TETRA TECH

December 19, 2023

District Mining – Pottsville DMO
2nd Floor 5 West Laurel Blvd
Pottsville, PA 17901

Subject: FINDINGS LETTER REPORT
SOLEBURY TOWNSHIP - BUCKS COUNTY, PA
NEW HOPE CRUSHED STONE & LIME COMPANY, INC. (NHCS)
QUARRY DISCHARGE OUTLET

New Hope Crushed Stone & Lime Co., Inc. (NHCS) operated a quarry in Solebury Township, Bucks County. The permittee, NHCS, has forfeited the site, and PADEP District Mining Operations (DMO) is taking over reclamation at the site. Tetra Tech was retained to assist PADEP with stream restoration of Primrose Creek where it exits the quarry pit and downstream to the existing channel. Elements of the stream restoration work involve designing a channel that will run from the pit to the Primrose Creek. Through consultation between DMO and the Department's Division of Dam Safety, it was established that the elevation of the historic natural surface will govern the elevation of the outlet from the quarry and ultimate elevation of the quarry lake. On November 13, 2023, DMO provided direction and design criteria for the quarry outlet and channel. The horizontal alignment and vertical alignment of the proposed channel were chosen by DMO to ensure it will reside in the native soil beneath the spoil material surrounding the quarry.

LOCATION AND DESCRIPTION

The New Hope Crushed Stone Quarry is located in Solebury Township along Phillips Mill Road, west of the intersection with River Road (Route 32), and approximately 0.90 miles from the Delaware River. Two unnamed tributaries drain a contiguous unnamed basin to the northeast and flow east to the Delaware River Canal. Three small unnamed tributaries drain the Primrose Basin in the northwest and form the Primrose Creek near Phillips Mill Road. Primrose Creek then flows eastward discharging into the NCHS quarry. The discharge collects in the quarry pit and the water level in the quarry is currently controlled by pumping into the Primrose Creek channel east of the quarry.

REGIONAL GEOLOGY

The New Hope Quarry Pit is located in the Piedmont Province, Gettysburg-Newark Lowland Section. The regional topography is characterized by rolling lowlands, shallow valleys and isolated hills. The dominate underlying geology is red shale, siltstone and sandstone with some conglomerate and diabase. The structure comprises a depressed block boarded by parallel faults with low, monoclinal, northwest-dipping beds. The Furlong Fault bisects the quarry pit trending N30E.

Along the east rim of the quarry pit and outlet area, the Jurassic and Triassic Age, Brunswick Formation is found and typically consists of reddish-brown shale, mudstone, and siltstone, with beds of green shale and brown shale. Near its base, the rock is tough, red argillite interbedded in some places with dark-gray argillite. Bedding is moderately well developed, thin, and flaggy. The Brunswick Formation has been intruded by many diabase dikes and sills. Since the Brunswick Formation is composed of very fine-grained rocks, groundwater movement is typically through secondary openings, consisting of fractures or joint planes.

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Previous studies found that the secondary openings are often plugged with weathered materials such as residual clay to depths ranging up to 200 feet below ground surface.

Along the west rim of the quarry pit, the Cambrian Age, Allentown Formation is found and typically consists of laminated, medium-gray dolomite and impure limestone, dark-gray chert stringers and nodules, some calcareous siltstone, and some oolites, stromatolites, and sharpstone conglomerate. Karst surface depressions are noted on the north rim and west of the quarry pit.

SITE EXPLORATION

A subsurface exploration program was implemented to assess the top of native ground east of the quarry pit and downstream to the existing stream channel. An initial subsurface exploration was conducted on June 22, 2022, and consisted of six (6) test pits (TP) along the eastern rim of the quarry. A supplemental subsurface exploration was conducted on July 12, 2023, and consisted of an additional six (6) TPs between the eastern rim of the quarry pit and Primrose Creek. A topographic survey was performed in October 2022.

All test pits were excavated until native ground was determined. Within each test pit, Tetra Tech noted visual observations of the mixed fill material, depth of mixed fill, and depth to native material. Fill material consisted predominantly of angular sand, gravel with cobble and boulder sized rock fragments, but also included some silt and clay materials. Native material consisted of silt with roots and traces of organics to shaley silt to clay, and fine gravel.

The soil and rock conditions discussed in this report represents conditions observed by Tetra Tech at the test pit locations. The subsurface conditions may differ between the exploratory locations at other locations on the site. A summary of test pits is provided on Table 1 and the locations of the test pits are shown on the attached plan Drawings.

A test pit was not located near the proposed outlet from the quarry along the rim. Prior to construction of the channel, the contractor is to excavate a test trench to the top of native material under the observation of the Department's Representative a minimum of 10' long from the quarry rim.

OUTLET AND CHANNEL

The outlet and channel will be constructed as the sole outlet for the water impounded at the quarry. The weir outlet and channel are designed to have a 2-tier configuration. The bottom tier of the channel will be lined with R-5 riprap, and the upper tier will be lined with NAGreen Vmax SC-250 channel liner and vegetated. As discussed with DMO and Dam Safety, the breach (quarry outlet) was sized so that the water surface upstream would be limited to an approximate 1-foot increase as compared to natural conditions. The 10-year storm event will flow at 1.5' deep in the bottom-tier of the weir interface of the pond. The 100-year storm event will flow at total depth of 3' at the interface of the pond and weir. Refer to the attached calculation brief.

CONCLUSION

Tetra Tech has submitted this stream restoration plan for the proposed outlet from the quarry and downstream channel to the existing stream. The outlet and channel design incorporated a wider floodplain to manage higher flows and a low flow notch to manage smaller storm events. The proposed outlet is designed to be constructed in native ground. Additional test excavation is included in the scope for the contractor to confirm the elevation of native soils at the quarry rim before installation of the channel.

It is anticipated that constructing the quarry outlet in native ground will minimize seepage and uncontrolled discharge through the fill material. However, considering the variability of the native rock elevations and mining history, the rock surface will likely vary in three dimensions. If the pool level is raised above the level of the native soil/rock that defines the quarry rim, there is a chance for uncontrolled seepage and discharge into the fill material potentially saturating the material downstream.

Respectfully Submitted,

Heather Trexler, PG

Project Manager

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
HEATHER ANNE TREXLER
GEOLOGIST
PG004798

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Table – Summary of Test Pits

Tetra Tech, Inc.

TABLE 1 - SCHEDULE OF TEST PITS

New Hope Crushed Stone & Lime Co., Inc. (NHCS)
Solebury Township, Bucks County, PA

TP Designation	Field Collection Date	Latitude	Longitude	Surveyed GS EL (feet)	Inferred Thickness of hardpack (feet)	Inferred Thickness of fill Mat'l (feet)	Depth to Native Ground (ft)	Elevation of Native Ground (ft)
TP-1	6/22/2022	40.37710	-74.97683	116.3	2	5	7	109.3
TP-2	6/22/2022	40.37786	-74.97667	105.2	7	NE	NE	NE
TP-3	6/22/2022	40.37787	-74.97602	100.8	NE	5	5	95.8
TP-4	6/22/2022	40.37891	-74.97624	111.8	2	6	8	103.8
TP-5	6/22/2022	40.37965	-74.97567	110.1	5	NE	5	105.1
TP-6	6/22/2022	40.37753	-74.97668	101.5	NE	9	9	92.5
TP A1	7/12/2023	40.377452	-74.976319	100.9			5.5	95.4
TP A2	7/12/2023	40.377456	-74.975990	100.8			1.5	99.3
TP A3	7/12/2023	40.377566	-74.975981	100.2			7.2	93.0
	7/12/2023	40.377566	-74.975978	97.1			Top of culvert	--
	7/12/2023	40.377566	-74.975976	93.8			Bottom of culvert	--
TP A4	7/12/2023	40.377448	-74.976467	101.1			3.2	97.9
TP A5	7/12/2023	40.378117	-74.976085	103.1			6.7	96.4
TP A6	7/12/2023	40.378098	-74.976372	105.71			8.0	97.7

NE = Not Encountered
GS = Ground Surface
EL = Elevation
Surveyed Ground Surface Elevations provided by Northeast Surveyors on October 3, 2022
Elevations of data collected on July 12, 2023 obtained using an EOS Arrow Gold and Ipad with active cellular service

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H&H Calculations

STANDARD DESIGN CALCULATION WORKSHEET

TETRA TECH	**CALCULATION WORKSHEET**		**PAGE 1 OF 2**
Client: Pennsylvania Department of Environmental Protection		**Project Number: 212C-PB-02248**	
Subject: Quarry Discharge Outlet Project – Outlet Design			
By: JP	**Checked By: LB**	**Approved By: HT**	**Date: 12/18/2023**

The purpose of this calculation package is to present the methods, procedures and assumptions used to calculate the size of a principal spillway and outlet channel from an existing quarry to Primrose Creek for the Quarry Discharge Outlet Project.

Peak-flow conditions and hydraulic analysis for the proposed post construction development were analyzed and determined by Michael Baker International, Inc., dated December 2023, and are provided in a separate report.

The 10-year and 100-year peak flow conditions presented in the Michael Baker International report were utilized in HydroCAD. The associated HydroCAD outlet reports are attached. The proposed basin routing utilizes an open channel/spillway only. The proposed invert elevation was set by PADEP to be within native material/bedrock.

The channel will be constructed as the sole outlet for the water impounded at the reclaimed quarry. The weir and outlet channel are designed to have a 2-tier configuration. Protective linings for the outlet channel were determined in accordance with Figure 6.1 and Table 6.6 from the PA DEP Erosion and Sedimentation Manual and NAGreen specifications. The bottom tier of the channel will be lined with R-5 riprap, and the upper tier will be lined with NAGreen Vmax SC-250 channel liner and vegetated. The bottom tier will have a 1.5-foot flow depth and the top tier have a 1.5-foot flow depth. The bottom tier weir outlet will pass the 10-year storm event, and the upper tier weir outlet will pass the 100-year storm flowing at 1.5’ deep, for a total flow depth of 3’ deep. The two-tier geometry was modeled in HydroCAD. The results of the routed 10- and 100- year storm events are summarized in the attached documents.

The bottom and top tiers were analyzed as separate channels to determine each channel liner. The lower tier of the channel, lined with riprap, was analyzed as flowing full to determine the required channel lining. The upper channel was analyzed to pass the 100-year storm with HydroCAD, with the lower tier bankfull flow mentioned above separate and subtracted from the upper tier, to determine the required channel liner.

During the temporary condition or prior to full vegetation of the NAGreen Vmax SC250 turf reinforcement mat, the water elevations calculated in the channel design worksheet (PA DEP Standard E&S Worksheet #11) for the 100-year storm event (representing the channel downstream of the weir interface with the pond) are similar to the water elevations calculated to flow into the weir interface at the pond in HydroCAD. In the vegetated condition during the 100-year storm event, after water enters the weir inlet of the channel, it will slightly rise in elevation downstream as a result of a higher manning’s “n” for vegetated channels. The gradual slope and large width of the channel results in low velocities occurring in the channel at all storm events. As a result, both channel liners will mitigate any erosion in the channel.

STANDARD DESIGN CALCULATION WORKSHEET

TETRA TECH	**CALCULATION WORKSHEET**		**PAGE 2 OF 2**
Client: Pennsylvania Department of Environmental Protection		**Project Number: 212C-PB-02248**	
Subject: Quarry Discharge Outlet Project – Outlet Design			
By: JP	**Checked By: LB**	**Approved By: HT**	**Date: 12/18/2023**

The outlet weir and channel are proposed to be approximately 60’ wide when considering the bottom width of the upper channel. The large width of the upper weir and channel is the result of head loss or entrance loss taken into account in the weir equations utilized in HydroCAD while maintaining the aforementioned flow depths. As water flows through the channel, Manning’s Equation is utilized in the attached channel design worksheets (PA DEP Standard E&S Worksheet #11) to account for friction between the water and the lining of the channel. The 10-year storm event will flow at 1.5’ deep in the bottom-tier of the weir interface of the pond. The 100-year storm event will flow at total depth of 3’ at the interface of the pond and weir.

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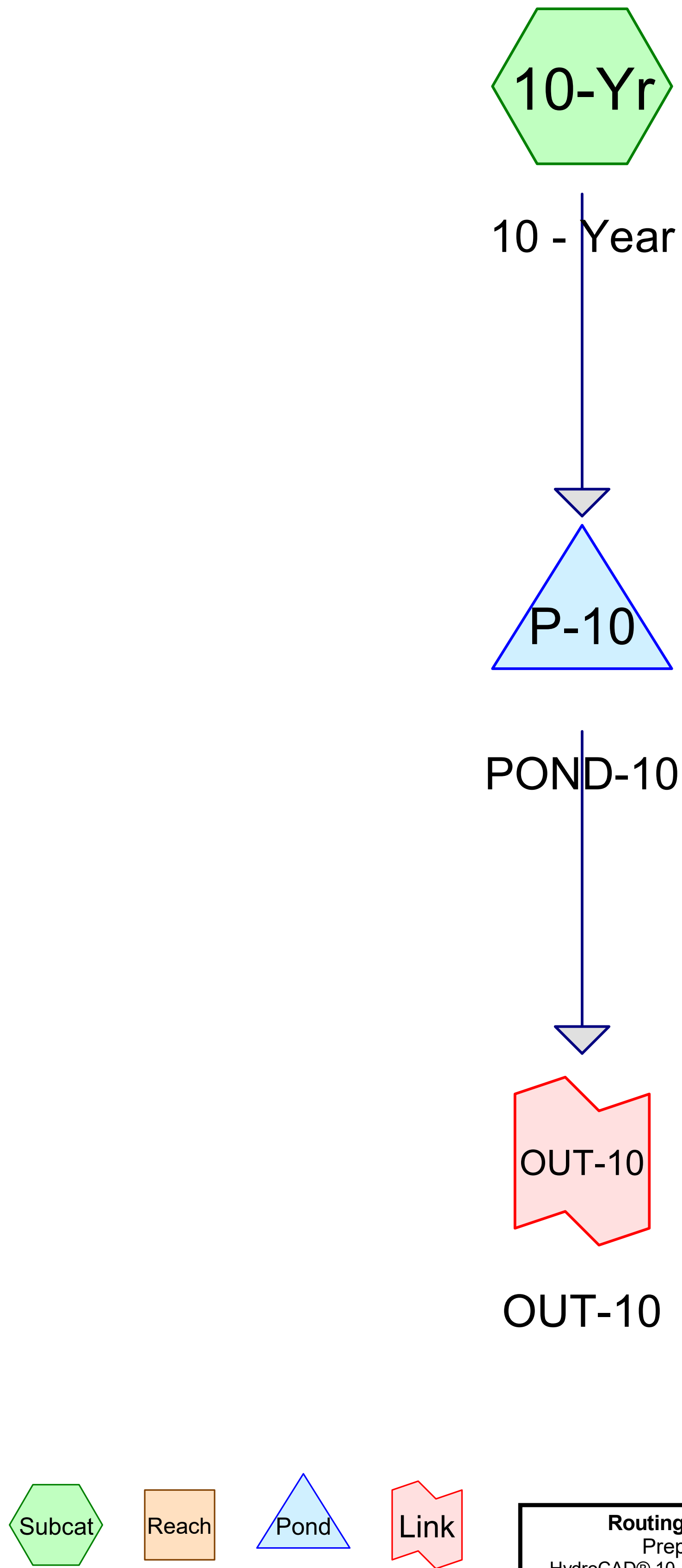
Attachments:

1 – HydroCAD Results
2 – HydroCAD Image of Weir Configuration
3 – Channel Design Worksheet – Riprap Lower Tier – 10-year/24-hour storm
4 – Channel Design Worksheet – NAG Vmax SC-250 Vegetated Liner - Channel Upper Tier - 100-year/24-hour storm
5 – NOAA Atlas 14

1. HYDROCAD RESULTS



Routing Diagram for New Hope Hydrocad - Dec 2023
Prepared by Tetra Tech Inc, Printed 12/1/2023

Summary for Subcatchment 10-Yr: 10 - Year

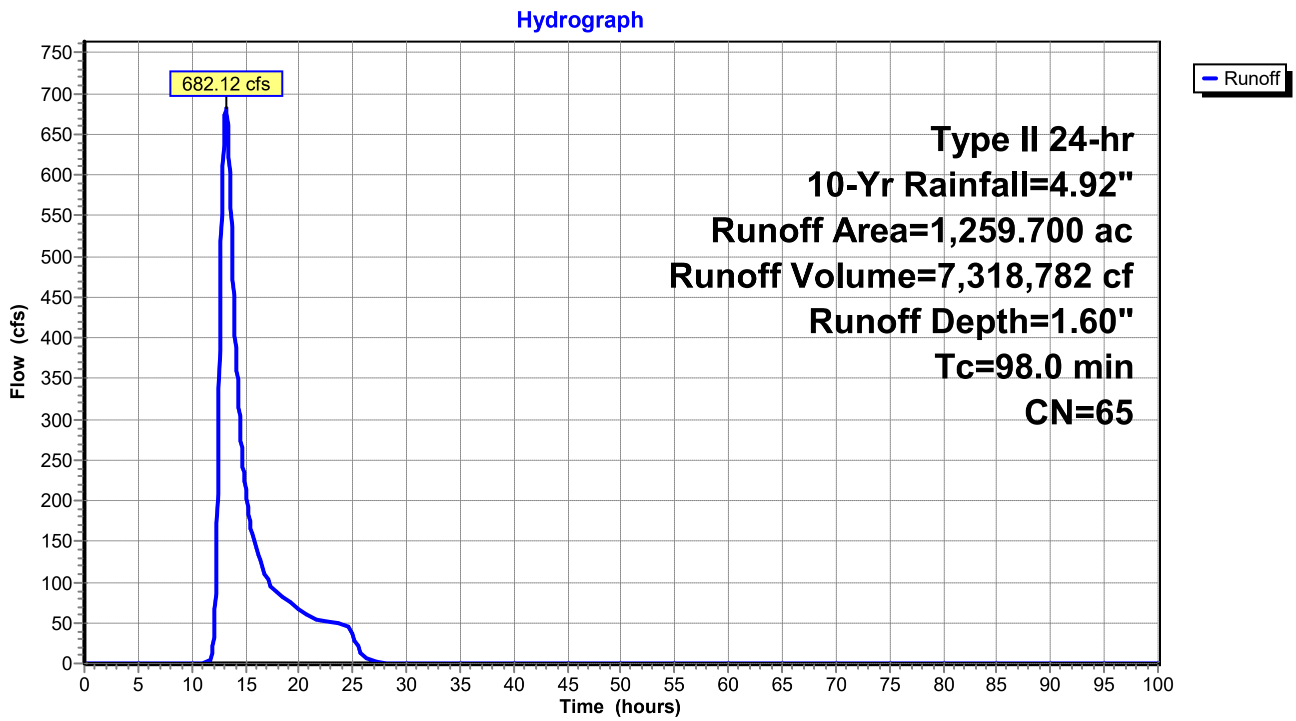
Runoff = 682.12 cfs @ 13.18 hrs, Volume= 7,318,782 cf, Depth= 1.60"
Routed to Pond P-10 : POND-10

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Yr Rainfall=4.92"

	Area (ac)	CN	Description
*	1,259.700	65	
	1,259.700		100.00% Pervious Area

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

Subcatchment 10-Yr: 10 - Year



Summary for Pond P-10: POND-10

Inflow Area = 54,872,532 sf, 0.00% Impervious, Inflow Depth = 1.60" for 10-Yr event
Inflow = 682.12 cfs @ 13.18 hrs, Volume= 7,318,782 cf
Outflow = 142.67 cfs @ 15.94 hrs, Volume= 7,219,011 cf, Atten= 79%, Lag= 165.3 min
Primary = 142.67 cfs @ 15.94 hrs, Volume= 7,219,011 cf
Routed to Link OUT-10 : OUT-10

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Starting Elev= 98.00' Surf.Area= 57.991 ac Storage= 270.567 af
Peak Elev= 99.49' @ 15.94 hrs Surf.Area= 58.281 ac Storage= 357.416 af (86.849 af above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 576.2 min (1,519.8 - 943.6)

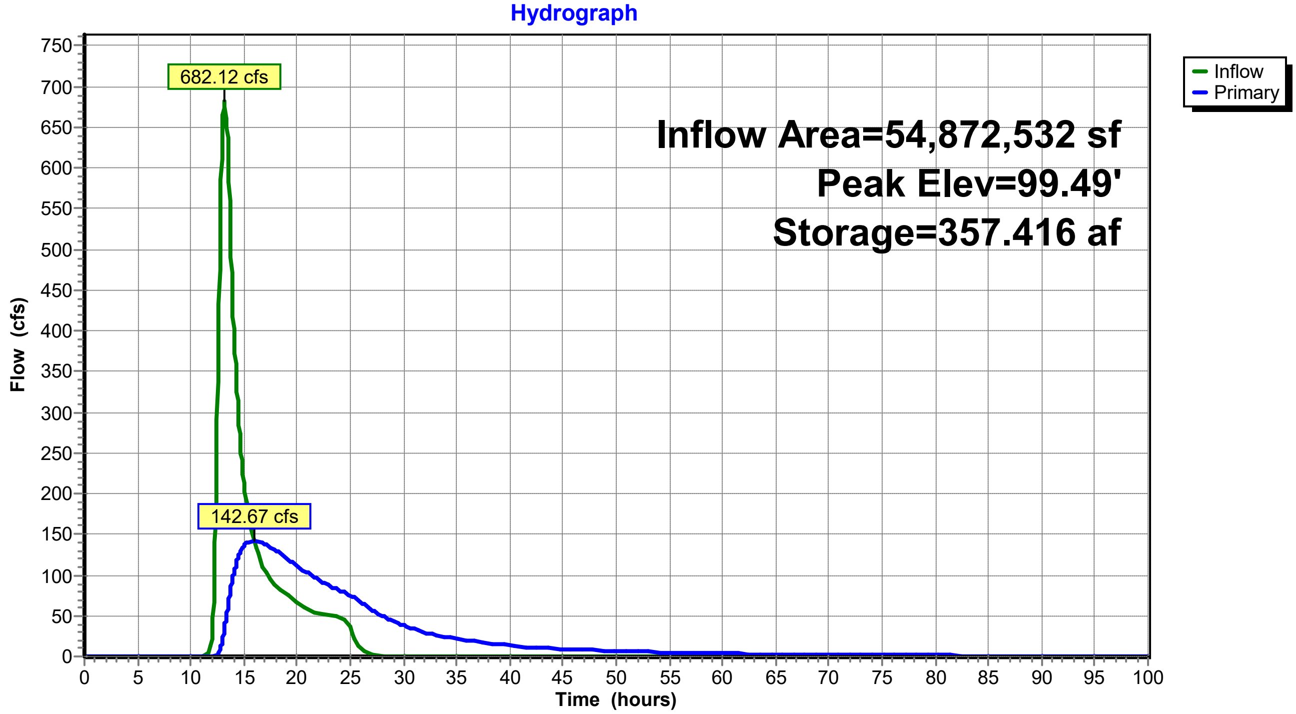
Volume	Invert	Avail.Storage	Storage Description
#1	93.30'	1,371.096 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
93.30	57.152	0.000	0.000
93.80	57.236	28.597	28.597
94.00	57.271	11.451	40.048
95.00	57.445	57.358	97.406
96.00	57.632	57.539	154.944
98.00	57.991	115.623	270.567
100.00	58.379	116.370	386.937
102.00	58.843	117.222	504.159
104.00	59.296	118.139	622.298
106.00	59.869	119.165	741.463
108.00	61.217	121.086	862.549
110.00	62.778	123.995	986.544
112.00	63.720	126.498	1,113.042
114.00	64.457	128.177	1,241.219
116.00	65.420	129.877	1,371.096

Device	Routing	Invert	Outlet Devices
#1	Primary	98.00'	**Custom Weir/Orifice, Cv= 2.65 (C= 3.31)** Head (feet) 0.00 1.50 1.50 4.00 Width (feet) 20.00 29.00 60.00 75.00

Primary OutFlow Max=142.65 cfs @ 15.94 hrs HW=99.49' (Free Discharge)
└─**1=Custom Weir/Orifice** (Weir Controls 142.65 cfs @ 3.90 fps)

Pond P-10: POND-10

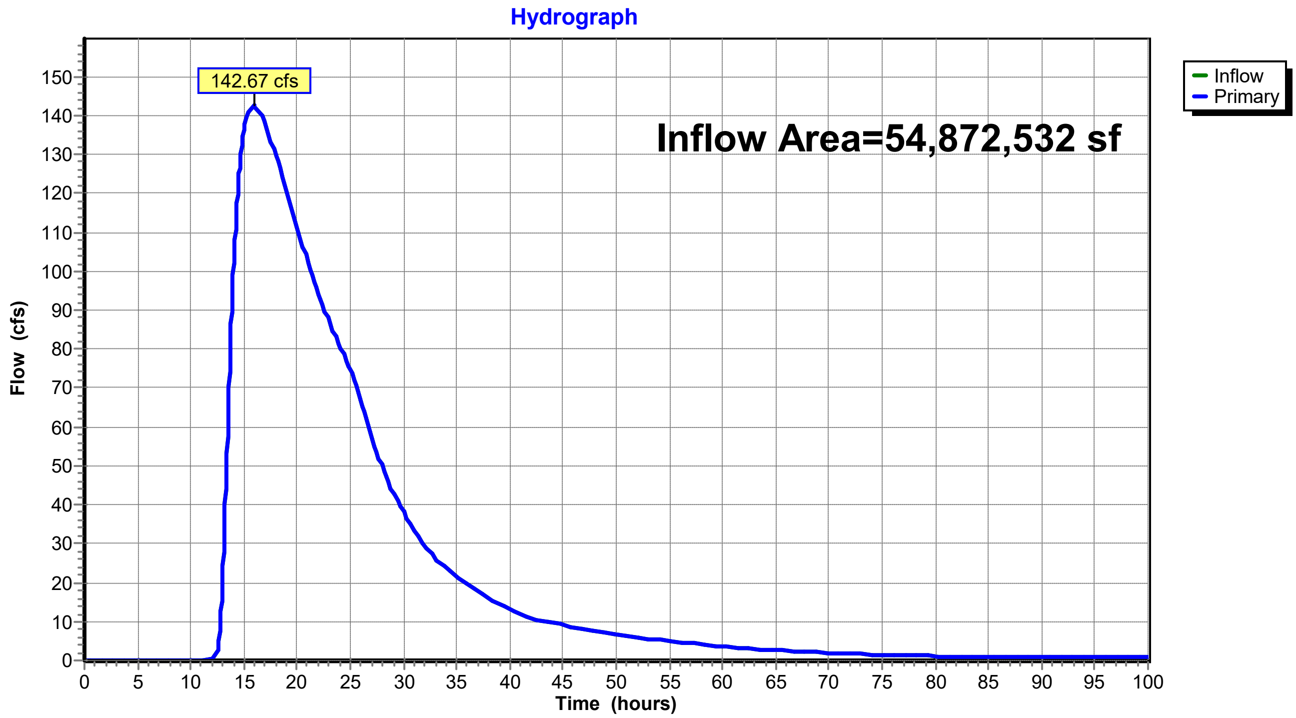


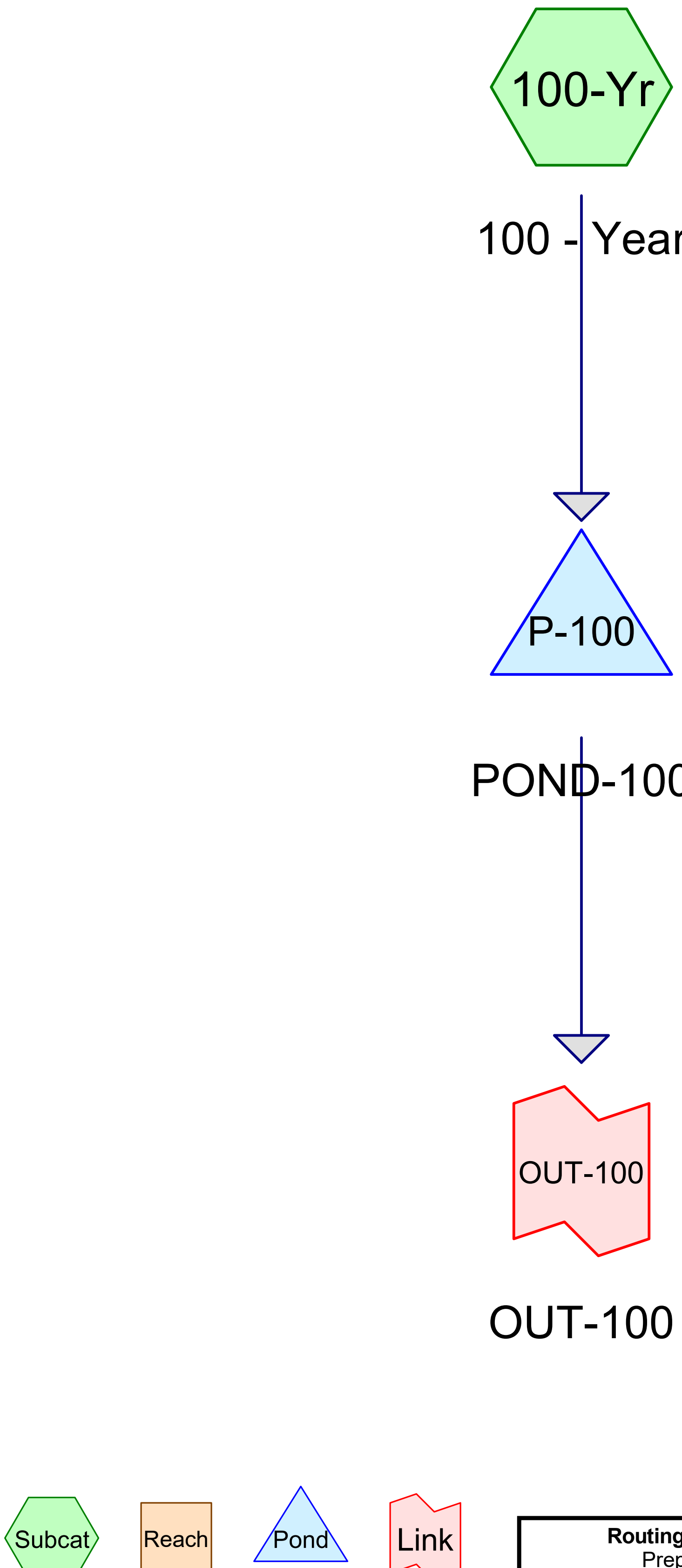
Summary for Link OUT-10: OUT-10

Inflow Area = 54,872,532 sf, 0.00% Impervious, Inflow Depth > 1.58" for 10-Yr event
Inflow = 142.67 cfs @ 15.94 hrs, Volume= 7,219,011 cf
Primary = 142.67 cfs @ 15.94 hrs, Volume= 7,219,011 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Link OUT-10: OUT-10





Routing Diagram for New Hope Hydrocad - Dec 2023
Prepared by Tetra Tech Inc, Printed 12/1/2023

Summary for Subcatchment 100-Yr: 100 - Year

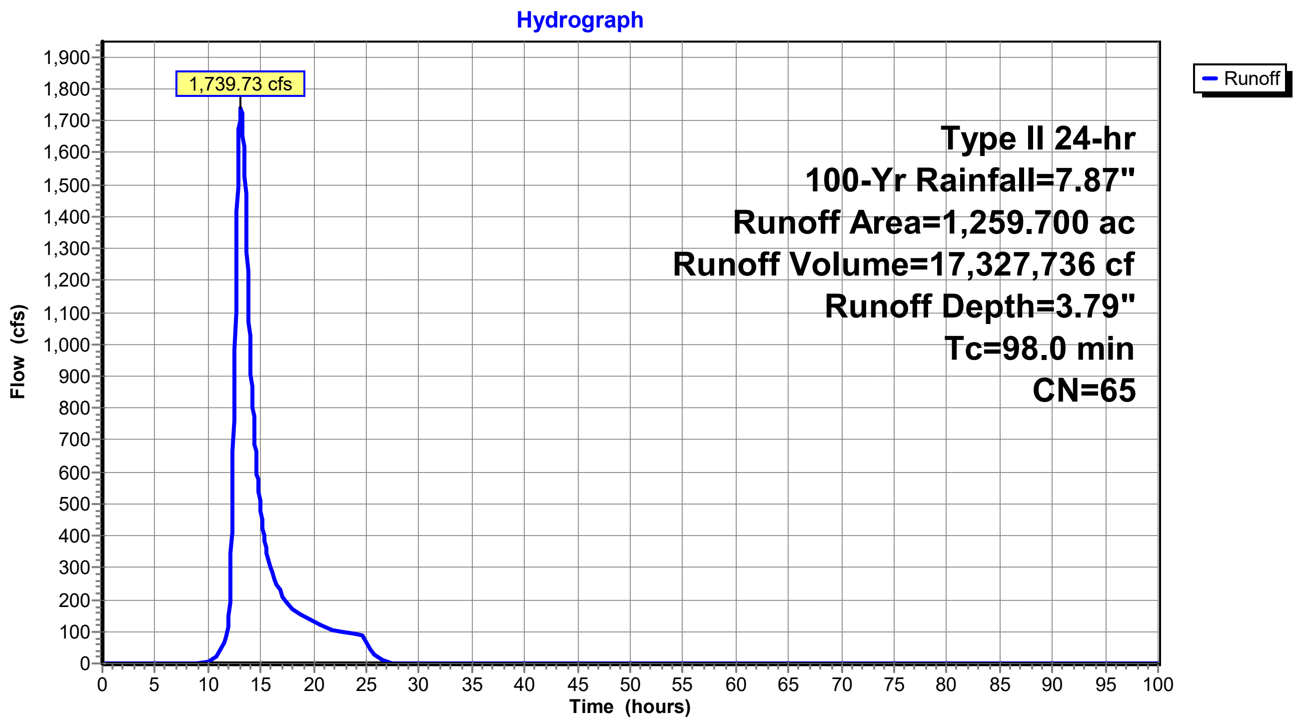
Runoff = 1,739.73 cfs @ 13.15 hrs, Volume= 17,327,736 cf, Depth= 3.79"
Routed to Pond P-100 : POND-100

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Yr Rainfall=7.87"

	Area (ac)	CN	Description
*	1,259.700	65	
	1,259.700		100.00% Pervious Area

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

Subcatchment 100-Yr: 100 - Year



Summary for Pond P-100: POND-100

Inflow Area = 54,872,532 sf, 0.00% Impervious, Inflow Depth = 3.79" for 100-Yr event
Inflow = 1,739.73 cfs @ 13.15 hrs, Volume= 17,327,736 cf
Outflow = 658.89 cfs @ 14.51 hrs, Volume= 17,220,578 cf, Atten= 62%, Lag= 81.4 min
Primary = 658.89 cfs @ 14.51 hrs, Volume= 17,220,578 cf
Routed to Link OUT-100 : OUT-100

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Starting Elev= 98.00' Surf.Area= 57.991 ac Storage= 270.567 af
Peak Elev= 101.00' @ 14.51 hrs Surf.Area= 58.612 ac Storage= 445.666 af (175.098 af above start)

Plug-Flow detention time= 1,142.2 min calculated for 5,431,955 cf (31% of inflow)
Center-of-Mass det. time= 360.2 min (1,278.2 - 918.0)

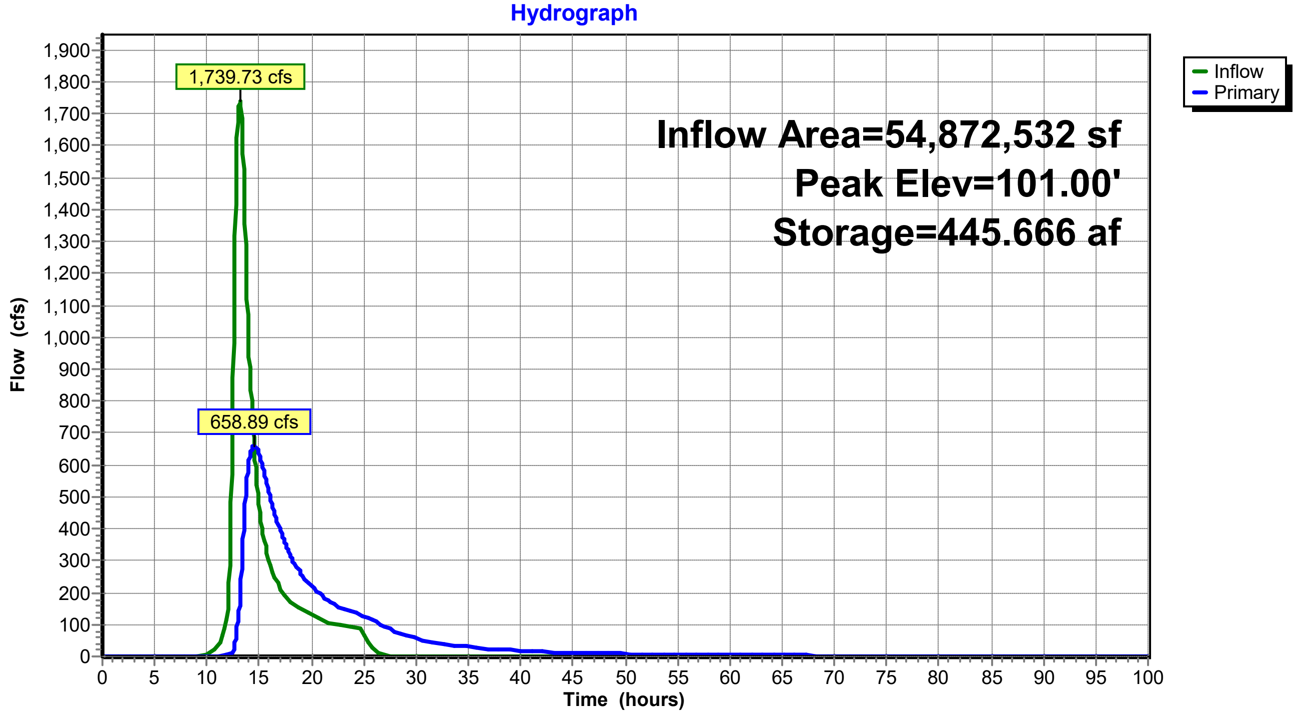
Volume	Invert	Avail.Storage	Storage Description
#1	93.30'	1,371.096 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
93.30	57.152	0.000	0.000
93.80	57.236	28.597	28.597
94.00	57.271	11.451	40.048
95.00	57.445	57.358	97.406
96.00	57.632	57.539	154.944
98.00	57.991	115.623	270.567
100.00	58.379	116.370	386.937
102.00	58.843	117.222	504.159
104.00	59.296	118.139	622.298
106.00	59.869	119.165	741.463
108.00	61.217	121.086	862.549
110.00	62.778	123.995	986.544
112.00	63.720	126.498	1,113.042
114.00	64.457	128.177	1,241.219
116.00	65.420	129.877	1,371.096

Device	Routing	Invert	Outlet Devices
#1	Primary	98.00'	**Custom Weir/Orifice, Cv= 2.65 (C= 3.31)** Head (feet) 0.00 1.50 1.50 4.00 Width (feet) 20.00 29.00 60.00 75.00

Primary OutFlow Max=658.62 cfs @ 14.51 hrs HW=101.00' (Free Discharge)
└─**1=Custom Weir/Orifice** (Weir Controls 658.62 cfs @ 4.92 fps)

Pond P-100: POND-100

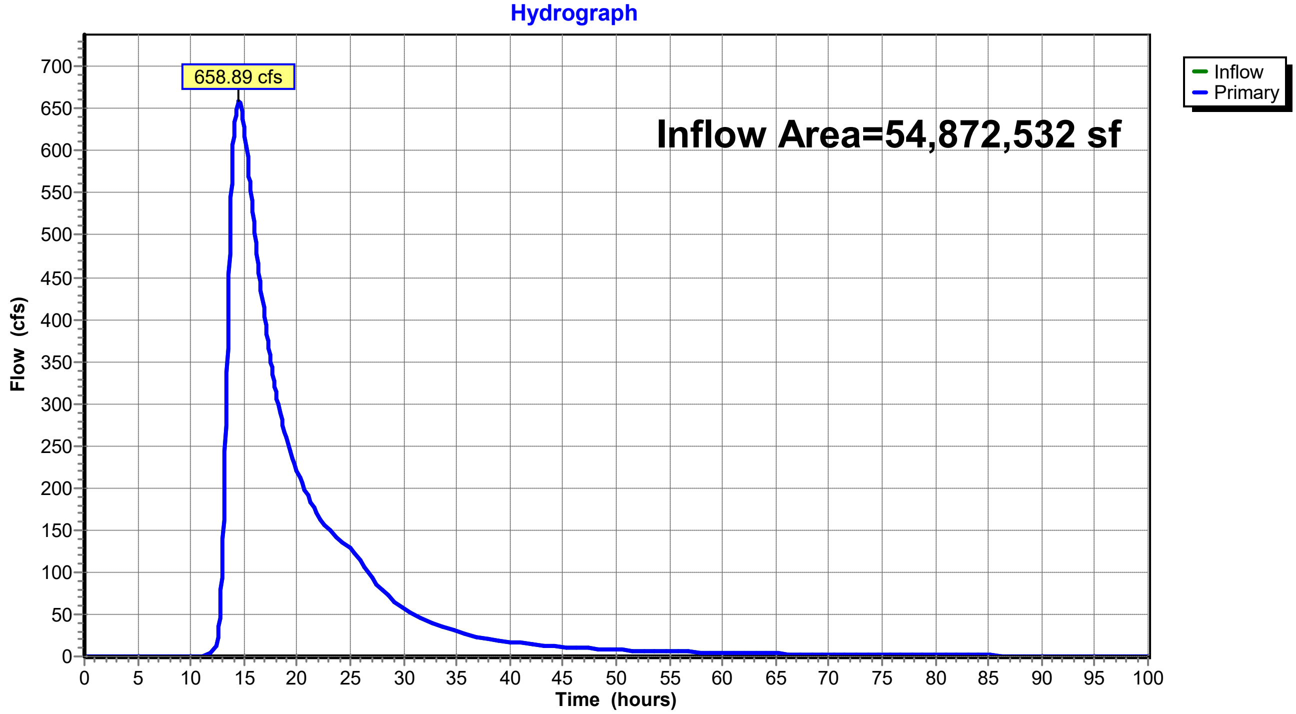


Summary for Link OUT-100: OUT-100

Inflow Area = 54,872,532 sf, 0.00% Impervious, Inflow Depth > 3.77" for 100-Yr event
Inflow = 658.89 cfs @ 14.51 hrs, Volume= 17,220,578 cf
Primary = 658.89 cfs @ 14.51 hrs, Volume= 17,220,578 cf, Atten= 0%, Lag= 0.0 min

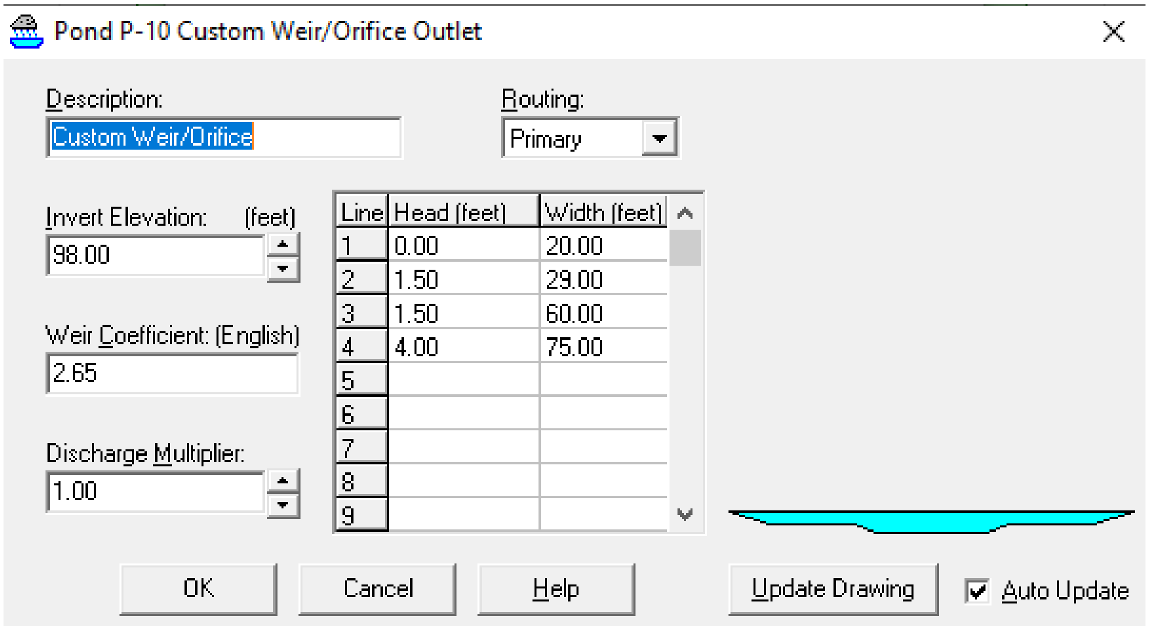
Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Link OUT-100: OUT-100



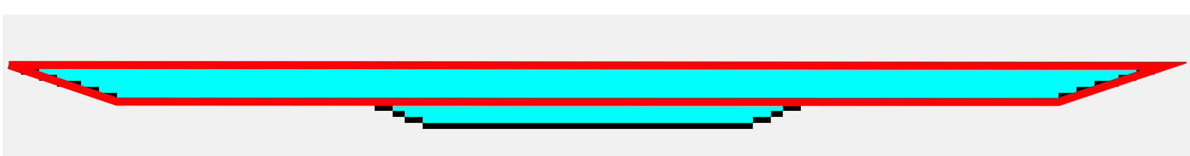
2. HYDROCAD IMAGE OF WEIR CONFIGURATION

HydroCAD channel configuration



Lower Channel Analysis Portion

Upper Channel Analysis Portion



3. CHANNEL DESIGN WORKSHEET – RIPRAP LOWER TIER – 10-YEAR/24-HOUR STORM

STANDARD E&S WORKSHEET #11

Channel Design Data

PROJECT NAME: New Hope

LOCATION: BUCKS COUNTY, PA

PREPARED BY: JRP **DATE:** December 18, 2023

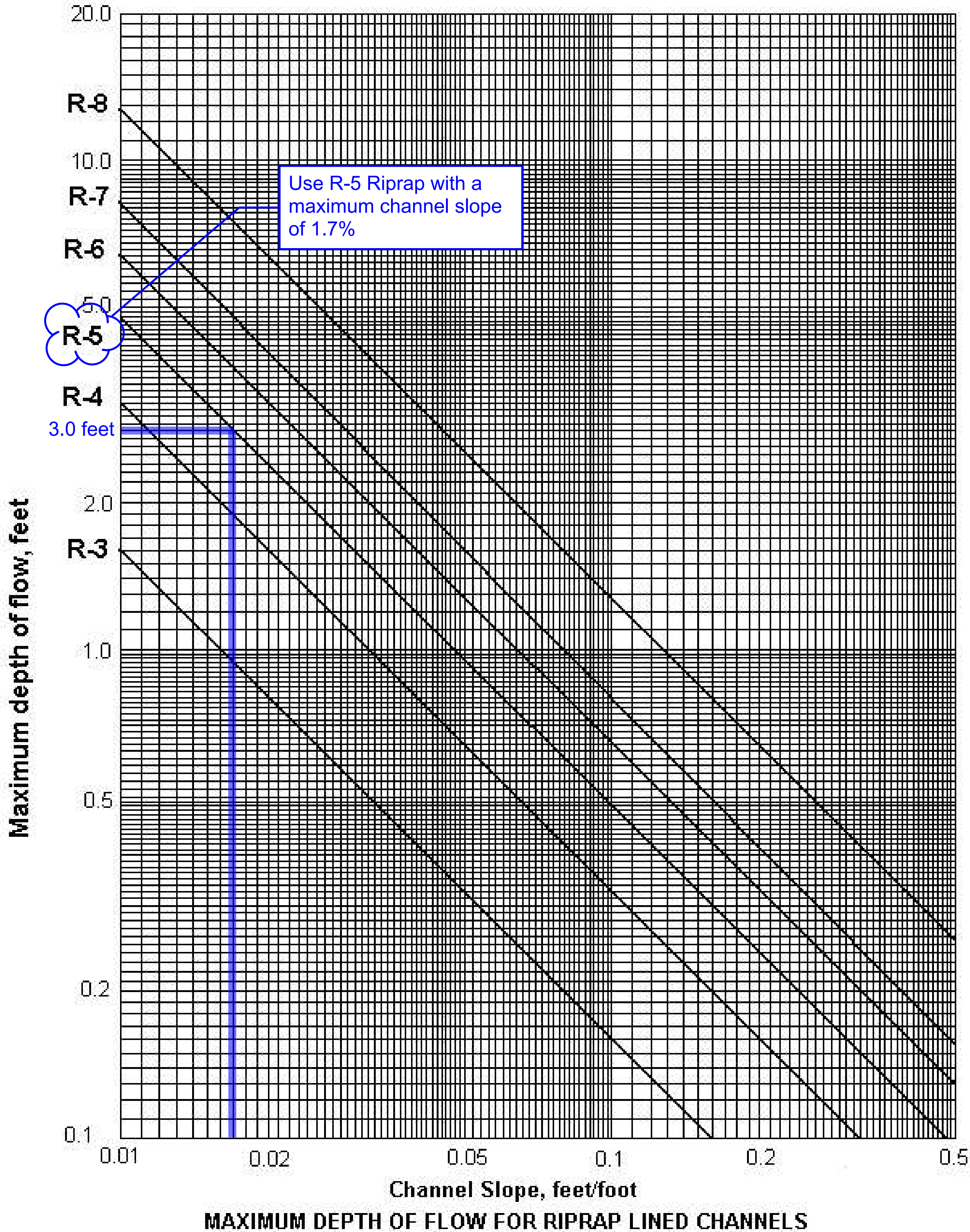
CHECKED BY: LAB **DATE:** December 18, 2023

CHANNEL OR CHANNEL SECTION	Lower Tier	Lower Tier			
TEMPORARY OR PERMANENT? (T OR P)	P	P			
SPECIAL PROTECTION WATERSHED? (YES OR NO)	Yes	Yes			
DESIGN STORM (2, 5, OR 10 YR)	NA - Channel Full	NA - Channel Full			
ACRES (AC)	--	--			
MULTIPLIER (1.6, 2.25, OR 2.75)[1]	--	--			
Qr (REQUIRED CAPACITY) (CFS)	308.85	308.85			
Q (CALCULATED AT FLOW DEPTH d) (CFS)	308.85	-			
VEGETATIVE LINING RETARDANCE	--	--			
PROTECTIVE LINING[2]	R-5	R-5			
n (MANNING'S COEFFICIENT)[2]	0.0479	0.0522			
Va (ALLOWABLE VELOCITY) (FPS)	11.50	11.50			
V (CALCULATED AT FLOW DEPTH d) (FPS)	5.65	--			
τ_a (MAX ALLOWABLE SHEAR STRESS) (LB/FT^2)	N/A	N/A			
τ_d (CALC'D SHEAR STRESS AT FLOW DEPTH d) (LB/FT^2)	N/A	N/A			
CHANNEL BOTTOM WIDTH (FT)	20.00	20.00			
CHANNEL SIDE SLOPES LEFT, Z_1 (H:V)	3.00	3.00			
CHANNEL SIDE SLOPES RIGHT, Z_2 (H:V)	3.00	3.00			
D (TOTAL DEPTH) (FT)	1.50	-			
CHANNEL TOP WIDTH @ D (FT)	29.00	-			
d (CALCULATED FLOW DEPTH) (FT)	2.08	1.50			
CHANNEL TOP WIDTH @ FLOW DEPTH d (FT)	32.50				
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	9.60	-			
d_{50} STONE SIZE (IN)	9.00	9.00			
A (CROSS-SECTIONAL AREA) (SQ. FT.)	54.71	36.75			
R (HYDRAULIC RADIUS)	1.649	-			
S (BED SLOPE)[3] (%)	1.70	1.68			
S_c (CRITICAL SLOPE) (%)	2.89	-			
.7S_c (%)	2.02	-			
1.3S_c (%)	3.75	-			
STABLE FLOW? (Y/N)	Y	-			
FREEBOARD BASED ON UNSTABLE FLOW (FT)	n/a	n/a			
FREEBOARD BASED ON STABLE FLOW (FT)	0.52	-			
MINIMUM REQUIRED FREEBOARD[4] (FT)	0.50	-			
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V	V			

1. The channel lining on this sheet is sized for the depth of flow that is known to be at the channel.
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 1/4 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.

* Riprap size obtained from page 17 of Appendix A (BMP Construction Details) in the E&S Model Plan.

FIGURE 6.1
Maximum Permissible Flow Depth for Riprap Channels



Adapted from VDH&T Drainage Manual

TABLE 6.6
Riprap Gradation, Filter Blanket Requirements, Maximum Velocities

Class, Size NO. / Rock Size (Inches)	Percent Passing (Square Openings)					
	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

AASHTO NUMBER	Total Percent Passing														
	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.

4. CHANNEL DESIGN WORKSHEET – NAG VMAX SC-250 VEGETATED LINER – CHANNEL UPPER TIER – 100-YEAR/24-HOUR STORM

Project: Quarry Discharge Outlet Project	By: JRP	Date: 12/18/2023
Channel Lining Calculations	Checked: LAB	Date: 12/18/2023
Channel: **Discharge Outlet Channel**		

Channel Section	Discharge Outlet Channel	
Temporary or Permanent	Temporary	Permanent
Design Storm	100 minus lower tier flow	100 minus lower tier flow
Acres (AC)	--	--
Multiplier (1.6, 2.25 or 2.75) [1]	--	--
Q_r (Required Capacity in CFS)	516.22	516.22
Q (at Flow Depth d in CFS)	516.22	516.22
Protective Lining [2]	NAG VMax SC250* - Temp. Stabilization	NAG Vmax SC250*, Veg.-Class C-Final Stabilization
n (Manning's Coefficient) [2]	0.028	0.050
V_a (Allowable Velocity in FPS)	9.5	15.0
V (at Flow Depth d in FPS)	7.2	5.0
t_a (Max Allowable Shear Stress in PSF)	--	--
t_d (Shear Stress at Flow Depth d in PSF)	1.2	1.7
Channel Bottom Width (FT)	60.00	60.00
Channel Side Slopes (Z=H:V)	3.00	3.00
D (Total Depth in FT)	3.00	3.00
Channel Top Width at D (FT)	78.00	78.00
d (Flow Depth in FT)	1.13	1.59
Channel Top Width at d (FT)	66.77	66.77
Bottom Width:Depth Ratio (12:1 Max)	53.2	37.7
d_{50} Stone Size (IN)	N/A	N/A
A (Area in SQ. FT)	71.52	103.02
R (Hydraulic Radius)	1.07	1.47
S (Bed Slope in FT/FT) [3]	0.0170	0.0170
S_c (Critical Slope in FT/FT)	0.011	0.034
Qr w/in 5% of Q?	0.00	0.00
$.7S_c$ (FT/FT)	0.008	0.024
$1.3S_c$ (FT/FT)	0.015	0.044
Stable Flow? (Yes or No)	YES	YES
Freeboard Based on Unstable Flow (FT)	0.6	0.6
Freeboard Based on Stable Flow (FT)	0.3	0.4
Minimum Required Freeboard (FT) [4]	0.5	0.5
Design Method for Protective Lining [5] (Permissible Velocity (V) or Shear Stress (S))	V	V

*Or approved equal

[1] In this case the channel lining is being determined with a known depth and channel configuration, so Acreage and multiplier will be disregarded.

[2] For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.

[3] Slopes may not be averaged.

[4] Minimum freeboard, F, is 0.5 FT.

[5] Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% of greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

5. NOAA ATLAS 14

NOAA Atlas 14, Volume 2, Version 3
Location name: Solebury Twp, Pennsylvania, USA*
Latitude: 40.3799°, Longitude: -74.9788°
Elevation: -131.28 ft**
* source: ESRI Maps
** source: USGS

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	0.341 (0.310-0.376)	0.407 (0.370-0.448)	0.480 (0.435-0.528)	0.533 (0.483-0.586)	0.598 (0.538-0.657)	0.643 (0.576-0.707)	0.688 (0.614-0.758)	0.729 (0.647-0.805)	0.779 (0.686-0.864)	0.817 (0.713-0.909)
10-min	0.545 (0.495-0.600)	0.651 (0.591-0.716)	0.769 (0.697-0.845)	0.853 (0.772-0.938)	0.952 (0.858-1.05)	1.02 (0.918-1.13)	1.09 (0.976-1.20)	1.16 (1.03-1.28)	1.23 (1.09-1.37)	1.29 (1.12-1.43)
15-min	0.682 (0.619-0.751)	0.818 (0.743-0.901)	0.972 (0.882-1.07)	1.08 (0.977-1.19)	1.21 (1.09-1.33)	1.30 (1.16-1.43)	1.38 (1.23-1.52)	1.46 (1.29-1.61)	1.55 (1.37-1.72)	1.62 (1.41-1.80)
30-min	0.934 (0.849-1.03)	1.13 (1.03-1.24)	1.38 (1.25-1.52)	1.56 (1.42-1.72)	1.79 (1.61-1.97)	1.95 (1.75-2.15)	2.12 (1.89-2.33)	2.27 (2.02-2.51)	2.47 (2.17-2.74)	2.62 (2.28-2.91)
60-min	1.17 (1.06-1.28)	1.42 (1.29-1.56)	1.77 (1.61-1.95)	2.04 (1.84-2.24)	2.38 (2.14-2.62)	2.65 (2.37-2.91)	2.92 (2.60-3.21)	3.18 (2.83-3.52)	3.54 (3.12-3.93)	3.82 (3.33-4.25)
2-hr	1.40 (1.27-1.55)	1.71 (1.55-1.88)	2.14 (1.94-2.37)	2.48 (2.24-2.73)	2.94 (2.64-3.23)	3.31 (2.95-3.64)	3.68 (3.26-4.05)	4.07 (3.58-4.48)	4.60 (4.00-5.09)	5.01 (4.32-5.57)
3-hr	1.54 (1.39-1.71)	1.88 (1.69-2.09)	2.36 (2.13-2.62)	2.74 (2.46-3.04)	3.26 (2.91-3.61)	3.67 (3.26-4.06)	4.10 (3.61-4.54)	4.54 (3.97-5.04)	5.15 (4.44-5.74)	5.63 (4.81-6.30)
6-hr	1.94 (1.76-2.16)	2.35 (2.13-2.62)	2.95 (2.67-3.28)	3.44 (3.09-3.82)	4.13 (3.69-4.58)	4.71 (4.17-5.21)	5.32 (4.67-5.89)	5.97 (5.18-6.62)	6.90 (5.89-7.68)	7.66 (6.45-8.56)
12-hr	2.37 (2.14-2.65)	2.86 (2.59-3.20)	3.62 (3.27-4.03)	4.25 (3.82-4.74)	5.18 (4.61-5.75)	5.98 (5.28-6.64)	6.85 (5.97-7.60)	7.80 (6.71-8.68)	9.22 (7.76-10.3)	10.4 (8.62-11.7)
24-hr	2.76 (2.56-2.98)	3.33 (3.09-3.60)	4.20 (3.89-4.53)	4.92 (4.55-5.31)	5.99 (5.50-6.45)	6.89 (6.29-7.41)	7.87 (7.13-8.47)	8.94 (8.02-9.62)	10.5 (9.30-11.3)	11.8 (10.3-12.7)
2-day	3.21 (2.96-3.50)	3.87 (3.57-4.22)	4.88 (4.50-5.33)	5.72 (5.25-6.22)	6.91 (6.31-7.50)	7.90 (7.18-8.57)	8.97 (8.09-9.72)	10.1 (9.05-11.0)	11.8 (10.4-12.8)	13.1 (11.5-14.3)
3-day	3.39 (3.13-3.68)	4.09 (3.78-4.45)	5.14 (4.74-5.58)	5.99 (5.52-6.51)	7.22 (6.61-7.82)	8.24 (7.51-8.92)	9.32 (8.44-10.1)	10.5 (9.42-11.3)	12.1 (10.8-13.2)	13.5 (11.9-14.7)
4-day	3.57 (3.30-3.86)	4.30 (3.99-4.67)	5.39 (4.98-5.84)	6.27 (5.79-6.79)	7.53 (6.92-8.15)	8.57 (7.84-9.26)	9.68 (8.80-10.4)	10.8 (9.80-11.7)	12.5 (11.2-13.6)	13.9 (12.3-15.1)
7-day	4.18 (3.89-4.51)	5.02 (4.66-5.41)	6.21 (5.76-6.69)	7.19 (6.66-7.75)	8.59 (7.93-9.24)	9.74 (8.96-10.5)	11.0 (10.0-11.8)	12.3 (11.2-13.2)	14.1 (12.7-15.3)	15.7 (14.0-16.9)
10-day	4.76 (4.45-5.11)	5.69 (5.32-6.11)	6.94 (6.48-7.44)	7.95 (7.41-8.52)	9.36 (8.69-10.0)	10.5 (9.72-11.2)	11.7 (10.8-12.5)	12.9 (11.8-13.8)	14.6 (13.3-15.7)	16.0 (14.4-17.2)
20-day	6.43 (6.05-6.85)	7.63 (7.18-8.13)	9.11 (8.56-9.71)	10.3 (9.63-10.9)	11.8 (11.1-12.6)	13.1 (12.2-13.9)	14.3 (13.3-15.2)	15.5 (14.4-16.6)	17.2 (15.8-18.4)	18.5 (16.9-19.8)
30-day	8.02 (7.59-8.45)	9.44 (8.95-9.96)	11.0 (10.4-11.6)	12.2 (11.6-12.9)	13.8 (13.1-14.6)	15.1 (14.2-15.9)	16.2 (15.2-17.1)	17.4 (16.3-18.4)	18.9 (17.6-20.0)	20.1 (18.6-21.3)
45-day	10.2 (9.70-10.7)	12.0 (11.4-12.6)	13.8 (13.1-14.5)	15.1 (14.4-15.9)	16.9 (16.0-17.7)	18.1 (17.2-19.1)	19.3 (18.3-20.4)	20.5 (19.4-21.6)	21.9 (20.7-23.1)	22.9 (21.6-24.3)
60-day	12.2 (11.7-12.8)	14.3 (13.7-15.0)	16.3 (15.6-17.1)	17.8 (17.0-18.7)	19.7 (18.8-20.7)	21.1 (20.1-22.1)	22.4 (21.2-23.5)	23.6 (22.3-24.7)	25.0 (23.6-26.3)	26.0 (24.5-27.4)

[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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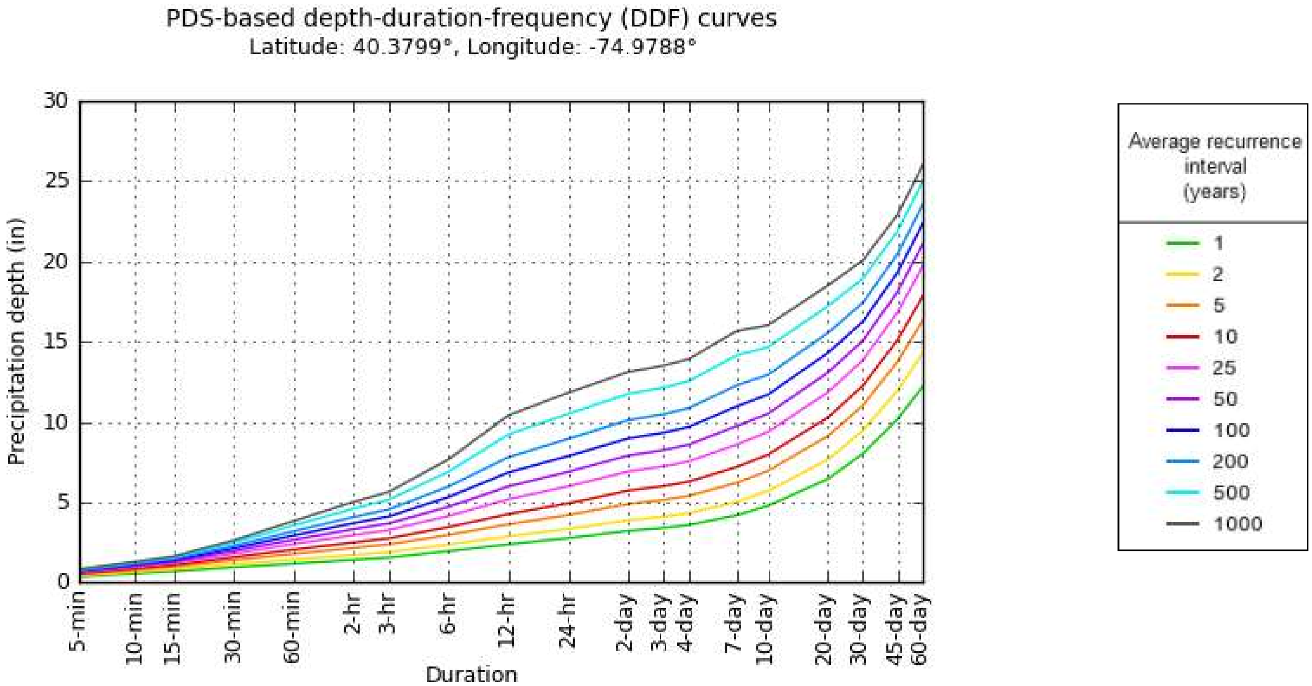
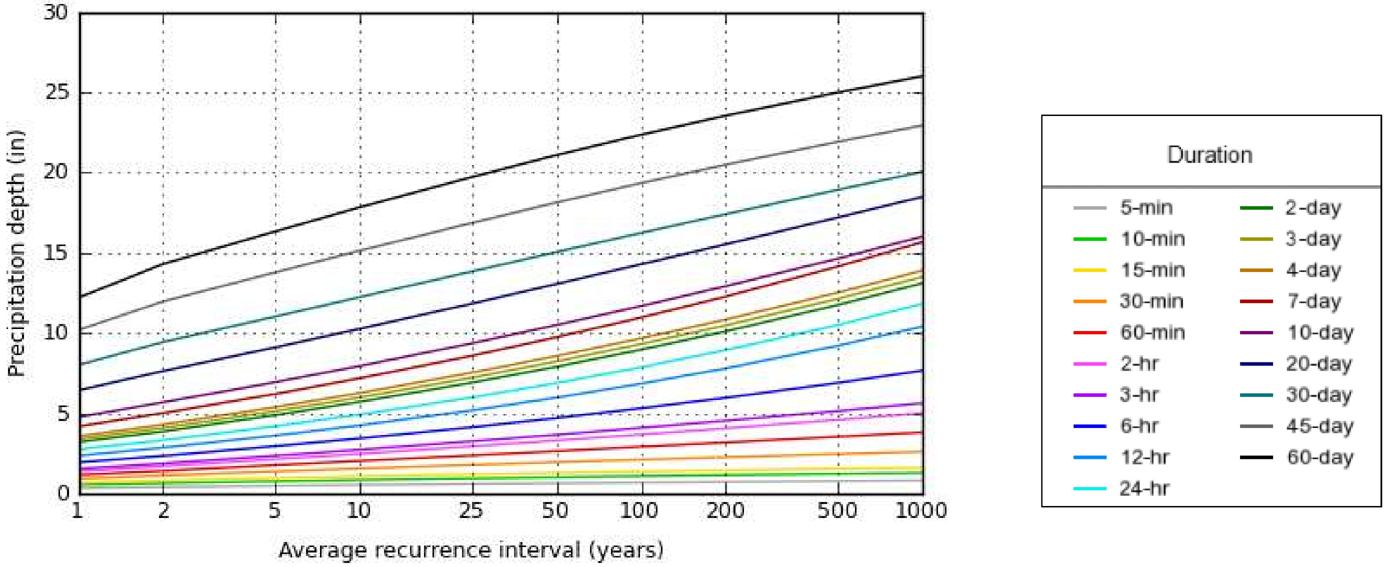
PF graphical





NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Tue May 10 18:33:15 2022

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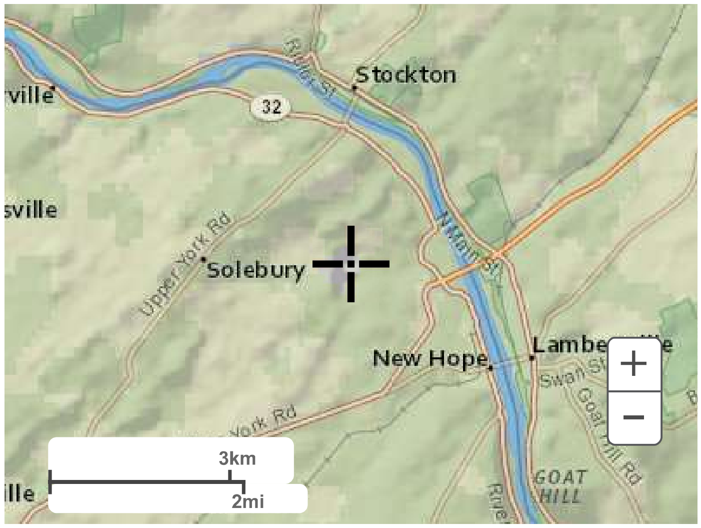
Maps & aerials

Small scale terrain



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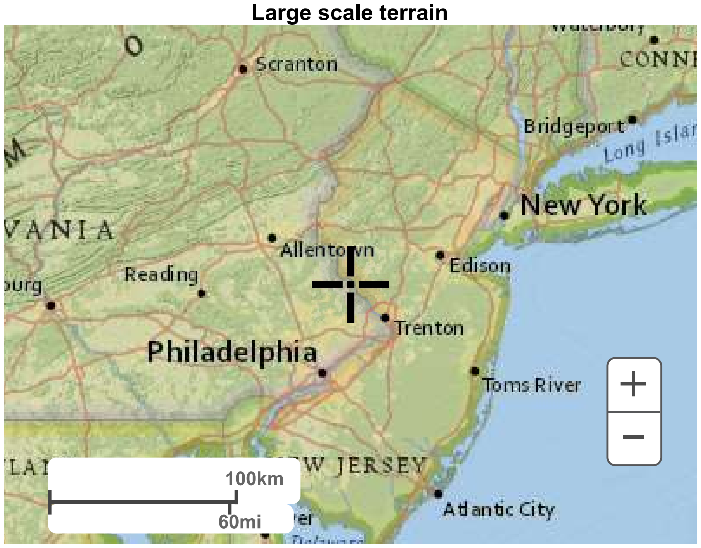
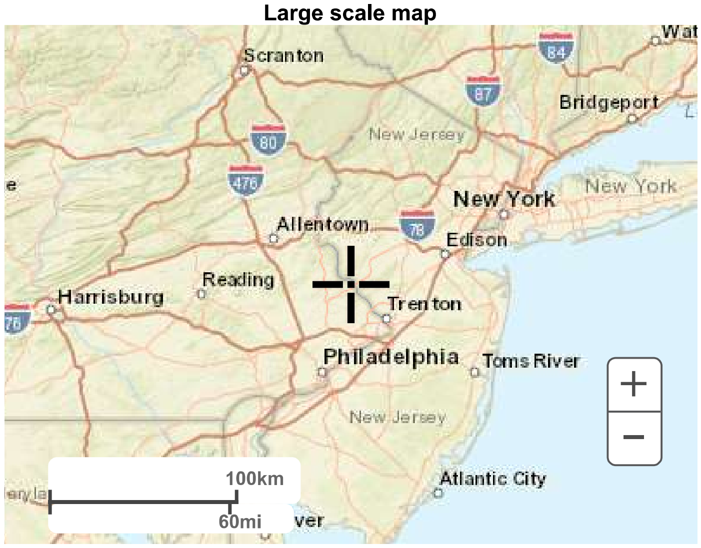
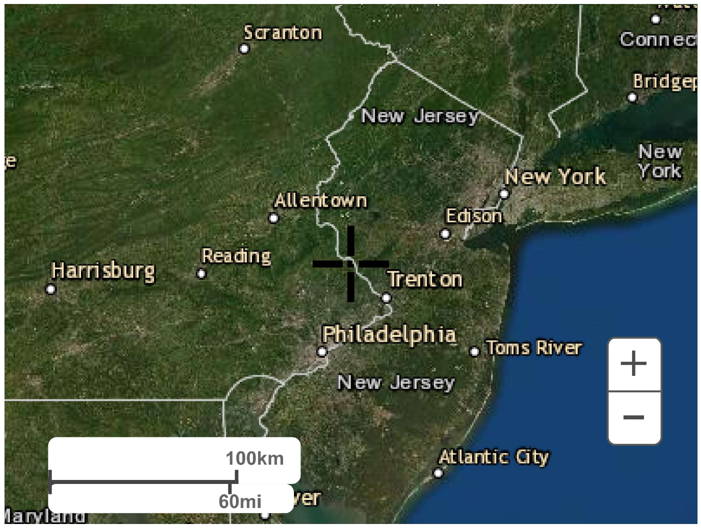


Large scale map



Large scale aerial



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