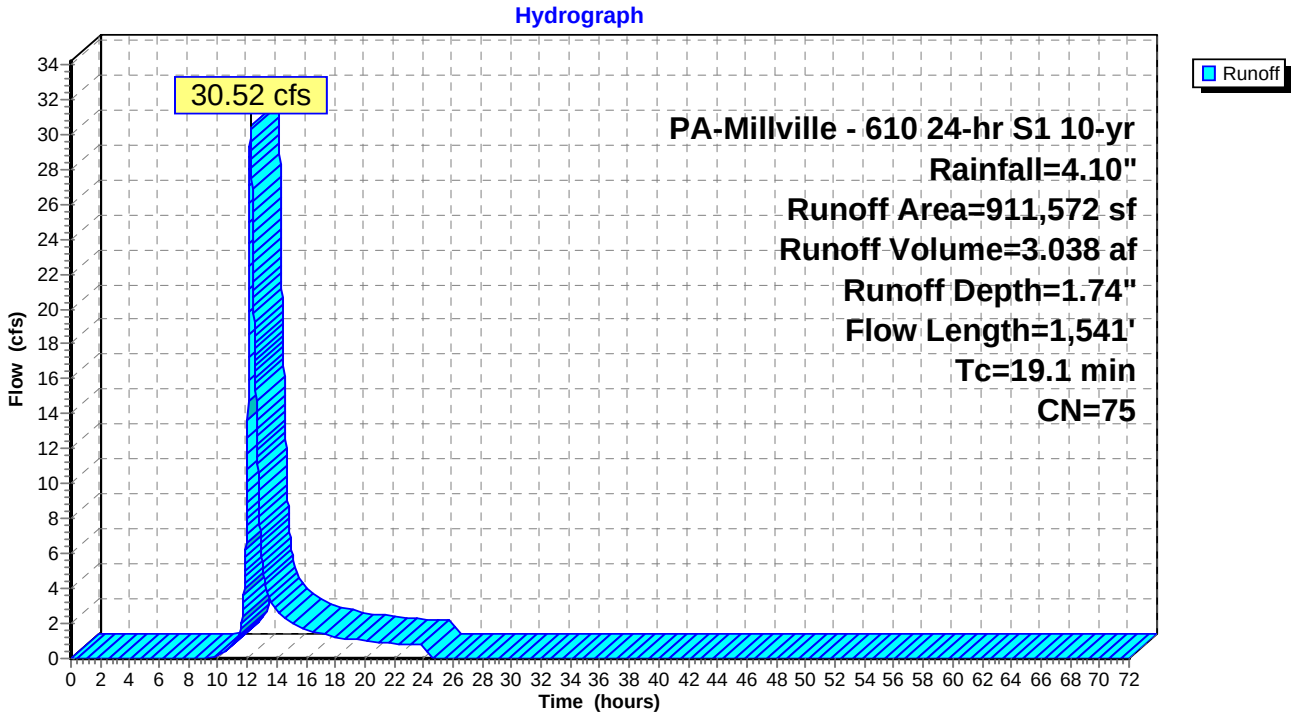
Subcatchment 2: POST DEVELOPMENT DRAINAGE AREA TO BASIN 1



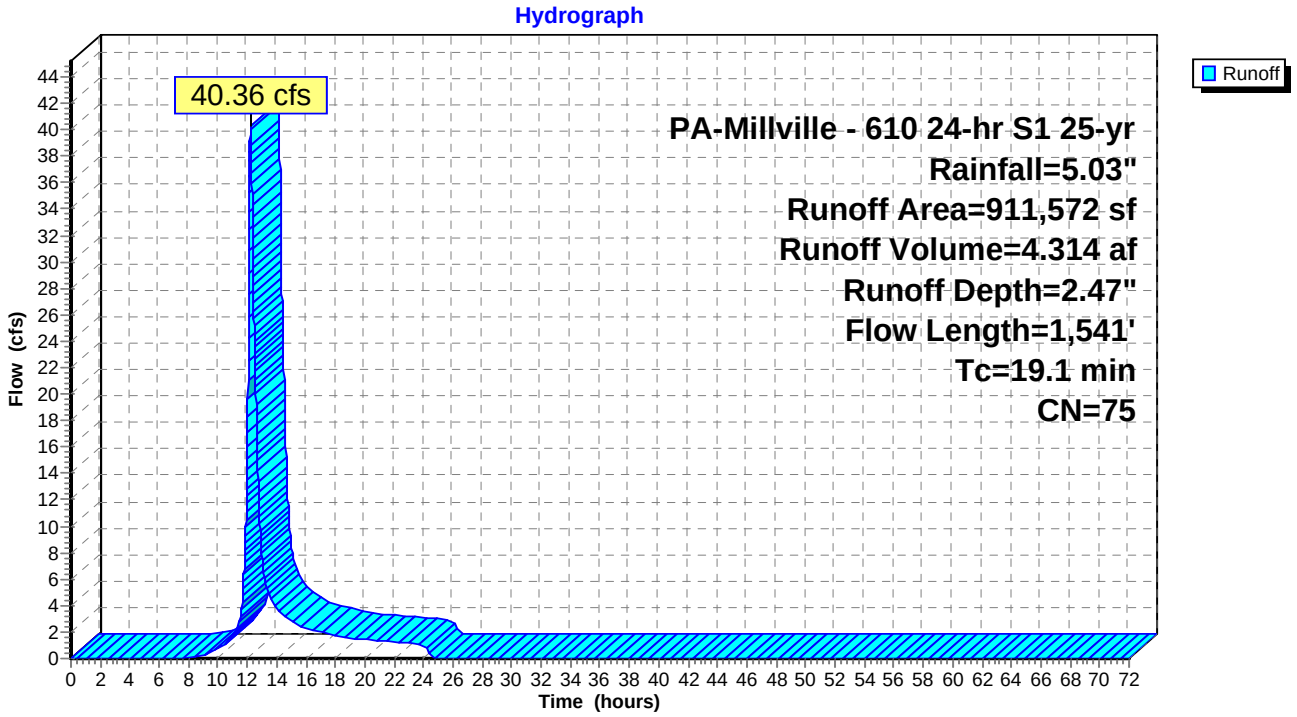
Subcatchment 2: POST DEVELOPMENT DRAINAGE AREA TO BASIN 1



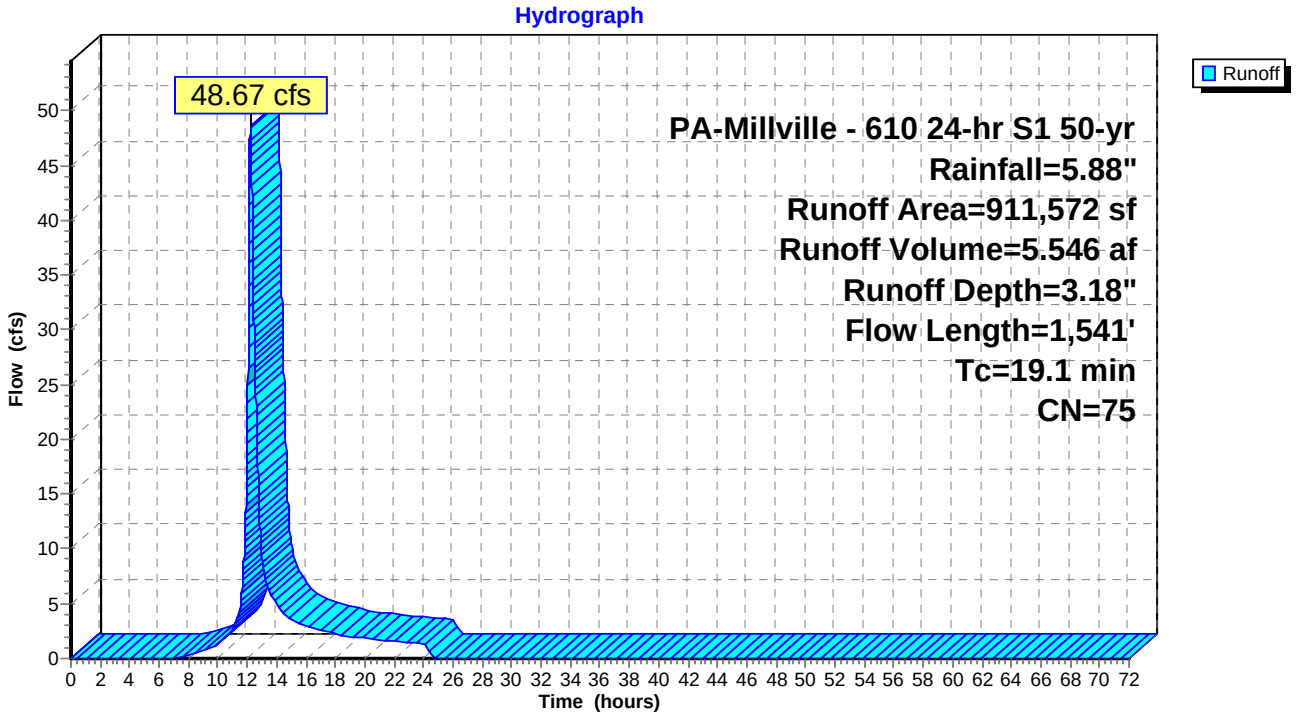
Subcatchment 2: POST DEVELOPMENT DRAINAGE AREA TO BASIN 1



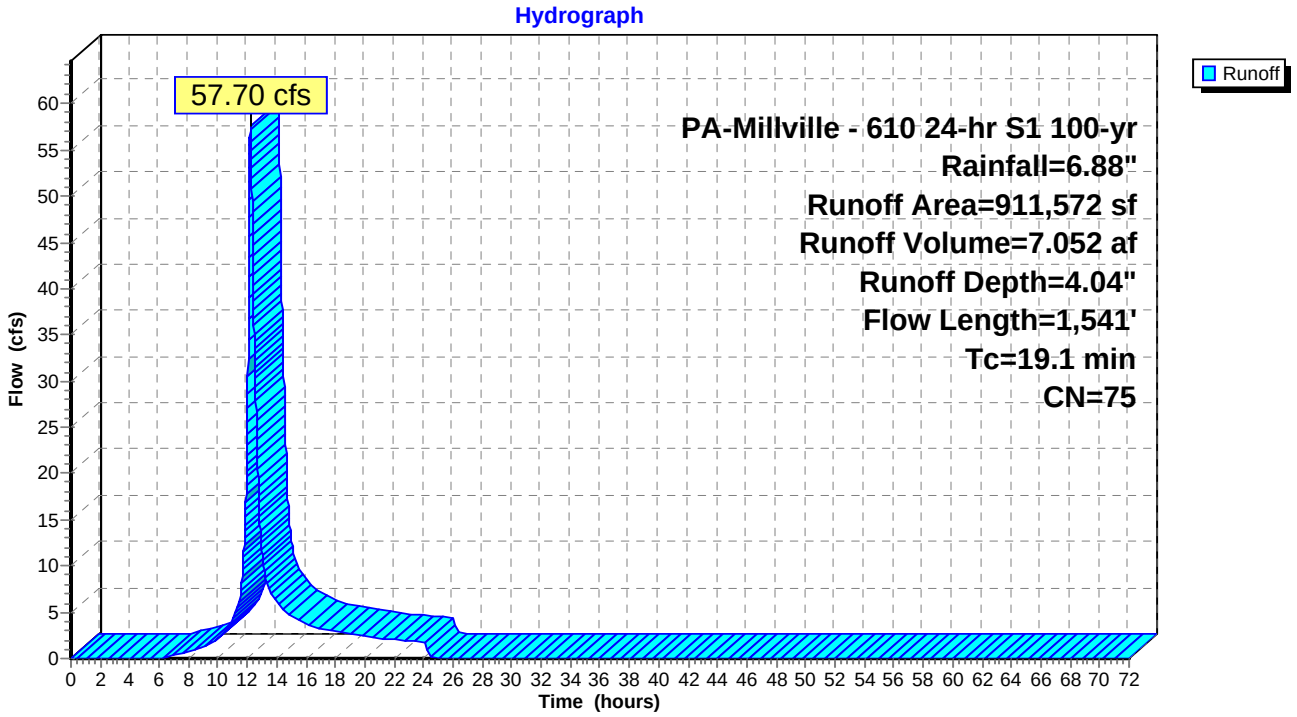
Subcatchment 2: POST DEVELOPMENT DRAINAGE AREA TO BASIN 1



Subcatchment 2: POST DEVELOPMENT DRAINAGE AREA TO BASIN 1



Subcatchment 2: POST DEVELOPMENT DRAINAGE AREA TO BASIN 1



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Point of Interest A
Post Development Infiltration Berm 1

Summary for Pond 3: INFILTRATION BERM 1

Inflow Area = 20.927 ac, 19.67% Impervious, Inflow Depth = 0.57" for 1-yr event
Inflow = 9.37 cfs @ 12.25 hrs, Volume= 0.995 af
Outflow = 1.55 cfs @ 13.26 hrs, Volume= 0.995 af, Atten= 83%, Lag= 61.0 min
Discarded = 0.32 cfs @ 13.26 hrs, Volume= 0.779 af
Primary = 1.23 cfs @ 13.26 hrs, Volume= 0.216 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 960.01' @ 13.26 hrs Surf.Area= 17,218 sf Storage= 20,148 cf

Plug-Flow detention time= 642.2 min calculated for 0.995 af (100% of inflow)
Center-of-Mass det. time= 642.1 min (1,539.7 - 897.6)

Volume	Invert	Avail.Storage	Storage Description
#1	958.00'	24,768 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
958.00	2,915	0	0
960.00	17,103	20,018	20,018
960.25	20,894	4,750	24,768

Device	Routing	Invert	Outlet Devices
#1	Discarded	958.00'	**0.810 in/hr Exfiltration over Surface area**
#2	Primary	960.00'	**490.0' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Discarded OutFlow Max=0.32 cfs @ 13.26 hrs HW=960.01' (Free Discharge)
↑└**1=Exfiltration** (Exfiltration Controls 0.32 cfs)

Primary OutFlow Max=0.82 cfs @ 13.26 hrs HW=960.01' (Free Discharge)
↑└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.82 cfs @ 0.22 fps)

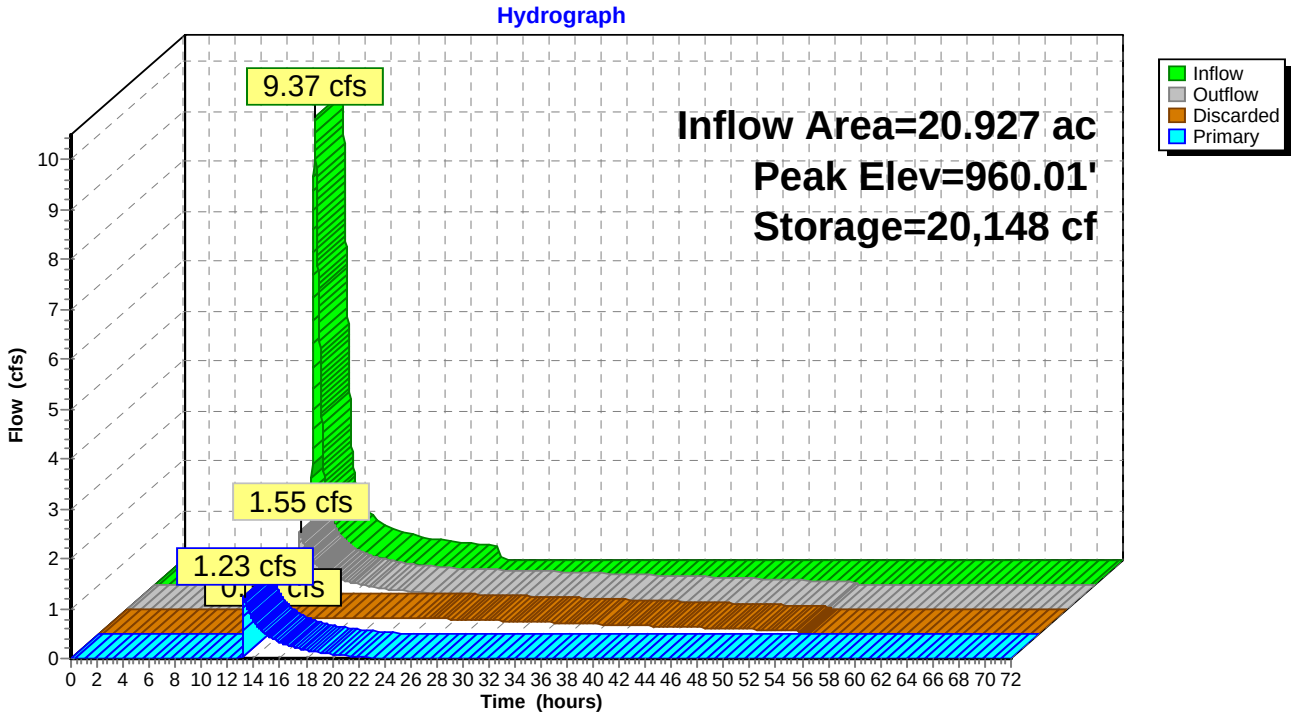
Stage-Discharge for Pond 3: INFILTRATION BERM 1

Elevation (feet)	Discharge (cfs)	Discarded (cfs)	Primary (cfs)
958.00	0.00	0.00	0.00
958.05	0.06	0.06	0.00
958.10	0.07	0.07	0.00
958.15	0.07	0.07	0.00
958.20	0.08	0.08	0.00
958.25	0.09	0.09	0.00
958.30	0.09	0.09	0.00
958.35	0.10	0.10	0.00
958.40	0.11	0.11	0.00
958.45	0.11	0.11	0.00
958.50	0.12	0.12	0.00
958.55	0.13	0.13	0.00
958.60	0.13	0.13	0.00
958.65	0.14	0.14	0.00
958.70	0.15	0.15	0.00
958.75	0.15	0.15	0.00
958.80	0.16	0.16	0.00
958.85	0.17	0.17	0.00
958.90	0.17	0.17	0.00
958.95	0.18	0.18	0.00
959.00	0.19	0.19	0.00
959.05	0.19	0.19	0.00
959.10	0.20	0.20	0.00
959.15	0.21	0.21	0.00
959.20	0.21	0.21	0.00
959.25	0.22	0.22	0.00
959.30	0.23	0.23	0.00
959.35	0.23	0.23	0.00
959.40	0.24	0.24	0.00
959.45	0.25	0.25	0.00
959.50	0.25	0.25	0.00
959.55	0.26	0.26	0.00
959.60	0.27	0.27	0.00
959.65	0.27	0.27	0.00
959.70	0.28	0.28	0.00
959.75	0.29	0.29	0.00
959.80	0.29	0.29	0.00
959.85	0.30	0.30	0.00
959.90	0.31	0.31	0.00
959.95	0.31	0.31	0.00
960.00	0.32	0.32	0.00
960.05	14.25	0.33	13.92
960.10	39.71	0.35	39.36
960.15	72.67	0.36	72.30
960.20	111.70	0.38	111.32
960.25	**157.04**	**0.39**	**156.65**

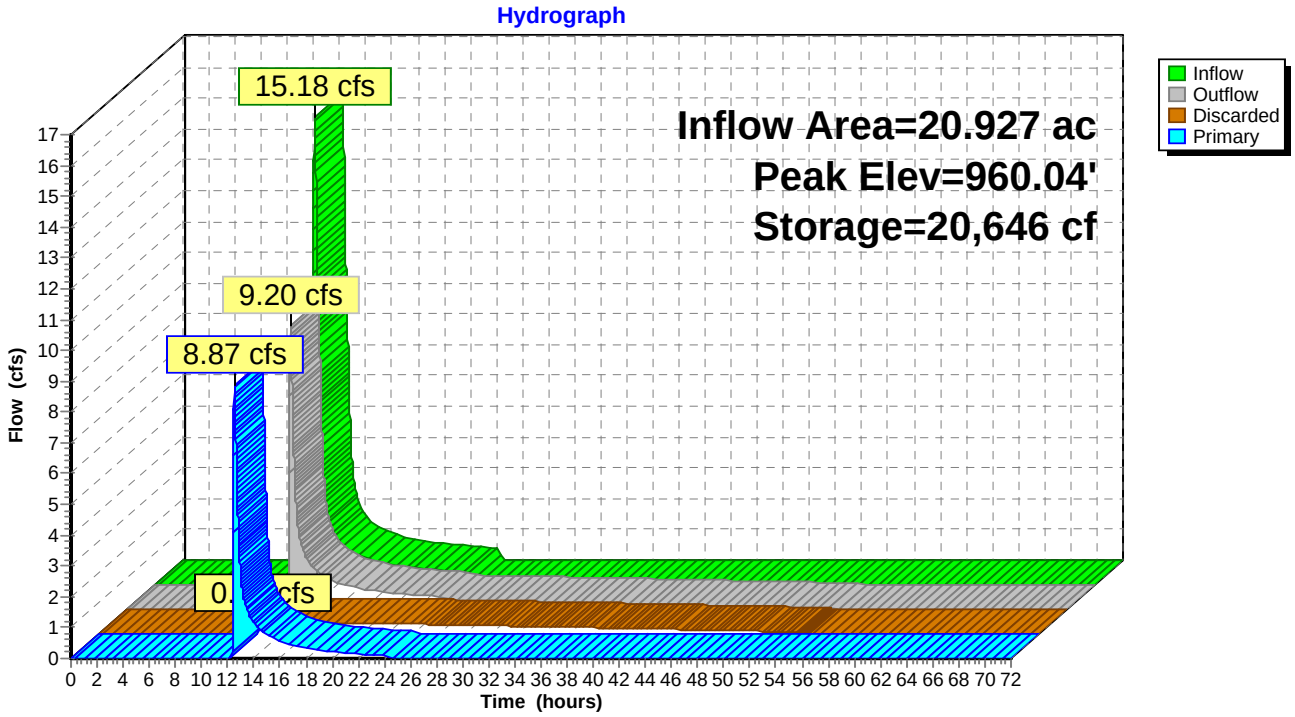
Stage-Area-Storage for Pond 3: INFILTRATION BERM 1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
958.00	2,915	0
958.05	3,270	155
958.10	3,624	327
958.15	3,979	517
958.20	4,334	725
958.25	4,689	950
958.30	5,043	1,194
958.35	5,398	1,455
958.40	5,753	1,734
958.45	6,107	2,030
958.50	6,462	2,344
958.55	6,817	2,676
958.60	7,171	3,026
958.65	7,526	3,393
958.70	7,881	3,779
958.75	8,236	4,181
958.80	8,590	4,602
958.85	8,945	5,040
958.90	9,300	5,497
958.95	9,654	5,970
959.00	10,009	6,462
959.05	10,364	6,971
959.10	10,718	7,498
959.15	11,073	8,043
959.20	11,428	8,606
959.25	11,783	9,186
959.30	12,137	9,784
959.35	12,492	10,400
959.40	12,847	11,033
959.45	13,201	11,684
959.50	13,556	12,353
959.55	13,911	13,040
959.60	14,265	13,744
959.65	14,620	14,466
959.70	14,975	15,206
959.75	15,330	15,964
959.80	15,684	16,739
959.85	16,039	17,532
959.90	16,394	18,343
959.95	16,748	19,172
960.00	17,103	20,018
960.05	17,861	20,892
960.10	18,619	21,804
960.15	19,378	22,754
960.20	20,136	23,742
960.25	**20,894**	**24,768**

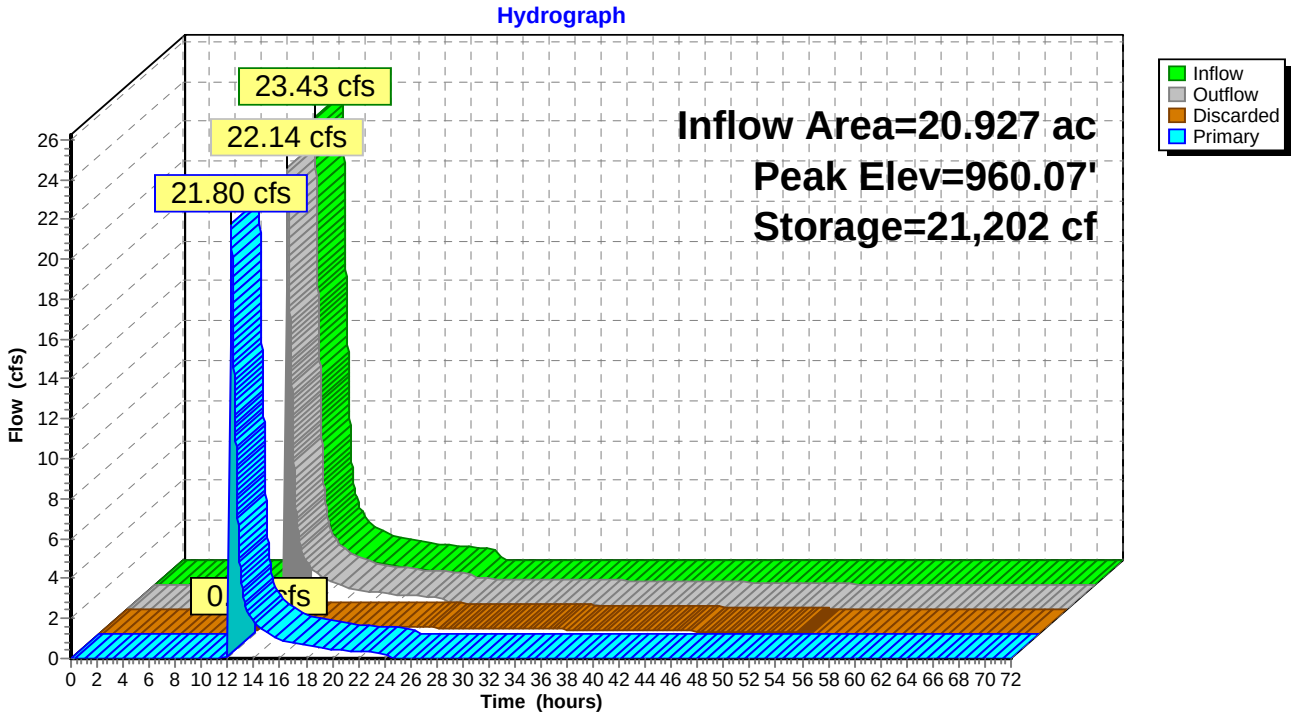
Pond 3: INFILTRATION BERM 1



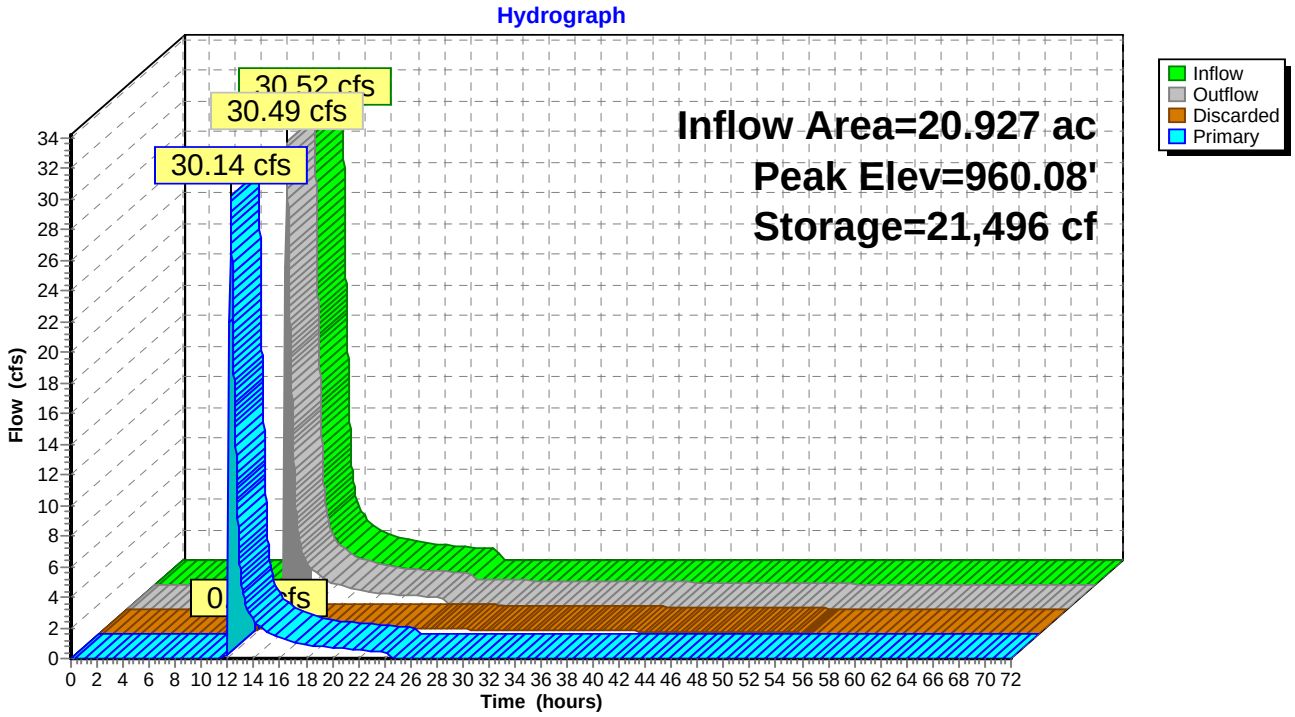
Pond 3: INFILTRATION BERM 1



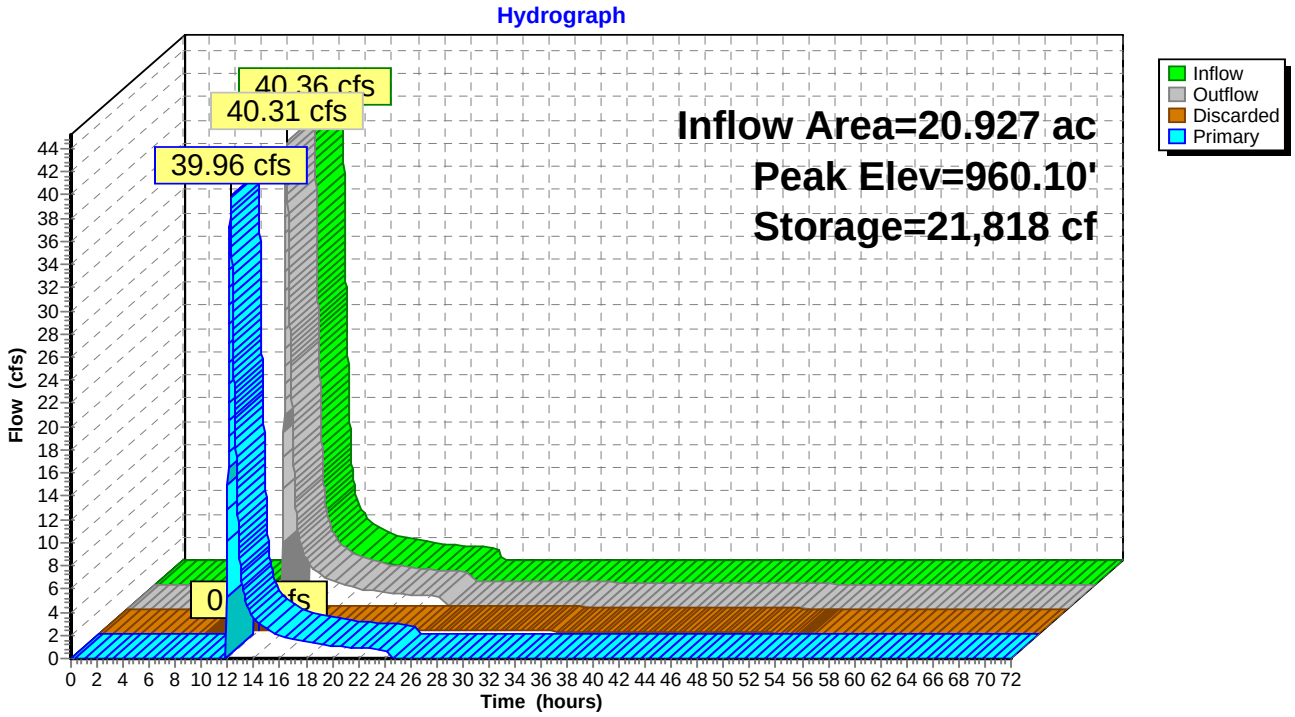
Pond 3: INFILTRATION BERM 1



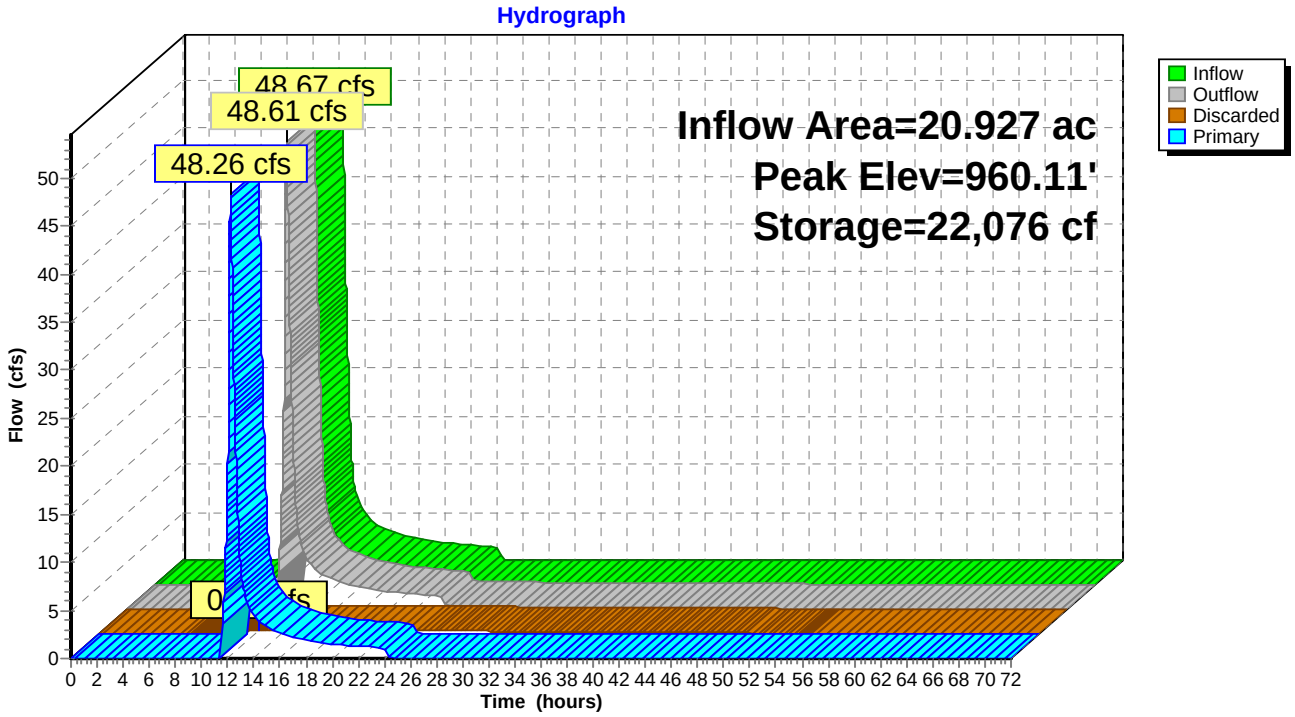
Pond 3: INFILTRATION BERM 1



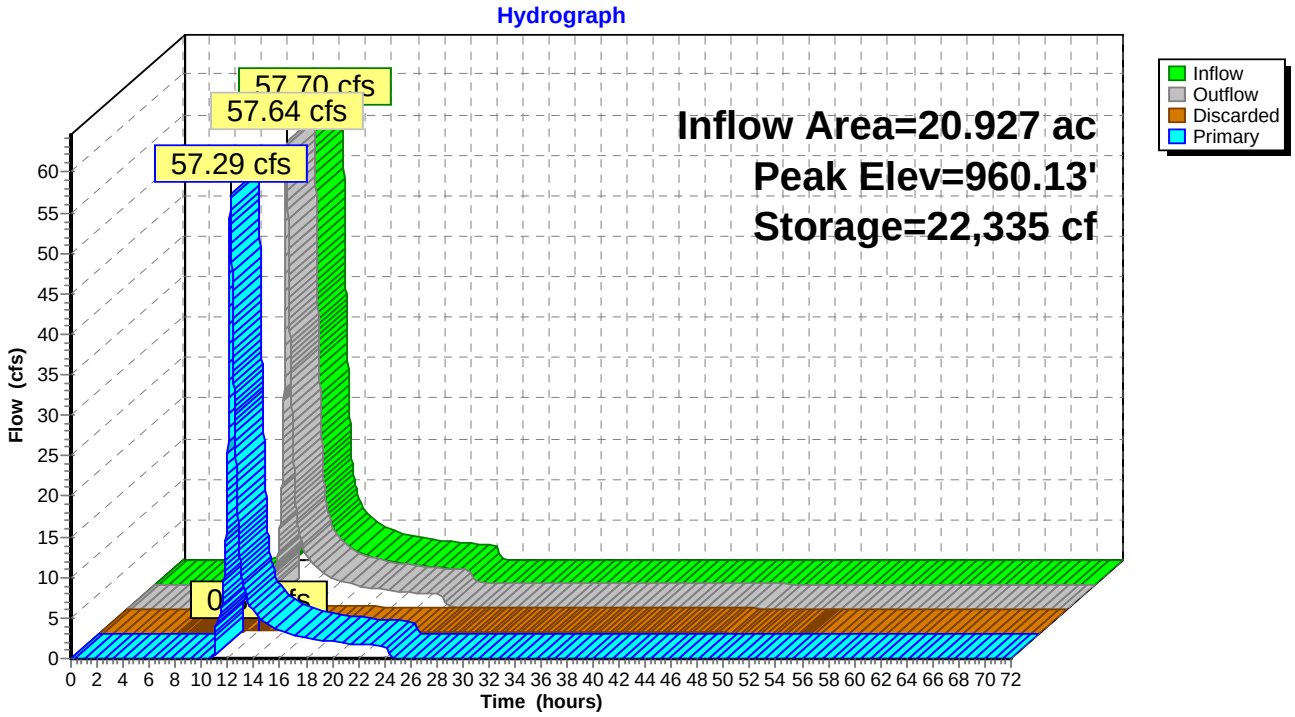
Pond 3: INFILTRATION BERM 1



Pond 3: INFILTRATION BERM 1



Pond 3: INFILTRATION BERM 1



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Point of Interest A
Post Development Infiltration Basin 1

Summary for Pond 4: INFILTRATION BASIN 1

Inflow Area = 20.927 ac, 19.67% Impervious, Inflow Depth = 0.12" for 1-yr event
Inflow = 1.23 cfs @ 13.26 hrs, Volume= 0.216 af
Outflow = 0.21 cfs @ 17.30 hrs, Volume= 0.216 af, Atten= 83%, Lag= 242.3 min
Discarded = 0.21 cfs @ 17.30 hrs, Volume= 0.216 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 954.51' @ 17.30 hrs Surf.Area= 11,215 sf Storage= 4,747 cf

Plug-Flow detention time= 269.3 min calculated for 0.216 af (100% of inflow)
Center-of-Mass det. time= 269.4 min (1,200.5 - 931.2)

Volume	Invert	Avail.Storage	Storage Description
#1	954.00'	168,903 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
954.00	7,235	0	0
956.00	22,706	29,941	29,941
958.00	36,022	58,728	88,669
960.00	44,212	80,234	168,903

Device	Routing	Invert	Outlet Devices
#1	Primary	953.00'	**24.0" Round Culvert** L= 40.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 953.00' / 951.00' S= 0.0500 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Discarded	954.00'	**0.810 in/hr Exfiltration over Surface area**
#3	Device 1	956.00'	**36.0" W x 6.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	958.25'	**24.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Primary	958.75'	**15.0' long x 18.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.21 cfs @ 17.30 hrs HW=954.51' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=954.00' (Free Discharge)
└**1=Culvert** (Passes 0.00 cfs of 5.35 cfs potential flow)
  └**3=Orifice/Grate** (Controls 0.00 cfs)
  └**4=Orifice/Grate** (Controls 0.00 cfs)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

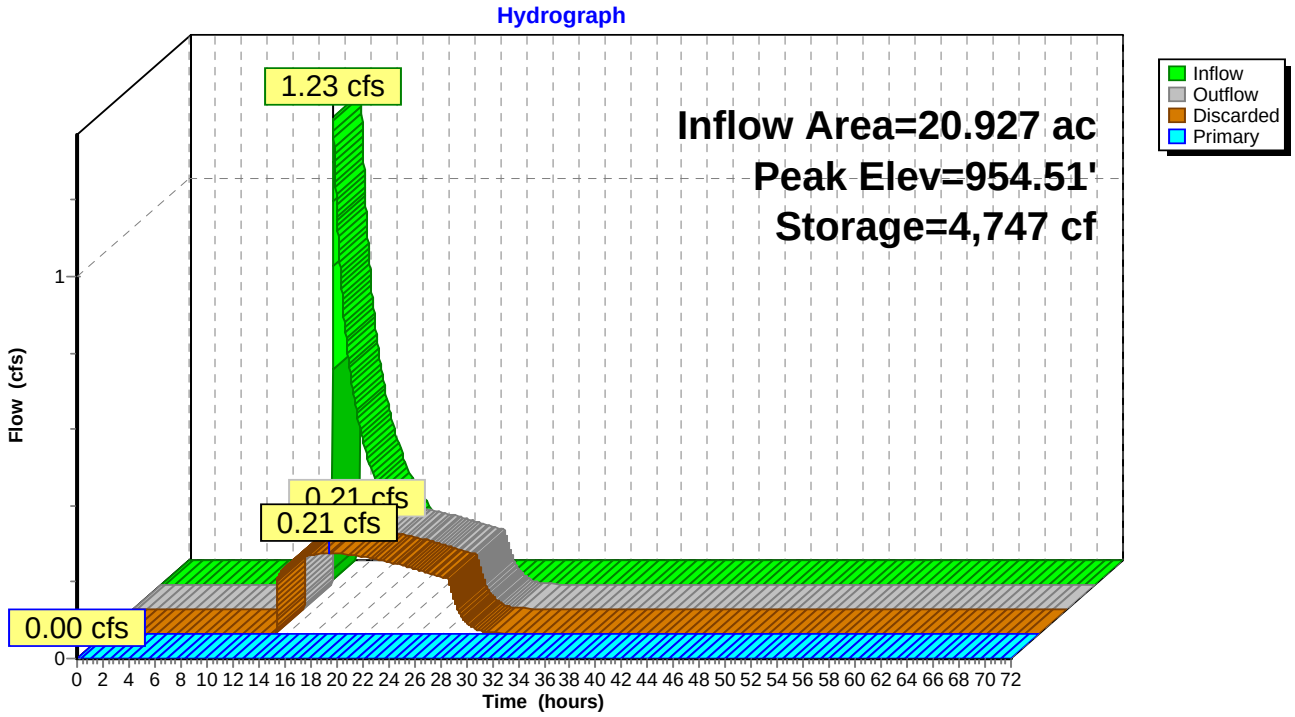
Stage-Discharge for Pond 4: INFILTRATION BASIN 1

Elevation (feet)	Discharge (cfs)	Discarded (cfs)	Primary (cfs)
954.00	0.00	0.00	0.00
954.10	0.15	0.15	0.00
954.20	0.16	0.16	0.00
954.30	0.18	0.18	0.00
954.40	0.19	0.19	0.00
954.50	0.21	0.21	0.00
954.60	0.22	0.22	0.00
954.70	0.24	0.24	0.00
954.80	0.25	0.25	0.00
954.90	0.27	0.27	0.00
955.00	0.28	0.28	0.00
955.10	0.30	0.30	0.00
955.20	0.31	0.31	0.00
955.30	0.32	0.32	0.00
955.40	0.34	0.34	0.00
955.50	0.35	0.35	0.00
955.60	0.37	0.37	0.00
955.70	0.38	0.38	0.00
955.80	0.40	0.40	0.00
955.90	0.41	0.41	0.00
956.00	0.43	0.43	0.00
956.10	0.74	0.44	0.30
956.20	1.31	0.45	0.86
956.30	2.05	0.46	1.58
956.40	2.91	0.48	2.44
956.50	3.89	0.49	3.40
956.60	4.67	0.50	4.17
956.70	5.29	0.51	4.78
956.80	5.83	0.53	5.31
956.90	6.32	0.54	5.79
957.00	6.78	0.55	6.23
957.10	7.20	0.56	6.63
957.20	7.59	0.58	7.02
957.30	7.97	0.59	7.38
957.40	8.33	0.60	7.73
957.50	8.67	0.61	8.06
957.60	9.01	0.63	8.38
957.70	9.32	0.64	8.69
957.80	9.63	0.65	8.98
957.90	9.93	0.66	9.27
958.00	10.22	0.68	9.55
958.10	10.50	0.68	9.82
958.20	10.77	0.69	10.08
958.30	11.47	0.70	10.77
958.40	13.57	0.71	12.86
958.50	16.45	0.71	15.73
958.60	19.91	0.72	19.19
958.70	23.87	0.73	23.15
958.80	28.72	0.74	27.98
958.90	35.40	0.74	34.65
959.00	39.61	0.75	38.86
959.10	43.29	0.76	42.53
959.20	47.49	0.77	46.72
959.30	52.12	0.78	51.34
959.40	57.04	0.78	56.26
959.50	62.13	0.79	61.34
959.60	67.60	0.80	66.80
959.70	73.48	0.81	72.68
959.80	79.73	0.81	78.92
959.90	86.35	0.82	85.53
960.00	**93.22**	**0.83**	**92.40**

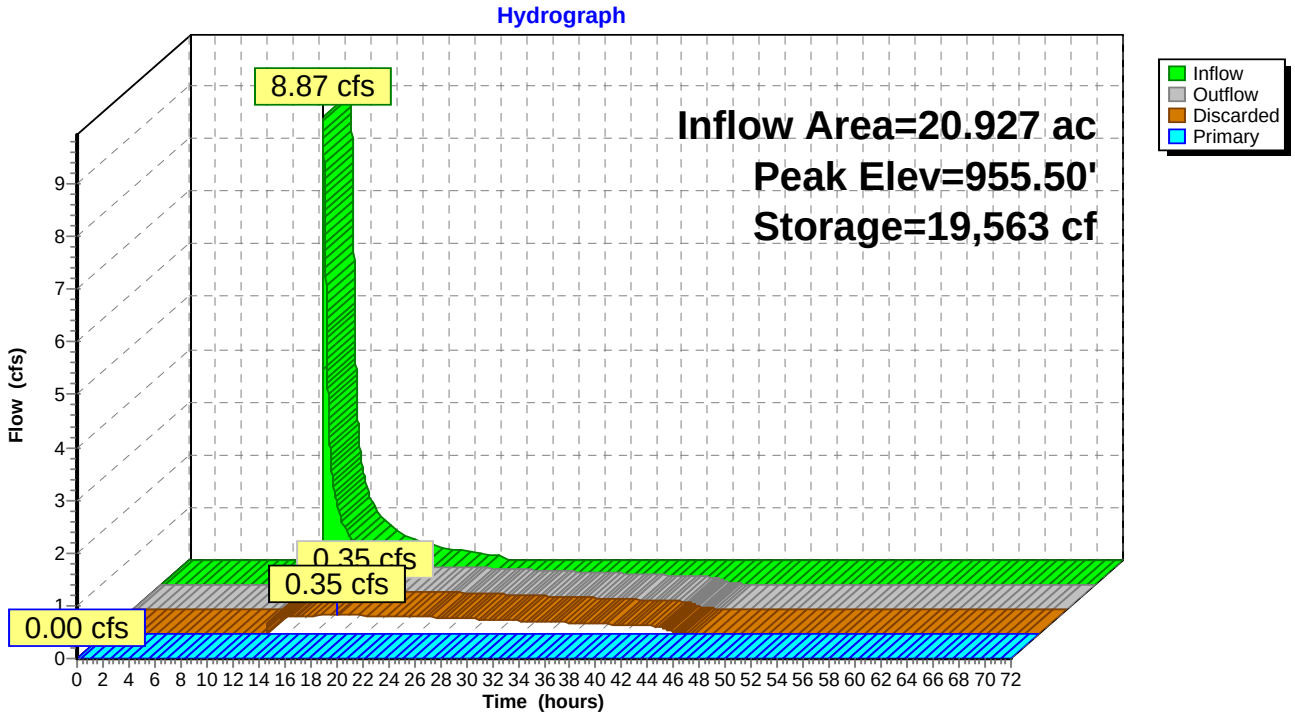
Stage-Area-Storage for Pond 4: INFILTRATION BASIN 1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
954.00	7,235	0
954.10	8,009	762
954.20	8,782	1,602
954.30	9,556	2,519
954.40	10,329	3,513
954.50	11,103	4,584
954.60	11,876	5,733
954.70	12,650	6,960
954.80	13,423	8,263
954.90	14,197	9,644
955.00	14,971	11,103
955.10	15,744	12,638
955.20	16,518	14,252
955.30	17,291	15,942
955.40	18,065	17,710
955.50	18,838	19,555
955.60	19,612	21,477
955.70	20,385	23,477
955.80	21,159	25,555
955.90	21,932	27,709
956.00	22,706	29,941
956.10	23,372	32,245
956.20	24,038	34,615
956.30	24,703	37,052
956.40	25,369	39,556
956.50	26,035	42,126
956.60	26,701	44,763
956.70	27,367	47,466
956.80	28,032	50,236
956.90	28,698	53,073
957.00	29,364	55,976
957.10	30,030	58,946
957.20	30,696	61,982
957.30	31,361	65,085
957.40	32,027	68,254
957.50	32,693	71,490
957.60	33,359	74,793
957.70	34,025	78,162
957.80	34,690	81,598
957.90	35,356	85,100
958.00	36,022	88,669
958.10	36,432	92,292
958.20	36,841	95,955
958.30	37,250	99,660
958.40	37,660	103,405
958.50	38,070	107,192
958.60	38,479	111,019
958.70	38,889	114,888
958.80	39,298	118,797
958.90	39,707	122,747
959.00	40,117	126,739
959.10	40,527	130,771
959.20	40,936	134,844
959.30	41,345	138,958
959.40	41,755	143,113
959.50	42,165	147,309
959.60	42,574	151,546
959.70	42,984	155,824
959.80	43,393	160,142
959.90	43,802	164,502
960.00	**44,212**	**168,903**

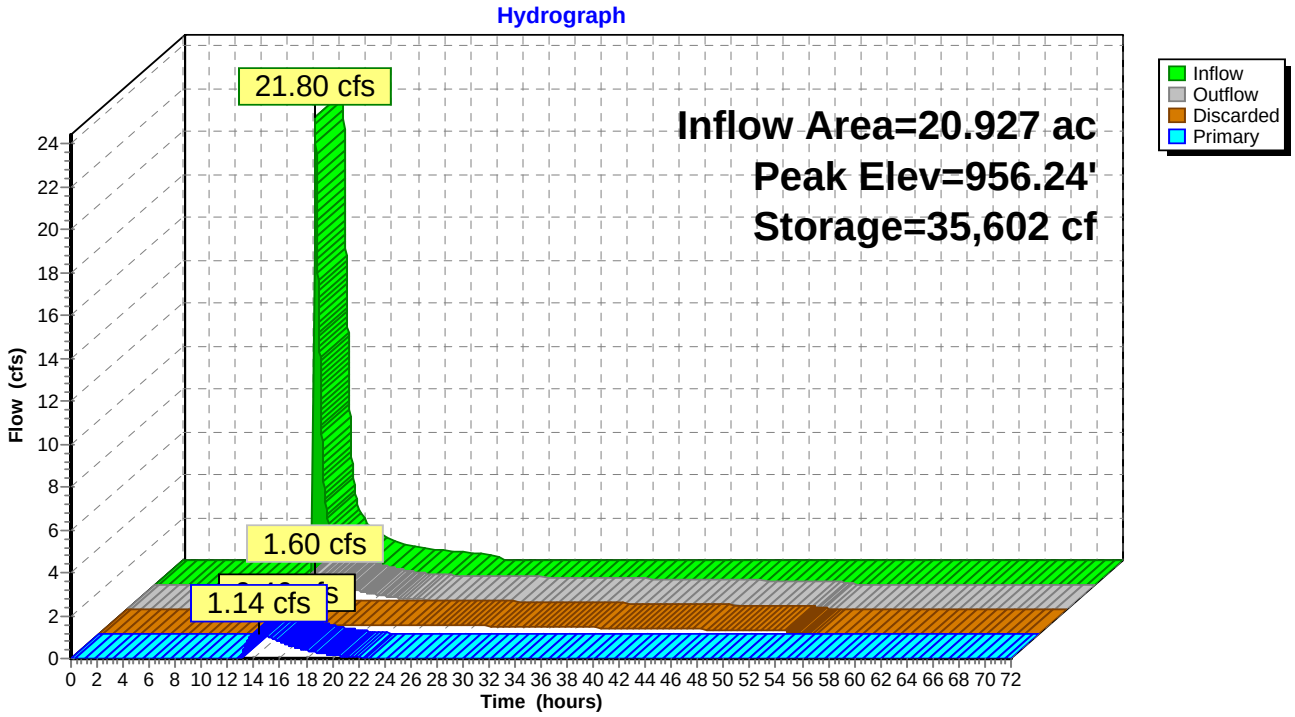
Pond 4: INFILTRATION BASIN 1



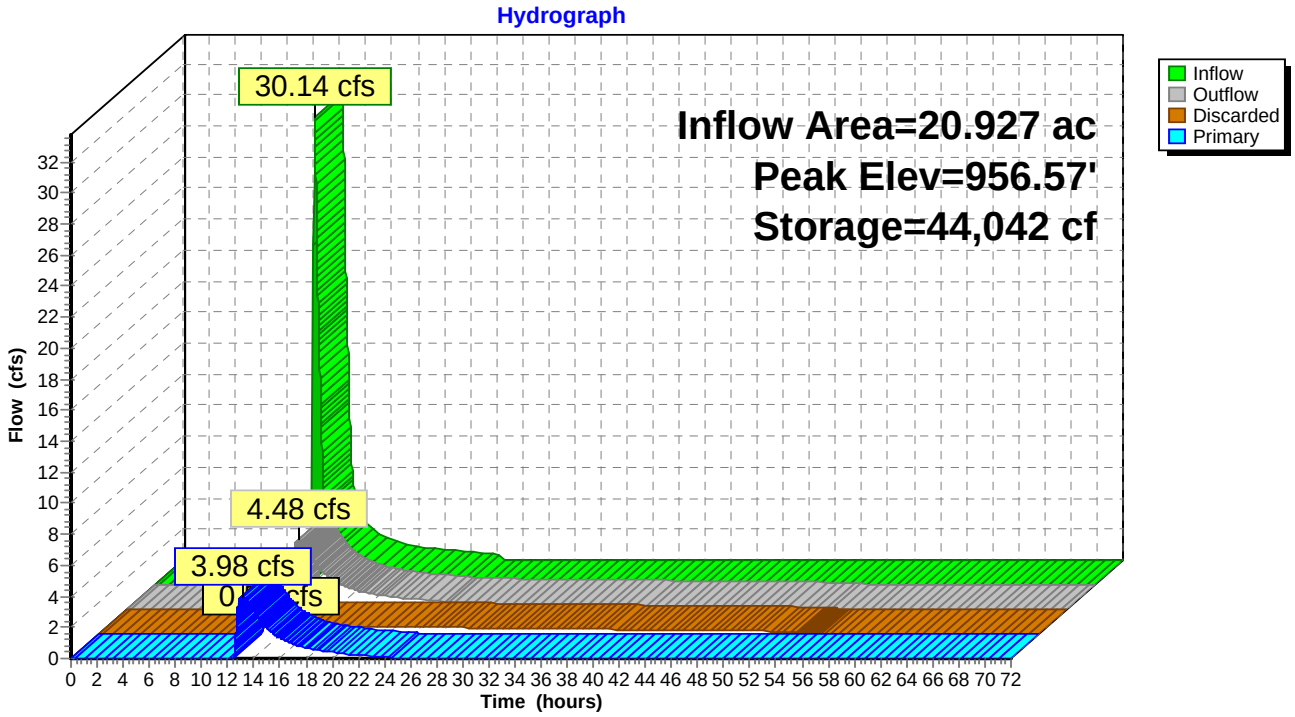
Pond 4: INFILTRATION BASIN 1



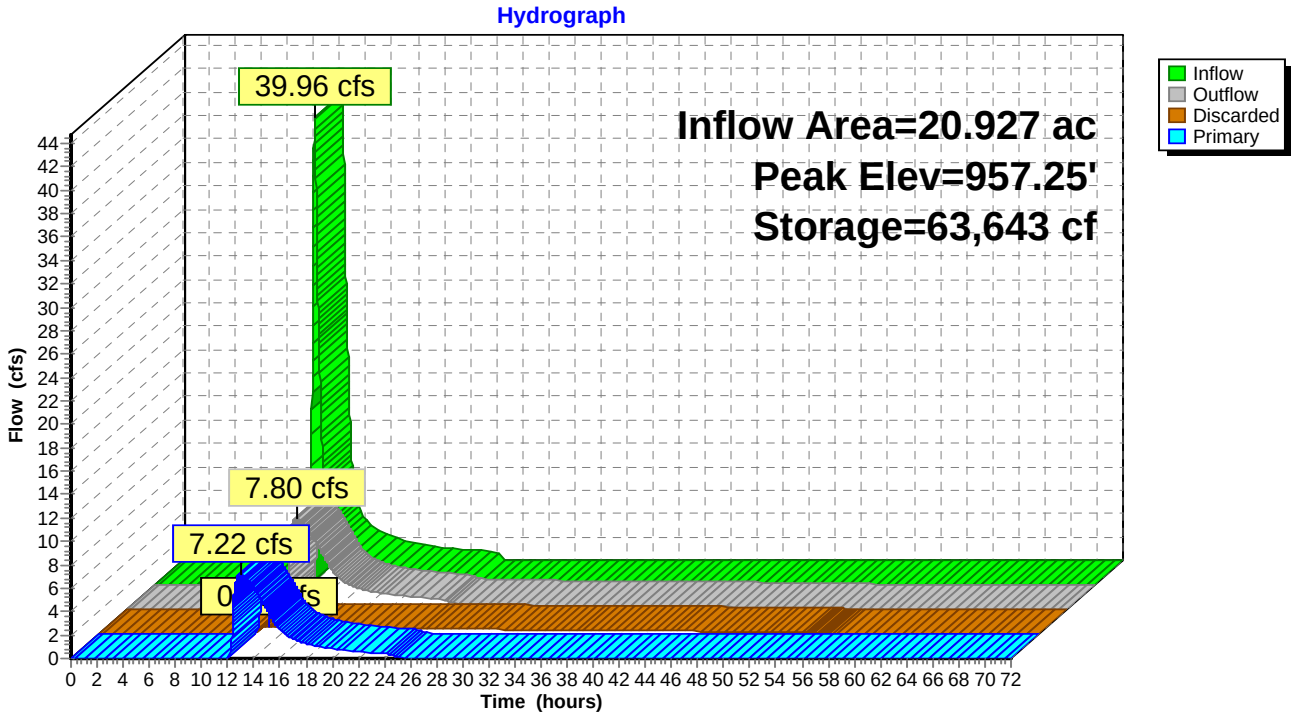
Pond 4: INFILTRATION BASIN 1



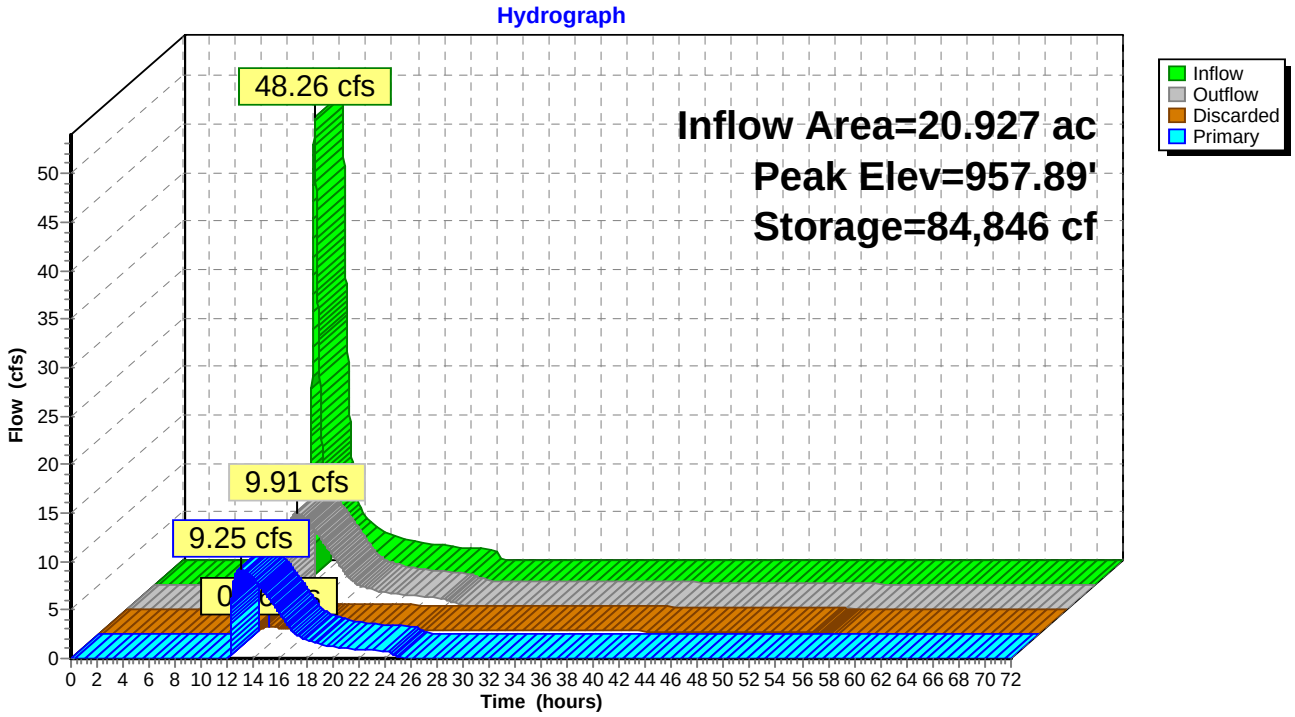
Pond 4: INFILTRATION BASIN 1



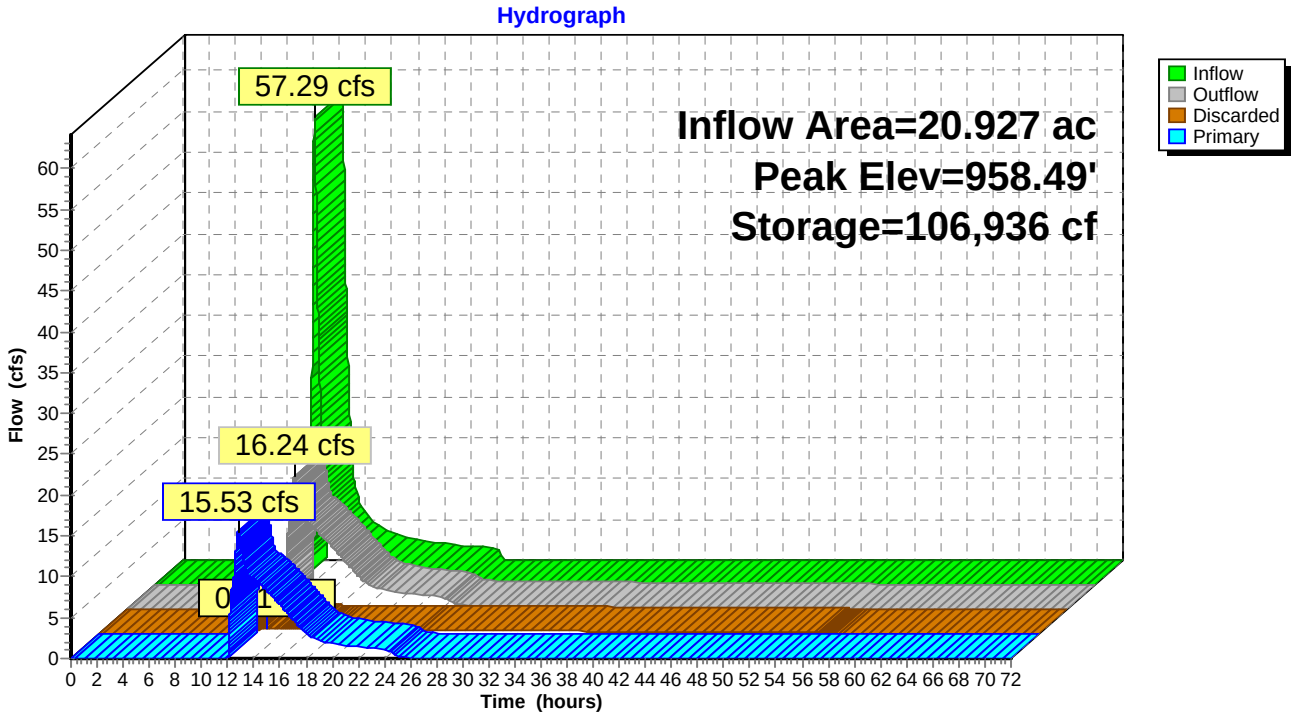
Pond 4: INFILTRATION BASIN 1



Pond 4: INFILTRATION BASIN 1



Pond 4: INFILTRATION BASIN 1



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Point of Interest A
Post Development Bypass Drainage Area

Summary for Subcatchment 5: POST DEVELOPMENT BYPASS DRAINAGE AREA

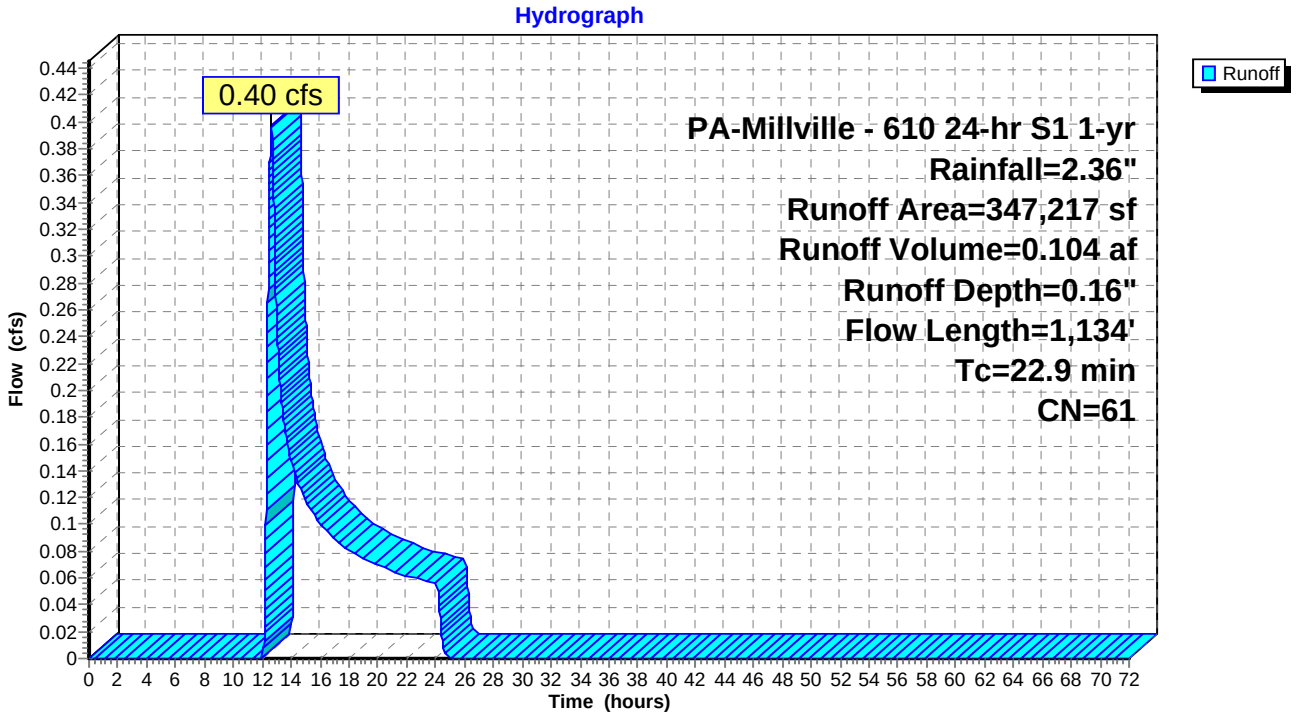
Runoff = 0.40 cfs @ 12.64 hrs, Volume= 0.104 af, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
PA-Millville - 610 24-hr S1 1-yr Rainfall=2.36"

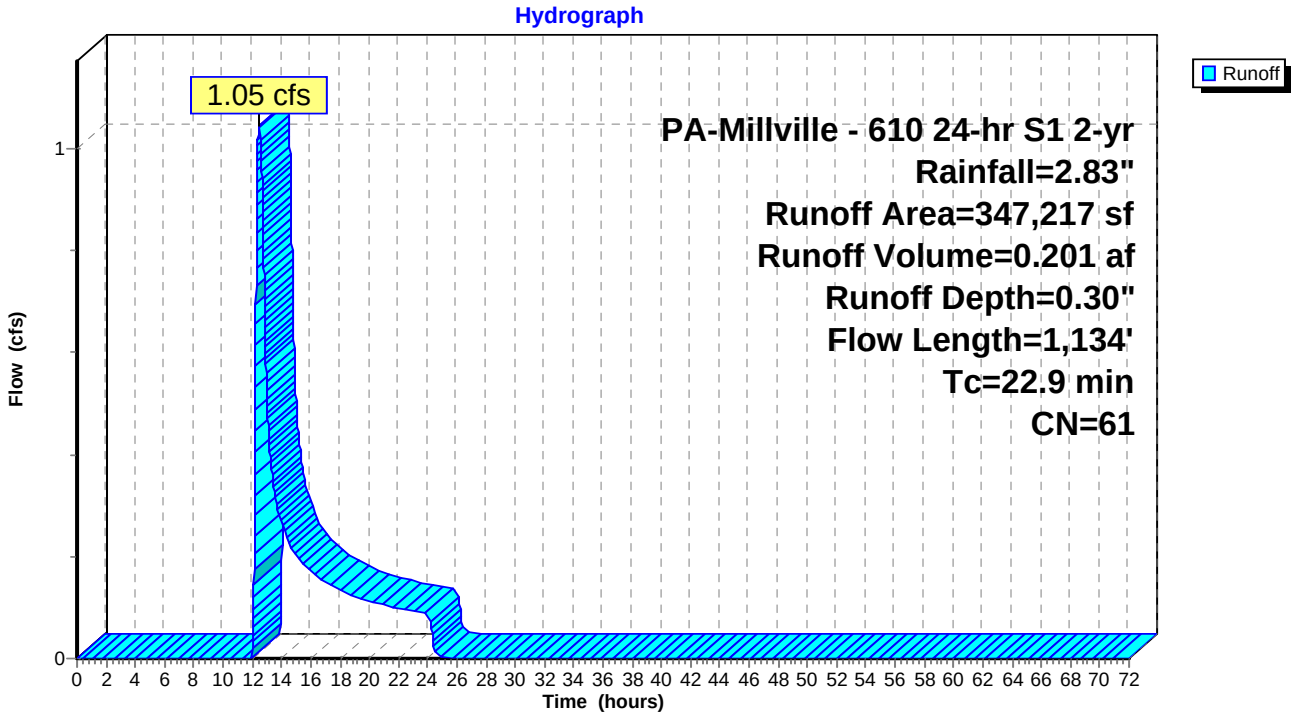
Area (sf)	CN	Description
58,825	61	>75% Grass cover, Good, HSG B
25,788	98	Paved parking, HSG B
262,604	58	Meadow, non-grazed, HSG B
347,217	61	Weighted Average
321,429		92.57% Pervious Area
25,788		7.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	100	0.0605	0.28		**Sheet Flow, SHT 1** Range n= 0.130 P2= 2.83"
4.9	433	0.0451	1.49		**Shallow Concentrated Flow, SCF 1** Short Grass Pasture Kv= 7.0 fps
12.0	601	0.0143	0.84		**Shallow Concentrated Flow, SCF 2** Short Grass Pasture Kv= 7.0 fps
22.9	1,134	Total			

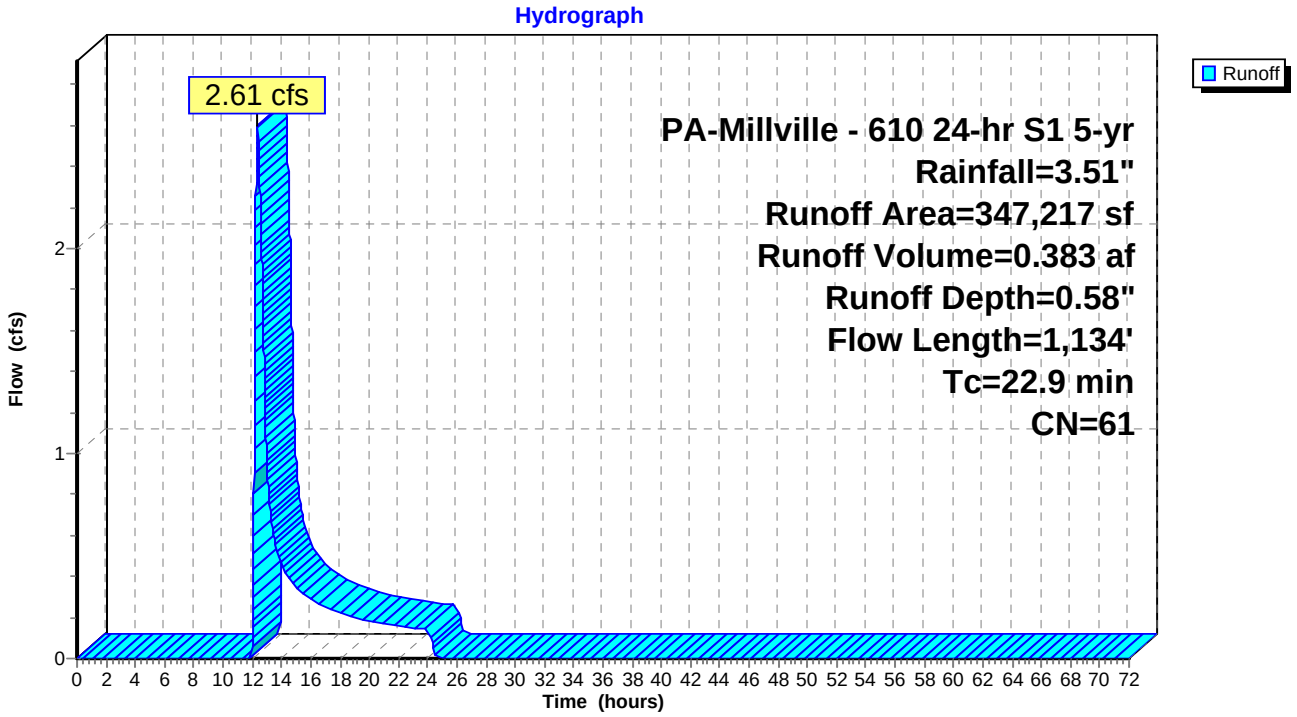
Subcatchment 5: POST DEVELOPMENT BYPASS DRAINAGE AREA



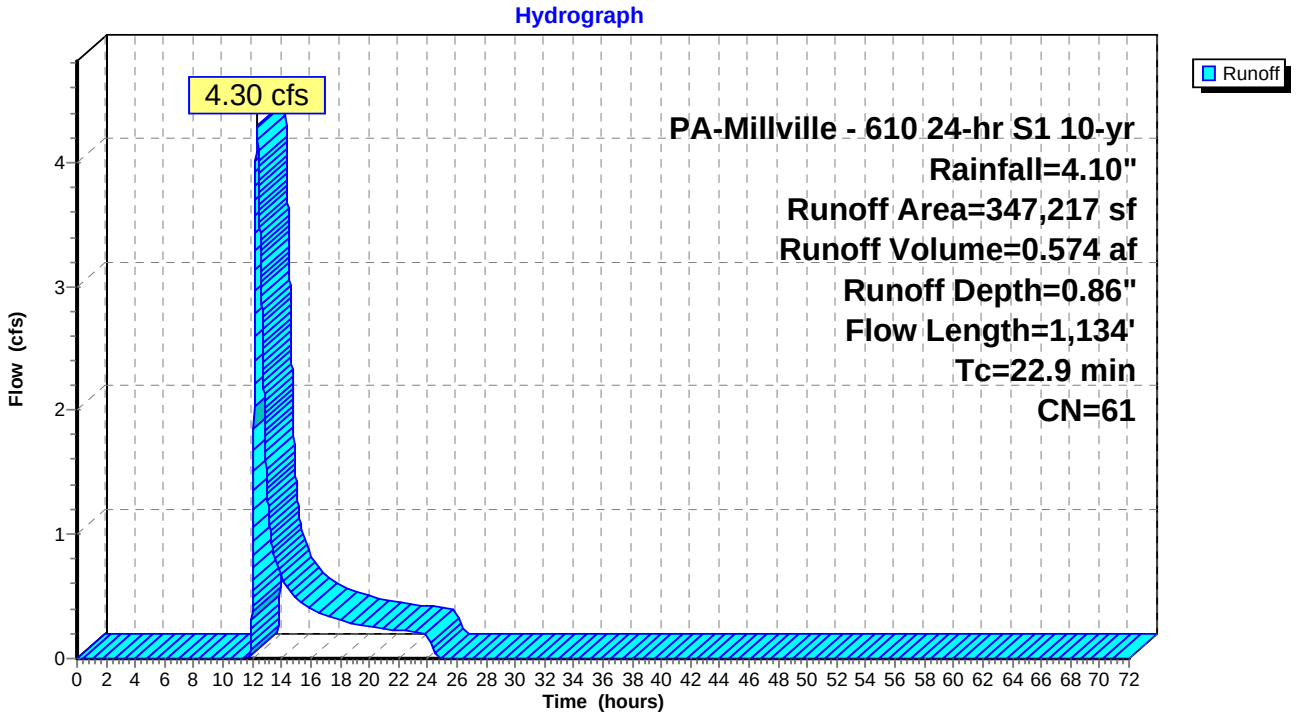
Subcatchment 5: POST DEVELOPMENT BYPASS DRAINAGE AREA



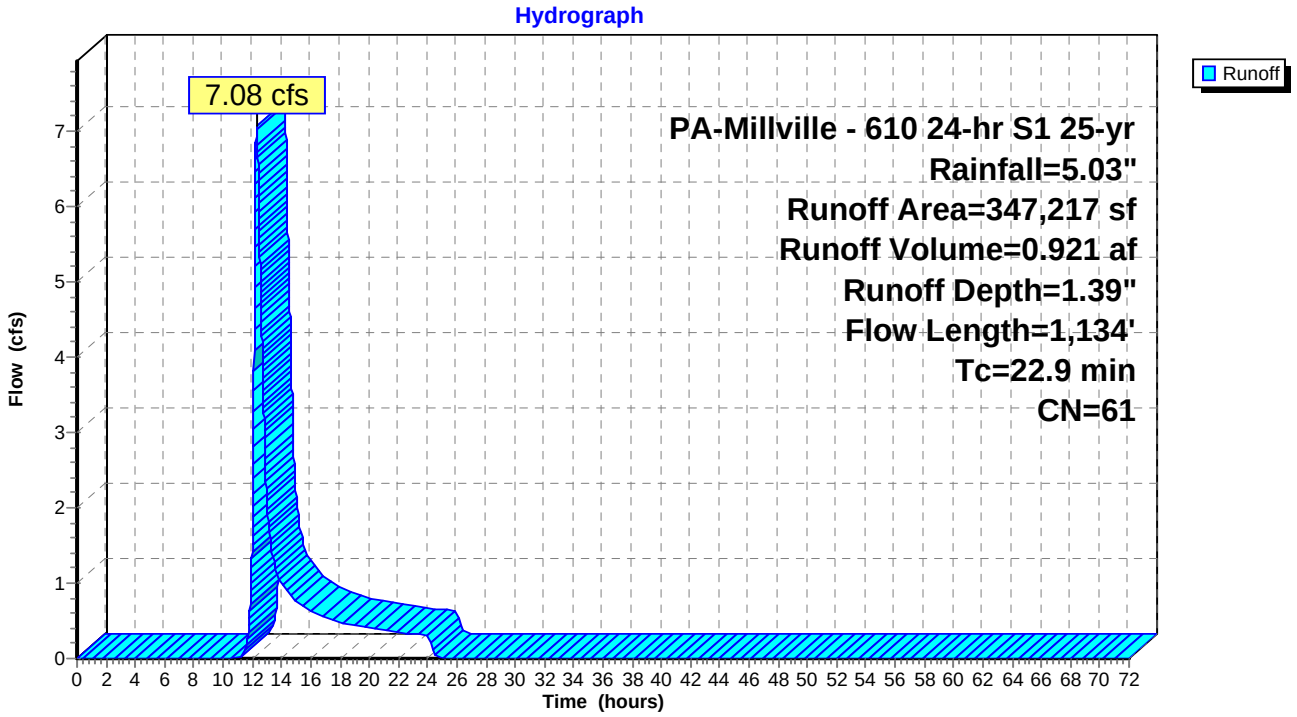
Subcatchment 5: POST DEVELOPMENT BYPASS DRAINAGE AREA



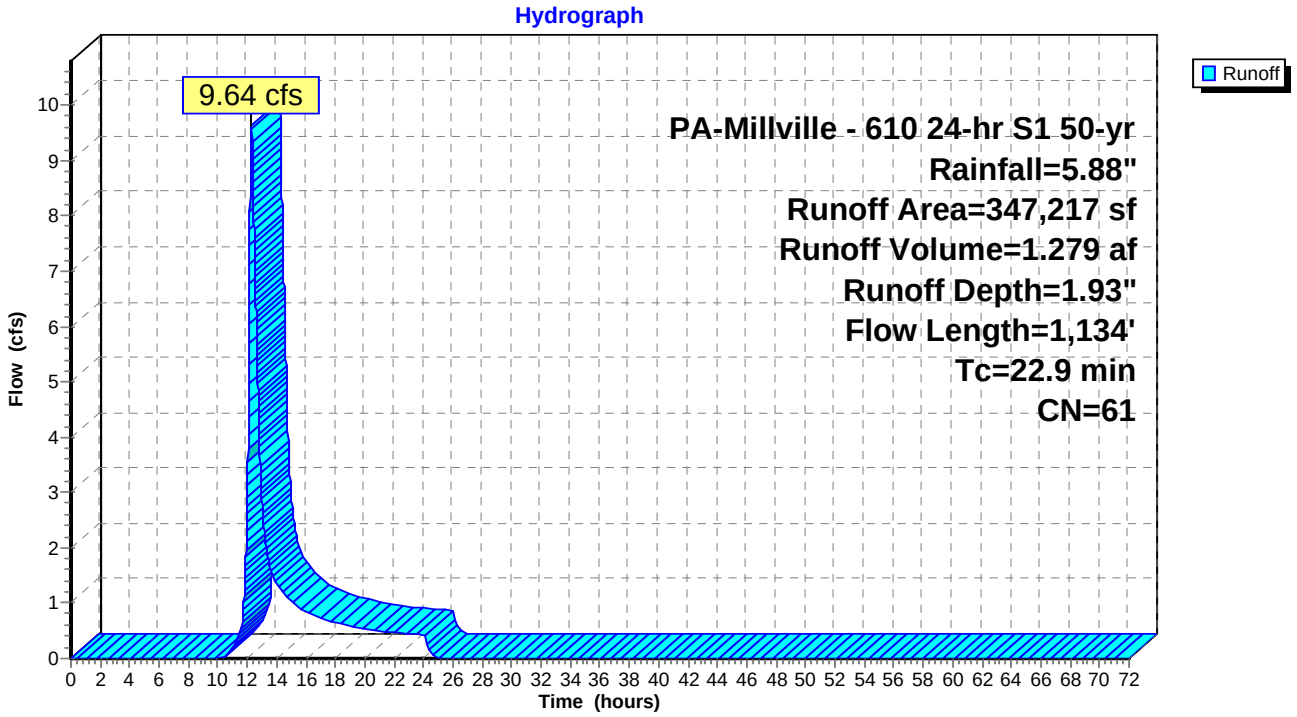
Subcatchment 5: POST DEVELOPMENT BYPASS DRAINAGE AREA



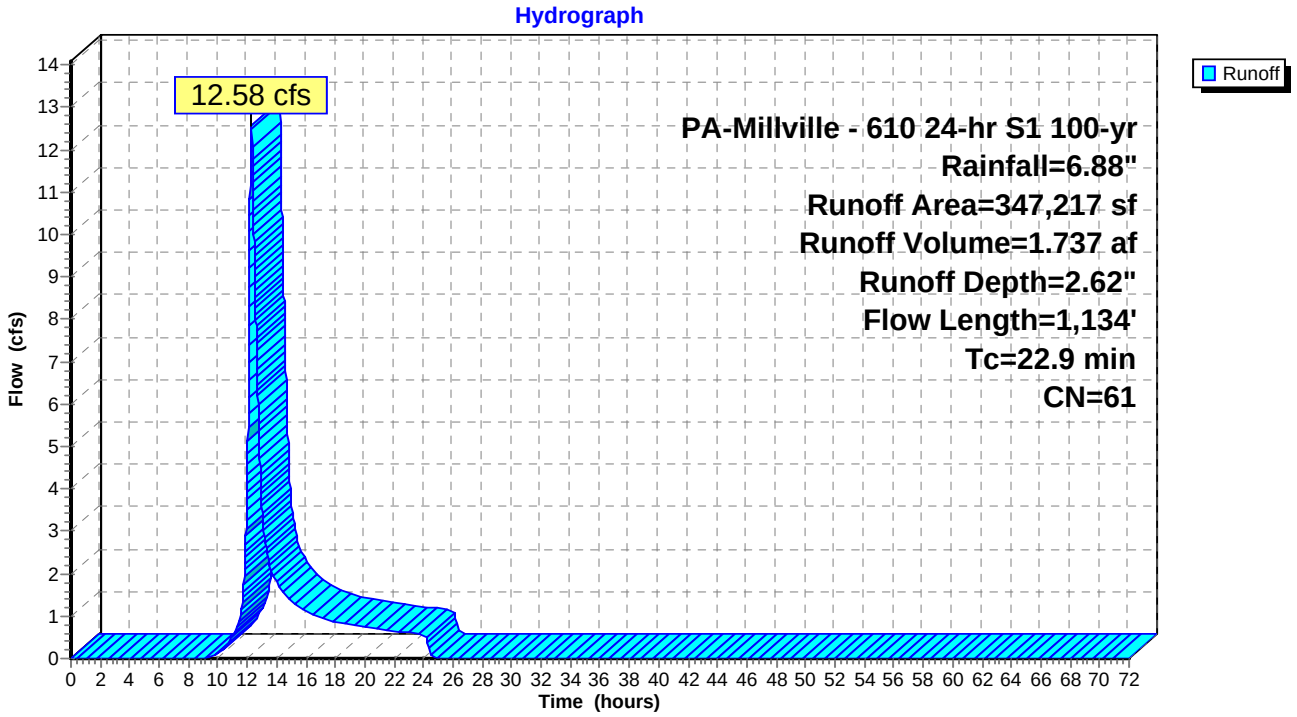
Subcatchment 5: POST DEVELOPMENT BYPASS DRAINAGE AREA



Subcatchment 5: POST DEVELOPMENT BYPASS DRAINAGE AREA



Subcatchment 5: POST DEVELOPMENT BYPASS DRAINAGE AREA



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Point of Interest B
Post Development Calculations

Summary for Subcatchment 8: POST DEVELOPMENT DRAINAGE AREA TO POI B

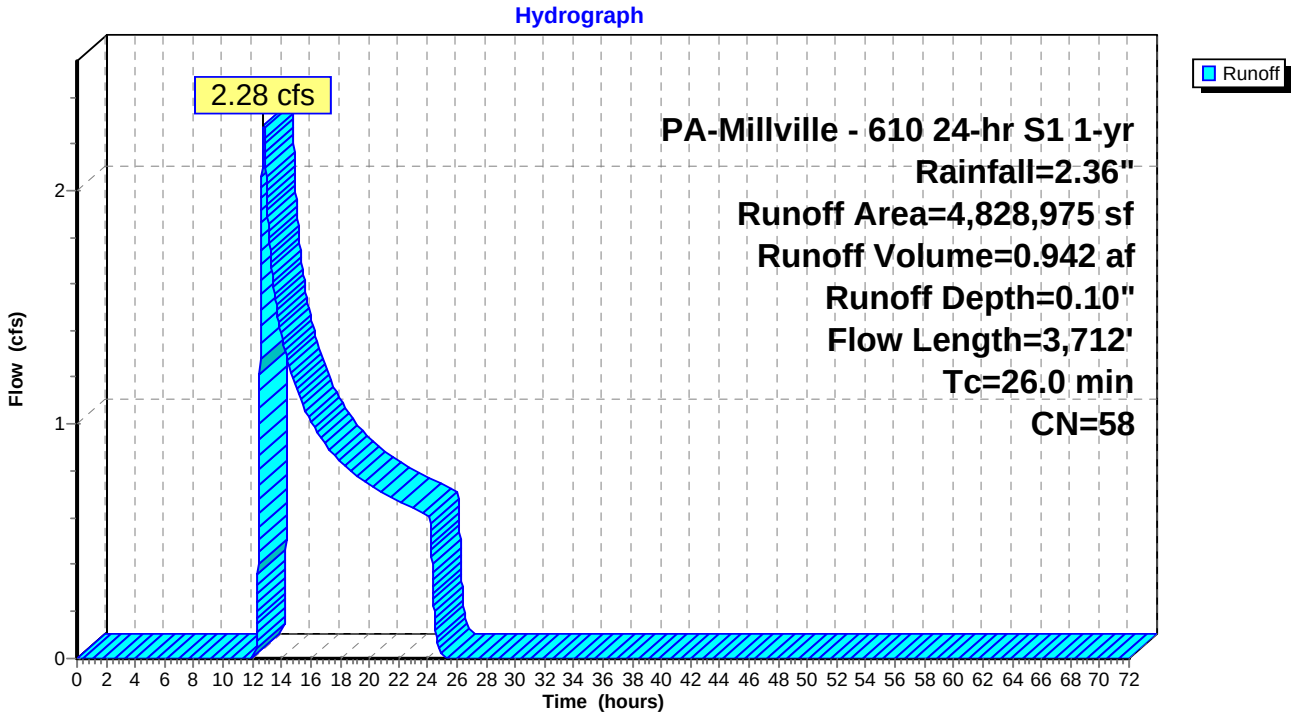
Runoff = 2.28 cfs @ 12.77 hrs, Volume= 0.942 af, Depth= 0.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
PA-Millville - 610 24-hr S1 1-yr Rainfall=2.36"

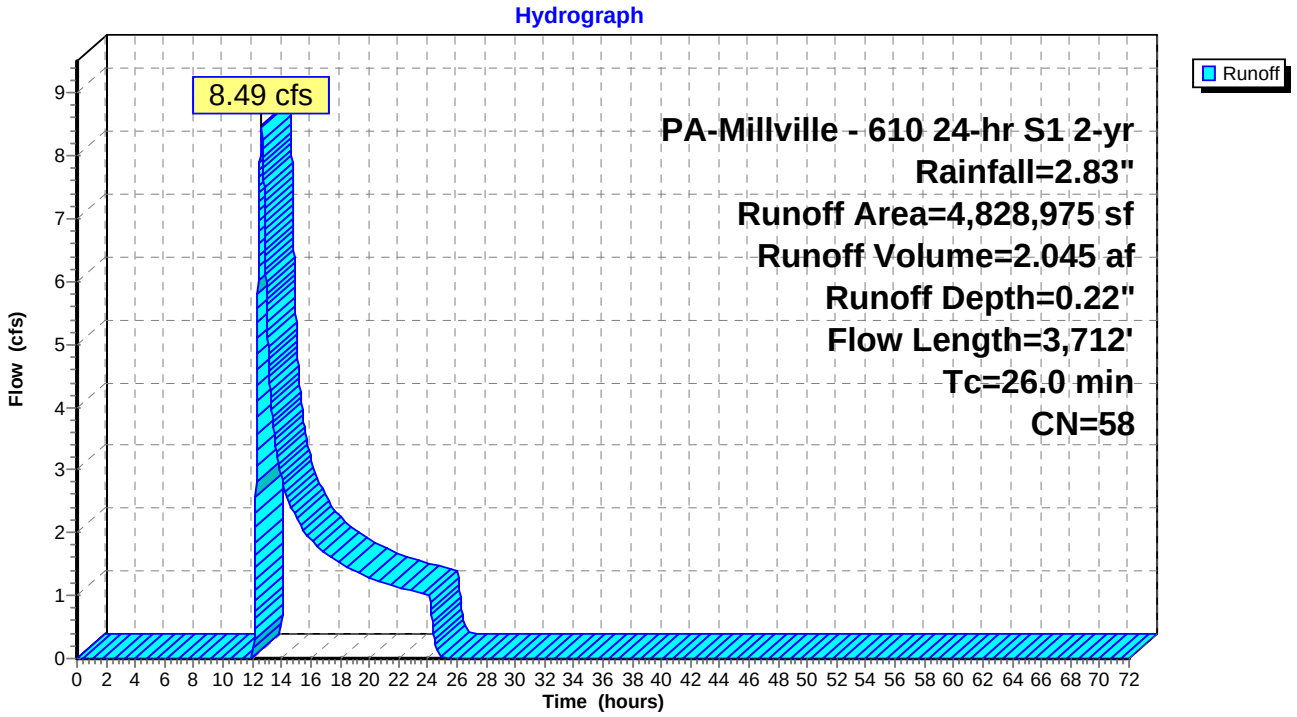
	Area (sf)	CN	Description
	792,008	55	Woods, Good, HSG B
	3,980,165	58	Meadow, non-grazed, HSG B
*	56,802	98	Impervious, HSG B
	4,828,975	58	Weighted Average
	4,772,173		98.82% Pervious Area
	56,802		1.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	100	0.0650	0.29		**Sheet Flow, SHT 1** Range n= 0.130 P2= 2.83"
8.2	1,084	0.0990	2.20		**Shallow Concentrated Flow, SCF 1** Short Grass Pasture Kv= 7.0 fps
1.6	262	0.0340	2.77		**Shallow Concentrated Flow, SCF 2** Grassed Waterway Kv= 15.0 fps
1.4	487	0.7000	5.86		**Shallow Concentrated Flow, SCF 3** Short Grass Pasture Kv= 7.0 fps
9.0	1,779	0.0480	3.29		**Shallow Concentrated Flow, SCF 4** Grassed Waterway Kv= 15.0 fps
26.0	3,712	Total			

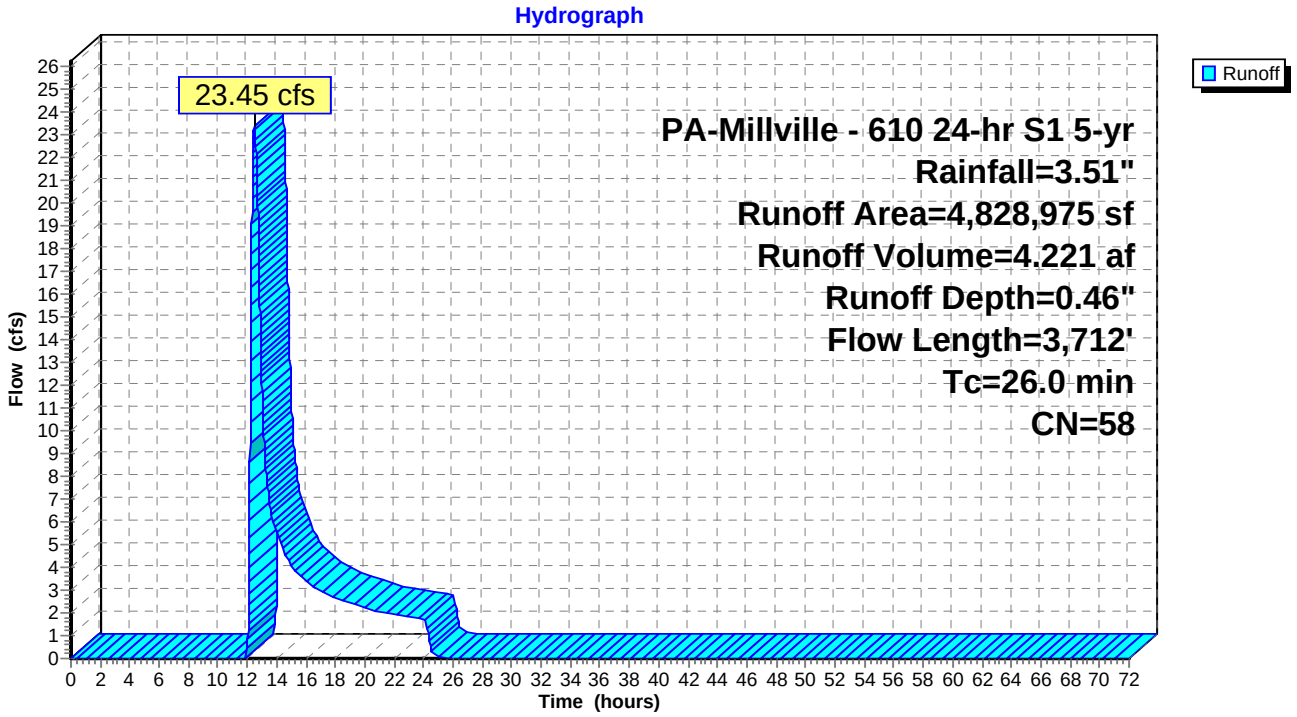
Subcatchment 8: POST DEVELOPMENT DRAINAGE AREA TO POI B



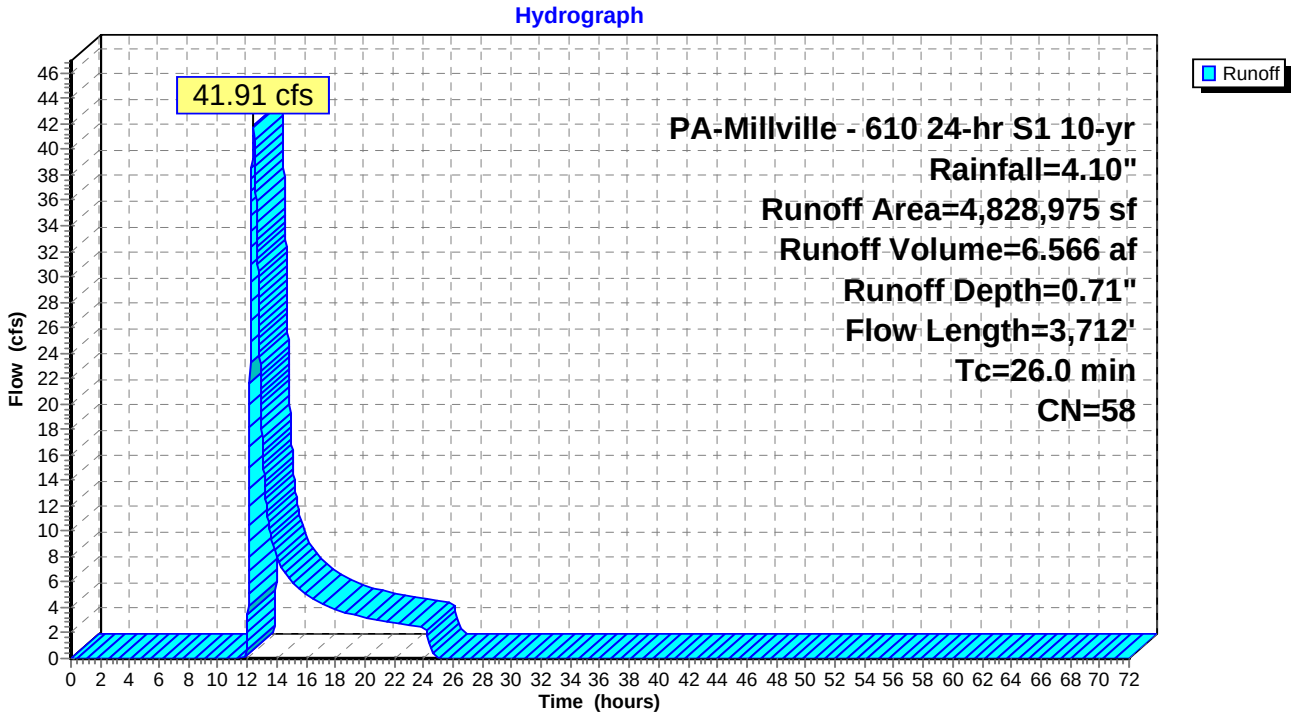
Subcatchment 8: POST DEVELOPMENT DRAINAGE AREA TO POI B



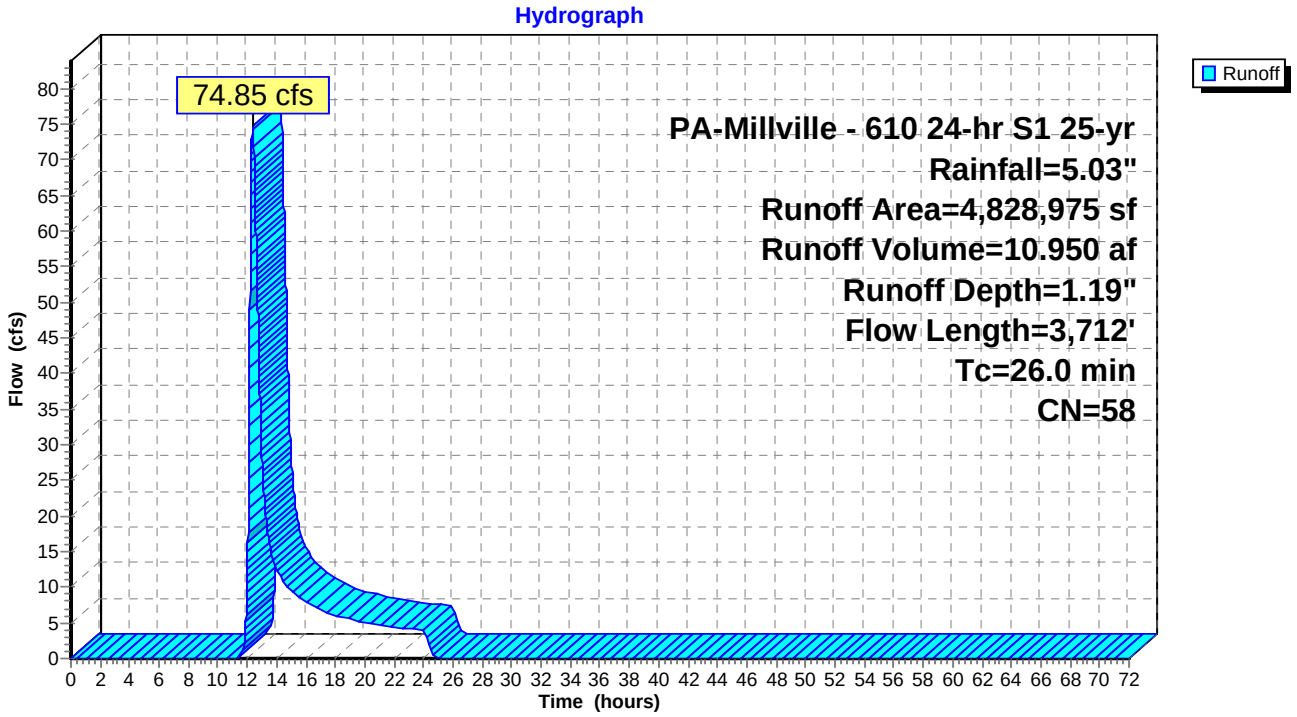
Subcatchment 8: POST DEVELOPMENT DRAINAGE AREA TO POI B



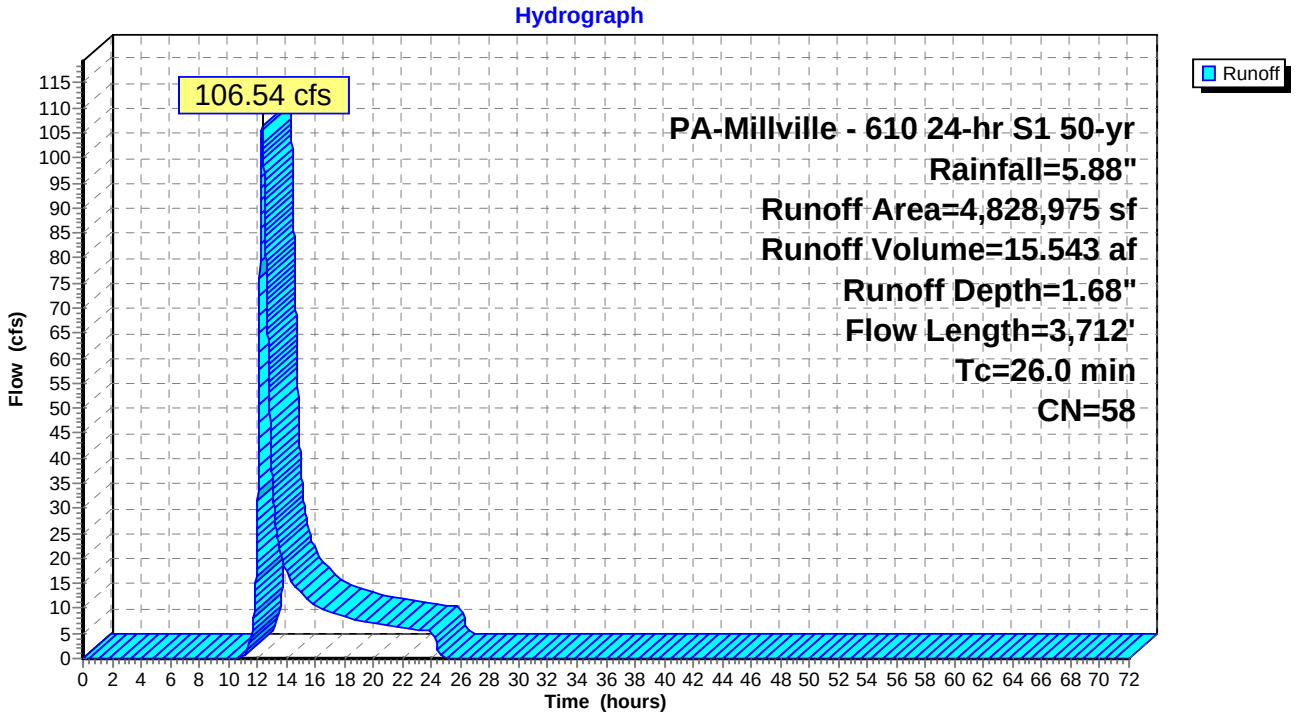
Subcatchment 8: POST DEVELOPMENT DRAINAGE AREA TO POI B



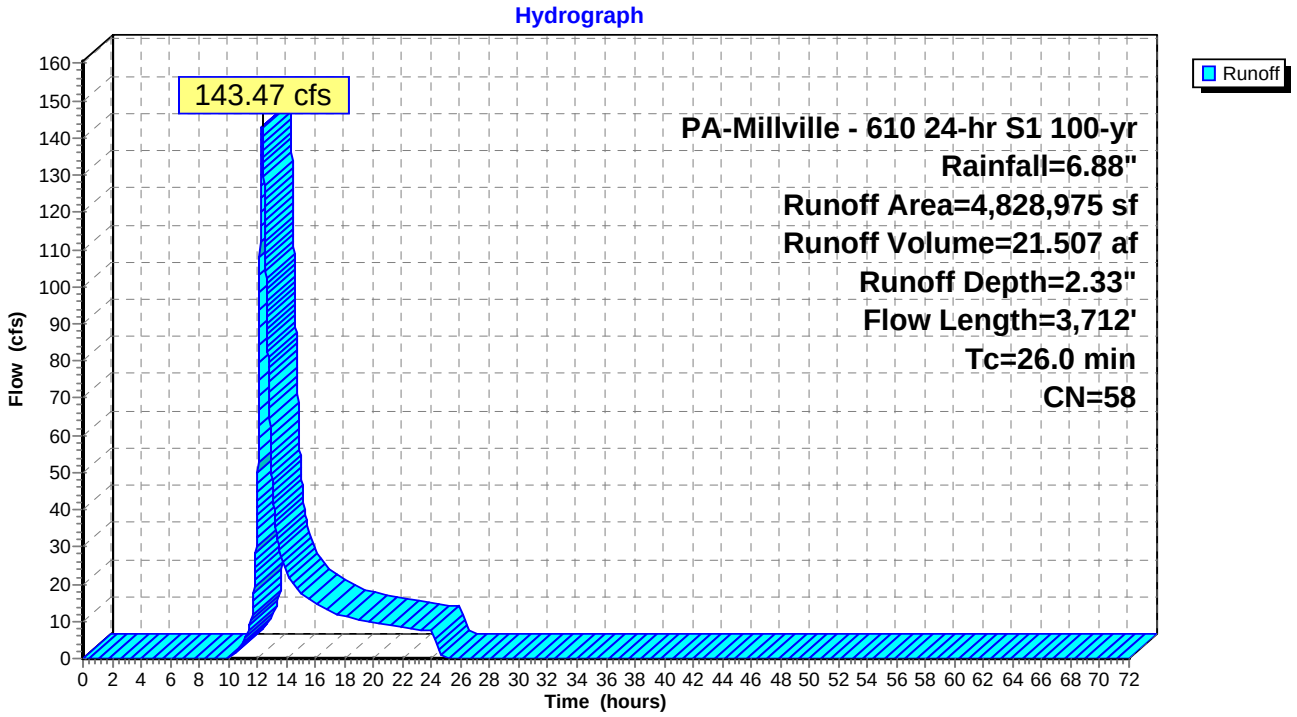
Subcatchment 8: POST DEVELOPMENT DRAINAGE AREA TO POI B



Subcatchment 8: POST DEVELOPMENT DRAINAGE AREA TO POI B



Subcatchment 8: POST DEVELOPMENT DRAINAGE AREA TO POI B



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Point of Interest C
Post Development Calculations

Summary for Subcatchment 13S: POST DEVELOPMENT DRAINAGE AREA TO POI C

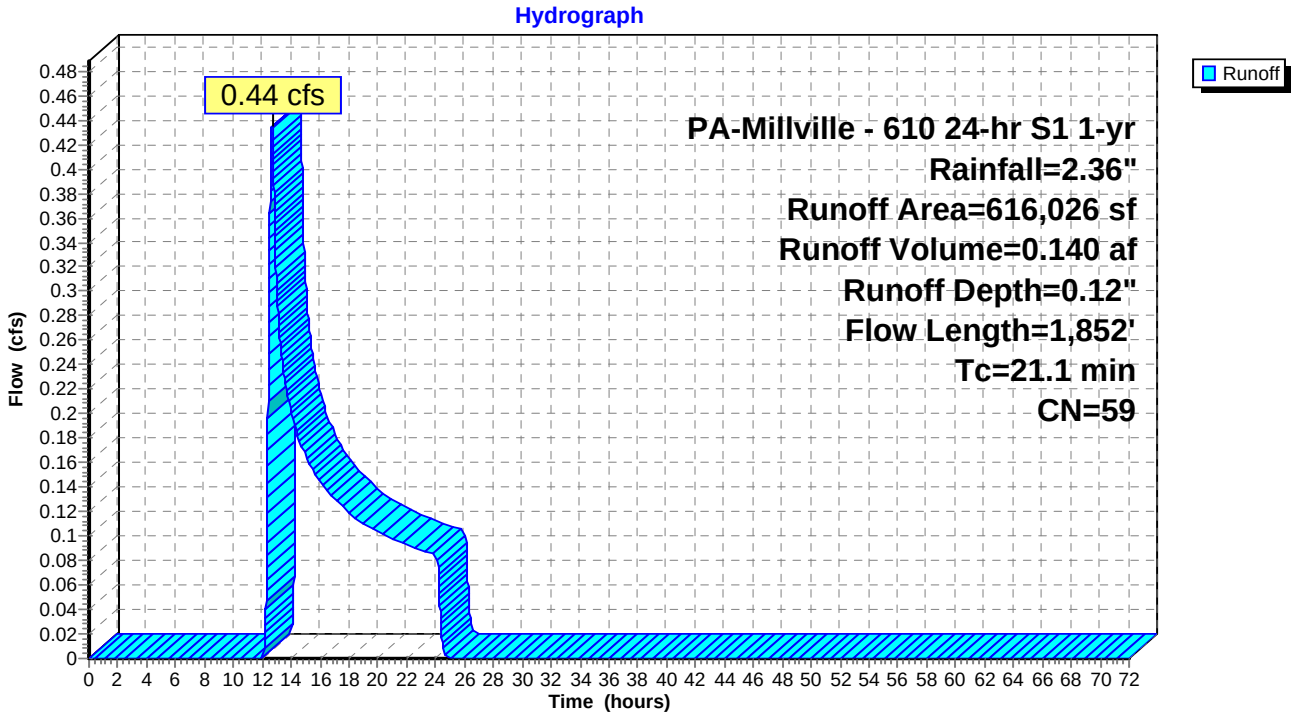
Runoff = 0.44 cfs @ 12.67 hrs, Volume= 0.140 af, Depth= 0.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
PA-Millville - 610 24-hr S1 1-yr Rainfall=2.36"

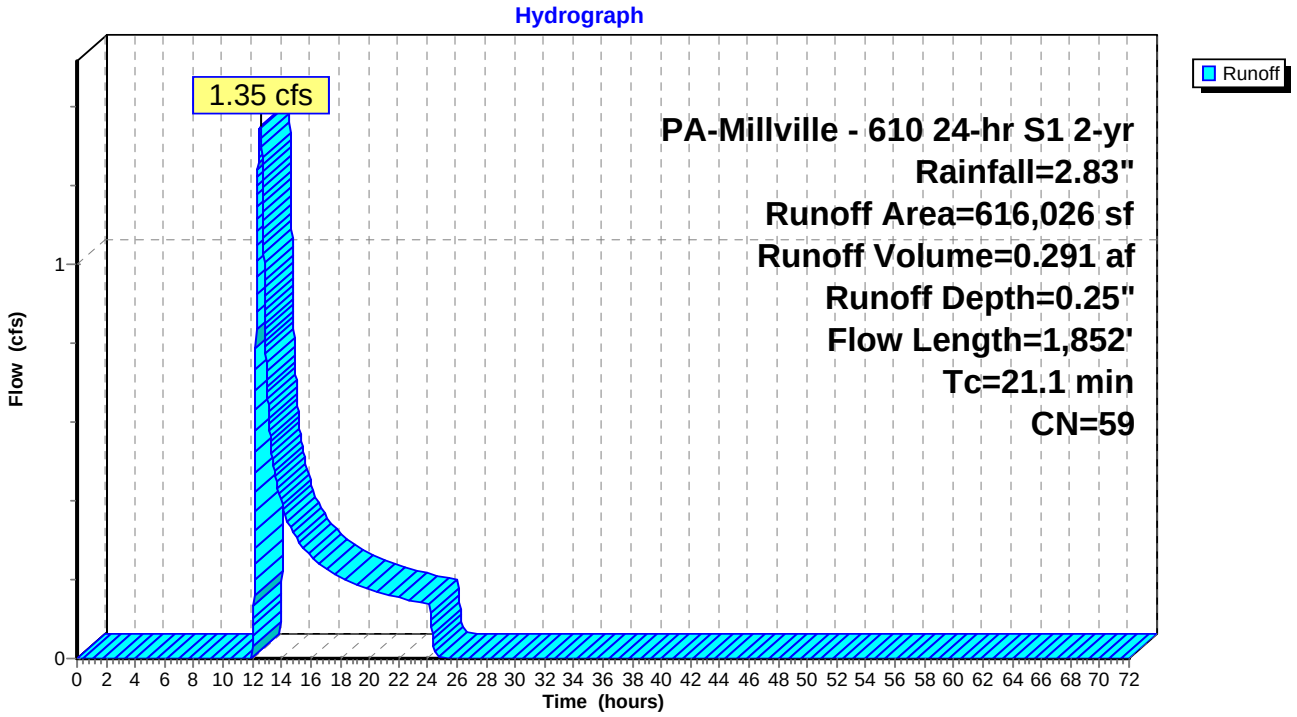
	Area (sf)	CN	Description
	605,789	58	Meadow, non-grazed, HSG B
*	10,237	98	Impervious, HSG D
	616,026	59	Weighted Average
	605,789		98.34% Pervious Area
	10,237		1.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.7	100	0.0450	0.25		**Sheet Flow, SHT 1** Range n= 0.130 P2= 2.83"
13.7	1,660	0.0830	2.02		**Shallow Concentrated Flow, SCF 1** Short Grass Pasture Kv= 7.0 fps
0.7	92	0.0200	2.12		**Shallow Concentrated Flow, SCF 2** Grassed Waterway Kv= 15.0 fps
21.1	1,852	Total			

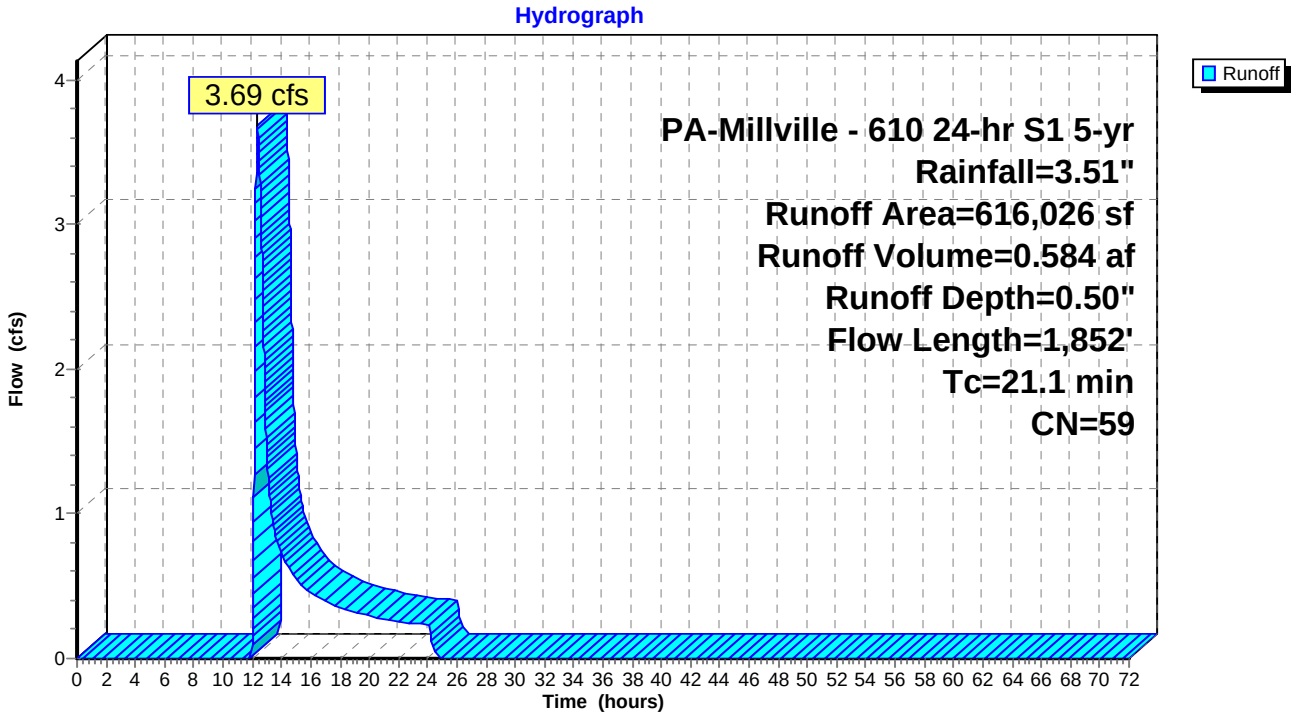
Subcatchment 13S: POST DEVELOPMENT DRAINAGE AREA TO POI C



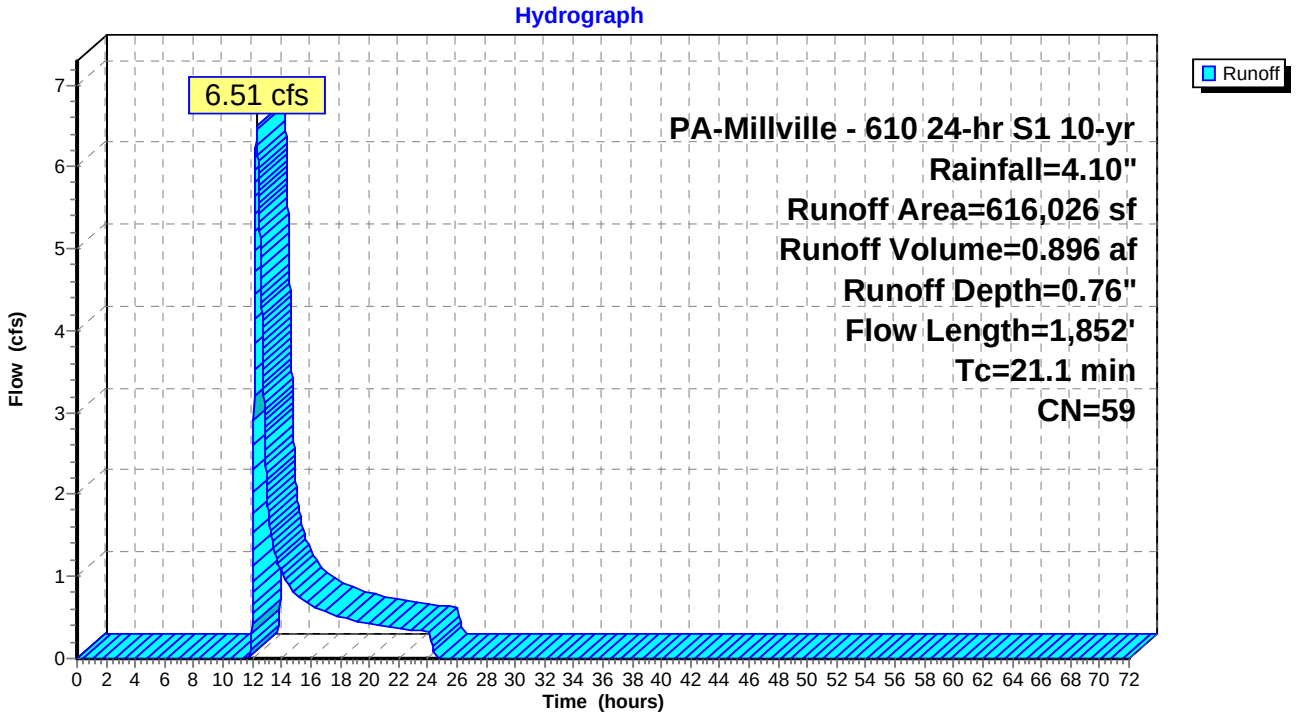
Subcatchment 13S: POST DEVELOPMENT DRAINAGE AREA TO POI C



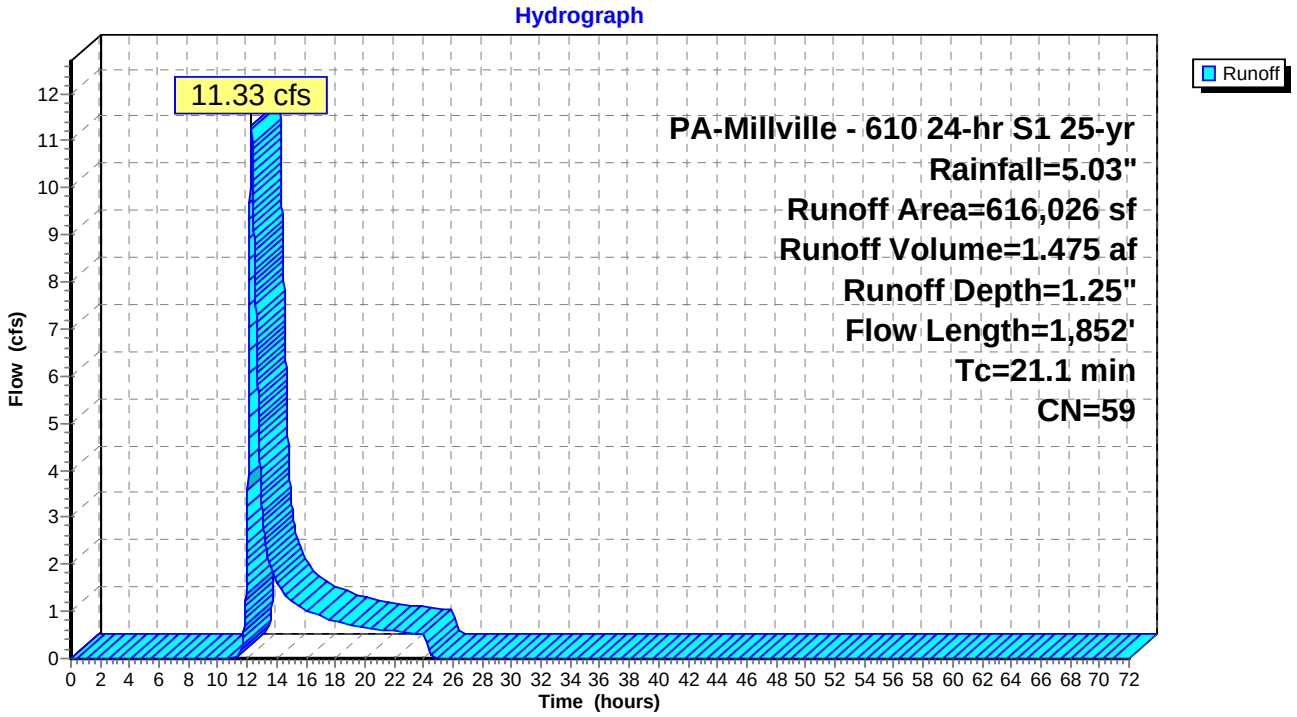
Subcatchment 13S: POST DEVELOPMENT DRAINAGE AREA TO POI C



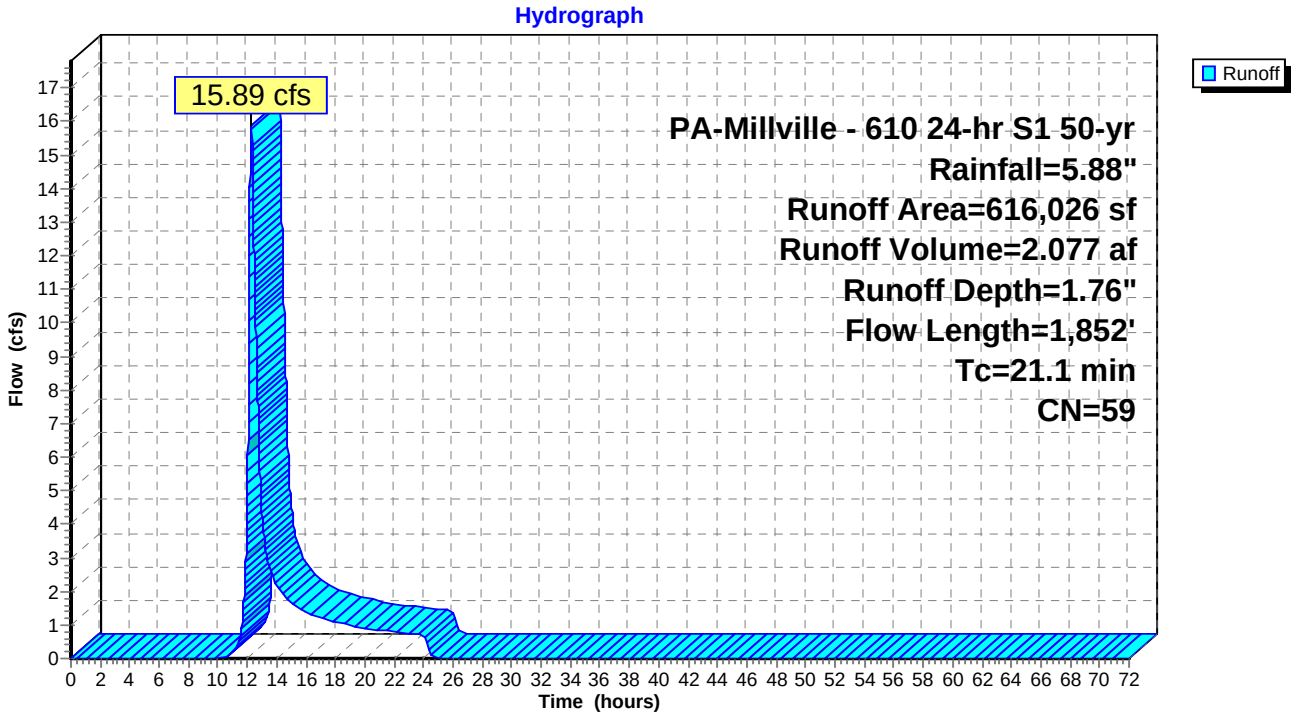
Subcatchment 13S: POST DEVELOPMENT DRAINAGE AREA TO POI C



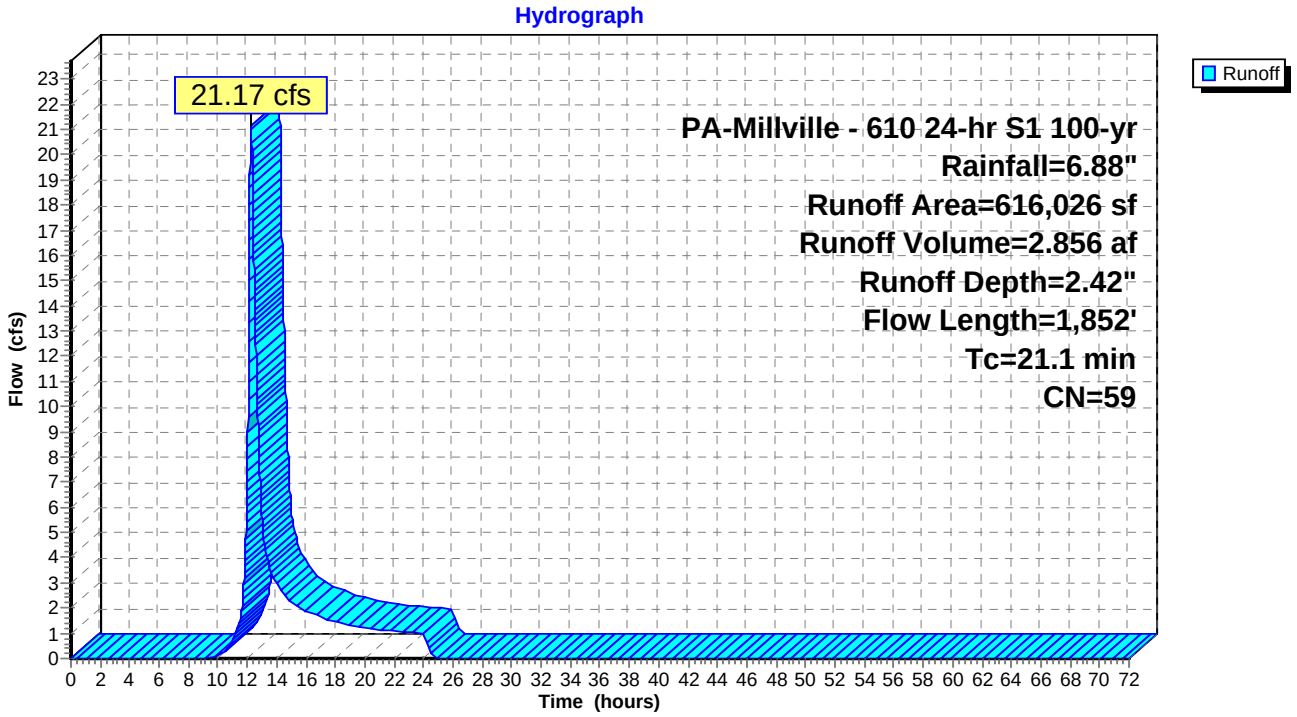
Subcatchment 13S: POST DEVELOPMENT DRAINAGE AREA TO POI C



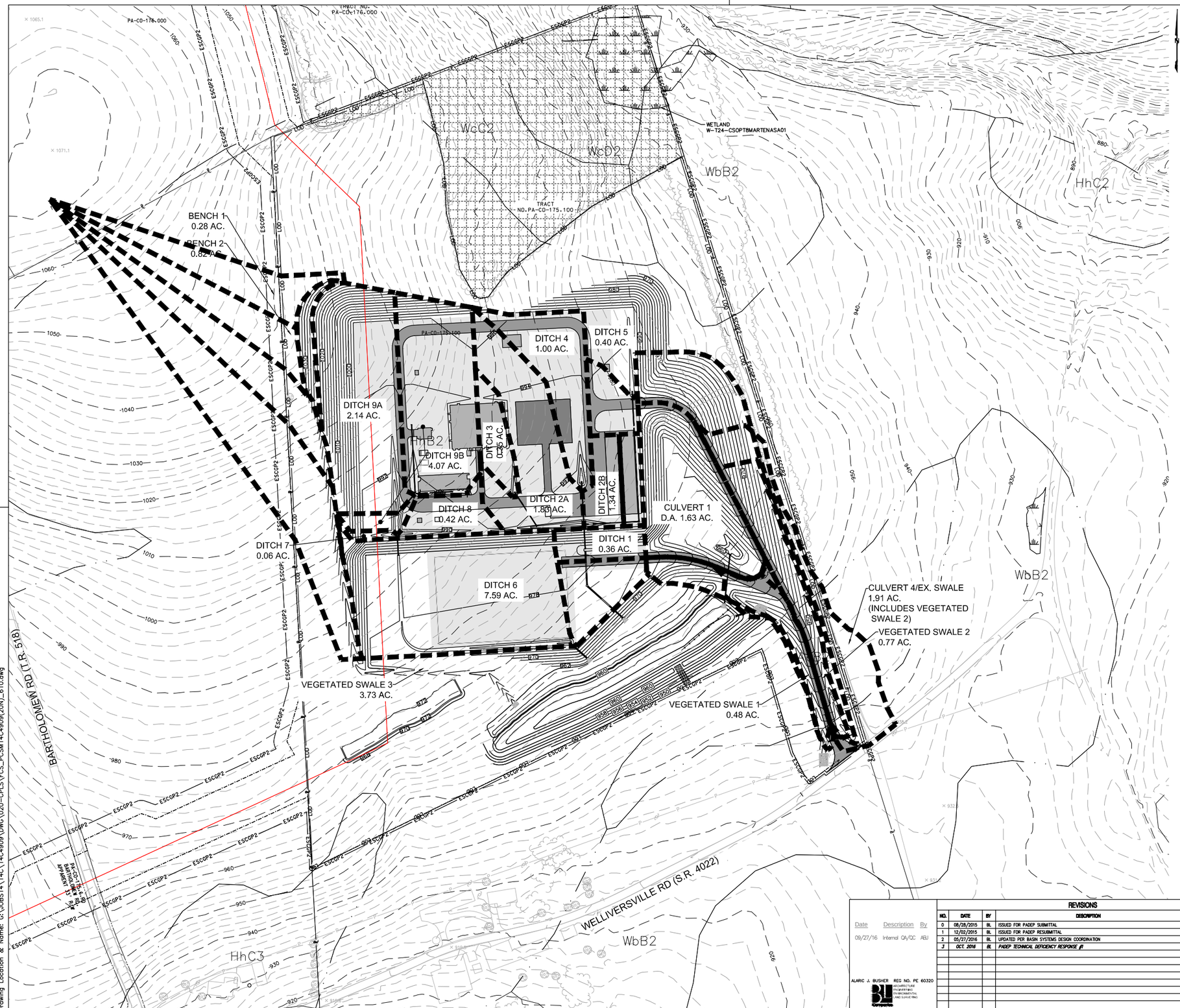
Subcatchment 13S: POST DEVELOPMENT DRAINAGE AREA TO POI C

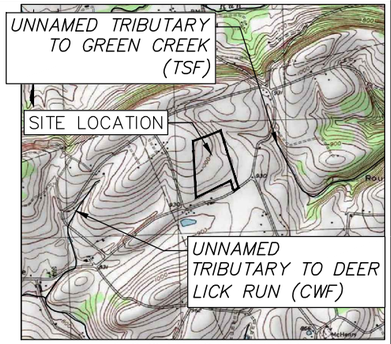


Subcatchment 13S: POST DEVELOPMENT DRAINAGE AREA TO POI C



A.3 Conveyance Calculations





LOCATION MAP

USGS BLOOMSBURG EAST QUADRANGLE
SCALE: 1"=2,000'

LEGEND

- PROPERTY BOUNDARY LINE (APPROXIMATE)
- 1460 MAJOR CONTOUR (10' INTERVAL)
- MINOR CONTOUR (2' INTERVAL)
- FENCE
- STONE ROW
- SOIL BOUNDARY
- TREELINE
- CENTERLINE STREAM/EDGE WATERBODY
- DELINEATED WETLANDS
- × 1353.0 SPOT ELEVATION
- TREE OR BUSH
- UTILITY POLE AND UTILITY LINE
- GUY POLE
- GUY POLE OR ANCHOR
- POST
- SIGN
- WATER WELL
- UTILITY BOX
- MONUMENT (PROPERTY BOUNDARY MARKER)
- IRON PIPE OR PIN (PROPERTY BOUNDARY MARKER)
- WsB SOIL TYPE DESIGNATION
- EXISTING ROAD
- ROW
- 1460 MAJOR CONTOUR (10' INTERVAL)
- MINOR CONTOUR (2' INTERVAL)
- MINOR CONTOUR (1' INTERVAL)
- LOD LIMIT OF DISTURBANCE (COMPRESSOR STATION 610)
- ESCGP2 ESCGP-2 PERMIT BOUNDARY
- CENTERLINE GAS PIPELINE
- LIMIT OF WORKSPACE (OVERALL PIPELINE PROJECT)
- PROPOSED ACCESS ROAD
- DRAINAGE AREA BOUNDARIES
- TRM LINING

GRAPHIC SCALE
100 50 0 100
SCALE IN FEET
1 inch = 100 ft.

Drawn By & Date/Time: EPierides Sep 27, 2016 - 2:40pm
Drawing Location & Name: G:\JOBS14\14C\14C4909\DWG\020-CPLS\FDS_PCSM14C4909(20N)_610.dwg

Date	Description	By
09/27/16	Internal QA/QC	AEU

ALARIC J. BUSHER REG NO. PE 60320
BLE Companies — ARCHITECTURE ENGINEERING ENVIRONMENTAL LAND SURVEYING

REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
0	08/28/2015	BL	ISSUED FOR PADEP SUBMITTAL	W01161505	DAK	AJB
1	12/02/2015	BL	ISSUED FOR PADEP RESUBMITTAL	W01161505	DAK	AJB
2	05/27/2016	BL	UPDATED PER BASIN SYSTEMS DESIGN COORDINATION	W01161505	AJB	AJB
3	*OCT. 2016*	*BL*	*PADEP TECHNICAL DEFICIENCY RESPONSE #1*	*W01161505*	*ABJ*	*ABJ*

TRANSCONTINENTAL GAS PIPELINE COMPANY LLC
ATLANTIC SUNRISE PROJECT– PROPOSED 42" NATURAL GAS PIPELINE
POST CONSTRUCTION STORMWATER MANAGEMENT PLANS
FOR COMPRESSOR STATION 610
ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA
POST DEVELOPMENT DRAINAGE AREA MAP

Williams

DRAWN BY:	AOE	DATE:	04/03/15	ISSUED FOR BID:	SCALE: AS NOTED
CHECKED BY:	AJB	DATE:	04/03/15	ISSUED FOR CONSTRUCTION:	REVISION: J
APPROVED BY:	AJB	DATE:	07/17/15	DRAWING NUMBER: (66-0610)F-1A-9	SHEET 1 OF 1
W.O.	1161505				

E&S WORKSHEET # 11

Channel Design Data

PROJECT NAME: ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610

LOCATION: ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA

PREPARED BY: AOE DATE: 08/17/2015

CHECKED BY: AJB DATE: 08/17/2015

CHANNEL OR CHANNEL SECTION		VEGETATED SWALE 1 MAX LINING	VEGETATED SWALE 1 MAX GRASS	VEGETATED SWALE 1 MIN LINING	VEGETATED SWALE 1 MIN GRASS	
TEMPORARY OR PERMANENT?	(T OR P)	P	P	P	P	
DESIGN STORM	(2, 5, OR 10 YR)	10	10	10	10	
ACRES	(AC)	THE REQUIRED CAPACITY (Qr) OF THIS SWALE IS THE DISCHARGE FROM INFILTRATION BASIN 1 COMBINED WITH THE FLOW FROM THE OVERLAND DRAINAGE AREA TO THE SWALE. Qr =3.98 (BASIN) +1.16 (OVERLAND) = **5.14CFS**				
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]					
Qr (REQUIRED CAPACITY)	(CFS)					
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	5.27	5.22	5.28	5.15	
PROTECTIVE LINING[2]		SC250	GRASS/ SC250	SC250	GRASS/ SC250	
n (MANNING'S COEFFICIENT)[2]		0.04	0.088	0.04	0.092	
Va (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A	N/A	N/A	
V (CALCULATED AT FLOW DEPTH d)	(FPS)	4.26	2.40	3.61	1.96	
τa (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	2.50	8.00	2.50	8.00	
τd (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	1.78	2.64	1.26	1.89	
CHANNEL BOTTOM WIDTH	(FT)	2	2	2	2	
CHANNEL SIDE SLOPES	(H:V)	3	3	3	3	
D (TOTAL DEPTH)	(FT)	2.0	2.0	2.0	2.0	
CHANNEL TOP WIDTH @ D	(FT)	14	14	14	14	
d (CALCULATED FLOW DEPTH)	(FT)	0.39	0.58	0.44	0.66	
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	4.34	5.48	4.64	5.96	
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	5.13	3.45	4.55	3.03	
d50 STONE SIZE	(IN)	N/A	N/A	N/A	N/A	
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	1.24	2.17	1.46	2.63	
R (HYDRAULIC RADIUS)		0.28	0.38	0.31	0.43	
S (BED SLOPE)[3]	(FT/FT)	0.073	0.073	0.046	0.046	
Sc (CRITICAL SLOPE)	(FT/FT)	0.037	0.161	0.036	0.170	
.7Sc	(FT/FT)	0.026	0.112	0.025	0.119	
1.3Sc	(FT/FT)	0.048	0.209	0.046	0.221	
STABLE FLOW?	(Y/N)	Y	Y	N	Y	
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.12	0.10	0.12	0.10	
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50	0.50	0.50	0.50	
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50	0.50	0.50	
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS	(S)	S	S	S	S	

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Source: 363-2134-008 / March 31, 2012 / Page 382

Summary for Subcatchment 11: DRAINAGE AREA TO VEGETATED SWALE 1

Runoff = 1.16 cfs @ 12.03 hrs, Volume= 0.067 af, Depth= 1.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
PA-Millville - 610 24-hr S1 10-yr Rainfall=4.10"

	Area (ac)	CN	Description
	0.320	61	Pasture/grassland/range, Good, HSG B
*	0.164	98	Impervious, HSG B
	0.484	74	Weighted Average
	0.320		66.12% Pervious Area
	0.164		33.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11: DRAINAGE AREA TO VEGETATED SWALE 1

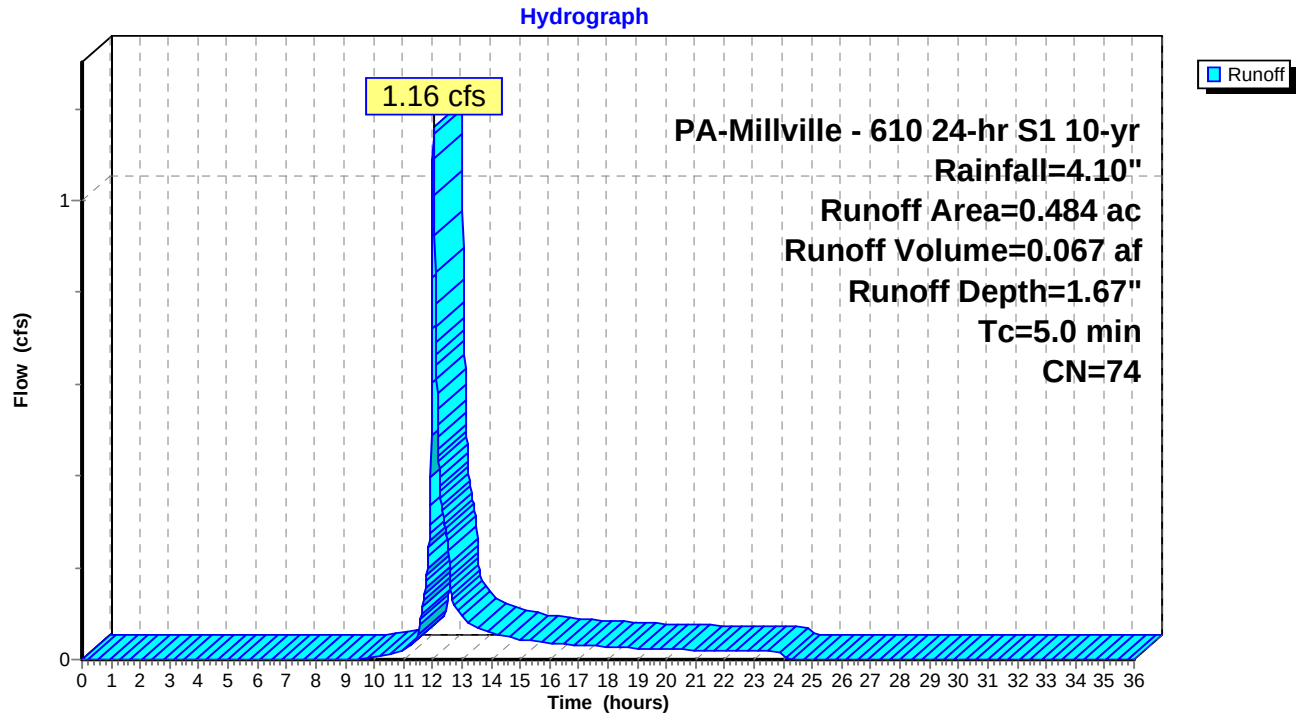
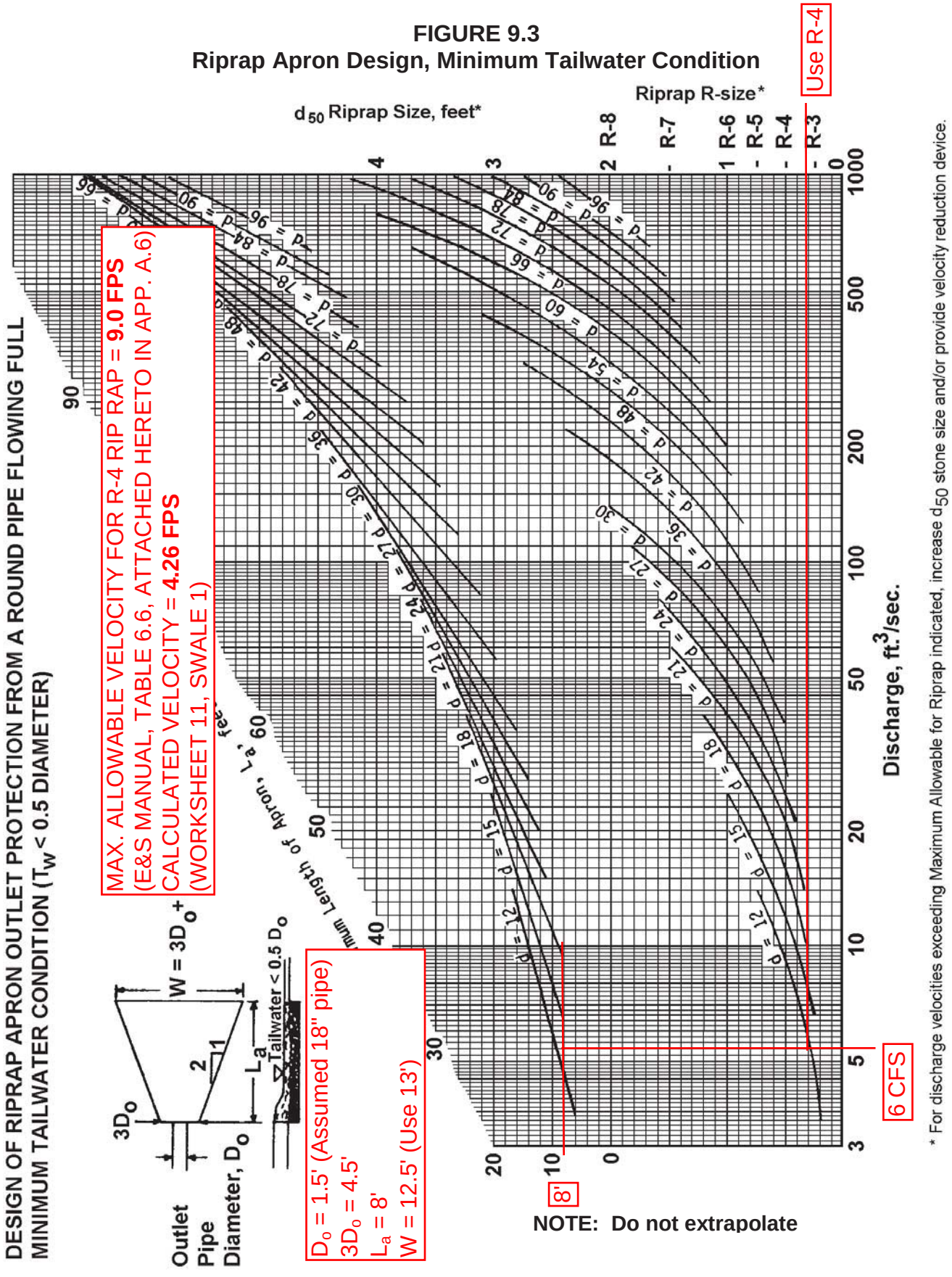


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

Not to be used for Box Culverts

E&S WORKSHEET # 11

Channel Design Data

PROJECT NAME: ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610

LOCATION: ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA

PREPARED BY: JEC DATE: 06/15/2015

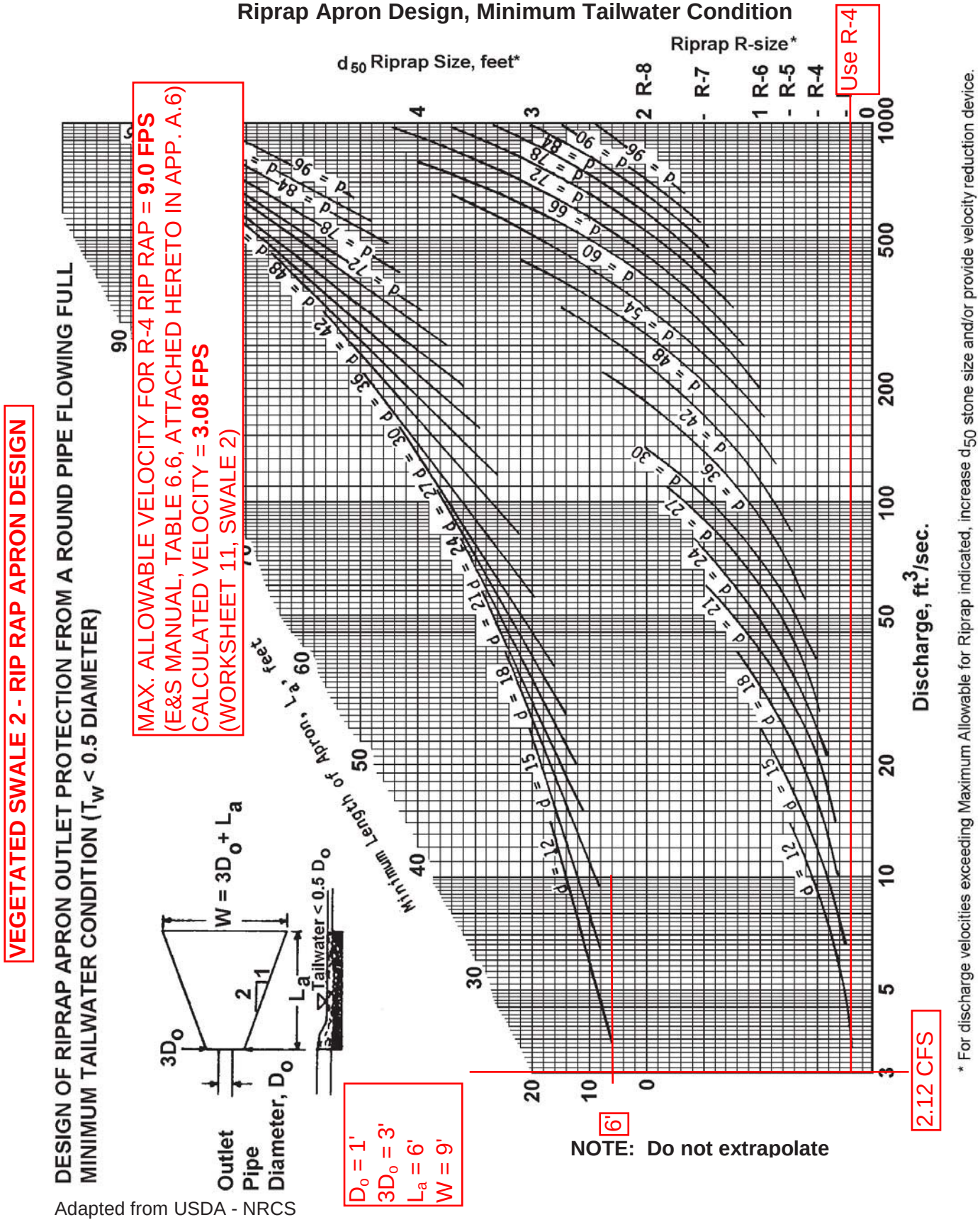
CHECKED BY: AJB DATE: 06/15/2015

CHANNEL OR CHANNEL SECTION		VEGETATED SWALE 2 MAX LINING	VEGETATED SWALE 2 MAX GRASS	VEGETATED SWALE 2 MIN LINING	VEGETATED SWALE 2 MIN GRASS	
TEMPORARY OR PERMANENT?	(T OR P)	P	P	P	P	
DESIGN STORM	(2, 5, OR 10 YR)	10	10	10	10	
ACRES	(AC)	0.77	0.77	0.77	0.77	
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]	2.75	2.75	2.75	2.75	
Qr (REQUIRED CAPACITY)	(CFS)	2.12	2.12	2.12	2.12	
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	2.12	2.12	2.17	2.17	
PROTECTIVE LINING[2]		SC250	GRASS/ SC250	SC250	GRASS/ SC250	
n (MANNING'S COEFFICIENT)[2]		0.04	0.126	0.04	0.129	
Va (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A	N/A	N/A	
V (CALCULATED AT FLOW DEPTH d)	(FPS)	3.08	1.36	2.86	1.24	
τa (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	2.50	8.00	2.50	8.00	
τd (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	0.97	1.78	0.83	1.53	
CHANNEL BOTTOM WIDTH	(FT)	2	2	2	2	
CHANNEL SIDE SLOPES	(H:V)	3	3	3	3	
D (TOTAL DEPTH)	(FT)	2.0	2.0	2.0	2.0	
CHANNEL TOP WIDTH @ D	(FT)	14	14	14	14	
d (CALCULATED FLOW DEPTH)	(FT)	0.25	0.46	0.27	0.50	
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	3.50	4.76	3.62	5.00	
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	8.00	4.35	7.41	4.00	
d50 STONE SIZE	(IN)	N/A	N/A	N/A	N/A	
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	0.69	1.55	0.76	1.75	
R (HYDRAULIC RADIUS)		0.19	0.32	0.20	0.34	
S (BED SLOPE)[3]	(FT/FT)	0.062	0.062	0.049	0.049	
Sc (CRITICAL SLOPE)	(FT/FT)	0.041	0.350	0.040	0.359	
.7Sc	(FT/FT)	0.029	0.245	0.028	0.251	
1.3Sc	(FT/FT)	0.054	0.455	0.053	0.466	
STABLE FLOW?	(Y/N)	Y	Y	N	Y	
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.06	0.05	0.06	0.05	
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50	0.50	0.50	0.50	
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50	0.50	0.50	
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS	(S)	S	S	S	S	

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Source: 363-2134-008 / March 31, 2012 / Page 382

FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

Not to be used for Box Culverts

E&S WORKSHEET # 11

Channel Design Data

PROJECT NAME: ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610

LOCATION: ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA

PREPARED BY: JEC DATE: 06/15/2015

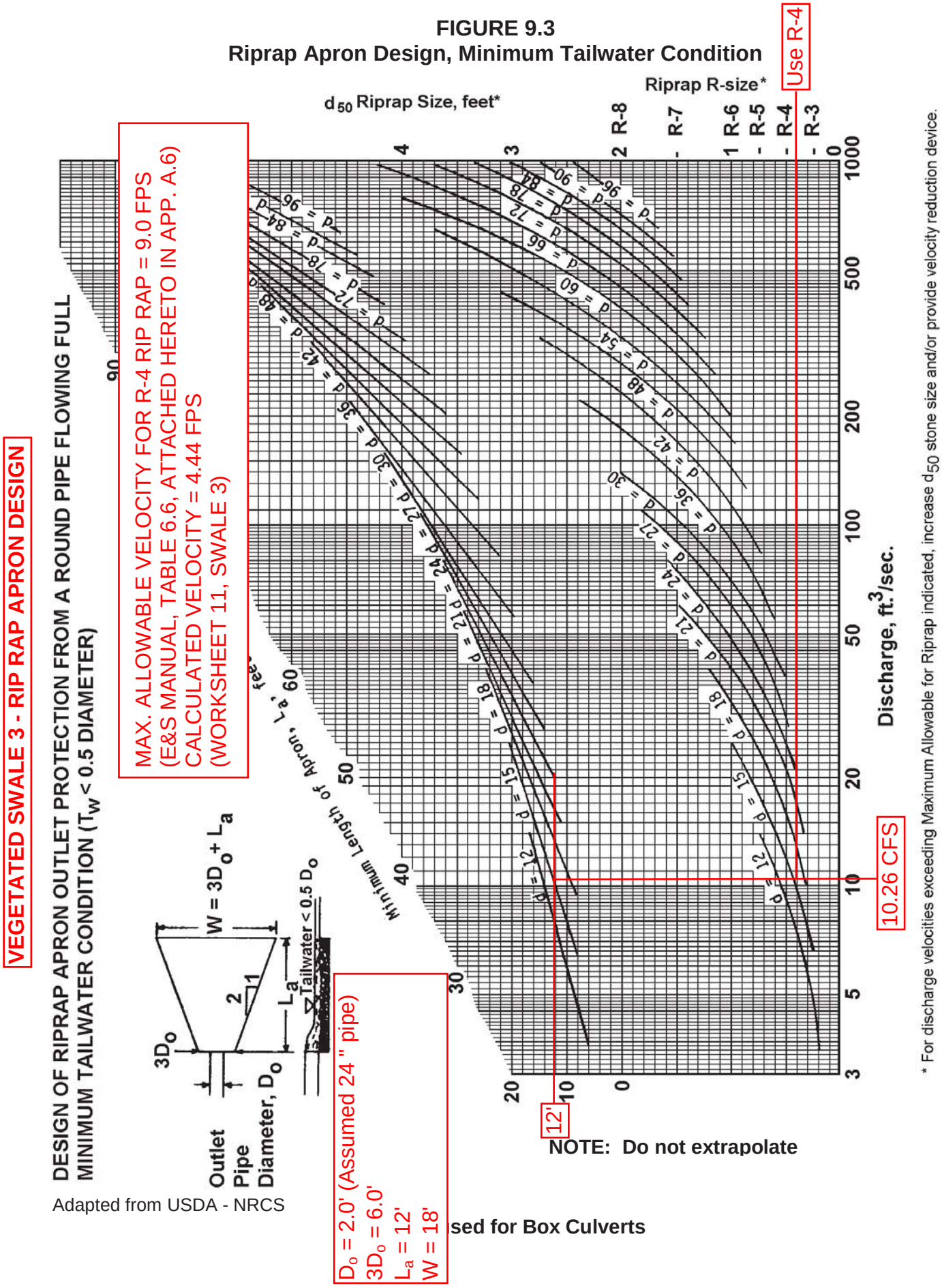
CHECKED BY: AJB DATE: 06/15/2015

CHANNEL OR CHANNEL SECTION		VEGETATED SWALE 3 LINING	VEGETATED SWALE 3 GRASS			
TEMPORARY OR PERMANENT?	(T OR P)	P	P			
DESIGN STORM	(2, 5, OR 10 YR)	10	10			
ACRES	(AC)	3.73	3.73			
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]	2.75	2.75			
Qr (REQUIRED CAPACITY)	(CFS)	10.26	10.26			
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	10.13	10.13			
PROTECTIVE LINING[2]		W3000	GRASS/ W3000			
n (MANNING'S COEFFICIENT)[2]		0.065	0.065			
Va (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A			
V (CALCULATED AT FLOW DEPTH d)	(FPS)	4.44	4.44			
τa (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	16.00	16.00			
τd (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	4.90	4.90			
CHANNEL BOTTOM WIDTH	(FT)	2	2			
CHANNEL SIDE SLOPES	(H:V)	3	3			
D (TOTAL DEPTH)	(FT)	1.5	1.5			
CHANNEL TOP WIDTH @ D	(FT)	11	11			
d (CALCULATED FLOW DEPTH)	(FT)	0.60	0.60			
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	5.60	5.60			
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	3.33	3.33			
d50 STONE SIZE	(IN)	N/A	N/A			
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	2.28	2.28			
R (HYDRAULIC RADIUS)		0.39	0.39			
S (BED SLOPE)[3]	(FT/FT)	0.131	0.131			
Sc (CRITICAL SLOPE)	(FT/FT)	0.087	0.087			
.7Sc	(FT/FT)	0.061	0.061			
1.3Sc	(FT/FT)	0.113	0.113			
STABLE FLOW?	(Y/N)	Y	Y			
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.20	0.20			
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50	0.50			
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50			
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS	(S)	S	S			

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Source: 363-2134-008 / March 31, 2012 / Page 382

FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

sed for Box Culverts

E&S WORKSHEET # 11

Channel Design Data

PROJECT NAME: ATLANTIC SUNRISE PIPELINE - COMPRESSOR STATION 610

LOCATION: ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA

PREPARED BY: JEC DATE: 06/15/2015

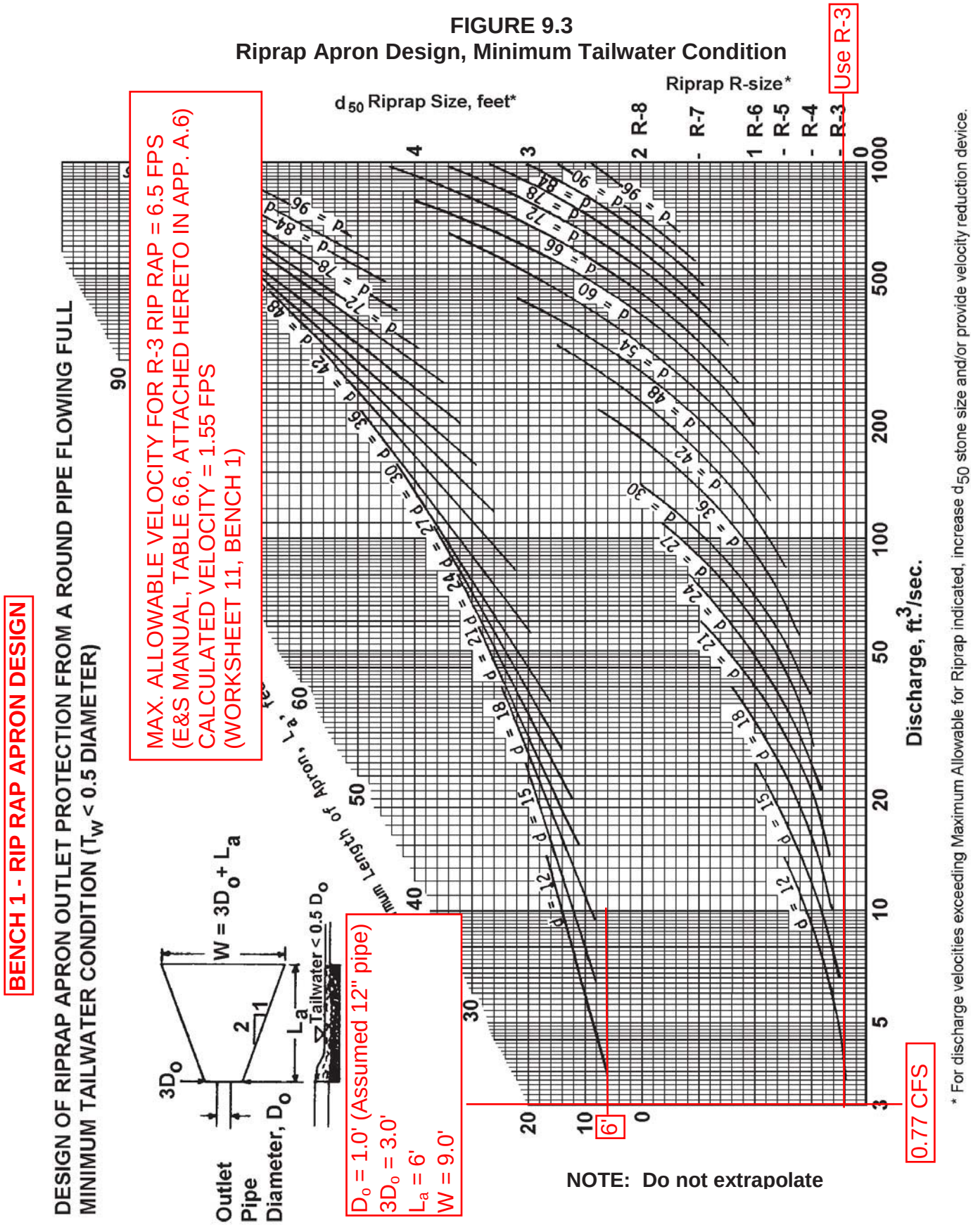
CHECKED BY: AJB DATE: 06/15/2015

CHANNEL OR CHANNEL SECTION		BENCH 1 LINING	BENCH 1 GRASS	BENCH 2 LINING	BENCH 2 GRASS
TEMPORARY OR PERMANENT?	(T OR P)	P	P	P	P
DESIGN STORM	(2, 5, OR 10 YR)	10	10	10	10
ACRES	(AC)	0.28	0.28	0.82	0.82
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]	2.75	2.75	2.75	2.75
Qr (REQUIRED CAPACITY)	(CFS)	0.77	0.77	2.26	2.26
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	0.76	0.77	2.30	2.22
PROTECTIVE LINING[2]		SC250	GRASS/ SC250	SC250	GRASS/ SC250
n (MANNING'S COEFFICIENT)[2]		0.04	0.25	0.04	0.155
Va (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A	N/A	N/A
V (CALCULATED AT FLOW DEPTH d)	(FPS)	1.55	0.39	2.05	0.73
τa (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	2.50	8.00	2.50	8.00
τd (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	0.41	0.82	0.62	1.02
CHANNEL BOTTOM WIDTH	(FT)	0	0	0	0
CHANNEL SIDE SLOPES	(H:V)	6 : 3	6 : 3	6 : 3	6 : 3
D (TOTAL DEPTH)	(FT)	1.00	1.00	1.00	1.00
CHANNEL TOP WIDTH @ D	(FT)	9.00	9.00	9.00	9.00
d (CALCULATED FLOW DEPTH)	(FT)	0.33	0.66	0.50	0.82
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	2.97	5.94	4.50	7.38
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	0.00	0.00	0.00	0.00
d50 STONE SIZE	(IN)	N/A	N/A	N/A	N/A
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	0.49	1.96	1.13	3.03
R (HYDRAULIC RADIUS)		0.16	0.32	0.24	0.40
S (BED SLOPE)[3]	(FT/FT)	0.02	0.02	0.02	0.02
Sc (CRITICAL SLOPE)	(FT/FT)	0.044	1.365	0.038	0.488
.7Sc	(FT/FT)	0.031	0.955	0.027	0.342
1.3Sc	(FT/FT)	0.057	1.774	0.050	0.634
STABLE FLOW?	(Y/N)	Y	Y	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.04	0.02	0.08	0.05
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50	0.50	0.50	0.50
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50	0.50	0.50
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS	(S)	S	S	S	S

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Source: 363-2134-008 / March 31, 2012 / Page 382

FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

Not to be used for Box Culverts

E&S WORKSHEET # 11
Channel Design Data

PROJECT NAME: ***ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610***

LOCATION: ***ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA***

PREPARED BY: ***AOE*** ***DATE:*** ***11/13/2015***

CHECKED BY: ***AJB*** ***DATE:*** ***11/13/2015***

CHANNEL OR CHANNEL SECTION		***EX. ROAD SWALE MAX SLOPE***	***EX. ROAD SWALE MIN SLOPE***			
TEMPORARY OR PERMANENT?	(T OR P)	***P***	***P***			
DESIGN STORM	(2, 5, OR 10 YR)	***10***	***10***			
ACRES	(AC)	***THE REQUIRED CAPACITY (Qr) OF THIS SWALE IS THE COMBINED DISCHARGE FROM SWALE 1 AND THE POST DEVELOPMENT BYPASS FLOW WHICH INCLUDES SWALE 2 AND THE DRAINAGE AREA TO CULVERT 4 Qr = 5.14 (SWALE 1) + 4.30 (BYPASS) = 9.44 CFS***				
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]					
Qr (REQUIRED CAPACITY)	(CFS)					
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	***9.45***	***9.45***			
PROTECTIVE LINING[2]		***GRASS***	***GRASS***			
n (MANNING'S COEFFICIENT)[2]		***0.082***	***0.084***			
Va (ALLOWABLE VELOCITY)	(FPS)	***3***	***3***			
V (CALCULATED AT FLOW DEPTH d)	(FPS)	***1.53***	***1.14***			
τa (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	***N/A***	***N/A***			
τd (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	***N/A***	***N/A***			
CHANNEL BOTTOM WIDTH	(FT)	***1***	***1***			
CHANNEL SIDE SLOPES	(H:V)	***VARIES SEE CHANNEL REPORT***				
D (TOTAL DEPTH)	(FT)	***1.31***	***1.31***			
CHANNEL TOP WIDTH @ D	(FT)	***14.90***	***17.56***			
d (CALCULATED FLOW DEPTH)	(FT)	***1.03***	***1.16***			
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	***14.90***	***14.90***			
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	***1.03:1***	***1.16:1***			
d50 STONE SIZE	(IN)	***N/A***	***N/A***			
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	***6.17***	***6.17***			
R (HYDRAULIC RADIUS)		***0.40***	***0.40***			
S (BED SLOPE)[3]	(FT/FT)	***0.025***	***0.012***			
Sc (CRITICAL SLOPE)	(FT/FT)	***0.138***	***0.144***			
.7Sc	(FT/FT)	***0.096***	***0.101***			
1.3Sc	(FT/FT)	***0.179***	***0.188***			
STABLE FLOW?	(Y/N)	***Y***	***Y***			
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	***0.12***	***0.10***			
FREEBOARD BASED ON STABLE FLOW	(FT)	***0.50***	***0.50***			
MINIMUM REQUIRED FREEBOARD[4]	(FT)	***0.50***	***0.50***			
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS	(S)	***V***	***V***			

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

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Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Nov 13 2015

EXISTING ROAD SWALE MAXIMUM SLOPE

User-defined

Invert Elev (ft)	= 931.25
Slope (%)	= 2.50
N-Value	= 0.082

Calculations

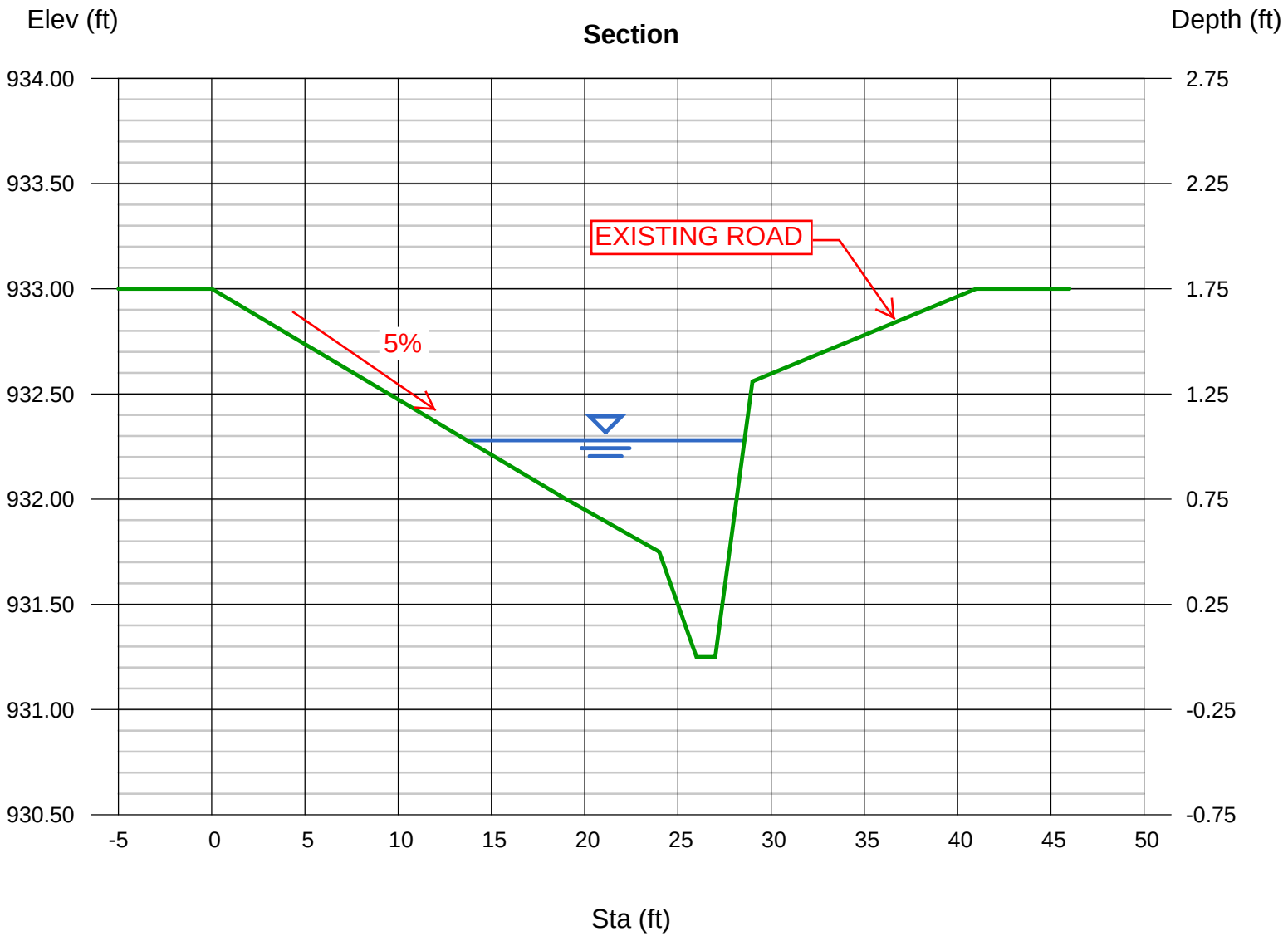
Compute by:	Known Q
Known Q (cfs)	= 9.45

Highlighted

Depth (ft)	= 1.03
Q (cfs)	= 9.450
Area (sqft)	= 6.17
Velocity (ft/s)	= 1.53
Wetted Perim (ft)	= 15.28
Crit Depth, Yc (ft)	= 0.77
Top Width (ft)	= 14.89
EGL (ft)	= 1.07

(Sta, El, n)-(Sta, El, n)...

(0.00, 933.00)-(19.00, 932.00, 0.090)-(24.00, 931.75, 0.080)-(26.00, 931.25, 0.060)-(27.00, 931.25, 0.060)-(29.00, 932.56, 0.100)-(41.00, 933.00, 0.015)



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Nov 13 2015

EXISTING ROAD SWALE MINIMUM SLOPE

User-defined

Invert Elev (ft)	= 931.25
Slope (%)	= 1.20
N-Value	= 0.084

Calculations

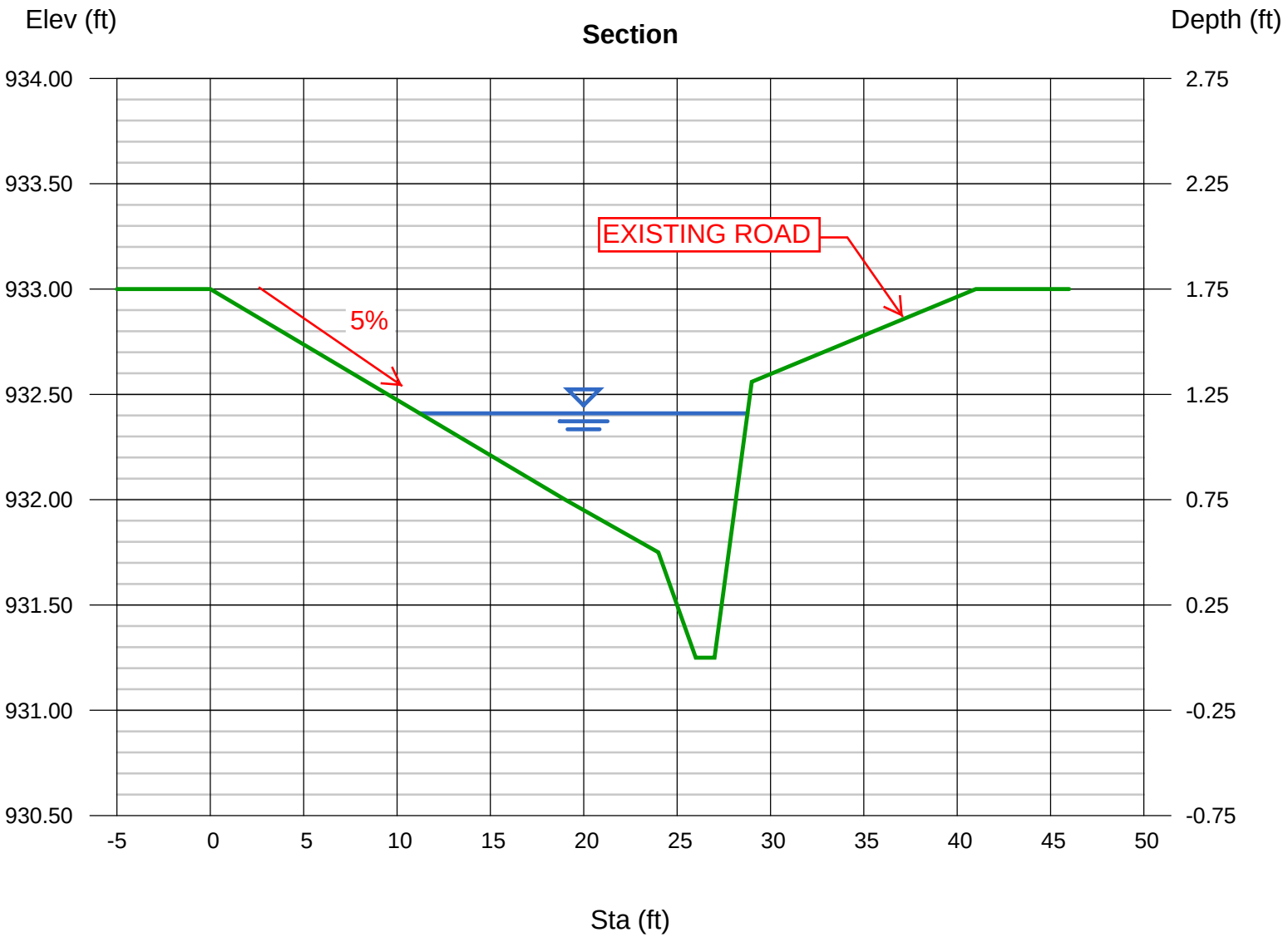
Compute by:	Known Q
Known Q (cfs)	= 9.45

Highlighted

Depth (ft)	= 1.16
Q (cfs)	= 9.450
Area (sqft)	= 8.28
Velocity (ft/s)	= 1.14
Wetted Perim (ft)	= 17.99
Crit Depth, Yc (ft)	= 0.77
Top Width (ft)	= 17.56
EGL (ft)	= 1.18

(Sta, El, n)-(Sta, El, n)...

(0.00, 933.00)-(19.00, 932.00, 0.090)-(24.00, 931.75, 0.080)-(26.00, 931.25, 0.060)-(27.00, 931.25, 0.060)-(29.00, 932.56, 0.100)-(41.00, 933.00, 0.015)



E&S WORKSHEET # 11

Channel Design Data

PROJECT NAME: ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610

LOCATION: ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA

PREPARED BY: AOE DATE: 03/07/16

CHECKED BY: AJB DATE: 03/07/16

CHANNEL OR CHANNEL SECTION		DITCH 1 R-4 RIP RAP LINING	DITCH 2A R-4 RIP RAP LINING	DITCH 2B R-4 RIP RAP LINING	DITCH 3 R-4 RIP RAP LINING	DITCH 4 R-4 RIP RAP LINING
TEMPORARY OR PERMANENT?	(T OR P)	P	P	P	P	P
DESIGN STORM	(2, 5, OR 10 YR)	10	10	10	10	10
ACRES	(AC)	0.36	1.83	1.34	0.35	1.00
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]	2.75	2.75	2.75	2.75	2.75
Qr (REQUIRED CAPACITY)	(CFS)	0.99	5.03	3.69	0.96	2.75
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	1.00	5.06	3.72	1.00	2.77
PROTECTIVE LINING[2]		R-4 RIP RAP	R-4 RIP RAP	R-4 RIP RAP	R-4 RIP RAP	R-4 RIP RAP
n (MANNING'S COEFFICIENT)[2]		0.064	0.059	0.063	0.064	0.064
Va (ALLOWABLE VELOCITY)	(FPS)	9	9	9	9	9
V (CALCULATED AT FLOW DEPTH d)	(FPS)	0.99	2.64	2.42	1.76	2.55
τa (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	N/A	N/A	N/A	N/A	N/A
τd (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	0.23	1.35	1.30	0.78	1.53
CHANNEL BOTTOM WIDTH	(FT)	2	2	2	2	2
CHANNEL SIDE SLOPES	(H:V)	2	2	2	2	2
D (TOTAL DEPTH)	(FT)	2.0	2.0	2.0	2.0	2.0
CHANNEL TOP WIDTH @ D	(FT)	10	10	10	10	10
d (CALCULATED FLOW DEPTH)	(FT)	0.37	0.60	0.51	0.23	0.39
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	3.48	4.40	4.04	2.92	3.56
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	5.41	3.33	3.92	8.70	5.13
d50 STONE SIZE	(IN)	6	6	6	6	6
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	1.01	1.92	1.54	0.57	1.08
R (HYDRAULIC RADIUS)		0.28	0.41	0.36	0.19	0.29
S (BED SLOPE)[3]	(FT/FT)	0.01	0.036	0.041	0.054	0.063
Sc (CRITICAL SLOPE)	(FT/FT)	0.096	0.073	0.086	0.108	0.095
.7Sc	(FT/FT)	0.067	0.051	0.060	0.076	0.066
1.3Sc	(FT/FT)	0.125	0.094	0.112	0.141	0.123
STABLE FLOW?	(Y/N)	Y	Y	Y	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.03	0.12	0.09	0.03	0.07
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50	0.50	0.50	0.50	0.50
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50	0.50	0.50	0.50
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS	(S)	V	V	V	V	V

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Source: 363-2134-008 / March 31, 2012 / Page 382

E&S WORKSHEET # 11

Channel Design Data

PROJECT NAME: ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610

LOCATION: ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA

PREPARED BY: AOE DATE: 02/05/17

CHECKED BY: AJB DATE: 02/05/17

CHANNEL OR CHANNEL SECTION		DITCH 5 R-4 RIP RAP LINING	DITCH 6 R-4 RIP RAP LINING	DITCH 7 R-4 RIP RAP LINING	DITCH 8 R-4 RIP RAP LINING	
TEMPORARY OR PERMANENT?	(T OR P)	P	P	P	P	
DESIGN STORM	(2, 5, OR 10 YR)	10	10	10	10	
ACRES	(AC)	0.40	7.59	0.06	0.42	
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]	2.75	2.75	2.75	2.75	
Qr (REQUIRED CAPACITY)	(CFS)	1.10	20.87	0.17	1.16	
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	1.15	20.91	0.21	1.19	
PROTECTIVE LINING[2]		R-4 RIP RAP	R-4 RIP RAP	R-4 RIP RAP	R-4 RIP RAP	
n (MANNING'S COEFFICIENT)[2]		0.064	0.045	0.064	0.064	
Va (ALLOWABLE VELOCITY)	(FPS)	9	9	9	9	
V (CALCULATED AT FLOW DEPTH d)	(FPS)	0.99	3.04	1.20	1.52	
τa (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	N/A	N/A	N/A	N/A	
τd (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	0.23	0.97	0.44	0.56	
CHANNEL BOTTOM WIDTH	(FT)	2	2	2	2	
CHANNEL SIDE SLOPES	(H:V)	2	2	2	2	
D (TOTAL DEPTH)	(FT)	2.0	2.0	2.0	2.0	
CHANNEL TOP WIDTH @ D	(FT)	10	10	10	10	
d (CALCULATED FLOW DEPTH)	(FT)	0.41	1.42	0.08	0.30	
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	3.64	7.68	2.32	3.20	
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	4.88	1.41	25.00	6.67	
d50 STONE SIZE	(IN)	6	6	6	6	
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	1.16	6.87	0.17	0.78	
R (HYDRAULIC RADIUS)		0.30	0.82	0.07	0.23	
S (BED SLOPE)[3]	(FT/FT)	0.009	0.011	0.088	0.030	
Sc (CRITICAL SLOPE)	(FT/FT)	0.094	0.034	0.145	0.101	
.7Sc	(FT/FT)	0.066	0.024	0.101	0.071	
1.3Sc	(FT/FT)	0.122	0.044	0.188	0.131	
STABLE FLOW?	(Y/N)	Y	Y	Y	Y	
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.03	0.32	0.01	0.03	
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50	0.50	0.50	0.50	
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50	0.50	0.50	
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS	(S)	V	V	V	V	

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Source: 363-2134-008 / March 31, 2012 / Page 382

E&S WORKSHEET # 11

Channel Design Data

PROJECT NAME: ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610

LOCATION: ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA

PREPARED BY: AOE DATE: 02/05/17

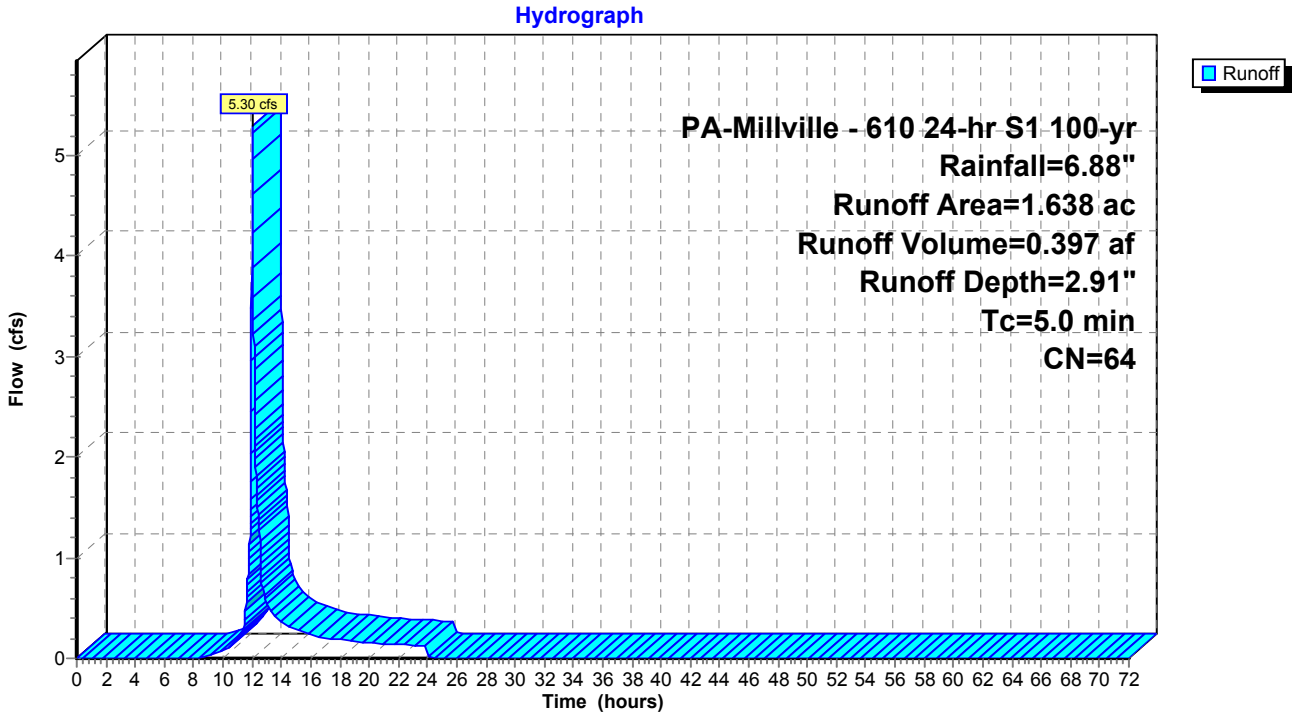
CHECKED BY: AJB DATE: 02/05/17

CHANNEL OR CHANNEL SECTION		DITCH 9A R-4 RIP RAP LINING	DITCH 9B R-4 RIP RAP LINING			
TEMPORARY OR PERMANENT?	(T OR P)	P	P			
DESIGN STORM	(2, 5, OR 10 YR)	10	10			
ACRES	(AC)	2.14	4.07			
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]	2.75	2.75			
Qr (REQUIRED CAPACITY)	(CFS)	5.89	11.19			
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	5.96	11.38			
PROTECTIVE LINING[2]		R-4 RIP RAP	R-4 RIP RAP			
n (MANNING'S COEFFICIENT)[2]		0.058	0.047			
Va (ALLOWABLE VELOCITY)	(FPS)	9	9			
V (CALCULATED AT FLOW DEPTH d)	(FPS)	2.90	2.13			
τa (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	N/A	N/A			
τd (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	1.57	0.53			
CHANNEL BOTTOM WIDTH	(FT)	2	2			
CHANNEL SIDE SLOPES	(H:V)	2	2			
D (TOTAL DEPTH)	(FT)	2.0	2.0			
CHANNEL TOP WIDTH @ D	(FT)	10	10			
d (CALCULATED FLOW DEPTH)	(FT)	0.63	1.21			
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	4.52	6.84			
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	3.17	1.65			
d50 STONE SIZE	(IN)	6	6			
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	2.05	5.35			
R (HYDRAULIC RADIUS)		0.43	0.72			
S (BED SLOPE)[3]	(FT/FT)	0.040	0.007			
Sc (CRITICAL SLOPE)	(FT/FT)	0.069	0.039			
.7Sc	(FT/FT)	0.049	0.027			
1.3Sc	(FT/FT)	0.090	0.051			
STABLE FLOW?	(Y/N)	Y	Y			
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.14	0.19			
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50	0.50			
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50			
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS	(S)	V	V			

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Source: 363-2134-008 / March 31, 2012 / Page 382

Subcatchment 10S: DRAINAGE AREA TO CULVERT 1



Culvert Report

CULVERT 1 100 YR STORM

Invert Elev Dn (ft)	=	956.00
Pipe Length (ft)	=	126.00
Slope (%)	=	1.24
Invert Elev Up (ft)	=	957.56
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Circular Culvert
Culvert Entrance	=	Smooth tapered inlet throat
Coeff. K,M,c,Y,k	=	0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

Top Elevation (ft)	=	962.00
Top Width (ft)	=	10.00
Crest Width (ft)	=	20.00

Calculations

Qmin (cfs)	=	6.00
Qmax (cfs)	=	6.00
Tailwater Elev (ft)	=	958

Highlighted

Qtotal (cfs)	=	6.00
Qpipe (cfs)	=	6.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.40
Veloc Up (ft/s)	=	5.12
HGL Dn (ft)	=	958.00
HGL Up (ft)	=	958.51
Hw Elev (ft)	=	958.97
Hw/D (ft)	=	0.94
Flow Regime	=	Inlet Control

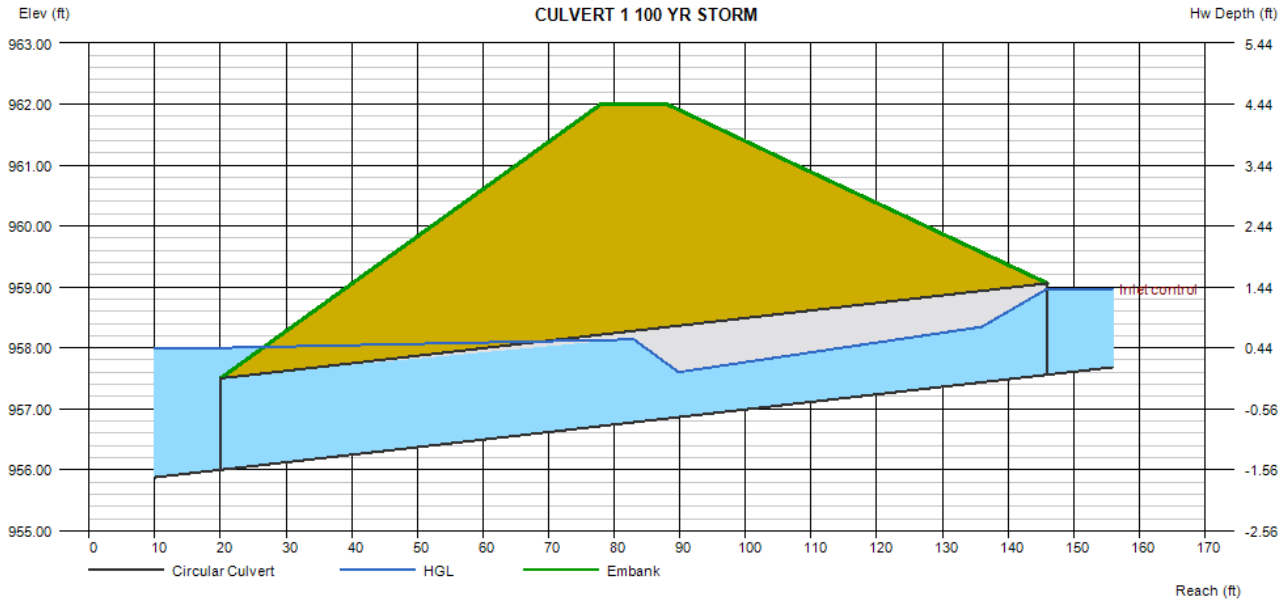
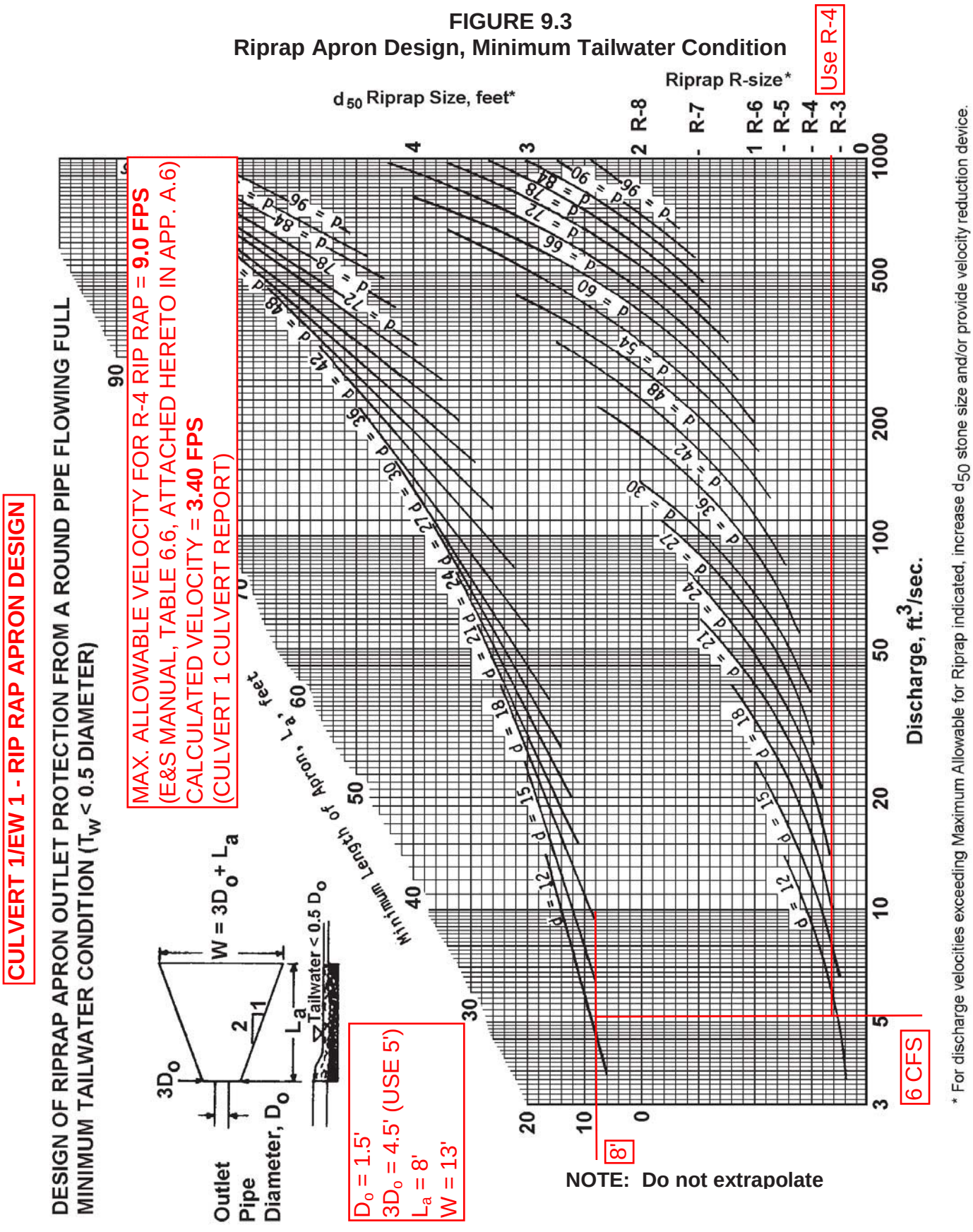


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

Not to be used for Box Culverts

Subcatchment 7S: DRAINAGE AREA TO EW 2

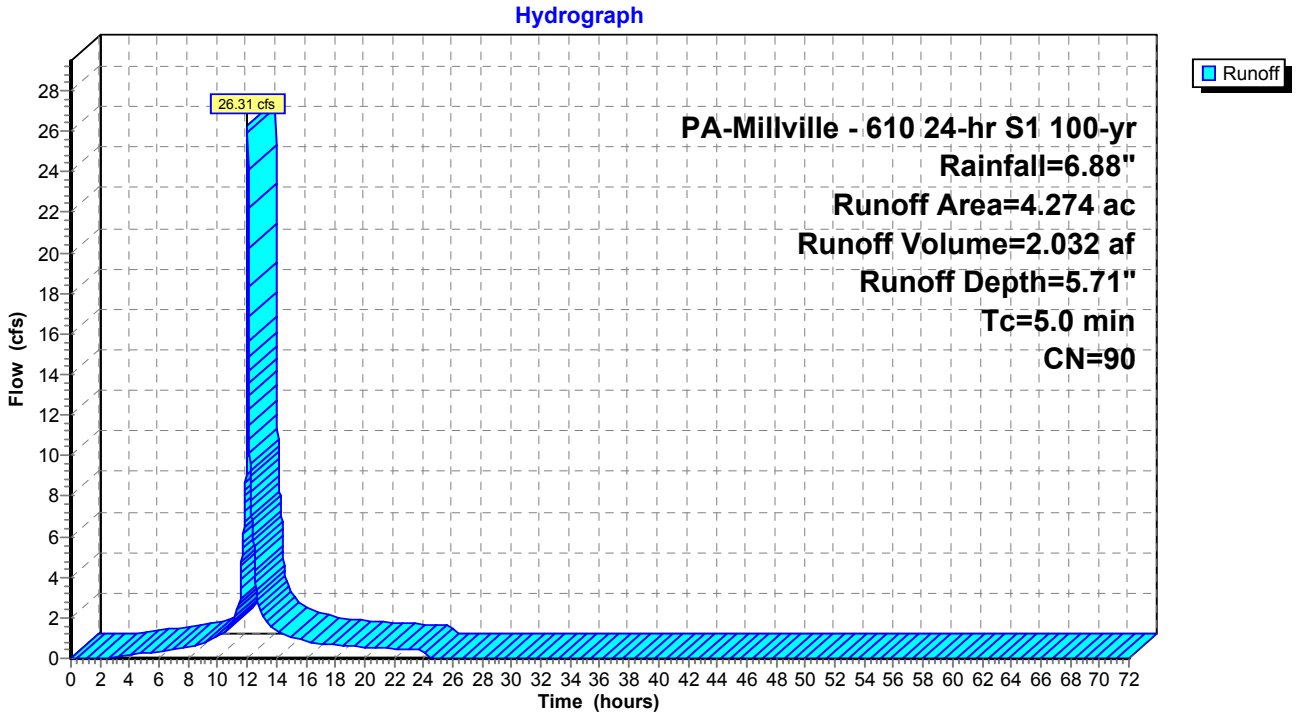
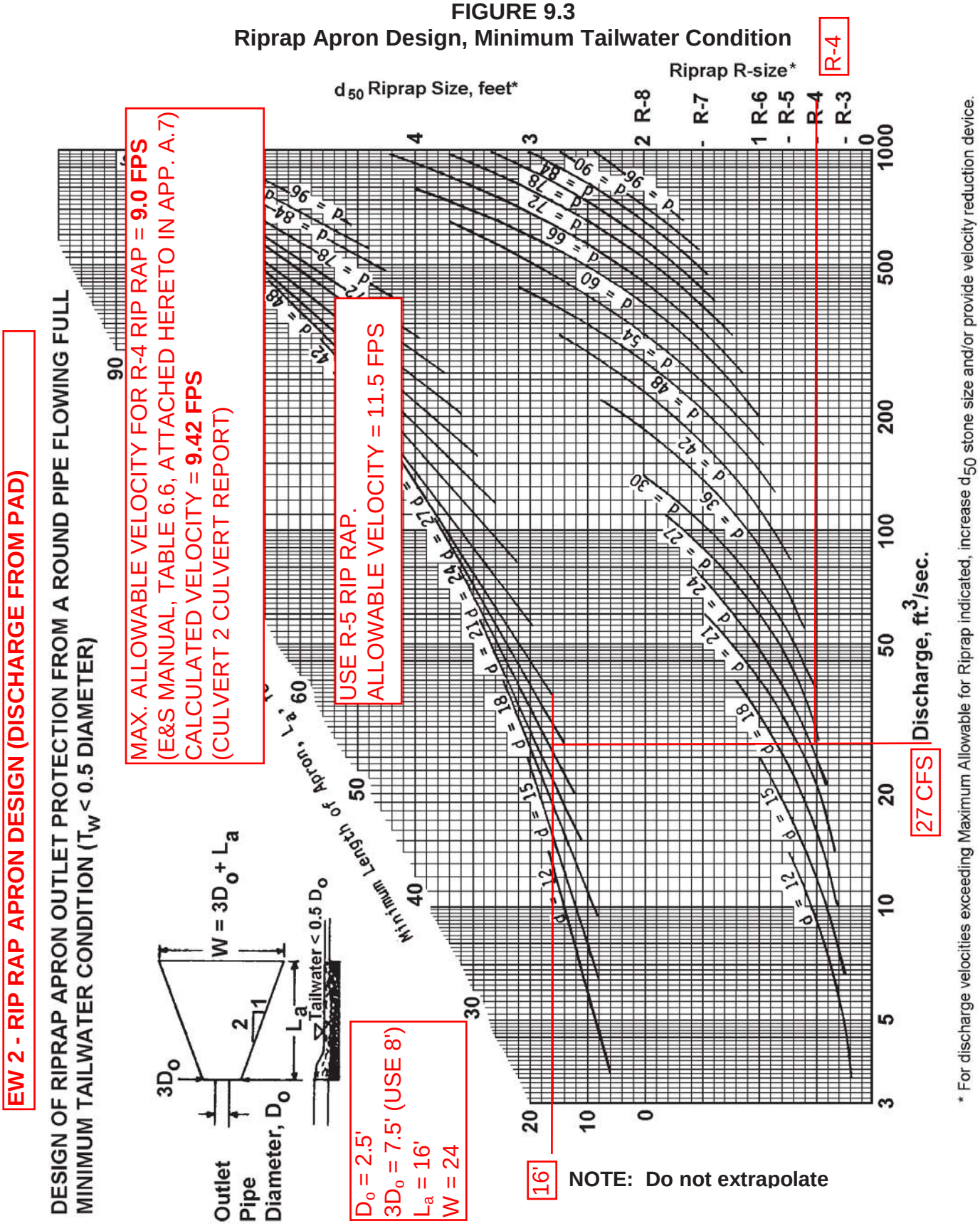


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

Not to be used for Box Culverts

Channel Report

CULVERT 3

Circular

Diameter (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 5.00
N-Value	= 0.012

Calculations

Compute by:	Known Q
Known Q (cfs)	= 16.00

Highlighted

Depth (ft)	= 0.74
Q (cfs)	= 16.00
Area (sqft)	= 1.06
Velocity (ft/s)	= 15.08
Wetted Perim (ft)	= 2.62
Crit Depth, Yc (ft)	= 1.44
Top Width (ft)	= 1.93
EGL (ft)	= 4.28

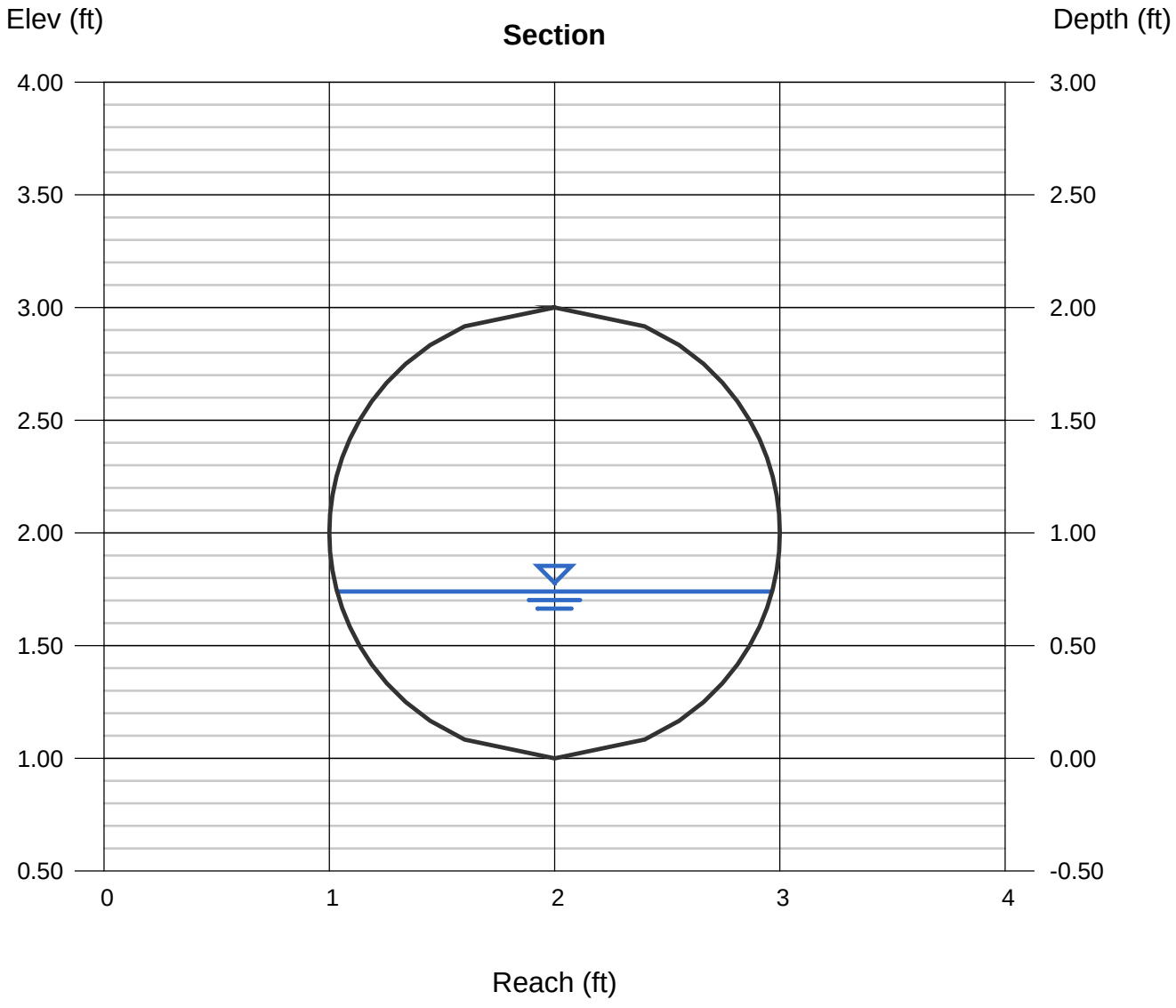
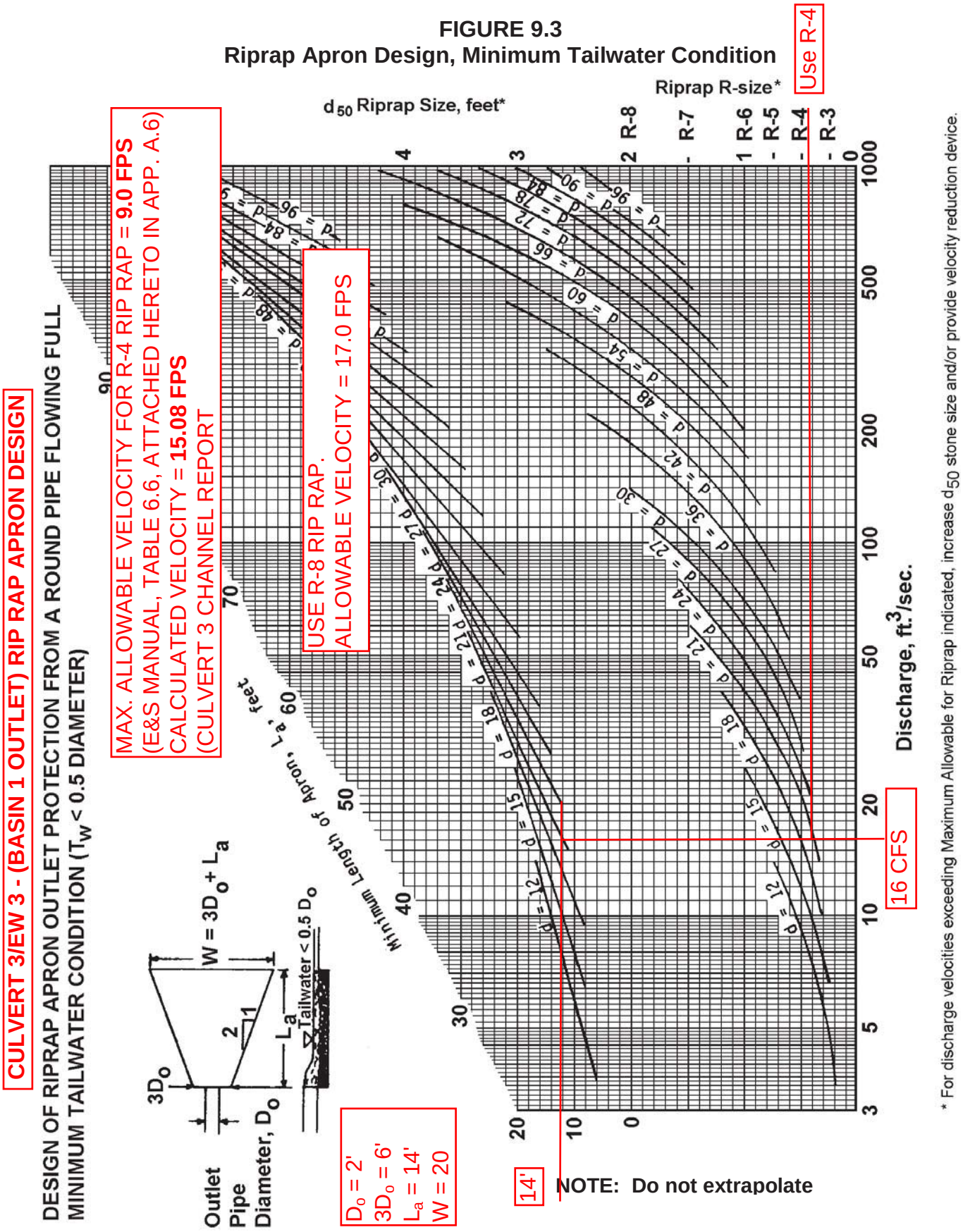


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

Not to be used for Box Culverts

Culvert Report

CULVERT 4 - 50 YR STORM

Invert Elev Dn (ft)	=	933.00
Pipe Length (ft)	=	48.00
Slope (%)	=	1.04
Invert Elev Up (ft)	=	933.50
Rise (in)	=	14.0
Shape	=	Elliptical
Span (in)	=	23.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Square edge w/headwall (H)
Coeff. K,M,c,Y,k	=	0.01, 2, 0.0398, 0.67, 0.5

Embankment

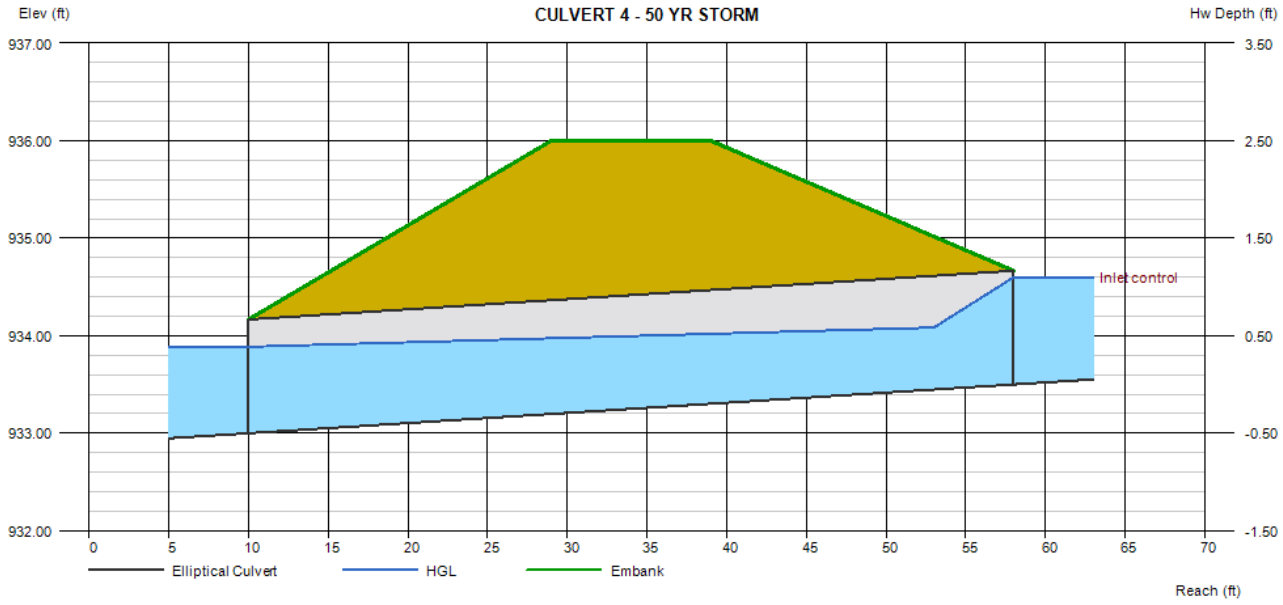
Top Elevation (ft)	=	936.00
Top Width (ft)	=	10.00
Crest Width (ft)	=	20.00

Calculations

Qmin (cfs)	=	4.77
Qmax (cfs)	=	4.77
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	4.77
Qpipe (cfs)	=	4.77
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.25
Veloc Up (ft/s)	=	5.22
HGL Dn (ft)	=	933.89
HGL Up (ft)	=	934.11
Hw Elev (ft)	=	934.60
Hw/D (ft)	=	0.94
Flow Regime	=	Inlet Control



Summary for Subcatchment 8S: DRAINAGE AREA TO CULVERT 4

Runoff = 4.77 cfs @ 12.06 hrs, Volume= 0.377 af, Depth= 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
PA-Millville - 610 24-hr S1 50-yr Rainfall=5.88"

	Area (ac)	CN	Description
	1.664	61	Pasture/grassland/range, Good, HSG B
*	0.261	98	Impervious, HSG B
	1.925	66	Weighted Average
	1.664		86.44% Pervious Area
	0.261		13.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	87	0.3300	0.48		**Sheet Flow, SHT 1** Grass: Short n= 0.150 P2= 2.83"
3.6	610	0.0350	2.81		**Shallow Concentrated Flow, SCF 1** Grassed Waterway Kv= 15.0 fps
0.7	135	0.0420	3.07		**Shallow Concentrated Flow, SCF 2** Grassed Waterway Kv= 15.0 fps
7.3	832	Total			

Subcatchment 8S: DRAINAGE AREA TO CULVERT 4

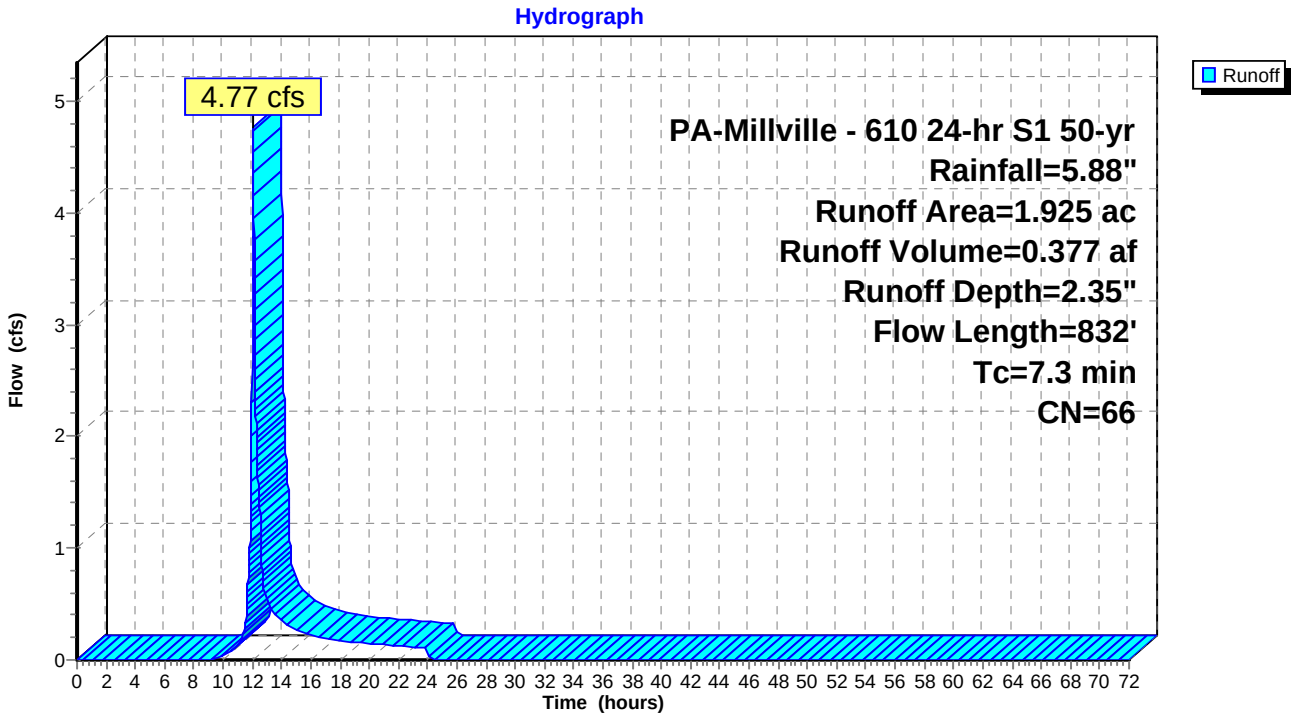
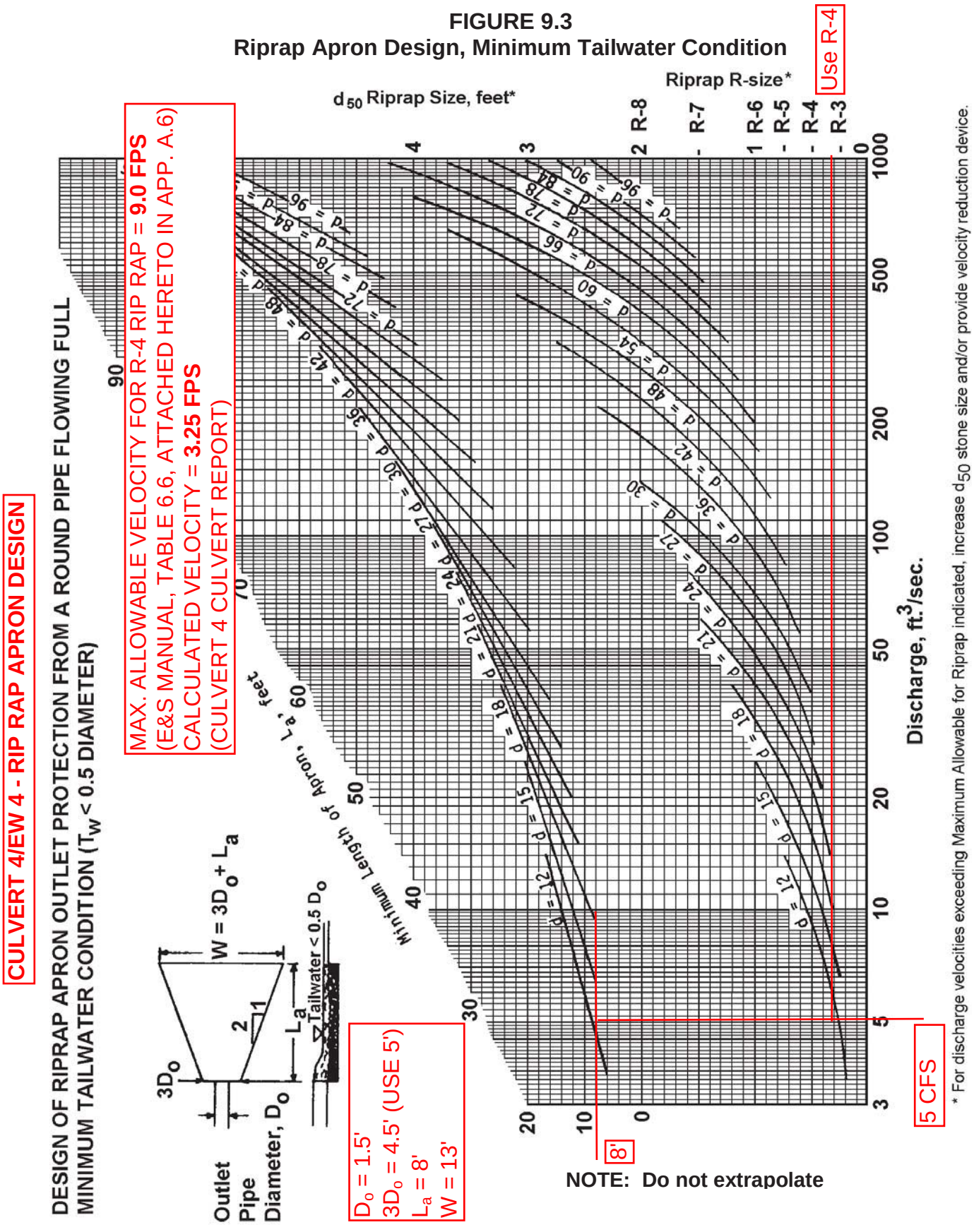


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

Not to be used for Box Culverts

Culvert Report

CULVERT 5 100 YR STORM

Invert Elev Dn (ft)	=	960.30
Pipe Length (ft)	=	59.00
Slope (%)	=	3.39
Invert Elev Up (ft)	=	962.30
Rise (in)	=	30.0
Shape	=	Circular
Span (in)	=	30.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

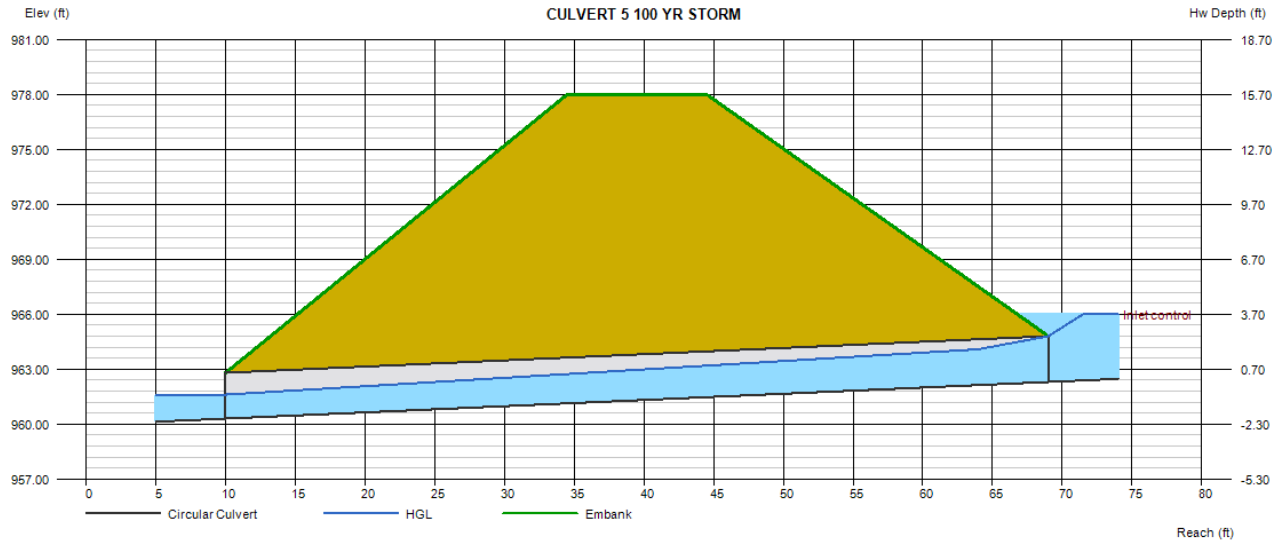
Top Elevation (ft)	=	978.00
Top Width (ft)	=	10.00
Crest Width (ft)	=	20.00

Calculations

Qmin (cfs)	=	35.40
Qmax (cfs)	=	35.40
Tailwater Elev (ft)	=	0.00

Highlighted

Qtotal (cfs)	=	35.40
Qpipe (cfs)	=	35.40
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	13.57
Veloc Up (ft/s)	=	8.34
HGL Dn (ft)	=	961.61
HGL Up (ft)	=	964.32
Hw Elev (ft)	=	966.00
Hw/D (ft)	=	1.48
Flow Regime	=	Inlet Control



Summary for Subcatchment 9S: DRAINAGE AREA TO CULVERT 5

Runoff = 35.40 cfs @ 12.03 hrs, Volume= 2.600 af, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
PA-Millville - 610 24-hr S1 100-yr Rainfall=6.88"

	Area (sf)	CN	Description
	166,277	85	Gravel roads, HSG B
*	34,702	98	Impervious, HSG B
	126,491	58	Meadow, non-grazed, HSG B
	327,470	76	Weighted Average
	292,768		89.40% Pervious Area
	34,702		10.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: DRAINAGE AREA TO CULVERT 5

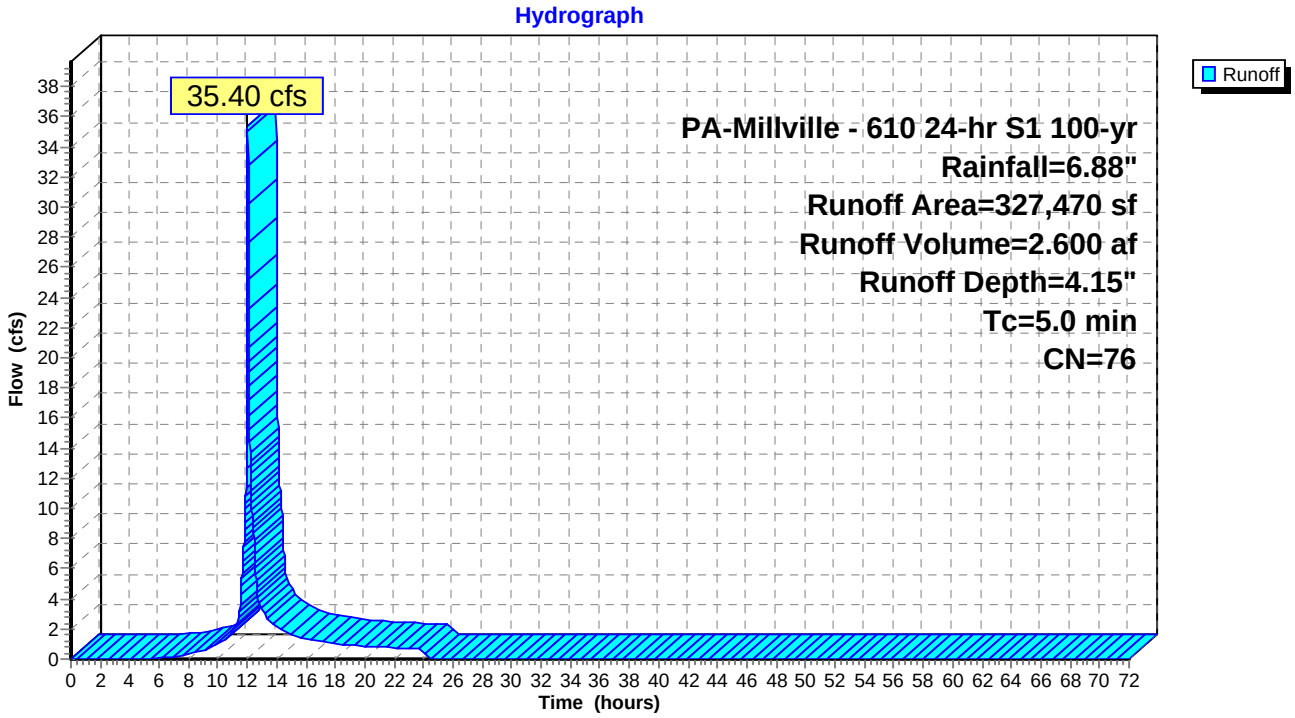
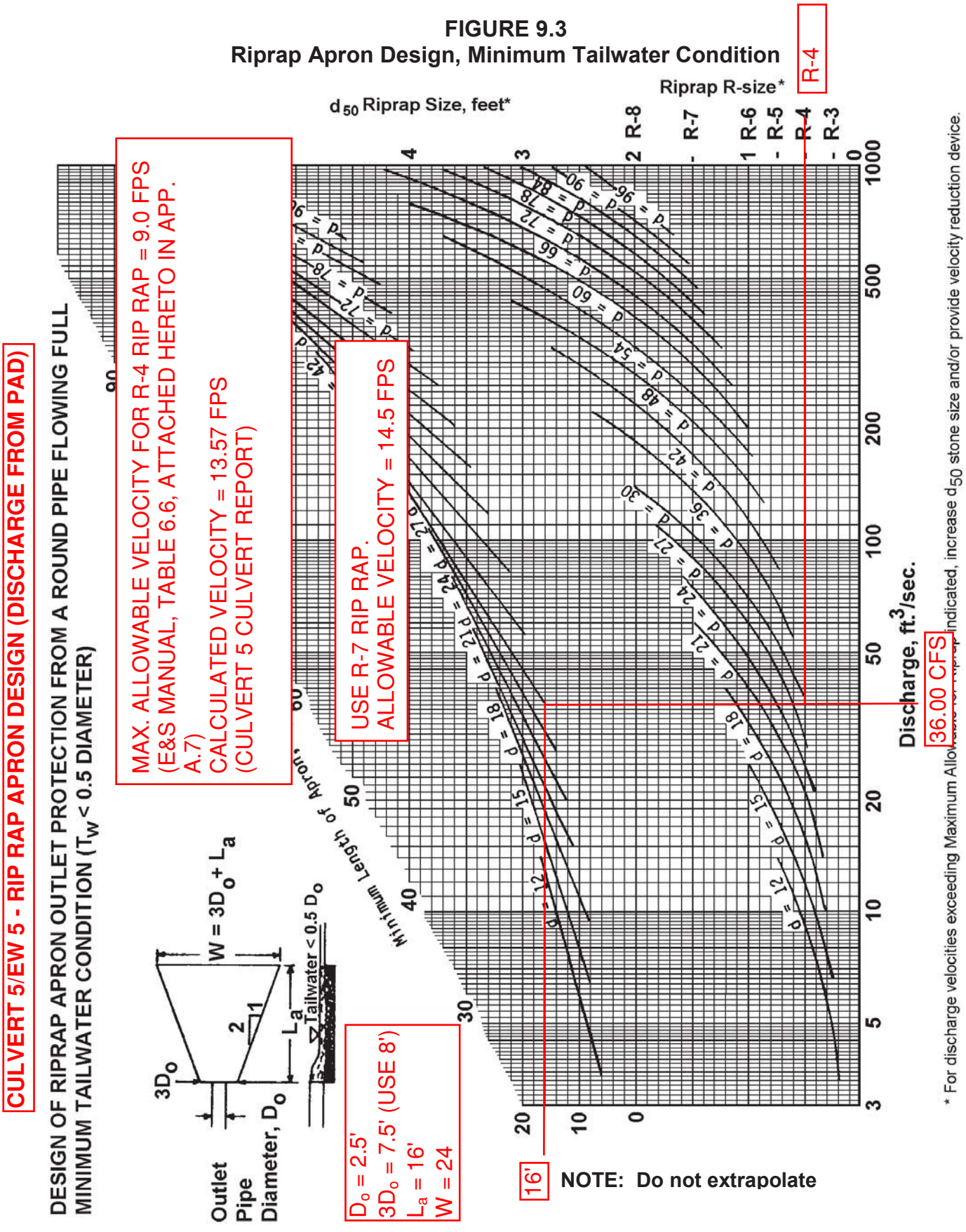


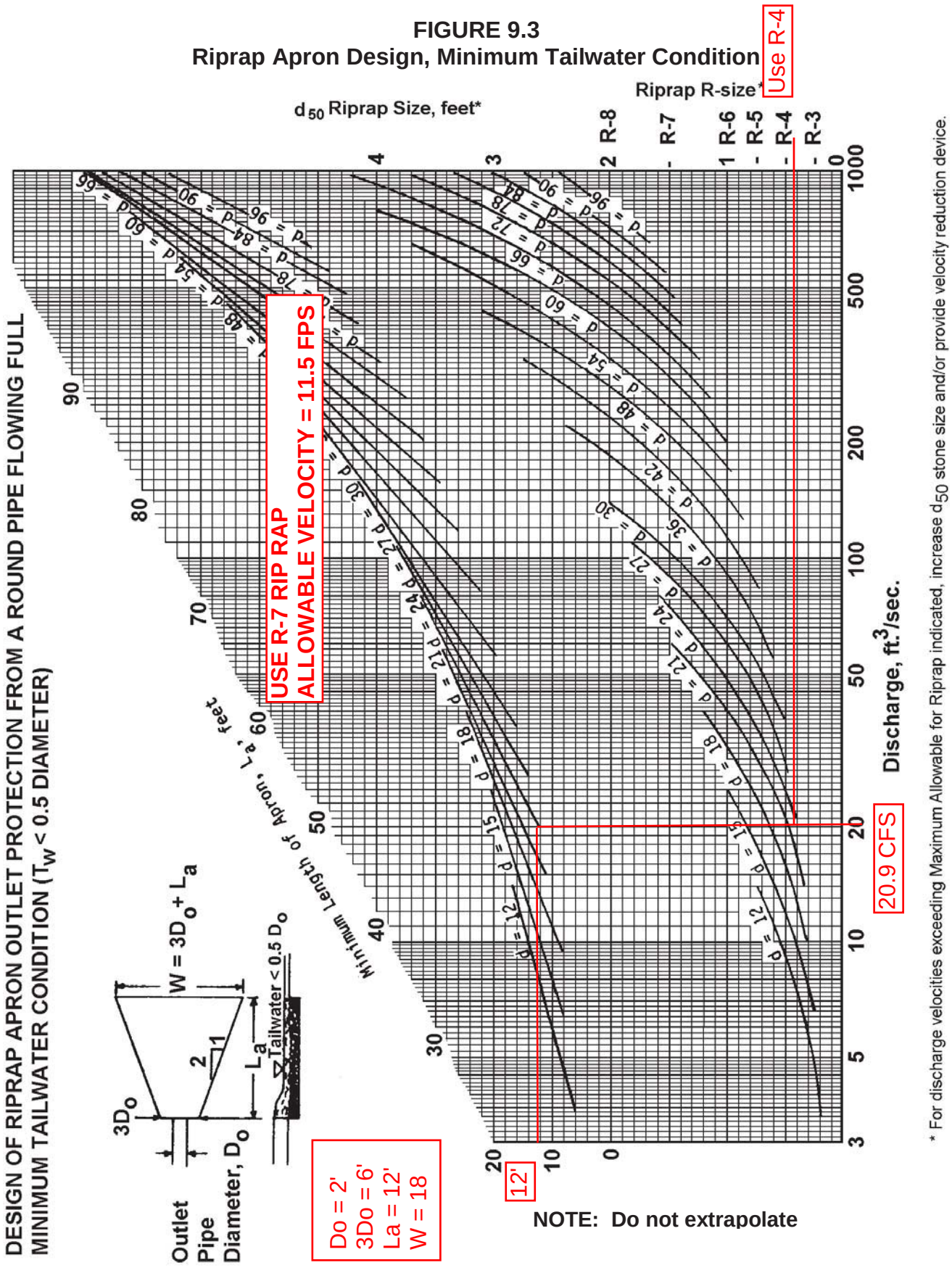
FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

Not to be used for Box Culverts

FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

Not to be used for Box Culverts

A.4 PCSM BMP Calculations

E&S WORKSHEET # 11

Channel Design Data

PROJECT NAME: ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610

LOCATION: ORANGE TOWNSHIP, COLUMBIA COUNTY, PENNSYLVANIA

PREPARED BY: AOE DATE: 08/17/2015

CHECKED BY: AJB DATE: 08/17/2015

CHANNEL OR CHANNEL SECTION		EMERGENCY SPILLWAY LINING/GRASS				
TEMPORARY OR PERMANENT?	(T OR P)	P				
DESIGN STORM	(2, 5, OR 10 YR)	100				
ACRES	(AC)	NA				
MULTIPLIER[1]	(1.6, 2.25, or 2.75)[1]	NA				
Qr (REQUIRED CAPACITY)	(CFS)	15.66				
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	16.20				
PROTECTIVE LINING[2]		GRASS/ W3000				
n (MANNING'S COEFFICIENT)[2]		0.085				
Va (ALLOWABLE VELOCITY)	(FPS)	N/A				
V (CALCULATED AT FLOW DEPTH d)	(FPS)	3.95				
τa (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	16.00				
τd (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	5.35				
CHANNEL BOTTOM WIDTH	(FT)	15				
CHANNEL SIDE SLOPES	(H:V)	3				
D (TOTAL DEPTH)	(FT)	1.3				
CHANNEL TOP WIDTH @ D	(FT)	22.5				
d (CALCULATED FLOW DEPTH)	(FT)	0.26				
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	16.56				
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	57.69				
d50 STONE SIZE	(IN)	N/A				
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	4.10				
R (HYDRAULIC RADIUS)		0.25				
S (BED SLOPE)[3]	(FT/FT)	0.33				
Sc (CRITICAL SLOPE)	(FT/FT)	0.169				
.7Sc	(FT/FT)	0.118				
1.3Sc	(FT/FT)	0.219				
STABLE FLOW?	(Y/N)	Y				
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.08				
FREEBOARD BASED ON STABLE FLOW	(FT)	0.50				
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50				
DESIGN METHOD FOR PROTECTIVE LINING [5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS	(S)	S				

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or ¼ Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Source: 363-2134-008 / March 31, 2012 / Page 382

Weir Report

BASIN 1 EMERGENCY SPILLWAY WEIR - 100 YR DISCHARGE

Rectangular Weir

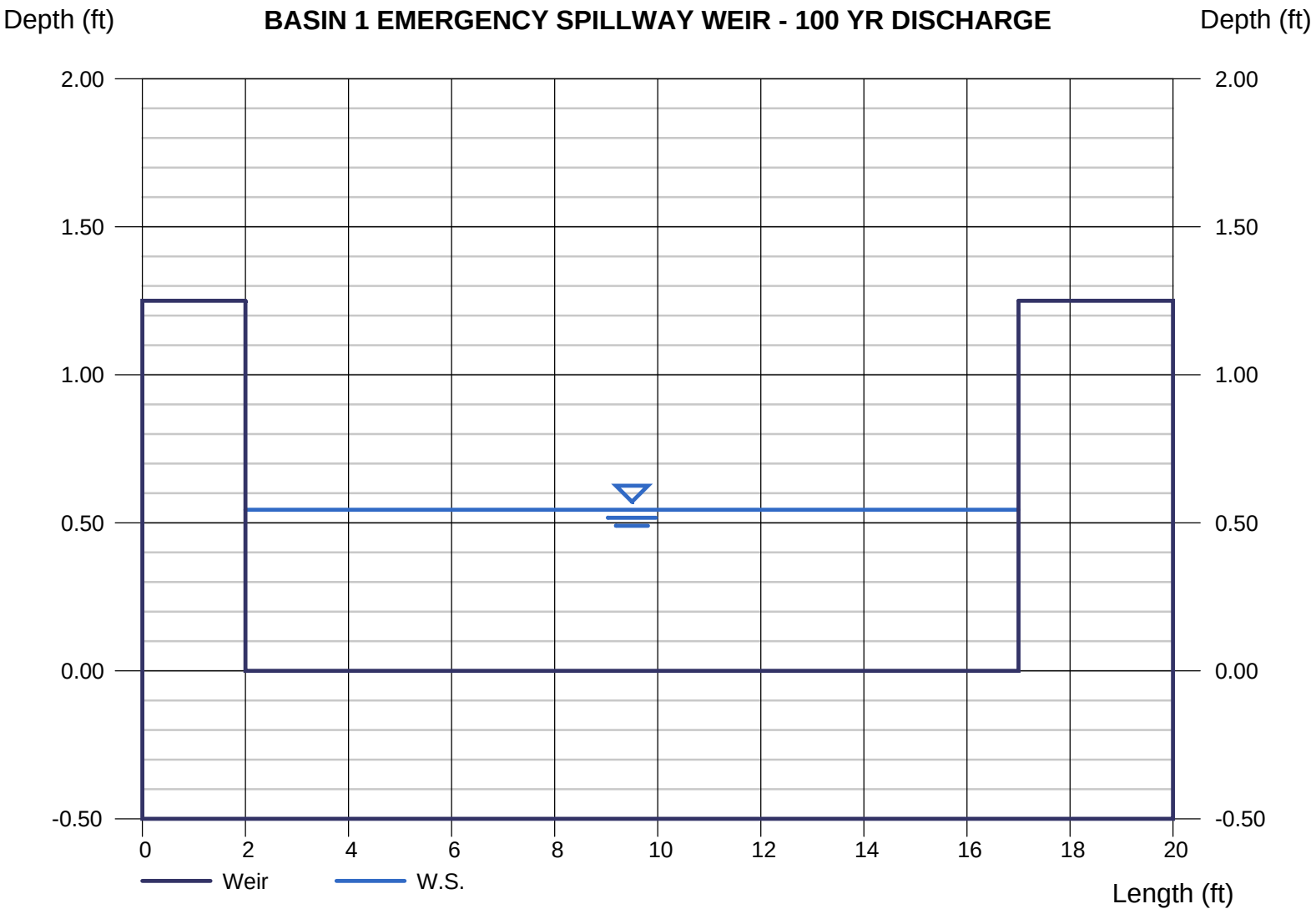
Crest	= Broad
Bottom Length (ft)	= 15.00
Total Depth (ft)	= 1.25

Calculations

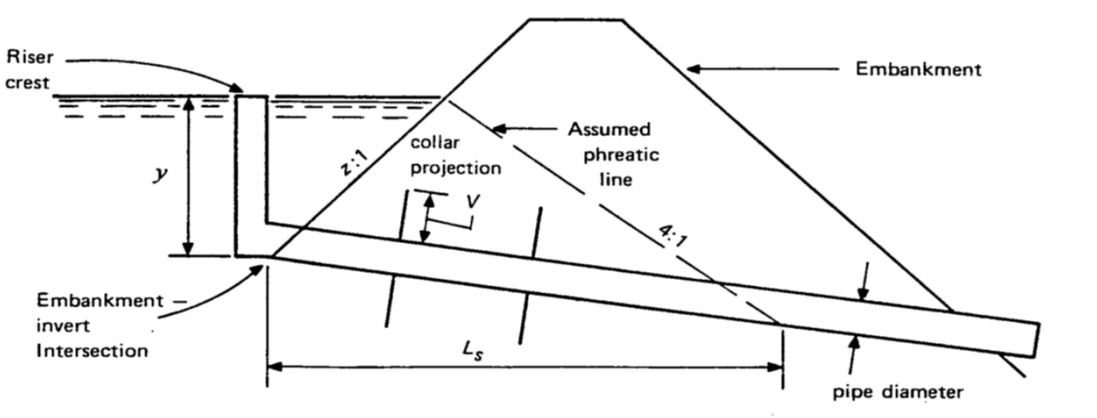
Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 15.66

Highlighted

Depth (ft)	= 0.54
Q (cfs)	= 15.66
Area (sqft)	= 8.16
Velocity (ft/s)	= 1.92
Top Width (ft)	= 15.00



WORKSHEET #18
Anti-seep Collar Design

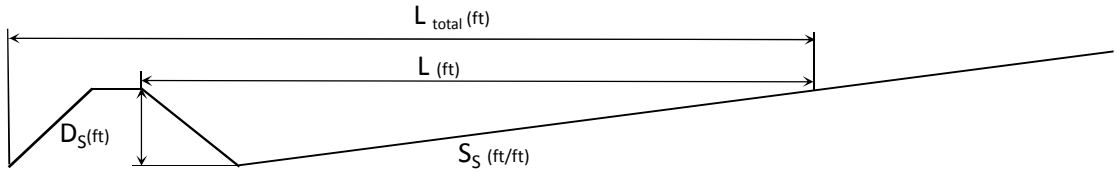


BASIN NO.	TEMP. OR PERM.	Y (FT)	Z	Ls (FT)	Lf (FT)	V (IN)	BARRELL DIA. (IN)	COLLAR SIZE (IN)	NO. COLLARS	COLLAR SPACING (FT)	DISTANCE TO 1ST COLLAR (FT)
1	P	***5.49***	3	48	55.2	22	24	***68***	2	10	15

Source: 363-2134-008 / March 31, 2012 / Page 389

ATLANTIC SUNRISE NATURAL GAS PIPELINE PROJECT
COMPRESSOR STATION 610 VEGETATED SWALE INFILTRATION VOLUME
ROCK FILTER VOLUME AND SPACING

Per the Pennsylvania Stormwater BMP Manual (pg 94), the minimum spacing of rock filter is determined by the length of the storage volume (L). The length of the storage volume is calculated by dividing the height of the rock filter (D_S) by the slope of the channel (S_S):



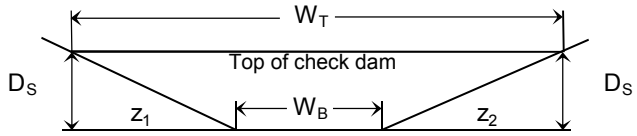
$L = D_S/S_S$

Where: L = Storage Length

S_S = Channel slope

D_S = Height of the rock filter

The volume of runoff that will be stored upstream of a rock filter is dependent on the height of the check dam, the slope of the upstream channel and the dimensions of the upstream channel. The storage volume (V_S) can be calculated with:



pl

$V_S = 0.25 \times L \times D_S \times (W_T + W_B)$

Where:

L = Storage Length

D_S = Height of rock filter

W_T = rock filter top width

W_B = rock filter bottom width

The rock filter top width (W_T) is given by:

$W_T = W_B + z_1 + z_2$

Where: W_B = rock filter bottom width

z_1 = side slope

z_2 = side slope

ATLANTIC SUNRISE PROJECT
COMPRESSOR STATION 610 VEGETATED SWALE INFILTRATION VOLUME

5/29/2015

TOTAL REACH VOLUME = 1,879 CF TOTAL REACH AREA = 1,843 SF

VEGETATED SWALE 1- 6.3%

Input data

S =	0.063	ft/ft
H =	1	ft
W_B =	2	
z_1 =	3	
z_2 =	3	

Output data

L =	16	ft
L_{total} =	21	ft
W_T =	8	ft
$W_T + W_B$ =	10	ft
V =	40	cf
No. of check dams =	3	
Subreach Volume =	119	CF
Sub Reach Area =	125	SF

VEGETATED SWALE 1 - 3.6%

Input data

S =	0.036	ft/ft
H =	1	ft
W_B =	2	
z_1 =	3	
z_2 =	3	

Output data

L =	28	ft
L_{total} =	33	ft
W_T =	8	ft
$W_T + W_B$ =	10	ft
V =	69	cf
No. of check dams =	4	
Subreach Volume =	278	CF
Sub Reach Area =	262	SF

VEGETATED SWALE 1 - 0.57%

Input data

S =	0.057	ft/ft
H =	1	ft
W_B =	2	
z_1 =	3	
z_2 =	3	

Output data

L =	18	ft
L_{total} =	23	ft
W_T =	8	ft
$W_T + W_B$ =	10	ft
V =	44	cf
No. of check dams =	4	
Subreach Volume =	175	CF
Sub Reach Area =	180	SF

VEGETATED SWALE 2

Input data

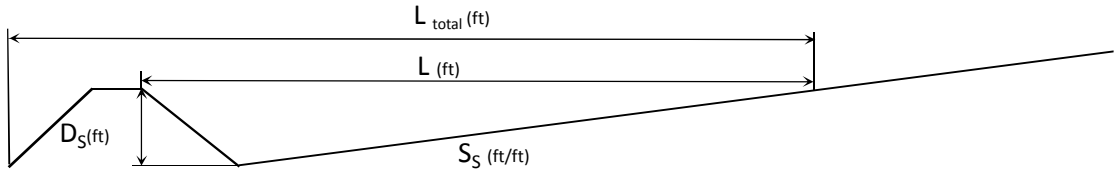
S =	0.044	ft/ft
H =	1	ft
W_B =	2	
z_1 =	3	
z_2 =	3	

Output data

L =	23	ft
L_{total} =	28	ft
W_T =	8	ft
$W_T + W_B$ =	10	ft
V =	57	cf
No. of check dams =	23	
Subreach Volume =	1,307	CF
Sub Reach Area =	1,275	SF

ATLANTIC SUNRISE NATURAL GAS PIPELINE PROJECT
COMPRESSOR STATION 610 VEGETATED SWALE INFILTRATION VOLUME
ROCK FILTER VOLUME AND SPACING

Per the Pennsylvania Stormwater BMP Manual (pg 94), the minimum spacing of rock filter is determined by the length of the storage volume (L). The length of the storage volume is calculated by dividing the height of the rock filter (D_S) by the slope of the channel (S_S):



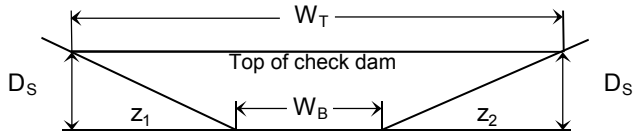
$L = D_S/S_S$

Where: L = Storage Length

S_S = Channel slope

D_S = Height of the rock filter

The volume of runoff that will be stored upstream of a rock filter is dependent on the height of the check dam, the slope of the upstream channel and the dimensions of the upstream channel. The storage volume (V_S) can be calculated with:



$V_S = 0.25 \times L \times D_S \times (W_T + W_B)$

Where:

L = Storage Length

D_S = Height of rock filter

W_T = rock filter top width

W_B = rock filter bottom width

The rock filter top width (W_T) is given by:

$W_T = W_B + z_1 + z_2$

Where: W_B = rock filter bottom width

z_1 = side slope

z_2 = side slope

INFILTRATION RATE/DEWATERING TIME

Note: the infiltration tests were performed with a double ring infiltrometer. Therefore, no reduction factors were applied.

INFILTRATION BASIN 1

Note: Due to the slopes on site, there is variation in the elevation of the infiltration testing. However, the depth to the limiting layer and the infiltration rates at the various test locations are similar. It follows that the infiltration rates and depth to limiting layers are also similar at the locations of the infiltration areas that are in close proximity to the test pit and infiltration locations. Therefore, the average infiltration rates at the closest test pits are used for the dewatering calulations for the infiltration berms and basin.

INFILTRATION BASIN 1 AND INFILTRATION BERM 1

Test pit 1	*3.63*	*in/hr*
Test pit 2	*3.63*	*in/hr*
Test pit 3	*1.25*	*in/hr*
Average	*2.83*	*in/hr*
Safety factor	*3.50*	
Adjusted rate	*0.81*	*in/hr*

Limiting Layer
The limiting layer is 36 inches deep in the area of Infiltration Basin 1. Therefore, the cut in this area is held to 1' depth.

Dewatering time

Infiltration depth	*24*	*in*
Dewatering time	*29.6*	*hr*

INFILTRATION BERM 2 & 3

Infiltration Rate

Test pit 4	*5.25*	*in/hr*
Test pit 5	*1.06*	*in/hr*
Average	*3.16*	*in/hr*
Safety factor	*3.00*	
Adjusted rate	*1.05*	*in/hr*

Limiting Layer
The limiting layer is 27 inches deep in the area of Infiltration Berms 2 and 3. Therefore, the infiltration area is at the existing ground surface.

Dewatering time

Infiltration depth	*24*	*in*
Dewatering time	*22.8*	*hr*

COMPRESSOR STATION 610
INFILTRATION BASIN OUTLET STRUCTURE FLOTATION CALCULATIONS

Assumptions

24" X 48" concrete inlet box riser

Total area of 24" x 48" inlet box = 10 sf

6" concrete wall thickness

6" thick bottom

Density of water = 62.4 lb/cf

Density of concrete = 150 lb/cf

Area of concrete in a 2' X 4' inlet box with a 6" thick wall = 3.5 sf

Volume of concrete per vertical foot of inlet box = 1' X 3.5 sf = 3.5 cf.

Weight of concrete per vertical foot of inlet box = 3.5 cf X 150 lb/cf = 525 Lbs

Buoyant force from water per vertical foot of inlet box = 62.4lb/cf X 10 sf X 1 ft = 624 lb.

Volume of bottom of inlet = 10 sf X 0.5 ft = 5 cf

Weight of bottom of inlet = 150 lb/cf X 5 cf = 750 lb

Buoyant force on bottom of inlet = 62.4 lb/cf X 5 = 312 lb

CS 610 outlet structure height = 5.25 ft

Weight of outlet structure = 5.25 X 525 + 750 = 3,506 lb

Buoyant force = 312 + 624 X 5.25 = 3,588 lb

Weight of outlet structure with 6 inches of concrete below invert:

3,506 + 10 X 150 = 5,006 lb OK

ATLANTIC SUNRISE PROJECT
COMPRESSOR STATION 610 INFILTRATION VOLUME

9/23/2016

BASIN 1

Elevation	Surface Area (S.F.)	Inc. Storage (C.F.)	Cumulative Storage (C.F.)
954	7235	0	0
956	22706	29941	29941
958	36022	58728	88669
960	44212	80234	168903

BERM 1

Elevation	Surface Area (S.F.)	Inc. Storage (C.F.)	Cumulative Storage (C.F.)
958	2915	0	0
960	17103	20018	20018
960.25	20894	4750	24768

BERM 2

Elevation	Surface Area (S.F.)	Inc. Storage (C.F.)	Cumulative Storage (C.F.)
959.75	0	0	0
960	767	96	96
962	7220	7987	8083

RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Atlantic Sunrise Project - Compressor Station 610- Deer Lick Run
DA: Infiltration Berm 1
2-Year Rainfall: 2.83 **in**

Total Contributing Area: 4.95 **acres**

Developed Conditions:

Cover Type	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Grass	B	290,980.00	6.68	61	6.39	1.28	0.30	7,345
Meadow	B	154,725.00	3.55	58	7.24	1.45	0.22	2,855
Impervious	B	179,292.00	4.12	98	0.20	0.04	2.60	38,832
Gravel Road	B	286,581.00	6.58	85	1.76	0.35	1.45	34,546
TOTAL:		911,578.00	20.93					83,577

Berm 1 Available Volume (ft^3)	**24,768**
Actual 2-Year Volume runoff (ft^3)	**83,577**

If 2-Year Volume Runnoff is less than Available Berm Volume, use 2-year volume in Worksheet 5

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where

   P = 2-Year Rainfall (in)

   S = (1000/ CN)-10

2. Runoff Volume (CF) = Q x Area x 1/12

   Q = Runoff (in)

   Area = Land use area (sq. ft.)

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
The use of a weighted CN value for volume calculations is not acceptable.

RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Atlantic Sunrise Project - Compressor Station 610- Deer Lick Run
DA: Infiltration Berm 2
2-Year Rainfall: 2.83 **in**

Total Contributing Area: 4.95 **acres**

Developed Conditions:

Cover Type	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Grass	B	-	0.00	61	6.39	1.28	0.30	-
Meadow	B	215,529.00	4.95	58	7.24	1.45	0.22	3,977
Impervious	B	-	0.00	98	0.20	0.04	2.60	-
Gravel Road	B	-	0.00	85	1.76	0.35	1.45	-
TOTAL:		215,529.00	4.95					3,977

Berm 2 Available Volume (ft^3)	**8,083**
Actual 2-Year Volume runoff (ft^3)	**3,977**

If 2-Year Volume Runnoff is less than Available Berm Volume, use 2-year volume in Worksheet 5

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where

   P = 2-Year Rainfall (in)

   S = (1000/ CN)-10

2. Runoff Volume (CF) = Q x Area x 1/12

   Q = Runoff (in)

   Area = Land use area (sq. ft.)

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
The use of a weighted CN value for volume calculations is not acceptable.

Criteria and Credits for BMP 5.4.1 Protect Sensitive/Special Value Features

To receive credit, the proposed areas:

- ☒ Shall include natural areas of floodplains, mapped wetlands, mapped woodlands, and natural slopes over 15% and 25%.
- ☐ May include other areas of significant natural resources that the applicant demonstrates are of special natural value. N/A
- ☒ Shall not be disturbed during project construction (i.e., cleared or graded) except for temporary impacts associated with mitigation and reforestation efforts. Utility disturbance is discouraged and should be kept to a minimum.
- ☒ Shall be protected by having the limits of disturbance clearly shown on all construction drawings and delineated in the field.
- ☒ Shall be located within an acceptable land preservation/protection agreement or other enforceable instrument, such as a deed restriction, that ensures perpetual protection of the proposed areas. The preservation agreement shall clearly specify how the natural area shall be managed and boundaries will be marked with permanent survey markers.
- ☒ Managed turf is not considered an acceptable form of vegetation management.
- ☒ Shall be located on the development project.

CREDITS

Volume and Quality

Protected Area is not to be included in Runoff Volume calculation

Stormwater Management Area = (Total Area – Protected Area)

Peak Rate and Channel Protection

Runoff from the Protected Area may be excluded from Peak Rate calculations and Channel Protection calculations for rate control, provided that the runoff from the protected area is not conveyed to and/or through stormwater management control structures. If necessary, runoff from Protected Areas should be directed around BMPs and stormwater pipes and inlets by means of vegetated swales or low berms that direct flow to natural drainage ways.

Criteria and Credits for BMP 5.6.2 Minimize Soil Compaction in Disturbed Areas

To receive credit, areas of Minimal Soil Compaction must meet the following criteria:

- ☒ Area shall NOT be stripped of existing topsoil.
- ☒ Area shall not be subject to excessive equipment movement. Vehicles movement, storage, or equipment/material laydown shall not be permitted in areas of Minimized Disturbance/Grading.
- ☒ The area shall be protected by having the limits of disturbance and access clearly shown on the Stormwater Management Plan, all construction drawings and delineated in the field.
- ☐ The use of soil amendments and additional topsoil is permitted. Light grading may be done with tracked vehicles that prevent compaction. N/A
- ☒ Lawn and turf grass are acceptable uses. Planted Meadow is an encouraged use.
- ☒ Area shall be located on the development project.

CREDITS

Volume and Quality

A Volume Reduction may be credited based upon the area of Minimal Soil Compaction.

For Lawn Areas:
Volume Reduction (ft^3) = Area of Min. Soil Compaction (ft^2) x ¼" / 12

For Meadow Areas:
Volume Reduction (ft^3) = Area of Min. Soil Compaction (ft^2) x 1/3" / 12

Note: The applicant may request a greater volume credit if calculations support a greater numerical value to Minimizing Soil Compaction.

Peak Rate and Channel Protection

The Peak Rate for flood protection and channel protection will be reduced by the reduction in runoff volume provided above.

Criteria and Credits for BMP 5.8.2 Disconnection from Storm Sewers

To receive credit, the following must be met:

- ☒ Runoff from the non-rooftop impervious cover shall be directed to pervious areas where it is infiltrated into the soil.
- ☒ May include Vegetated Swales as outlined in BMP 6.8.
- ☒ May include check dams, low berms, native vegetation, and limited grading to improve natural drainage features.
- ☒ Shall be designed such that flows after development are non-erosive.
- ☐ Shall be protected from compaction or unintended disturbance during construction by having the limits of disturbance clearly shown on all construction drawings and delineated in the field. N/A
- ☒ Shall be noted on stormwater management plans as part of stormwater management system and included in any municipal easement requirements for stormwater systems.
- ☒ Shall be located on the development project.
- ☒ Runoff cannot originate from a designated hotspot.
- ☒ The maximum contributing impervious flow path length shall be 75 feet.
- ☒ The disconnection shall drain continuously through a vegetated swale or filter strip, or planted area to the property line or BMP.
- ☒ The length of the disconnection area must be at the least the length of the contributing area.
- ☒ The entire vegetated "disconnection" area shall have a maximum slope of 5%.
- ☒ The contributing impervious area to any one discharge point shall not exceed 1000 ft^2.
- ☐ Disconnections are encouraged on relatively well-draining soils (HSG A & B).
- ☐ If the site cannot meet the required disconnect length, a level-spreading device, recharge garden, infiltration trench, or other storage device may be needed for compensation.

CREDITS
Volume and Quality

Volume Reduction (ft^3) = Contributing Impervious Area (ft^2) x 1/4" / 12

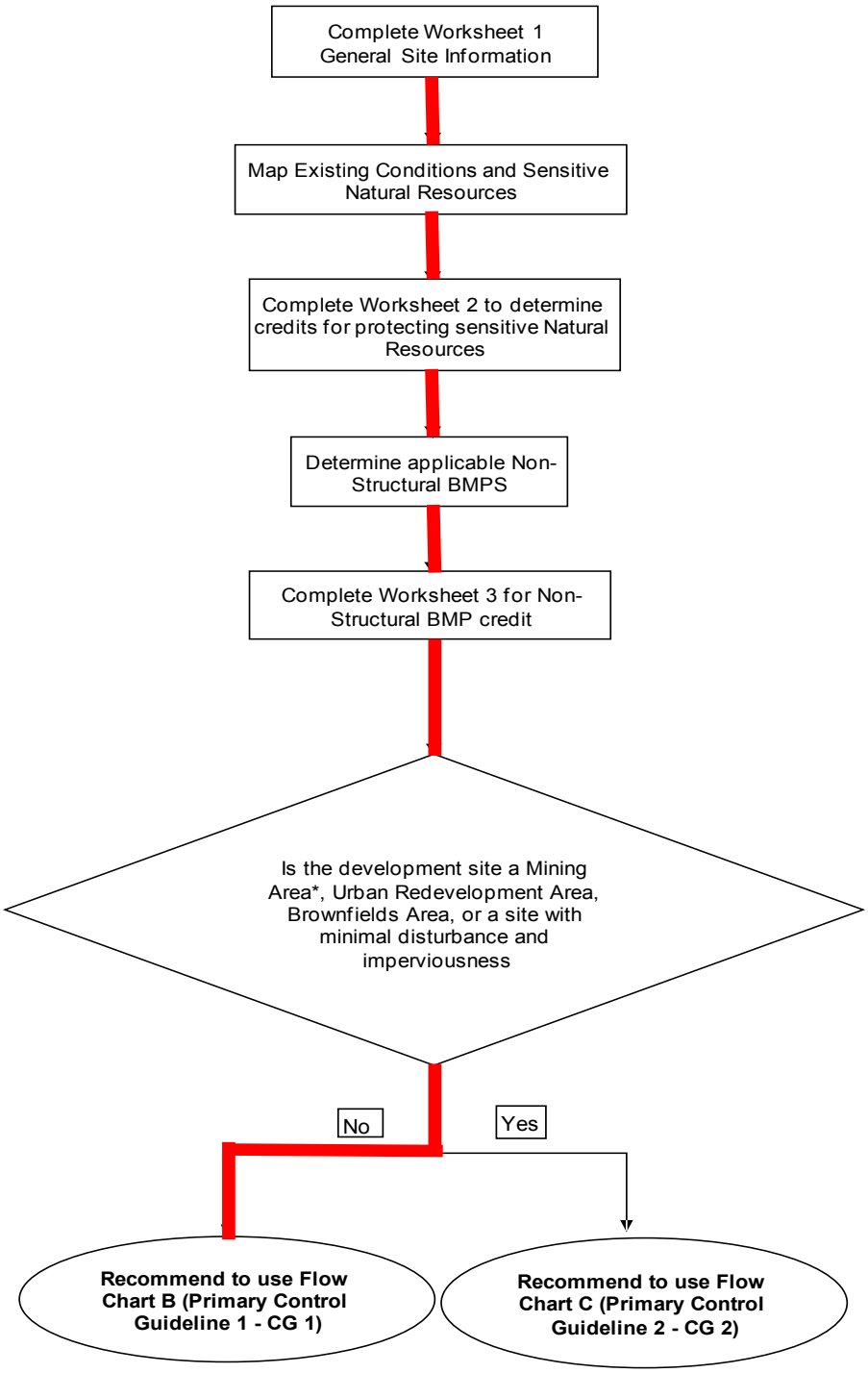
Note: A greater volume credit may be requested by the applicant if calculations support a greater numerical value to Minimizing Soil Compaction.

Peak Rate and Channel Protection

The Peak Rate for flood protection and channel protection will be reduced by the reduction in runoff volume provided above.

A.5 Water Quality Worksheets

FLOW CHART A (Green Creek POI)
Stormwater Calculation Process



Worksheet 1. General Site Information

INSTRUCTIONS: Fill out Worksheet 1 for each watershed

Date: 25-Oct-15

Project Name: Atlantic Sunrise Project - Compressor Station 610 - Green Creek

Municipality: Orange Township

County: Columbia County

Total Area (acres): 13.36

Major River Basin: Susquehanna River
http://www.dep.state.pa.us/dep/depupdate/watermgt/wc/default.htm#newtopics

Watershed: Fishing Creek - Columbia Co.

Sub-Basin: Green Creek

Nearest Surface Water(s) to Receive Runoff: UNTs to Green Creek

Chapter 93 - Designated Water Use: TSF
http://www.pacode.com/secure/data/025/chapter93/chap93toc.html

Impaired according to Chapter 303(d) List?
http://www.dep.state.pa.us/dep/deputate/watermgt/wqp/wqstandards/303d-Report.htn

Yes	
No	X

List Causes of Impairment: N/A

Is project subject to, or part of:

Municipal Separate Storm Sewer System (MS4) Requirements?
http://www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StormwaterManagement/GeneralPermits/default.htm

Yes	
No	X

Existing or planned drinking water supply?

Yes	
No	X

If yes, distance from proposed discharge (miles):

Approved Act 167 Plan?
http://www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StormwaterManagement/Approved_1.html

Yes	
No	X

Existing River Conservation Plan?
http://www.dcnr.state.pa.us/brc/rivers/riversconservation/planningprojects/

Yes	
No	X

Worksheet 2. Sensitive Natural Resources

INSTRUCTIONS: (Green Creek)

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

NOTE: NO DEVELOPMENT WILL TAKE PLACE WITHIN THE GREEN CREEK WATERSHED.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies	N/A	0.00	0.00
Floodplains	N/A	0.00	0.00
Riparian Areas	N/A	0.00	0.00
Wetlands	Y	0.00	0.00
Woodlands	Y	5.63	5.63
Natural Drainage Ways	N/A	0.00	0.00
Steep Slopes, 15% - 25%	N/A	0.00	0.00
Steep Slopes, over 25%	N/A	0.00	0.00
Other:			
Other:			
TOTAL EXISTING:		5.63	5.63

Worksheet 3. Nonstructural BMP Credits

PROTECTED AREA (Green Creek)

1.1 Area of Protected Sensitive/Special Value Features (see WS 2) 5.63 Ac.

1.2 Area of Riparian Forest Buffer Protection - Ac.

3.1 Area of Minimum Disturbance/Reduced Grading - Ac.

NOTE: NO DEVELOPMENT WILL TAKE PLACE WITHIN THE GREEN CREEK WATERSHED.

TOTAL 5.63 Ac.

Site Area	*minus*	Protected Area	=	Stormwater Management Area
13.36	-	-	=	13.36

This is the area that requires stormwater management

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn _____ ft² x 1/4" x 1/12 = 0 ft³

Meadow _____ ft² x 1/3" x 1/12 = _____ ft³

3.3 Protect Existing Trees

For Trees within 100 feet of impervious area:

Tree Canopy _____ ft² x 1/2" x 1/12 = _____ ft³

For Trees within 20 feet of impervious area:

Tree Canopy _____ x 1/12 = _____ ft³

5.1 Disconnect Roof Leaders to Vegetated Areas

For Runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area _____ ft² x 1/12 = _____ ft³

For all other disconnected roof areas

Roof Area _____ ft² x 1/4" x 1/12 = _____ ft³

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For Runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Area _____ ft² x 1/3" x 1/12 = - ft³

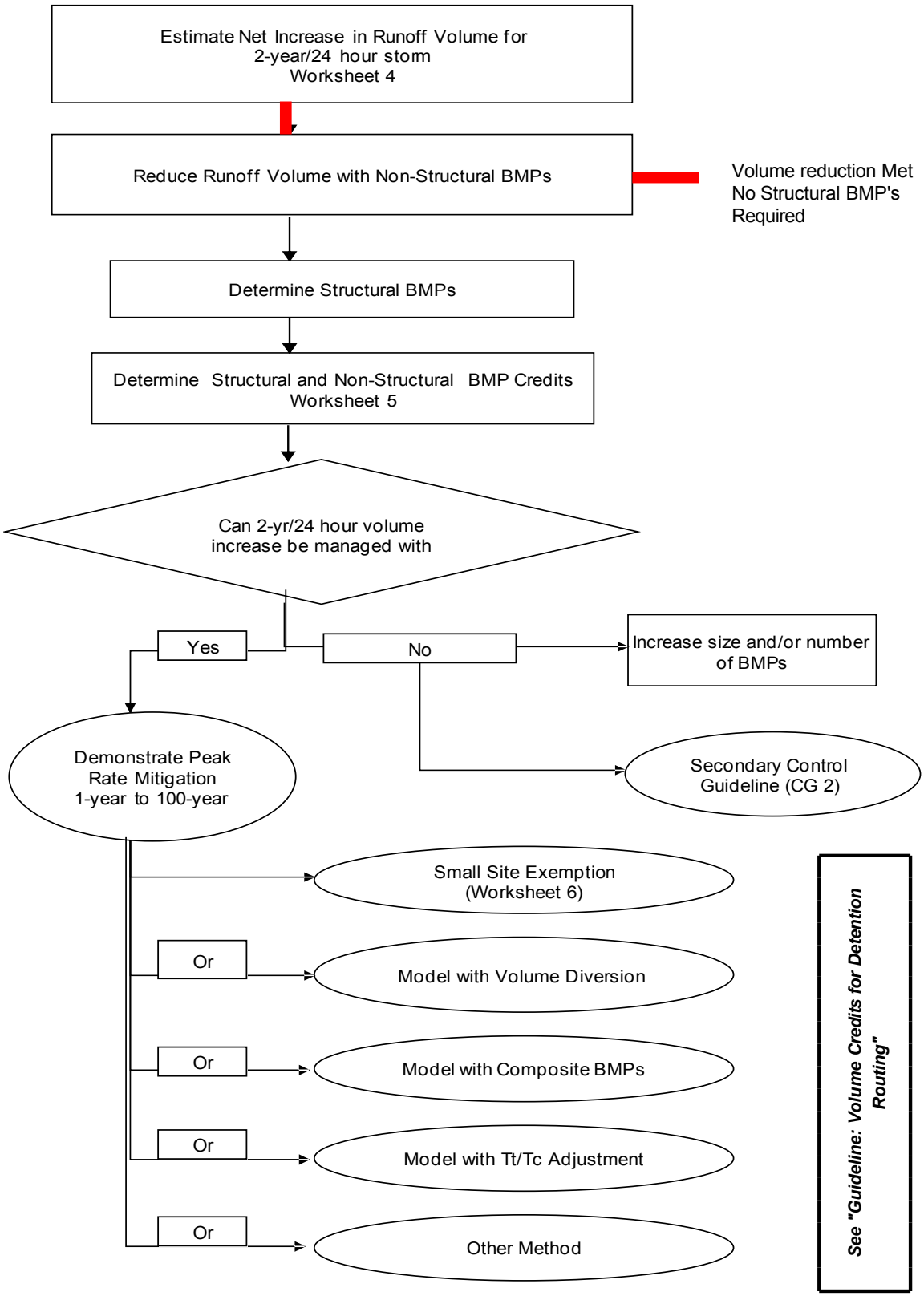
For all other disconnected roof areas

Impervious Area _____ ft² x 1/4" x 1/12 = _____ ft³

TOTAL NON-STRUCTURAL VOLUME CREDIT* - ft³

** For use on Worksheet 5*

FLOW CHART B (Green Creek POI)
Control Guideline 1 Process



WORKSHEET 4 . CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Atlantic Sunrise Project - Compressor Station 610 - Green Creek
DA: Green Creek
2-Year Rainfall: 2.83 in

Total Site Area: 13.36 acres
Protected Site Area: 5.63 acres
Managed Area 7.73 acres

Existing Conditions:

Cover Type	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff [1] (in)	Runoff Volume[2] (ft^3)
Woods	B	-	0.00	55	8.18	1.64	0.15	-
Meadow	B	565,283.00	12.98	58	7.24	1.45	0.22	10,430
Meadow 20%	B	2,221.00	0.05	58	7.24	1.45	0.22	40.98
Impervious	B	8,885.00	0.20	98	0.20	0.04	2.60	1,924.36
TOTAL:		576,389.00	13.23					12,395

Developed Conditions:

Cover Type	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff [1] (in)	Runoff Volume[2] (ft^3)
Woods	B	-	0.00	55	8.18	1.64	0.15	-
Meadow	B	325,614.00	7.48	58	7.24	1.45	0.22	6,008
Impervious	B	11,107.00	0.25	98	0.20	0.04	2.60	2,406
TOTAL:		336,721.00	7.73					8,413

2-Year Volume Increase (ft^3) (3,982)

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where

   P = 2-Year Rainfall (in)

   S = (1000/ CN)-10

2. Runoff Volume (CF) = Q x Area x 1/12

   Q = Runoff (in)

   Area = Land use area (sq. ft.)

NOTE: NO DEVELOPMENT WILL TAKE PLACE WITHIN THE GREEN CREEK WATERSHED.

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
The use of a weighted CN value for volume calculations is not acceptable.

WORKSHEET 5. STRUCTURAL BMP VOLUME CREDITS

PROJECT: Atlantic Sunrise Project - Compressor Station 610 - Green Creek
SUB-BASIN:

Required Control Volume (ft^3) - *from Worksheet 4*: (3,982)
Non-structural Volume Credit (ft^3) - *from Worksheet 3*: - 0

Structural Volume Reqmt (ft^3) (3,982)
(Required Control Volume minus Non-structural Credit)

Proposed BMP		Area (ft^2)	Storage Volume (ft^3)
6.4.1	Porous Pavement		
6.4.2	Infiltration Basin		
6.4.3	Infiltration Bed	**NOTE: NO DEVELOPMENT WILL TAKE PLACE WITHIN THE GREEN CREEK WATERSHED.**	
6.4.4	Infiltration Trench		
6.4.5	Rain Garden/Bioretention		
6.4.6	Dry Well / Seepage Pit		
6.4.7	Constructed Filter		
6.4.8	Vegetated Swale		
6.4.9	Vegetated Filter Strip		
6.4.10	Berm		
6.5.1	Vegetated Roof		
6.5.2	Capture and Re-use		
6.6.1	Constructed Wetlands		
6.6.2	Wet Pond / Retention Basin		
6.6.3	Dry Extended Detention Basin		
6.6.4	Water Quality Filters		
6.7.1	Riparian Buffer Restoration		
6.7.2	Landscape Restoration / Reforestation		
6.7.3	Soil Amendment		
6.8.1	Level Spreader		
6.8.2	Special Storage Areas		
Other	Check Dams in Vegetated Swales		

Total Structural Volume (ft^3): 0
Structural Volume Requirement (ft^3) -3,982

DIFFERENCE 3,982

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary "yes" rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the

PRIMARY BMPs FOR NITRATE:

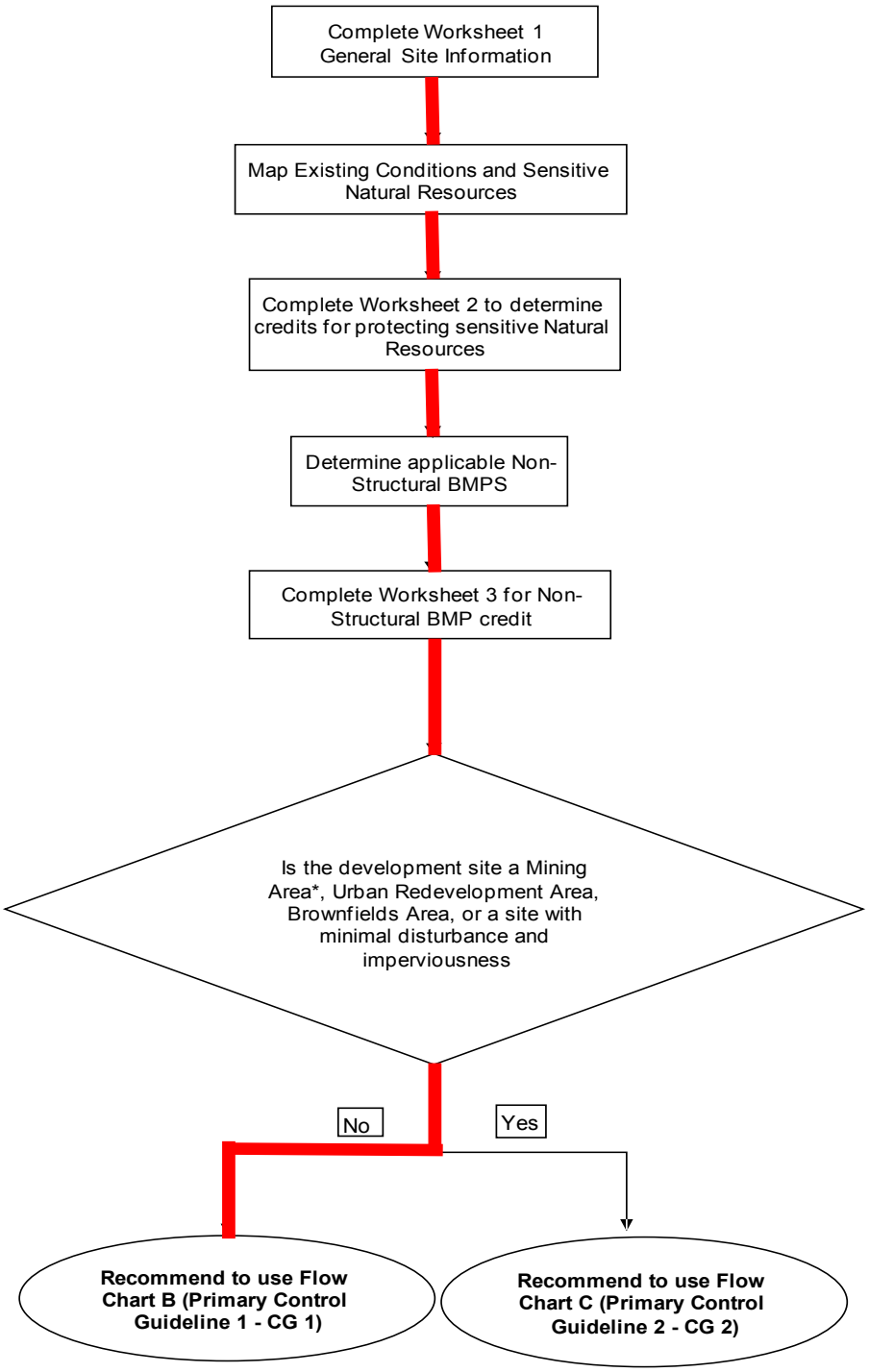
	YES	NO
NS BMP 5.4.2 - Protect / Conserve / Enhance Riparian Buffers		
NS BMP 5.5.4 - Cluster Uses at Each Site		
NS BMP 5.6.1 - Minimize Total Disturbed Area		
NS BMP 5.6.3 - Re-Vegetate / Re-Forest Disturbed Areas (Native		
NS BMP 5.9.1 - Street Sweeping / Vacuuming		
Structural BMP 6.7.1 - Riparian Buffer Restoration		
Structural BMP 6.7.2 - Landscape Restoration		

SECONDARY BMPs FOR NITRATE:

NOTE: NO DEVELOPMENT WILL TAKE PLACE WITHIN THE GREEN CREEK WATERSHED.

NS BMP 5.4.1 - Protect Sensitive / Special Value Features		
NS BMP 5.4.3 - Protect / Utilize Natural Drainage Features		
NS BMP 5.6.2 - Minimize Soil Compaction		
Structural BMP 6.4.5 - Rain Garden / Bioretention		
Structural BMP 6.4.8 - Vegetated Swale		
Structural BMP 6.4.9 - Vegetated Filter Strip		
Structural BMP 6.6.1 - Constructed Wetland		
Structural BMP 6.7.1 - Riparian Buffer Restoration		
Structural BMP 6.7.2 - Landscape Restoration		
Structural BMP 6.7.3 - Soils Amendment/Restoration		

FLOW CHART A (Deer Lick Run POI)
Stormwater Calculation Process



Worksheet 1. General Site Information

INSTRUCTIONS: Fill out Worksheet 1 for each watershed

Date: 1-Jul-15

Project Name: Atlantic Sunrise Project - Compressor Station 610- Deer Lick Run

Municipality: Orange Township

County: Columbia County

Total Area (acres): 25.85

Major River Basin: Susquehanna River
http://www.dep.state.pa.us/dep/depupdate/watermgt/wc/default.htm#newtopics

Watershed: Fishing Creek - Columbia Co.

Sub-Basin: Deer Lick Run

Nearest Surface Water(s) to Receive Runoff: UNTs to Deer Lick Run

Chapter 93 - Designated Water Use: CWF
http://www.pacode.com/secure/data/025/chapter93/chap93toc.html

Impaired according to Chapter 303(d) List?
http://www.dep.state.pa.us/dep/deputate/watermgt/wqp/wqstandards/303d-Report.htn

Yes	
No	X

List Causes of Impairment: N/A

Is project subject to, or part of:

Municipal Separate Storm Sewer System (MS4) Requirements?
http://www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StormwaterManagement/GeneralPermits/default.htm

Yes	
No	X

Existing or planned drinking water supply?

Yes	
No	X

If yes, distance from proposed discharge (miles):

Approved Act 167 Plan?
http://www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StormwaterManagement/Approved_1.html

Yes	
No	X

Existing River Conservation Plan?
http://www.dcnr.state.pa.us/brc/rivers/riversconservation/planningprojects/

Yes	
No	X

Worksheet 2. Sensitive Natural Resources

INSTRUCTIONS: (Deer Lick Run POI)

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies	N/A	0.00	0.00
Floodplains	N/A	0.00	0.00
Riparian Areas	N/A	0.00	0.00
Wetlands	N/A	0.00	0.00
Woodlands	N/A	0.00	0.00
Natural Drainage Ways	N/A	0.00	0.00
Steep Slopes, 15% - 25%	N/A	0.00	0.00
Steep Slopes, over 25%	N/A	0.00	0.00
Other:			
Other:			
TOTAL EXISTING:		0.00	0.00

Worksheet 3. Nonstructural BMP Credits

PROTECTED AREA (Deer Lick Run POI)

1.1 Area of Protected Sensitive/Special Value Features (see WS 2)	**5.41**	**Ac.**
1.2 Area of Riparian Forest Buffer Protection	**-**	**Ac.**
3.1 Area of Minimum Disturbance/Reduced Grading	**0.69**	**Ac.**
TOTAL	**6.10**	**Ac.**

Site Area	*minus*	Protected Area	=	Stormwater Management Area
25.85	-	-	=	25.85

This is the area that requires stormwater management

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn		ft²	x 1/4"	x 1/12	=	**0** **ft³**
Meadow	49725	ft²	x 1/3"	x 1/12	=	**1381** **ft³**

3.3 Protect Existing Trees

For Trees within 100 feet of impervious area:

Tree Canopy		ft²	x 1/2"	x 1/12	=	**ft³**

For Trees within 20 feet of impervious area:

Tree Canopy				x 1/12	=	**ft³**

5.1 Disconnect Roof Leaders to Vegetated Areas

For Runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area		ft²		x 1/12	=	**ft³**

For all other disconnected roof areas

Roof Area		ft²	x 1/4"	x 1/12	=	**ft³**

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For Runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Area		ft²	x 1/3"	x 1/12	=	**-** **ft³**

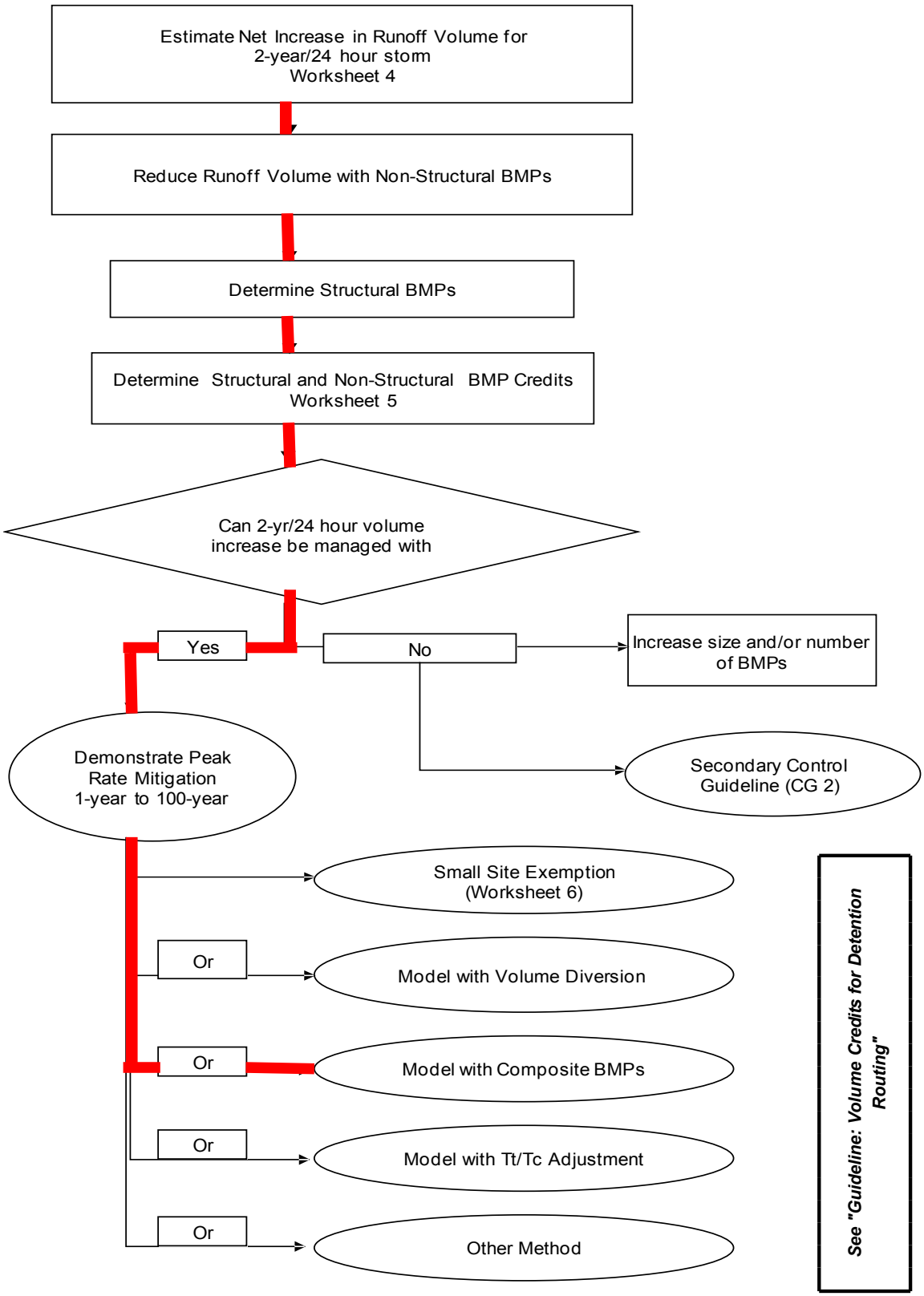
For all other disconnected roof areas

Impervious Area	9125	ft²	x 1/4"	x 1/12	=	**190** **ft³**

TOTAL NON-STRUCTURAL VOLUME CREDIT* 1,571 **ft³**

** For use on Worksheet 5*

FLOW CHART B (Deer Lick Run POI)
Control Guideline 1 Process



WORKSHEET 4 . CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Atlantic Sunrise Project - Compressor Station 610- Deer Lick Run
DA: Deer Lick Run
2-Year Rainfall: 2.83 in

Total Site Area: 25.85 acres
Protected Site Area: 0.00 acres
Managed Area 25.85 acres

Existing Conditions:

Cover Type	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff [1] (in)	Runoff Volume[2] (ft^3)
Meadow	B	883,590.00	20.28	58	7.24	1.45	0.22	16,302
Impervious	B	6,503.00	0.15	98	0.20	0.04	2.60	1,408
TOTAL:		890,093.00	20.43					17,711

Developed Conditions:

Cover Type	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff [1] (in)	Runoff Volume[2] (ft^3)
Grass	B	349,798.00	8.03	61	6.39	1.28	0.30	8,830
Meadow	B	351,890.00	8.08	58	7.24	1.45	0.22	6,492
Impervious	B	137,948.00	3.17	98	0.20	0.04	2.60	29,877
Gravel Road	B	286,581.00	6.58	85	1.76	0.35	1.45	34,546
TOTAL:		1,126,217.00	25.85					79,745

2-Year Volume Increase (ft^3)	**62,034**

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where

   P = 2-Year Rainfall (in)

   S = (1000/ CN)-10

2. Runoff Volume (CF) = Q x Area x 1/12

   Q = Runoff (in)

   Area = Land use area (sq. ft.)

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
The use of a weighted CN value for volume calculations is not acceptable.

WORKSHEET 5. STRUCTURAL BMP VOLUME CREDITS

PROJECT: Atlantic Sunrise Project - Compressor Station 610- Deer Lick Run
SUB-BASIN:

Required Control Volume (ft^3) - *from Worksheet 4*: 62,034
Non-structural Volume Credit (ft^3) - *from Worksheet 3*: - 1,571

Structural Volume Reqmt (ft^3) 60,463
(Required Control Volume minus Non-structural Credit)

	Proposed BMP	Area (ft^2)	Volume Reduction Permanently Removed (ft^3)
6.4.1	Porous Pavement		
6.4.2	Infiltration Basin	39,809	29,941
6.4.3	Infiltration Bed		
6.4.4	Infiltration Trench		
6.4.5	Rain Garden/Bioretention		
6.4.6	Dry Well / Seepage Pit		
6.4.7	Constructed Filter		
6.4.8	Vegetated Swale		
6.4.9	Vegetated Filter Strip		
6.4.10	Berm	34,611	28,745
6.5.1	Vegetated Roof		
6.5.2	Capture and Re-use		
6.6.1	Constructed Wetlands		
6.6.2	Wet Pond / Retention Basin		
6.7.1	Riparian Buffer/Riparian Forest Buffer Restoration		
6.7.2	Landscape Restoration / Reforestation		
6.7.3	Soil Amendment		
6.8.1	Level Spreader		
6.8.2	Special Storage Areas		
Other	Check Dams in Vegetated Swales	1,879	1,879

Total Structural Volume (ft^3): 60,565
Structural Volume Requirement (ft^3): 60,463

DIFFERENCE 102

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary "yes" rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the

PRIMARY BMPs FOR NITRATE: (Deer Lick Run POI)

	YES	NO
NS BMP 5.4.2 - Protect / Conserve / Enhance Riparian Buffers		
NS BMP 5.5.4 - Cluster Uses at Each Site		
NS BMP 5.6.1 - Minimize Total Disturbed Area		
NS BMP 5.6.3 - Re-Vegetate / Re-Forest Disturbed Areas (Native		
NS BMP 5.9.1 - Street Sweeping / Vacuuming	X	
Structural BMP 6.7.1 - Riparian Buffer Restoration		
Structural BMP 6.7.2 - Landscape Restoration		

SECONDARY BMPs FOR NITRATE:

NS BMP 5.4.1 - Protect Sensitive / Special Value Features		
NS BMP 5.4.3 - Protect / Utilize Natural Drainage Features		
NS BMP 5.6.2 - Minimize Soil Compaction	X	
Structural BMP 6.4.5 - Rain Garden / Bioretention		
Structural BMP 6.4.8 - Vegetated Swale	X	
Structural BMP 6.4.9 - Vegetated Filter Strip		
Structural BMP 6.6.1 - Constructed Wetland		
Structural BMP 6.7.1 - Riparian Buffer Restoration		
Structural BMP 6.7.2 - Landscape Restoration		
Structural BMP 6.7.3 - Soils Amendment/Restoration		

A.6 Site Characterization Assessment

Field Observation Report

Project Number: 14C4909

Project Name: Atlantic Sunrise Project – Compressor Station 610

Date of Field Visit: March 10, 2015

Weather Conditions: Overcast Temperature: Approximately 26-45°F

Prepared By: Krystal Bealing, APSS and Joseph Kempf

Copies of Report Have Been Sent To: ☒ Client ☐ Contractor ☐ Other

Client:
Transcontinental Gas Pipe Line
Company, LLC
2800 Post Oak Blvd
Houston, TX 77251

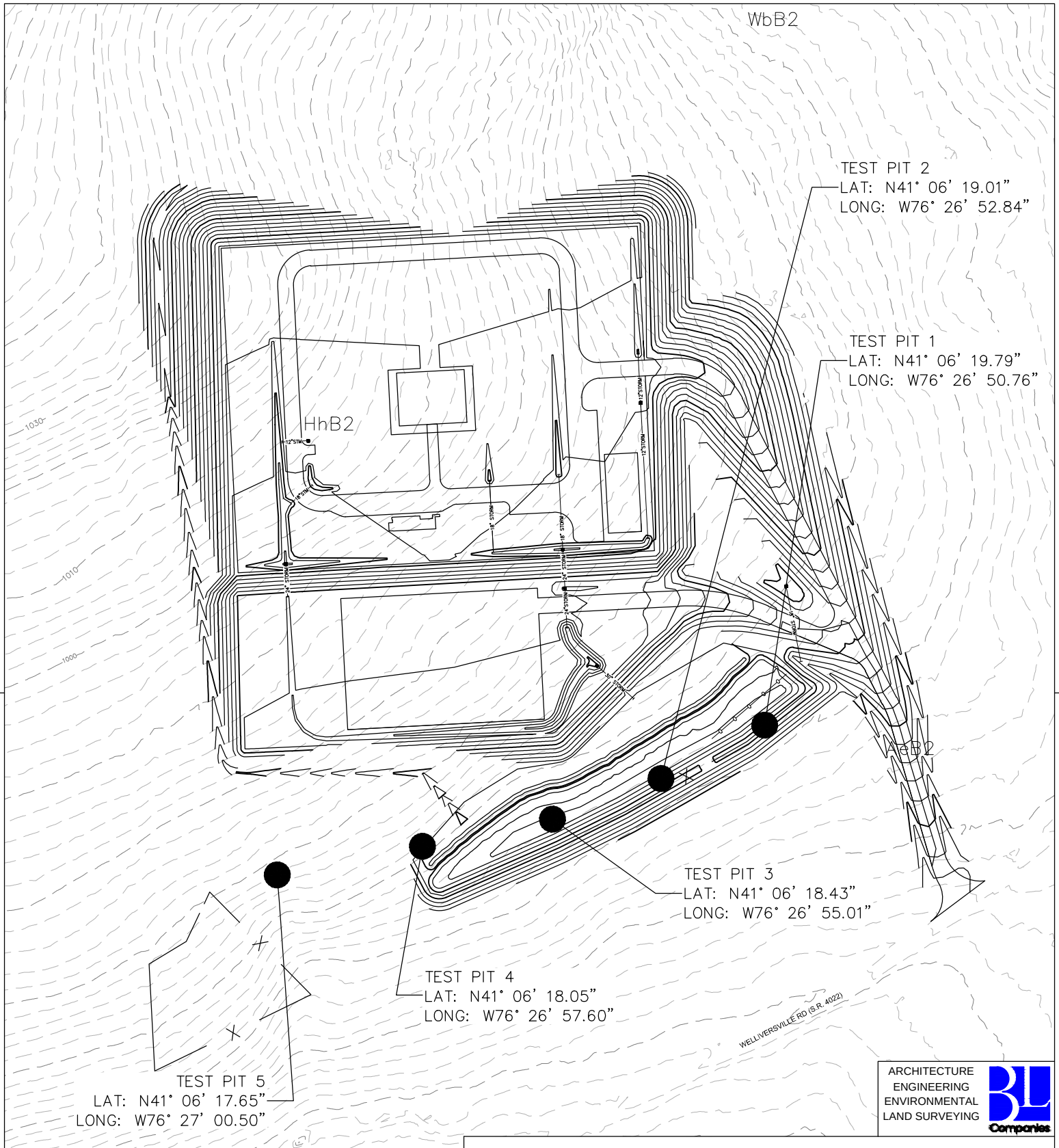
Contractor:
BL Companies
4242 Carlisle Pike, Suite 260
Camp Hill, PA 17011

Five soil pits were excavated by backhoe and described to varying depths. Additionally, infiltration tests using the double ring infiltrometer method were conducted at each pit location, at depths ranging from 27 to 36 inches.

Infiltration testing did not appear to be hindered by weather conditions.

The test pit location map, soil profile descriptions, infiltration worksheet and photographs are attached. Determined limiting layer depths are listed below:

Pit #1: 60 inches deep, Limiting Layer observed at 36 inches
Infiltration conducted at 36 inches, Infiltration Rate = 22.594 inches/hour
Pit #2: 58 inches deep, Limiting Layer observed at 36 inches
Infiltration conducted at 36 inches, Infiltration Rate = 3.625 inches/hour
Pit #3: 59 inches deep, Limiting Layer observed at 30 inches
Infiltration conducted at 30 inches, Infiltration Rate = 1.250 inches/hour
Pit #4: 59 inches deep, Limiting Layer observed at 27 inches
Infiltration conducted 27 inches, Infiltration Rate = 5.250 inches/hour
Pit #5: 58 inches deep, Limiting Layer observed at 27 inches
Infiltration conducted at 27 inches, Infiltration Rate = 1.063 inches/hour



ARCHITECTURE
ENGINEERING
ENVIRONMENTAL
LAND SURVEYING

BL Companies

ATLANTIC SUNRISE PROJECT

COMPRESSOR STATION 610

INFILTRATION TEST PIT LOCATIONS

ORANGE TOWNSHIP
COLUMBIA COUNTY, PENNSYLVANIA

Williams

NO.	DATE	BY	REVISION DESCRIPTION	W.O. NO.	CHK.	APP.

DRAWN BY: AOE	DATE: 3/27/15	ISSUED FOR BID:	SCALE: 1"=150'
CHECKED BY: AJB	DATE: 3/27/15	ISSUED FOR CONSTRUCTION:	
APPROVED BY: AJB	DATE: 3/27/15	DRAWING NUMBER: CS 610 TEST PITS	SHEET 1 OF 1
WO:			

Soil Profile Log

Project 14C4909-A Atlantic Sunrise Project - Compressor Station 610
Test Pit # 1
Name Krystal Bealing, APSS
Date March 10, 2015
Weather 26-45°F; Overcast
Equipment Mini Excavator

Elevation 955 AMSL
Soil Type Hartleton channery silt loam, 3-12% slopes
Geology Trimmers Rock Formation
Landscape Position/Slope Hillslope bench, 0-3%
Land Use Agriculture
Additional Comments Approximately 12" snow; Approximiately 6" frozen soil

Horizon	Upper Boundary (inches)	Lower Boundary (inches)	Soil Textural Class	Type, Size, Coarse Fragments, etc.	Soil Matrix Color	Color Patterns	Pores, Roots, Structure	Depth to Bedrock	Depth to Water	Comments
Ap	0	12	SiL	-	10YR 4/3	-	Roots present; Weak, Granular	-	-	-
Bt	12	36	SiL	15-35% Channery	7.5YR 4/6	-	Roots present; Weak, Subangular Blocky	-	-	-
C	36	60+	CL	35-60% Channery	5YR 5/8	-	Stong, Subangular Blocky	-	-	Limiting Layer - Restrictive Soil Horizon

Note: Unless stated otherwise, horizon strike and dip was not observed to have a significant impact on water flow within the profile.

Soil Profile Log

Project	14C4909-A Atlantic Sunrise Project - Compressor Station 610	**Elevation**	956 AMSL
Test Pit #	2	**Soil Type**	Hartleton channery silt loam, 3-12% slopes
Name	Krystal Bealing, APSS	**Geology**	Trimmers Rock Formation
Date	March 10, 2015	**Landscape Position/Slope**	Hillslope bench, 0-3%
Weather	26-45°F; Overcast	**Land Use**	Agriculture
Equipment	Mini Excavator	**Additional Comments**	Approximately 12" snow; Approximiately 6" frozen soil

Horizon	Upper Boundary (inches)	Lower Boundary (inches)	Soil Textural Class	Type, Size, Coarse Fragments, etc.	Soil Matrix Color	Color Patterns	Pores, Roots, Structure	Depth to Bedrock	Depth to Water	Comments
Ap	0	13	SiL	-	10YR 4/3	-	Roots present; Weak, Granular	-	-	-
Bt	13	36	SiL	15-35% Channery	7.5YR 4/6	-	Roots present; Weak, Subangular Blocky	-	-	-
C	36	58+	CL	35-60% Channery	5YR 5/8	-	Stong, Subangular Blocky	-	-	Limiting Layer - Restrictive Soil Horizon

Note: Unless stated otherwise, horizon strike and dip was not observed to have a significant impact on water flow within the profile.

Soil Profile Log

Project 14C4909-A Atlantic Sunrise Project - Compressor Station 610
Test Pit # 3
Name Krystal Bealing, APSS
Date March 10, 2015
Weather 26-45°F; Overcast
Equipment Mini Excavator

Elevation 959 AMSL
Soil Type Hartleton channery silt loam, 3-12% slopes
Geology Trimmers Rock Formation
Landscape Position/Slope Hillslope bench, 0-3%
Land Use Agriculture
Additional Comments Approximately 12" snow; Approximiately 6" frozen soil

Horizon	Upper Boundary (inches)	Lower Boundary (inches)	Soil Textural Class	Type, Size, Coarse Fragments, etc.	Soil Matrix Color	Color Patterns	Pores, Roots, Structure	Depth to Bedrock	Depth to Water	Comments
Ap	0	12	SiL	-	10YR 4/3	-	Roots present; Weak, Granular	-	-	-
Bt	12	30	SiL	15-35% Channery	7.5YR 5/6	-	Roots present; Weak, Subangular Blocky	-	-	-
C	30	59+	CL	35-60% Channery	5YR 5/6	-	Stong, Subangular Blocky	-	-	Limiting Layer - Restrictive Soil Horizon

Note: Unless stated otherwise, horizon strike and dip was not observed to have a significant impact on water flow within the profile.

Soil Profile Log

Project	14C4909-A Atlantic Sunrise Project - Compressor Station 610	**Elevation**	964 AMSL
Test Pit #	4	**Soil Type**	Hartleton channery silt loam, 3-12% slopes
Name	Krystal Bealing, APSS	**Geology**	Trimmers Rock Formation
Date	March 10, 2015	**Landscape Position/Slope**	Hillslope bench, 0-3%
Weather	26-45°F; Overcast	**Land Use**	Agriculture
Equipment	Mini Excavator	**Additional Comments**	Approximately 12" snow; Approximiately 6" frozen soil

Horizon	Upper Boundary (inches)	Lower Boundary (inches)	Soil Textural Class	Type, Size, Coarse Fragments, etc.	Soil Matrix Color	Color Patterns	Pores, Roots, Structure	Depth to Bedrock	Depth to Water	Comments
Ap	0	13	SiL	-	10YR 4/4	-	Roots present; Weak, Granular	-	-	-
Bt	13	27	SiL	15-35% Channery	7.5YR 5/6	-	Roots present; Weak, Subangular Blocky	-	-	-
C	27	59+	CL	35-60% Channery	5YR 5/8	-	Stong, Subangular Blocky	-	-	Limiting Layer - Restrictive Soil Horizon

Note: Unless stated otherwise, horizon strike and dip was not observed to have a significant impact on water flow within the profile.

Soil Profile Log

Project 14C4909-A Atlantic Sunrise Project - Compressor Station 610
Test Pit # 5
Name Krystal Bealing, APSS
Date March 10, 2015
Weather 26-45°F; Overcast
Equipment Mini Excavator

Elevation 973 AMSL
Soil Type Hartleton channery silt loam, 3-12% slopes
Geology Trimmers Rock Formation
Landscape Position/Slope Hillslope bench, 0-3%
Land Use Agriculture
Additional Comments Approximately 12" snow; Approximiately 6" frozen soil

Horizon	Upper Boundary (inches)	Lower Boundary (inches)	Soil Textural Class	Type, Size, Coarse Fragments, etc.	Soil Matrix Color	Color Patterns	Pores, Roots, Structure	Depth to Bedrock	Depth to Water	Comments
Ap	0	12	SiL	-	10YR 4/3	-	Roots present; Weak, Granular	-	-	-
Bt	12	27	SiL	15-35% Channery	7.5YR 5/6	-	Roots present; Weak, Subangular Blocky	-	-	-
C	27	58+	CL	35-60% Channery	5YR 5/6	-	Stong, Subangular Blocky	-	-	Limiting Layer - Restrictive Soil Horizon

Note: Unless stated otherwise, horizon strike and dip was not observed to have a significant impact on water flow within the profile.

ATLANTIC SUNRISE PROJECT - COMPRESSOR STATION 610													
SOIL INFILTRATION WORKSHEET - DOUBLE RING INFILTROMETER METHOD													
Hole Number	Drop >2 inches after 30 minute presoak?[1]	Reading Interval (minutes)	Reading 1 (Inches of Drop)	Reading 2 (Inches of Drop)	Reading 3 (Inches of Drop)	Reading 4 (Inches of Drop)	Reading 5 (Inches of Drop)	Reading 6 (Inches of Drop)	Reading 7 (Inches of Drop)	Reading 8 (Inches of Drop)	Average Stabilized Reading[2] (Inches of Drop)	Infiltration Rate[3] (in/hr)	Comments
1	Yes	10	4.375	3.250	3.875	3.750	3.750	3.688			3.766	22.594	Approximately 26-45 degrees, overcast, approximately 12" snow cover. Frozen layer approximately 6" deep. Test done at 36" below surface.
2	No	30	1.500	1.750	1.875	1.875	1.750				1.813	3.625	Approximately 26-45 degrees, overcast, approximately 12" snow cover. Frozen layer approximately 6" deep. Test done at 36" below surface.
3	No	30	0.625	0.563	0.563	0.750					0.625	1.250	Approximately 26-45 degrees, overcast, approximately 12" snow cover. Frozen layer approximately 6" deep. Test done at 30" below surface.
4	Yes	10	0.875	0.875	0.750	1.000					0.875	5.250	Approximately 26-45 degrees, overcast, approximately 12" snow cover. Frozen layer approximately 6" deep. Test done at 27" below surface.
5	No	30	0.500	0.563	0.563	0.500					0.531	1.063	Approximately 26-45 degrees, overcast, approximately 12" snow cover. Frozen layer approximately 6" deep. Test done at 27" below surface.

[1]Inches of drop greater than 2 inches after the 30 minute presoak? Yes, use 10 minute interval; No, use 30 minute interval.

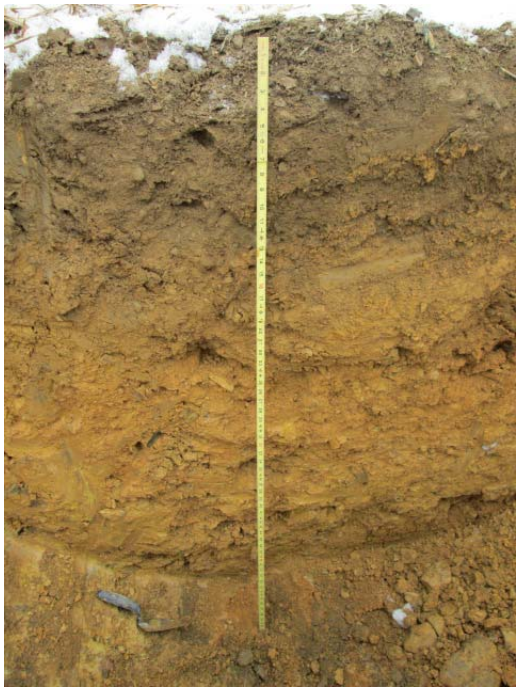
[2]Calculated as the average of the last four stabilized (less than 0.25-inch difference overall) readings.

[3]Calculated as the average stabilized reading x 2 for 30 minute intervals; x 6 for 10 minute intervals.

View of Pit #1.

View of Pit #2.

View of Pit #3.



View of Pit #4.

View of Pit #5.

A.7 Supporting Documentation

TABLE 6.6
Riprap Gradation, Filter Blanket Requirements, Maximum Velocities

Percent Passing (Square Openings)						
Class, Size NO. / **Rock Size (Inches)**	**R-8**	**R-7**	**R-6**	**R-5**	**R-4**	**R-3**
42	100					
30		100				
24	15-50		100			
18		15-50		100		
15	0-15					
12		0-15	15-50		100	
9				15-50		
6			0-15		15-50	100
4				0-15		
3					0-15	15-50
2						0-15
Nominal Placement Thickness (inches)	63	45	36	27	18	9
Filter Stone[1]	AASHTO #1	AASHTO #1	AASHTO #1	AASHTO #3	AASHTO #3	AASHTO #57
V_{max} (ft/sec)	17.0	14.5	13.0	11.5	9.0	6.5

Adapted from PennDOT Pub. 408, Section 703.2(c), Table C

1 This is a general standard. Soil conditions at each site should be analyzed to determine actual filter size. A suitable woven or non-woven geotextile underlayment, used according to the manufacturer's recommendations, may be substituted for the filter stone for gradients < 10%.

TABLE 6.7
Comparison of Various Gradations of Coarse Aggregates

Total Percent Passing															
AASHTO NUMBER	**6 ½**	**4"**	**3 ½"**	**2 ½**	**2"**	**1 ½ "**	**1"**	**3/4 "**	**1/2"**	**3/8"**	**#4**	**#8**	**#16**	**#30**	**#100**
1		100	90-100	25-60		0-15		0-5							
3				100	90-100	35-70	0-15		0-5						
5						100	90-100	20-55	0-10	0-5					
57						100	90-100		25-60		0-10	0-5			
67							100	90-100		20-55	0-10	0-5			
7								100	90-100	40-70	0-15	0-5			
8									100	85-100	10-30	0-10	0-5		
10										100	75-100				10-30

PennDOT Publication 408, Section 703.2(c), Table C

Tables 6.6 and 6.7 should be placed on the plan drawings of all sites where riprap channel linings are proposed.

NOAA Atlas 14, Volume 2, Version 3
Location name: Millville, Pennsylvania, US*
Latitude: 41.1067°, Longitude: -76.4493°
Elevation: 998 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.334** (0.302-0.369)	**0.396** (0.359-0.438)	**0.460** (0.416-0.509)	**0.506** (0.457-0.559)	**0.562** (0.506-0.621)	**0.604** (0.543-0.669)	**0.647** (0.579-0.715)	**0.690** (0.615-0.765)	**0.750** (0.664-0.835)	**0.795** (0.700-0.888)
10-min	**0.520** (0.470-0.573)	**0.619** (0.560-0.683)	**0.715** (0.646-0.791)	**0.781** (0.706-0.863)	**0.859** (0.774-0.950)	**0.916** (0.823-1.01)	**0.973** (0.872-1.08)	**1.03** (0.918-1.14)	**1.10** (0.977-1.23)	**1.16** (1.02-1.29)
15-min	**0.637** (0.576-0.703)	**0.756** (0.685-0.836)	**0.878** (0.793-0.971)	**0.961** (0.868-1.06)	**1.06** (0.956-1.17)	**1.13** (1.02-1.25)	**1.21** (1.08-1.34)	**1.28** (1.14-1.42)	**1.38** (1.22-1.53)	**1.45** (1.27-1.62)
30-min	**0.843** (0.762-0.930)	**1.01** (0.917-1.12)	**1.20** (1.09-1.33)	**1.33** (1.21-1.48)	**1.50** (1.35-1.66)	**1.62** (1.46-1.79)	**1.75** (1.56-1.93)	**1.87** (1.67-2.07)	**2.04** (1.81-2.27)	**2.17** (1.91-2.42)
60-min	**1.03** (0.930-1.14)	**1.24** (1.13-1.37)	**1.51** (1.36-1.67)	**1.70** (1.53-1.88)	**1.94** (1.75-2.15)	**2.14** (1.92-2.36)	**2.33** (2.09-2.58)	**2.54** (2.26-2.81)	**2.82** (2.50-3.14)	**3.04** (2.68-3.40)
2-hr	**1.19** (1.07-1.32)	**1.44** (1.29-1.59)	**1.76** (1.58-1.95)	**2.02** (1.81-2.25)	**2.41** (2.15-2.67)	**2.73** (2.42-3.04)	**3.10** (2.73-3.45)	**3.51** (3.07-3.92)	**4.13** (3.58-4.64)	**4.67** (4.00-5.27)
3-hr	**1.29** (1.16-1.45)	**1.55** (1.40-1.73)	**1.91** (1.71-2.14)	**2.21** (1.98-2.47)	**2.65** (2.36-2.96)	**3.04** (2.69-3.40)	**3.48** (3.05-3.90)	**3.99** (3.46-4.47)	**4.77** (4.07-5.37)	**5.46** (4.60-6.18)
6-hr	**1.62** (1.45-1.82)	**1.94** (1.74-2.18)	**2.37** (2.13-2.67)	**2.75** (2.45-3.08)	**3.30** (2.92-3.69)	**3.78** (3.33-4.24)	**4.33** (3.79-4.86)	**4.96** (4.29-5.57)	**5.93** (5.05-6.69)	**6.80** (5.72-7.70)
12-hr	**2.00** (1.79-2.26)	**2.39** (2.15-2.71)	**2.95** (2.64-3.33)	**3.42** (3.05-3.85)	**4.13** (3.65-4.64)	**4.77** (4.18-5.36)	**5.50** (4.78-6.18)	**6.33** (5.44-7.13)	**7.65** (6.47-8.66)	**8.84** (7.36-10.1)
24-hr	**2.36** (2.15-2.63)	**2.83** (2.59-3.15)	**3.51** (3.20-3.90)	**4.10** (3.72-4.54)	**5.03** (4.53-5.54)	**5.88** (5.25-6.45)	**6.88** (6.09-7.51)	**8.06** (7.07-8.76)	**9.96** (8.60-10.8)	**11.7** (9.98-12.6)
2-day	**2.78** (2.49-3.15)	**3.33** (2.99-3.77)	**4.11** (3.69-4.66)	**4.80** (4.29-5.42)	**5.89** (5.22-6.62)	**6.88** (6.06-7.71)	**8.05** (7.03-8.99)	**9.43** (8.16-10.5)	**11.7** (9.94-12.9)	**13.7** (11.5-15.2)
3-day	**2.95** (2.65-3.34)	**3.53** (3.18-4.00)	**4.34** (3.90-4.91)	**5.05** (4.52-5.69)	**6.16** (5.49-6.92)	**7.18** (6.35-8.04)	**8.38** (7.35-9.36)	**9.79** (8.51-10.9)	**12.1** (10.3-13.4)	**14.2** (12.0-15.6)
4-day	**3.13** (2.82-3.54)	**3.73** (3.37-4.22)	**4.56** (4.11-5.16)	**5.29** (4.76-5.96)	**6.44** (5.75-7.22)	**7.49** (6.64-8.38)	**8.72** (7.67-9.71)	**10.2** (8.87-11.3)	**12.5** (10.7-13.8)	**14.6** (12.4-16.1)
7-day	**3.67** (3.35-4.11)	**4.38** (3.99-4.90)	**5.31** (4.82-5.93)	**6.12** (5.54-6.82)	**7.37** (6.64-8.20)	**8.51** (7.61-9.44)	**9.83** (8.73-10.9)	**11.4** (10.0-12.5)	**13.8** (12.0-15.2)	**16.0** (13.8-17.6)
10-day	**4.24** (3.89-4.69)	**5.04** (4.62-5.58)	**6.04** (5.53-6.68)	**6.91** (6.30-7.63)	**8.23** (7.46-9.06)	**9.41** (8.49-10.3)	**10.8** (9.64-11.8)	**12.3** (10.9-13.5)	**14.7** (13.0-16.1)	**16.9** (14.7-18.4)
20-day	**5.79** (5.40-6.27)	**6.83** (6.36-7.38)	**7.98** (7.41-8.61)	**8.96** (8.29-9.65)	**10.4** (9.61-11.2)	**11.7** (10.7-12.5)	**13.1** (12.0-14.1)	**14.7** (13.4-15.8)	**17.1** (15.5-18.3)	**19.2** (17.2-20.6)
30-day	**7.21** (6.76-7.77)	**8.45** (7.91-9.11)	**9.72** (9.09-10.5)	**10.8** (10.1-11.6)	**12.3** (11.5-13.3)	**13.7** (12.7-14.7)	**15.2** (14.0-16.3)	**16.8** (15.4-18.0)	**19.2** (17.5-20.6)	**21.2** (19.3-22.7)
45-day	**9.12** (8.58-9.75)	**10.6** (10.0-11.4)	**12.0** (11.3-12.9)	**13.2** (12.4-14.1)	**14.9** (14.0-15.9)	**16.3** (15.3-17.4)	**17.9** (16.7-19.0)	**19.5** (18.1-20.8)	**21.9** (20.3-23.4)	**23.9** (22.0-25.5)
60-day	**11.0** (10.4-11.7)	**12.8** (12.1-13.6)	**14.3** (13.5-15.2)	**15.6** (14.8-16.6)	**17.5** (16.5-18.6)	**19.1** (18.0-20.3)	**20.8** (19.5-22.1)	**22.6** (21.2-24.1)	**25.3** (23.6-26.9)	**27.4** (25.5-29.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

APPENDIX B

Preparer Qualifications

STANDARD E&S WORKSHEET # 22
PLAN PREPARER RECORD OF TRAINING AND EXPERIENCE IN EROSION AND SEDIMENT POLLUTION CONTROL METHODS AND TECHNIQUES

NAME OF PLAN PREPARER: Alaric J. Busher, PE, CPESC

FORMAL EDUCATION:

Name of College or Technical Institute: The Pennsylvania State University

Curriculum or Program: Civil Engineering

Dates of Attendance: **From:** 9/1995 **To:** 5/1999

Degree Received Bachelor of Science - Civil Engineering

OTHER TRAINING:

Name of Training:	Annual Oil and Gas Training	Chapter 102 Update Training for the Regulated Community
Presented By:	PADEP	PADEP
Date:	7/10/2013	11/12/2010

EMPLOYMENT HISTORY:

Current Employer: BL Companies

Telephone: 717-651-9850

Former Employer: N/A

Telephone:

RECENT E&S PLANS PREPARED:

Name of Project:	Constitution Pipeline, Access Roads and Meter Station (ES, PCSM)	Reynolds Alford Pipeline (E&S, PCSM)	Annville Medical Office (E&S, PCSM)
County:	Susquehanna	Susquehanna	Lebanon
Municipality:	Multiple	Brooklyn, Harford	Annville Twp
Permit Number:	ESG0011540002	ESX13-115-0152(01)	PAG-02-0038-15-010
Approving Agency:	Susquehanna CCD	PADEP (O&G)	Lebanon CCD

APPENDIX C

United States Department of Agriculture (USDA)
Natural Resources Conservation Service (NRCS)
Custom Soil Resource Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Columbia County, Pennsylvania

Compressor Station 610

July 6, 2015

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:3,200 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Columbia County, Pennsylvania
Survey Area Data: Version 7, Sep 15, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 14, 2011—Sep 18, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Columbia County, Pennsylvania (PA037)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AeB2	Allenwood silt loam, 3 to 12 percent slopes, moderately eroded	1.0	2.9%
HhB2	Hartleton channery silt loam, 3 to 12 percent slopes, moderately eroded	30.8	90.1%
HhC3	Hartleton channery silt loam, 12 to 20 percent slopes, severely eroded	0.3	0.8%
WbB2	Watson silt loam, 3 to 8 percent slopes, moderately eroded	1.3	3.9%
WcC2	Weikert channery silt loam, 12 to 20 percent slopes, moderately eroded	0.8	2.3%
Totals for Area of Interest		**34.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been

observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Columbia County, Pennsylvania

AeB2—Allenwood silt loam, 3 to 12 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l3b8
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 44 to 57 degrees F
Frost-free period: 130 to 180 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Allenwood and similar soils: 90 percent
Minor components: 8 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Allenwood

Setting

Landform: Valley sides
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Old till derived from sedimentary rock

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 58 inches: silty clay loam
H3 - 58 to 70 inches: very gravelly silt loam

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

Minor Components

Watson

Percent of map unit: 8 percent

HhB2—Hartleton channery silt loam, 3 to 12 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l3cj
Elevation: 500 to 1,500 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 140 to 175 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hartleton, moderately deep, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hartleton, Moderately Deep

Setting

Landform: — error in exists on —
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Parent material: Residuum weathered from sandstone and shale

Typical profile

H1 - 0 to 8 inches: channery silt loam
H2 - 8 to 30 inches: channery silt loam
H3 - 30 to 35 inches: very channery loam
R - 35 to 39 inches: weathered bedrock

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

Minor Components

Allenwood
Percent of map unit: 5 percent

Watson
Percent of map unit: 5 percent

HhC3—Hartleton channery silt loam, 12 to 20 percent slopes, severely eroded

Map Unit Setting
National map unit symbol: l3cl
Elevation: 500 to 1,500 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 140 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition
Hartleton, moderately deep, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hartleton, Moderately Deep

Setting
Landform: — error in exists on —
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Parent material: Residuum weathered from sandstone and shale

Typical profile
H1 - 0 to 5 inches: channery silt loam
H2 - 5 to 30 inches: channery silt loam
H3 - 30 to 35 inches: very channery loam
R - 35 to 39 inches: weathered bedrock

Properties and qualities
Slope: 12 to 20 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

Minor Components

Allenwood

Percent of map unit: 8 percent

Watson

Percent of map unit: 2 percent

WbB2—Watson silt loam, 3 to 8 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l3gb
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 40 to 60 degrees F
Frost-free period: 130 to 180 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Watson and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Watson

Setting

Landform: Valley sides
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old till derived from sedimentary rock

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 27 inches: gravelly silty clay loam
H3 - 27 to 45 inches: gravelly clay loam
H4 - 45 to 61 inches: channery loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)

Depth to water table: About 18 to 33 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Minor Components

Allenwood

Percent of map unit: 10 percent

Shelmadine

Percent of map unit: 5 percent
Landform: Drainageways
Down-slope shape: Concave
Across-slope shape: Concave

Alvira

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave

WcC2—Weikert channery silt loam, 12 to 20 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l3gf
Elevation: 500 to 1,600 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 120 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Weikert and similar soils: 95 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Weikert

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex

Across-slope shape: Convex
Parent material: Residuum weathered from shale and siltstone

Typical profile

H1 - 0 to 8 inches: channery silt loam
H2 - 8 to 20 inches: very channery silt loam
H3 - 20 to 24 inches: weathered bedrock

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D

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