Delaware County
Act 167 Stormwater Management Plan

Document no: DRAFT No. 1
Last Revised: 7/9/2026

County of Delaware, Pennsylvania
Delaware County Act 167 Stormwater Management Plan
XX/XX/XXXX

Delaware County Planning Department

Jacobs
Challenging today.
Reinventing tomorrow.

Newell Tereska & Mackay
ENGINEERING

Executive summary

This document contains the Delaware County Act 167 Stormwater Management Plan, which has been developed to comply with the Pennsylvania Act 167 requirements, and has been completed in coordination with the Pennsylvania Department of Environmental Protection. The Plan includes:

- *public engagement documentation from the Watershed Plan Advisory Committee (WPAC)/ stakeholder committee meetings,*
- *a variety of stormwater management relevant mapping and geospatial exhibits for Delaware County,*
- *a compilation of relevant datasets obtained for inventory and assessment,*
- *over 250 Countywide reported stormwater problem areas, prioritized for field visits, technical analysis, and development of potential solutions,*
- *field visit reports and photograph documentation from 177 site visits*
- *potential solution analysis reports for 130 problem areas*
- *advanced 2-dimensional hydraulic and hydrologic modeling analysis of three flooding prone target watersheds,*
- *identification of over 75 potential stream gage locations for future implementation by the County,*
- *potential future funding and grants opportunities for stormwater projects, and*
- *recommendations on future studies, collaboration and coordination with other entities, etc. related to stormwater management and flood mitigation in the County.*

This Act 167 Plan also includes updated Standards and Criteria for the County, which have been coordinated with the updated draft PA DEP Post Construction Stormwater Management (PCSM) Manual, and an updated Countywide Model Ordinance which is consistent with the latest PA DEP Model Ordinance.

Contents

Acronyms and abbreviations ..... **vi**
1. Introduction **9**
2. Background/Context **11**
2.1 Act 167 Purpose and Delaware County Goals 11
2.2 Plan Boundaries and Existing County Conditions 12
2.3 Strategies to Achieve Goals of the Delaware County Stormwater Management Plan 14
2.4 Watershed Plan Advisory Committee (WPAC) 15
3. Delaware County Act 167 Project Task Summary **16**
4. Technical Analysis **18**
4.1 Technical Analysis Approach 18
4.2 Act 167 Status: Review by Watershed 18
4.3 WPAC Survey and Problem Areas 19
4.4 Problem Areas 2D Flood Modeling 22
4.4.1 Marcus Hook Creek 22
4.4.2 Muckinipattis Creek 22
4.4.3 Naylors Run 23
4.5 SCALGO Modeling 23
4.6 Stream Gage Locations 23
5. Standards and Criteria for Stormwater Control **26**
5.1 Introduction 26
5.2 National Pollutant Discharge Elimination System (NPDES), Phase II Requirements 26
5.3 Standards and Criteria 27
5.3.1 Infiltration 28
5.3.2 Water Quality 29
5.3.3 Streambank Erosion 31
5.3.4 Overbank Events 32
5.3.5 Extreme Events 32
5.3.6 Peak Runoff Rate Management 33
5.4 Redevelopment 37
5.5. Process to Accomplish Standards and Criteria 37
5.6 Alternative Runoff Control Techniques 40
5.7 Sub-Regional (Combined Site) Storage 44
5.8 Exemptions 45
5.9 Small Project Standards 48

6. Delaware County Model Ordinance 49
6.1 Organization 50
6.2 MS4 NPDES Requirements 51
6.3 Implementation 52
6.4 Administration 52
7. Plan Implementation 53
7.1 Overview 53
7.2 County Action Items 53
7.3 High Priority Problem Areas 54
7.4 Proposed Solutions for Highest Priority Stormwater Problem Areas 56
Highest Priority Solution: R069 – Newsome Park and Weir Road Culvert 59
Highest Priority Solution: S002 – Kerlin Street Bridge and Nearby Upland Borough Problem Areas 60
Highest Priority Solution: S005 – Boothwyn Town Center 61
Highest Priority Solution: S016 – Wynnefield Drive Properties 62
Highest Priority Solution: S027 – Naylors Run Problem Areas 63
Highest Priority Solution: S054 – Confluence of Crum Creek and Lewis Run 65
Highest Priority Solution: S073 / S091 – Darby Creek Problem Areas 66
Highest Priority Solution: S085 - Brookhaven Memorial Park 67
Highest Priority Solution: S092 - Eastwick Problem Areas 68
Highest Priority Solution: S094 - Larkin Road 69
Highest Priority Solution: S103 – Marsh Road 70
Highest Priority Solution: S104 – Zebley Road 71
Highest Priority Solution: S105 – Vernon Run at Rose Valley Rd 71
Highest Priority Solution: S110 – Brandywine Creek at US 1 72
Highest Priority Solution: S116 – S. Academy Ave 73
Highest Priority Solution: S117 - Linden Ave 73
Highest Priority Solution: S118 / S119 – Delmar Drive 74
Highest Priority Solution: S144 – Crum Creek Road 75
Highest Priority Solution: S175 – Ivy Mills Road 76
7.5 Problem-Potential Solutions Matrix 76
7.6 Funding & Grant Opportunities 80
7.7 Plan Review, Revision, and Update Procedures 87
8. References 89

Appendices

Appendix A – Maps
- Appendix A.1 – Watersheds Map
- Appendix A.2 – Watersheds and Municipalities Map
- Appendix A.3 – Base Map
- Appendix A.4 – Digital Elevation Model Map
- Appendix A.5 – Existing Stormwater and Flood Control Facilities Map
- Appendix A.6 – Floodplains and Flood Hazard Areas Map
- Appendix A.7 – Future Land Use Map
- Appendix A.8 – Impaired Water Bodies Map
- Appendix A.9 – Impervious Cover Map
- Appendix A.10 – Existing Land Use Map
- Appendix A.11 – Socioeconomically Distressed Areas Map
- Appendix A.12 – Hydrologic Soil Groups Map
- Appendix A.13 – Wetlands and Surface Water Map

Appendix B – Modeling Technical Data
- Appendix B.1 – Marcus Hook Creek Pilot Study
- Appendix B.2 – Muckinipattis Creek Pluvial Model
- Appendix B.3 – Naylors Run Pluvial Model

Appendix C – Stream Gage Locations
- Appendix C.1 – Potential Stream Gages Map
- Appendix C.2 – Potential Stream Gages Location Description Table

Appendix D – Delaware County Model Ordinance

Appendix E – Problem Areas and Obstructions Maps
- Appendix E.1 – Stormwater Problem Areas Map
- Appendix E.2 – Flooding Related Stormwater Problem Areas Map
- Appendix E.3 – Stormwater Problem Areas by Property Type Map
- Appendix E.4 – Surveyed Flooding Problem Areas: Number of Damaged Properties Map
- Appendix E.5 – Stormwater Problem Area Prioritization Map

Appendix F – High Priority Problem Area Solution Forms

Appendix G – Highest Priority Problem Area Solutions
- Appendix G.1 –Potential Solution Analysis: R069
- Appendix G.2 –Potential Solution Analysis: S002
- Appendix G.3 –Potential Solution Analysis: S005
- Appendix G.4 –Potential Solution Analysis: S016
- Appendix G.5 –Potential Solution Analysis: S027
- Appendix G.6 –Potential Solution Analysis: S054
- Appendix G.7 –Potential Solution Analysis: S073 / S091
- Appendix G.8 –Potential Solution Analysis: S085
- Appendix G.9 –Potential Solution Analysis: S092
- Appendix G.10 –Potential Solution Analysis: S094
- Appendix G.11 –Potential Solution Analysis: S103
- Appendix G.12 –Potential Solution Analysis: S104
- Appendix G.13 –Potential Solution Analysis: S105
- Appendix G.14 –Potential Solution Analysis: S110
- Appendix G.15 –Potential Solution Analysis: S116
- Appendix G.16 –Potential Solution Analysis: S117
- Appendix G.17 –Potential Solution Analysis: S118 / S119

Appendix G.18 –Potential Solution Analysis: S144
Appendix G.19 –Potential Solution Analysis: S175
Appendix H - Public Involvement Documentation
Appendix H.1 - WPAC Meeting #1 7.01.2025
Appendix H.2 - WPAC Meeting #2 8.19.2025
Appendix H.3 - WPAC Meeting #3 11.13.2025
Appendix H.4 - WPAC Meeting #4 2.26.2026
Appendix H.5 - WPAC Meeting #5 4.30.2026
Appendix H.6 - WPAC Meeting #6 7.09.2026
Appendix H.7 – Act 167 Draft Plan Comments and Responses

Tables

Table 1. Summary of WPAC Meeting Dates and Topics 15
Table 2. Act 167 Status: Review by Watershed 19
Table 3. Criteria for Potential Stream Gage Locations 24
Table 4. Stormwater Management District Standards in the Crum Creek Watershed 36
Table 5. Process to Achieve the Standards and Criteria - Order of Required Consideration (Ultimate Goal - Match Existing Conditions Hydrograph) 37
Table 6. Required Criteria and Standards 38
Table 7. Recommended Criteria and Standards 39
Table 8. Non-structural Stormwater Best Management Practices 41
Table 9. Benefits of Riparian Buffers 42
Table 10. Techniques that Moderate Temperature 43
Table 11. Possible On-site Stormwater Control Methods 44
Table 12. Ordinance Exemptions 45
Table 13. Estimated Recommended Solution Cost Ranges for Highest Priority Problem Areas 58
Table 14. Grant and Loan Summary Table 81
Table 15. Act 167 Plan References 89
Table 16. Studies & Models References 90

Figures

Figure 1. Delaware County Watersheds and Municipalities 12
Figure 2. Delaware County Watersheds 13
Figure 3. WPAC Survey 21
Figure 4. Potential Stream Gage Locations 25
Figure 5. Delaware County Watersheds 35
Figure 6. High Priority Problem Areas Map 55
Figure 7. Highest Priority Stormwater Problem Area 57
Figure 8. R069 Location 59
Figure 9. S002 Location 60
Figure 10. S005 Location 61
Figure 11. S016 Location 62
Figure 12. S027 Location 63
Figure 13. S054 Location 65
Figure 14. S073 / S091 Location 66

Figure 15. S085 Location 67
Figure 16. S092 Location 68
Figure 17. S094 Location 69
Figure 18. S103 Location 70
Figure 19. S104 Location 71
Figure 20. S105 Location 71
Figure 21. S110 Location 72
Figure 22. S116 Location 73
Figure 23. S117 Location 74
Figure 24. S118 / S119 Location 74
Figure 25. S144 Location 75
Figure 26. S175 Location 76
Figure 27. Problem-Potential Solutions Matrix 78
Figure 28. Non-High Priority Problem Areas Map 79

Acronyms and abbreviations

Acronym	Description
BMP	Best Management Practice
BSTEM	Bank Stability and Toe Erosion Model
CFA	Commonwealth Financing Authority
CZM	Coastal Zone Management
DCED	Department of Community & Economic Development
DEM	Digital Elevation Model
DEP	Department of Environmental Protection
DWCF	Delaware Watershed Conservation Fund
E&S	Erosion and Sedimentation
EI	Environmental Infrastructure
EPA	Environmental Protection Agency
EV	Exceptional Value

FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
FMCE	Flood Mitigation Council of Eastwick
FWS	U.S. Fish and Wildlife Service
GSI	Green Stormwater Infrastructure
GTRP	Greenways, Trails and Recreation Program
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HQ	High Quality
HSG	Hydrologic Soil Group
LID	Low Impact Development
LSA	Local Share Account
MCM	Minimum Control Measure
MRC	Managed Release Concept
MS4	Municipal Separate Storm Sewer System
MTF	Multimodal Transportation Funding
NFWF	National Fish and Wildlife Foundation
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PA	Pennsylvania
PADEP	Pennsylvania Department of Environmental Protection
PAS	Planning Assistance to States Program
PASDA	Pennsylvania Spatial Data Access
PCSM	Post Construction Stormwater Management

PEMA	PA Emergency Management Agency
PWD	Philadelphia Water Department
SCM	Stormwater Control Measure
SEPTA	Southeastern Pennsylvania Transportation Authority
SMP	Stormwater Management Plan
SSURGO	Soil Survey Geographic
SWM	Stormwater Management
UNT	Unnamed Tributary
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
WPAC	Watershed Plan Advisory Committee
WRDA	Water Resources Development Act
WRPP	Watershed Restoration and Protection Program

1. Introduction

This County-Wide Act 167 Stormwater Management Plan (SMP) has been developed for Delaware County, Pennsylvania to comply with the requirements of the 1978 Pennsylvania Stormwater Management Act, Act 167. The Act requires Pennsylvania counties to prepare and adopt stormwater management plans for each watershed located within the County, as designated by the Pennsylvania Department of Environmental Protection (PADEP). It also requires municipalities to implement a stormwater management ordinance limiting stormwater runoff from new development and redevelopment. This SMP details the analyses that were performed to fulfill the requirements of Act 167 and the results of those analyses. The main objective of this SMP is to control stormwater runoff on a watershed-wide basis, considering how development and land cover in one part of a watershed will affect stormwater runoff in other parts of the watershed. Consistent with Act 167, the SMP seeks to:

- preserve and restore the flood-carrying capacity of watershed streams;
- reduce erosion and sedimentation;
- preserve natural stormwater runoff regimes and the natural course, current and cross sections of streams; and
- protect and conserve groundwater and groundwater recharge areas.

The plan also seeks to address serious stormwater problem areas that are highlighted throughout **Section 4**. The vast majority of the County's streams are considered impaired according to water quality reports prepared by the DEP. Through implementation of the stormwater improvements recommended in **Section 7** and **Appendix F** & **Appendix G**, the plan will reduce flooding and erosion and sedimentation and improve water quality. The final plan offers a unique approach to the Act 167 planning process that incorporates watershed scale hydrologic and hydraulic modeling in select areas as a result of a targeted focus on the problem areas, as recommended by PADEP. Additional flood modeling analyses coupled with appropriate floodplain restoration and other riparian improvement projects are recommended as an opportunity to address the goal of preserving and restoring the flood carrying capacity of streams. The Plan endorses the use of Stormwater Control Measures (SCMs) as the preferred means to achieve improved water quality, groundwater recharge, streambank protection, and volume control. The implementation of retrofits and new SCMs in conjunction with regulation of new development and redevelopment through new stormwater ordinances will reduce stormwater problems in Delaware County. The plan encourages municipalities to implement the stormwater improvements, as quickly as feasible, within 10 years if possible. The stormwater problem areas were assigned a priority ranking according to their reported or estimated severity of impact. The recommended improvements for the highest priority problems include associated cost ratings as well as additional site-specific mapping which municipalities can use as a basis for funding projects.

This plan also presents criteria and standards for new development and redevelopment in **Section 5** and a model ordinance in **Section 6** and **Appendix D**. Within six months of the adoption of the plan, each municipality shall adopt or amend ordinances and regulations, including zoning, subdivision and development, building codes, and erosion and sedimentation ordinances, as are necessary to regulate development within the municipality in a manner consistent with the plan. The project team recommends that municipalities adopt the model ordinance (with the necessary customization) in its entirety to avoid omissions and allow for easier updates in the future. If a municipality includes more than one watershed, the applicable criteria and standards should be identified for the different watersheds.

This Delaware County Act 167 Plan was prepared by Jacobs Engineering Group Inc. and NTM Engineering, Inc. in collaboration with the Delaware County Planning Department. The plan was prepared in consultation with municipalities located within Delaware County, working through a Watershed Plan Advisory Committee (WPAC) comprised of municipal officials and other interested parties. Where possible, the plan provides uniform technical standards and criteria throughout County for the management of stormwater runoff from new land development and redevelopment sites.

2. Background/Context

2.1 Act 167 Purpose and Delaware County Goals

Traditional land development causes an increase in the volume and rate of runoff when natural land cover is converted to impervious surfaces. This reduces infiltration and the quality of stormwater leading to flooding, erosion, overtaxing streams, water quality issues, and reduction of groundwater recharge. Inadequate management of stormwater increases the cost of public facilities and threatens public health and safety.

Recognizing the adverse impacts of excessive stormwater runoff resulting from development, Act 167, the Pennsylvania Stormwater Management Act of 1978, was enacted. The primary purpose of Act 167 is to ensure stormwater runoff is managed at the watershed level rather than by individual sites or municipalities acting independently to try to reduce flooding and protect resources.

Delaware County will adhere to this Act 167 Plan via county planning, once the Plan is fully conformed and implemented. Municipalities are required by law to adopt ordinances consistent with approved Act 167 plans to regulate development and enforce stormwater management requirements. Therefore, developers and engineers must design projects that comply with the established release rate criteria, peak flow controls, and water quality requirements. This allows counties and municipalities to plan, regulate, and control stormwater.

The main goal of this plan is to bring Delaware County into compliance with Act 167 requirements by providing all of Delaware County's municipalities with consistent stormwater management planning, regulation, and implementation based on accurate and current data. Municipal adoption of the plan will:

- Decrease costly flood damages by reducing local uncontrolled runoff
- Increase municipalities and developers' awareness of comprehensive planning in stormwater control
- Help protect the water quality of watercourses within the County

In accordance with Act 167, the overall goals are the following:

1. Encourage planning and management of stormwater runoff in a manner consistent with sound water and land-use practices
2. Authorize a comprehensive program of stormwater management to preserve and restore the flood carrying capacity of streams, to preserve to the maximum extent practicable natural stormwater runoff regimes, and to protect and conserve groundwater and groundwater recharge areas
3. Encourage local administration and management of stormwater in a manner consistent with the commonwealth's duty as trustee of natural resources and the people's constitutional right to preservation of natural, economic, scenic, aesthetic, recreational and historic values of the environment

2.2 Plan Boundaries and Existing County Conditions

Delaware County is located in southeastern Pennsylvania (PA) and shares a border with the states of Delaware and New Jersey, as well as three (3) other PA counties: Philadelphia, Montgomery, and Chester. Delaware County spans 183.8 square miles of land area and has a population of 576,830 per the 2020 United States Census. The County lies in the Delaware Valley, featuring relatively flat terrain with level features to mild sloping. Elevations range from approximately 160 feet to -60 feet (the bottom of a quarry).

The County is comprised of 49 municipalities. A map of Delaware County depicting its location within PA and its municipalities can be found in **Figure 1** and **Appendix A.2.** Delaware County lies entirely in the Delaware River Basin. As part of this Plan, the Delaware River Basin is further divided into the watersheds, shown in **Figure 2** and **Appendix A.1.** There are 12 watersheds within the Delaware County limits.

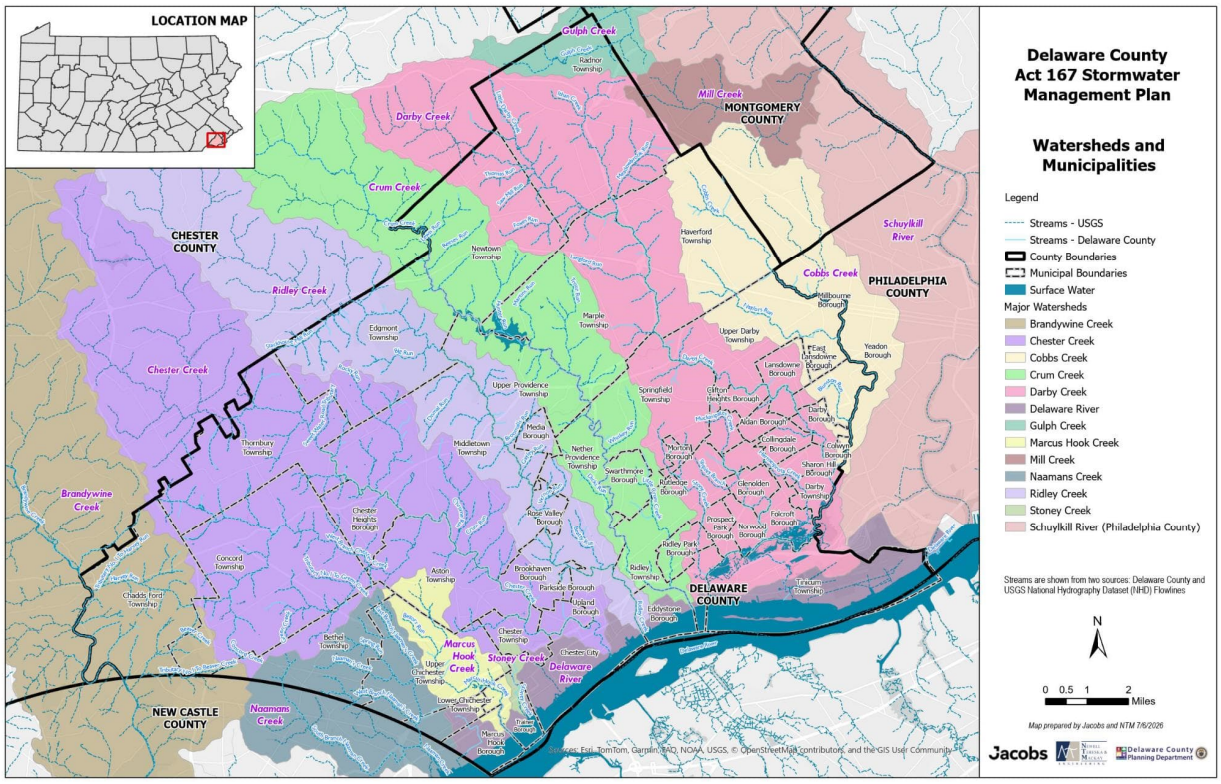


Figure 1. Delaware County Watersheds and Municipalities

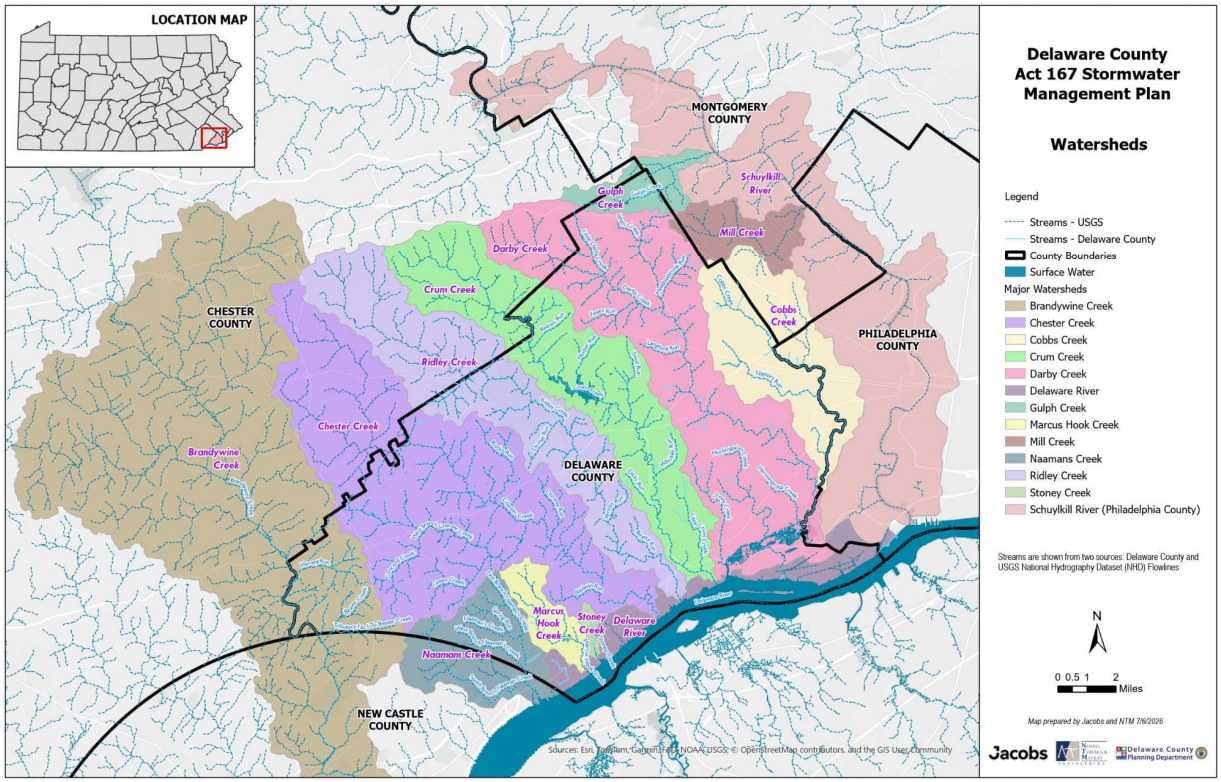


Figure 2. Delaware County Watersheds

The following data was collected on the physical features and existing conditions of the County:

1. Base Data: The base data includes streams, major roads, railroad lines, municipal boundaries, and county boundaries. A map depicting this data can be found in **Appendix A.3 – Base Map**.

2. Elevation Data: A Digital Elevation Model (DEM) for the County was developed from elevation data from Pennsylvania Spatial Data Access (PASDA) Delaware Valley Regional Planning Commission 2015 LiDAR-DEM. A map depicting the DEM can be found in **Appendix A.4 – Digital Elevation Model**.

3. Existing Stormwater and Flood Control Facilities: These facilities were identified utilizing Delaware County data, and WPAC and stakeholder provided submissions of supporting studies and plans. Refer to **Appendix A.5 – Existing Stormwater and Flood Control Facilities** for a map of these facilities. Please note, these are only facilities made available during the Act 167 request process; the datasets are limited and not comprehensive for each municipality.

4. Floodplains and Flood Hazard Areas: Refer to **Appendix A.6 – Floodplains and Flood Hazard Areas** for a map of Federal Emergency Management Agency (FEMA) flood zones within Delaware County.

5. Impaired Water Bodies: Impaired water bodies were identified by PADEP and are shown in **Appendix A.8 – Impaired Water Bodies**.

6. Impervious Cover: The percent of impervious cover was obtained from the United States Geological Survey National Land Cover Database (USGS). Refer to **Appendix A.9 – Impervious Cover** for a map of the percent of impervious cover throughout the County.

7. Existing Land Use: Refer to **Appendix A.10 – Existing Land Use** for Delaware Valley Regional Planning Commission's existing land use data for Delaware County.

8. Socioeconomically Distressed Areas: Socioeconomically distressed areas were identified from the PADEP PennEnviroScreen and are depicted in **Appendix A.11 – Socioeconomically Distressed Areas**.

9. Hydrologic Soil Groups (HSGs): HSG data was obtained from the Web Soil Survey and Soil Survey Geographic (SSURGO) database. HSGs classify soils based on their ability to infiltrate water and their runoff potential. Group A soils exhibit high infiltration rates, whereas Group D soils exhibit low infiltration rates. A HSG map is shown in **Appendix A.12 – Hydrologic Soil Groups**.

10. Wetlands and Surface Water (excluding streams included previously under base data): Delaware County features lakes, the Delaware River, ponds, and wetlands. Wetlands and surface water data was obtained from the US Fish and Wildlife Service and National Wetlands Inventory. A map showing wetlands and surface water through the County is shown in **Appendix A.13 – Wetlands and Surface Water**.

Additionally, future land use data was compiled from the Delaware County 2035 Comprehensive Plan. Future Land Use data is presented in **Appendix A.7 – Future Land Use**.

2.3 Strategies to Achieve Goals of the Delaware County Stormwater Management Plan

Effective stormwater management requires a combination of planning, engineering, funding, regulatory compliance and long-term maintenance in collaboration with the various municipalities impacted. Strategies for implementation are as follows:

- Development of the ordinance for adoption by all municipalities to provide consistent regulations and requirements throughout the County.
- Encouraging the use of stormwater management SCMs with a focus on improving water quality and reducing volume and pollutants to protect streams.
- Additional analysis of Flooding Problem Areas to support future proposed improvements that mitigate existing flooding occurrences and promote safety.
    a. Stream gage implementation will support monitoring and modeling of streams which can support future flooding analyses.
- Consistency across municipalities in efforts to preserve natural stormwater runoff.
- Encouraging the use of green solutions by requiring infiltration on development projects
    a. Infiltration supports conservation of groundwater and groundwater recharge
- Collaborative solutions

a. Documenting and providing potential solutions to problem areas identified by WPAC

2.4 Watershed Plan Advisory Committee (WPAC)

The Watershed Plan Advisory Committee (WPAC) was established by the Delaware County Planning Department during the Phase 1 Act 167 Stormwater Management Plan, which was completed in August 2024. The WPAC consists of representatives from 49 municipalities across the County. The WPAC was assembled to advise on the development of the Act 167 Stormwater Plan and ensure the needs of all the County's communities are reflected. In addition to the WPAC, a Stakeholder Committee was also created during Phase 1, comprised of other interested partner organizations throughout the County's watersheds. The Stakeholder Committee includes seven advocacy groups, thirteen county/government entities, and four university representatives.

Four WPAC meetings were held during Phase 1. The goals of the Phase 1 WPAC meetings were to: introduce the planning process, distribute the municipal survey of preliminary watershed characteristics and existing stormwater issues, and to develop preliminary goals for the Phase 2 plan.

During Phase 2, the WPAC and Stakeholder group met on six occasions and reviewed the following discussion items listed in **Table 1** below. Meeting documentation is provided in **Appendix H**.

Table 1. Summary of WPAC Meeting Dates and Topics

WPAC Mtg	Date/Type	Topics/Agenda
WPAC - 1	July 1, 2025 In person	Review SWMP requirements and scope Define expectations and introduce goals Initiate WPAC survey
WPAC - 2	August 19, 2025 Virtual	Review survey responses Describe Technical Analysis next steps
WPAC - 3	November 13, 2025 Hybrid	Share findings from inventory, assessment, and field work Share progress on Technical Analysis
WPAC - 4	February 2026 Virtual	Update proposed solutions and modeling effort Update on development of standards/criteria Solicit ordinance input
WPAC - 5	April 2026 Virtual	Present standards and criteria for stormwater control; Update model ordinance status; Update on Plan Implementation
WPAC - 6	July 9, 2026 Hybrid	Present draft Act 167 Plan report and final summary of work/model.

3. Delaware County Act 167 Project Task Summary

The goal of this project is to develop a countywide Act 167 Stormwater Management Plan and an updated Delaware County Stormwater Management Model Ordinance. All data resulting from the project will be retained by the County to facilitate future Act 167 Plan updates in accordance with Pennsylvania Act 167 requirements and support ongoing County stormwater planning and emergency management efforts. The project tasks were designated as follows:

Task 1: Project Administration
Bi-weekly meetings were conducted with the County to conduct project coordination and ensure quality control. Additional meetings with select project stakeholders were also conducted, as well as planning for WPAC/Stakeholder Committee meetings.

Task 2: Public Engagement
Stakeholder engagement for this project included a map-based survey to WPAC members to gather additional information on stormwater problem areas and potential locations for stormwater projects. There were six (6) WPAC/Stakeholder Committee meetings to guide plan development. For more information on Task 2 refer to **Section 2.4** and **Section 4.3** of this Plan.

Task 3: Inventory & Assessment
To achieve the goals of this plan, data and information regarding existing and future conditions in the County's watersheds were gathered, reviewed, and analyzed. Data collection included geospatial data of the County's watersheds, as well as aggregation and review of applicable regulations and past Act 167 Plans to support the development of stormwater management standards and criteria for Task 5, and updated the Model Ordinance for Task 5. Additionally, Task 3 included field visits to the problem areas identified from the Task 2 survey, as well as gathering of additional problem areas made available from various reports and studies submitted to the County. For more information on Task 3 refer to **Section 2.2** of this Plan which includes the mapping exhibits that were developed.

Task 4: Technical Analysis
The Technical Analysis phase consisted of the following concurrent activities:

1. Watershed Review – Comprehensive review of all previous Act 167's and their release rate standards towards determination of current status and applicability for reuse or update.
    a. Note – New release rate modeling was determined as not required at this time for the watersheds of Delaware County, based on the status of each individual watershed and coordination with PA DEP. Refer to **Section 4.1** for further detail.
2. Problem Area Prioritization and Technical Analysis
    a. Three (3) 2-Dimensional HEC-RAS Hydrologic and Hydraulic modeling analyses were completed for watersheds of high priority based on the highest rated problem areas. These watersheds included: Marcus Hook, Naylor's Run, and Muckinipattis Creek. Naylor's Run and Muckinipattis Creek are subwatersheds located within the larger DEP Act 167 watersheds. Naylor's Run is a subwatershed of Cobbs Creek and Muckinipattis Creek is a subwatershed of Darby Creek. Refer to **Section 4.4**.
    b. Individual 2D flood vulnerability analysis on the 100-year rainfall event was completed on all other high priority problems not captured in the HEC-RAS models. The SCALGO tool was utilized for this effort, refer to **Section 4.5** for more detail.

3. Eighty-seven (87) Stream Gage locations were selected throughout Delaware County based on site criteria developed in collaboration with the County. Gages were recommended per three ranking categories, and additional site information provided. Refer to **Section 4.6** for more detail.

Task 5: Standards & Criteria
The standards required of this Act 167 Plan were prepared in coordination with the <Insert Publish Date> Pennsylvania Post Construction Stormwater Management (PCSM) manual. The standards and criteria developed for this Action 167 Plan are consistent with the PCSM manual while also maintaining consistency with current standards and criteria across the Delaware County municipalities, where possible. For more information on water quality, groundwater recharge, streambank erosion, and other standards/criteria, refer to **Section 5** of this Plan.

Task 6: Model Ordinance
The County's previous Stormwater Model Ordinance (2022) was updated by utilizing language available in the <Insert Publish Date> PA DEP's Model Ordinance, which is set for implementation in 2028. A detailed comparison was conducted, and the County's Model Ordinance was updated where necessary, while also maintaining as much of the current standards as possible. For more information refer to **Section 6** of this Plan.

Task 7: Plan Implementation
Results from Technical Analysis conducted under Task 4, were used to inform the study's recommendations and implementation strategy. Conceptual solutions for identified stormwater problem areas were developed and preliminarily evaluated for feasibility, benefits, and costs. All high priority problem areas received a solution analysis, with a top twenty (20) sites receiving more detailed additional analysis mapping. All submitted problem areas, including non-high priority problem areas were designated a path forward via the Solutions Matrix. Additionally, stormwater project funding agencies and programs were identified and aligned with the prioritized list of potential stormwater projects. An outline of administrative procedures for periodic Plan review, revision, and updates were developed to streamline future updates and ensure consistency with planning efforts of County municipalities. For more information refer to **Section 7** of this Plan.

Task 8: Stormwater Management Plan Preparation and Review
Deliverables of this project include a County Act 167 Stormwater Management Plan with all contents complying with the requirements of Pennsylvania Act 167. The Plan will be subject to County, WPAC, and Stakeholder Committee review and feedback will be incorporated as appropriate.

4. Technical Analysis

4.1 Technical Analysis Approach

The Technical Analysis initiated with a detailed watershed review of all previous Act 167's within the County and their release rate standards towards determination of current status and applicability for reuse or update, as summarized in **Section 4.2**. Current release rates were still applicable and there is no need for updates. A direct result of this review led to the understanding that most of the watersheds that would benefit from updated release rate modeling, required future cross-county collaboration with adjoining counties outside of Delaware County. Many of the smaller watersheds within the County, when reviewed, were also not deemed appropriate for release rate modeling as their size would not necessitate multiple release rate districts. After these findings were shared with PA DEP, it was determined that the Technical Analysis phase' original scope should be modified to prioritize focus on evaluation of the reported problem areas since release rate modeling would not be necessary. As such, a 2D flood modeling focused evaluation was pursued utilizing HEC-RAS as well as a SCALGO tool, instead of the traditional release rate modeling analysis which would have utilized HEC-HMS. **Sections 4.3**, **4.4**, and **4.5**, provide detailed information on the problem area prioritization and subsequent flood modeling evaluations that were incorporated into the Act 167 Technical Analysis. Additionally, the County requested locations for a countywide stream gage network which is presented in **Section 4.6**.

4.2 Act 167 Status: Review by Watershed

The consultant team reviewed the existing Act 167 Plans for the watersheds within Delaware County for inclusion of relevant information into the County-wide Plan. Delaware County has 12 DEP Act 167 designated watersheds within the County boundaries. Two of the watersheds, Marcus Hook and Stoney Creek, fall entirely within Delaware County; the other 11 watersheds include area from multiple counties. For the majority of the watersheds that span multiple counties, Delaware County is in the downstream portion of the watershed. Delaware County is therefore subject to the effects of upstream stormwater management plans or lack thereof. The percentage of each watershed that falls within Delaware County is summarized in **Table 2**.

The previous Act 167 plans were approved and adopted as far back as 1988 and as recently as 2011, summarized in **Table 2**. The available data, modeling capacity, and stormwater management guidance have changed significantly during the 23-year span in which existing Act 167 plans were developed and continued to evolve in the following 15 years. The date of the plan and the available modeling information were reviewed to provide a recommendation for the incorporation of existing release rates into this new plan or a recommendation for the development of release rate districts in the future, as needed. These recommendations were discussed with PADEP and are summarized below. The existing release rates in the Act 167 plans for Chester Creek (2002), Cobbs Creek (2002), Crum Creek (2011), and Darby Creek (2005) are acceptable for use in the Delaware County Act 167 plan. Future modeling should be considered (in collaboration with adjacent counties where applicable) for Brandywine Creek, Ridley Creek, Mill Creek, Gulph Creek, and Marcus Hook Creek.

Some watersheds are so small that separate release rate districts would not be necessitated, therefore updated or new release rate modeling is not recommended. Those watersheds are also listed in **Table 2**.

The Delaware River watershed is over 13,500 square miles; the drainage area to the Delaware River in Delaware County is 15.22 sq miles. The portion of the Delaware River in Delaware County is also tidally influenced and in the downstream portion of the drainage area. Due to the scale of the watershed and

presence of tidal influence, the standards and criteria in the localized Delaware River watershed in Delaware County differ from other watersheds within the county, refer to **Section 5** for more information.

Table 2. Act 167 Status: Review by Watershed

Watershed	Previous Act 167	% in DelCo	Need for Release Rate Modeling	Problem Area Analysis	Notes
Brandywine Creek	No	7%	Future Potential	Yes	2025 Brandywine Flood Study reviewed
Ridley Creek	Yes	54%	Future Potential Update	Yes	Previous Act 167 from 1988, rainfall has changed
Chester Creek	Yes	69%	Acceptable Previous Rates	Yes	Previous Act 167 from 2002
Cobbs Creek	Yes	54%	Acceptable Previous Rates	Yes	Previous Act 167 from 2005
Crum Creek	Yes	67%	Acceptable Previous Rates	Yes	Previous Act 167 from 2011, Drexel H&H Model/Study reviewed
Darby Creek	Yes	86%	Acceptable Previous Rates	Yes	Previous Act 167 from 2005, Drexel H&H Model/Study reviewed
Delaware River	No	88%	Not Recommended	Yes	Given watershed setting, should convey flows rather than detain for portion with Delco
Mill Creek	Yes	3%	Modification of Act 167 Rates	Yes	Previous Act 167 from 1997, Smaller watershed
Gulph Creek	No	40%	Not Recommended	Yes	Smaller watershed
Marcus Hook Creek	No	100%	Not Recommended	Yes	Smaller watershed
Stoney Creek	No	100%	Not Recommended	Yes	Smaller watershed
Naamans Creek	No	51%	Not Recommended	Yes	Smaller watershed

4.3 WPAC Survey and Problem Areas

A GIS-based survey of WPAC members was conducted to identify stormwater problem areas throughout the County. The survey captured flooding issues, water quality problems, areas with erosion or sedimentation, obstructions and capacity limitations, and proposed stormwater facilities. Participants provided information on problem location, problem type (flooding, water pollution,

erosion/sedimentation, groundwater), frequency, and severity. Examples of survey questions are presented in **Figure 3**.

The survey identified 178 problem areas, with an additional 95 issues sourced through supplemental studies. Responses were received in all major watersheds across Delaware County. The highest percentage of responses were related to flooding alone or in combination with other issues. The second most frequently reported problem included erosion.

Field investigations were conducted at 177 problem area sites where site visits were deemed necessary to supplement the available data. These site visits gathered additional information on submitted problems and informed the development of proposed solutions outlined in **Section 7** of this Plan.

Appendix E presents the stormwater problem areas through maps organized by problem type, property type, number of properties impacted, and solution prioritization.

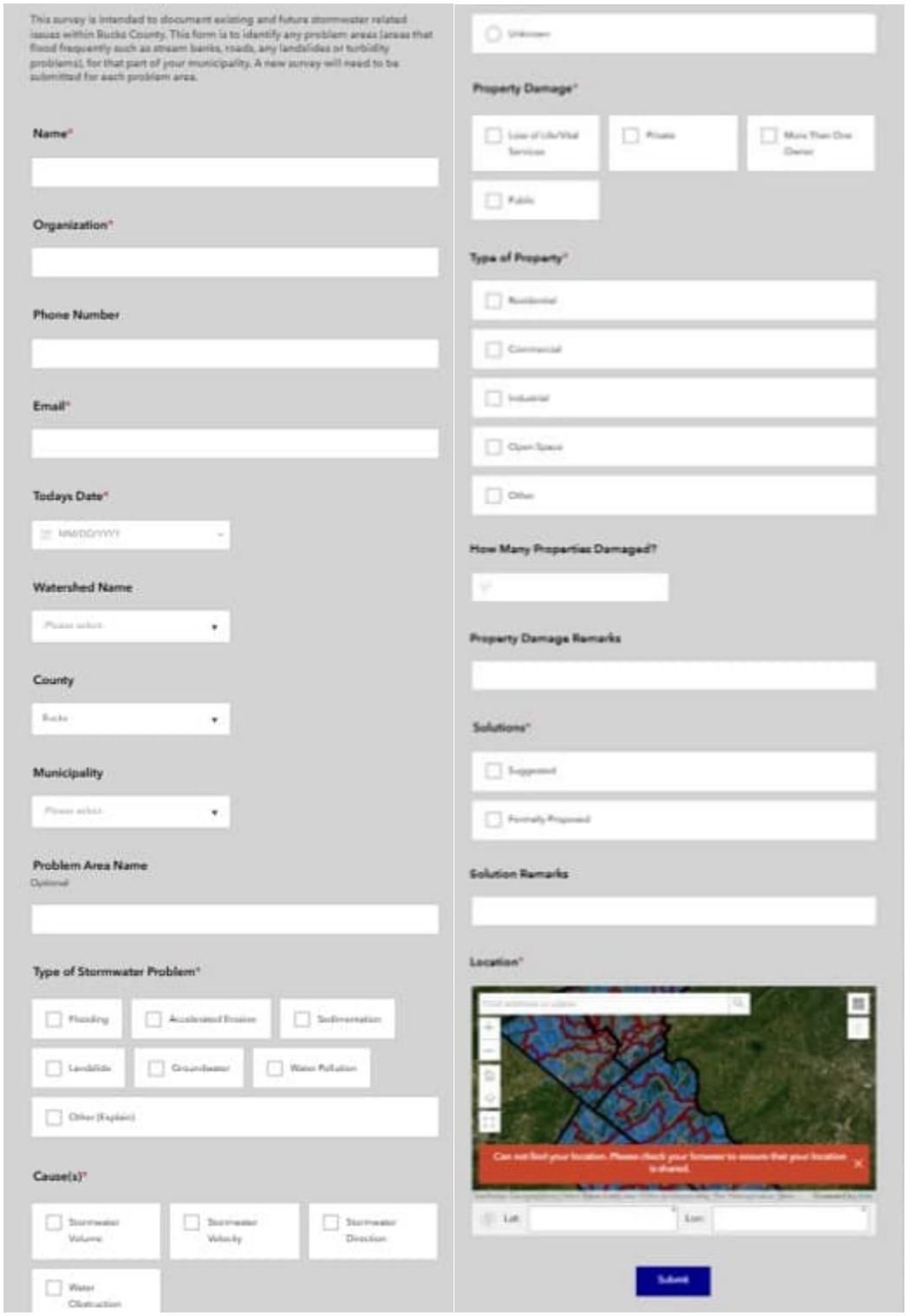


Figure 3. WPAC Survey

4.4 Problem Areas 2D Flood Modeling

Limited detail two-dimensional (2D) rain-on-grid hydrologic and hydraulic modeling in HEC-RAS was used to better characterize flooding mechanisms in three subwatersheds with key stormwater problem areas in Delaware County and to inform the development of adaptation strategies. 5-, 10-, and 100-year precipitation events were simulated using NOAA Atlas 14 24-hour precipitation depths with a NOAA Type C temporal distribution. While the best publicly available terrain, land use, soils, and rainfall datasets were utilized, the majority of structures such as bridges, culverts, and dams were not explicitly modeled due to data availability and the scope limitations of the project. Local stormwater drainage systems were also not explicitly modeled. Accordingly, model results are not meant to supersede the regulatory flood studies which yield precise flood mapping locations with well-defined depths per event. Further refinement and validation using detailed structure and stormwater infrastructure information, high-quality datasets, and topographic surveys would be necessary to enhance model applicability for more rigorous analyses. Modeling results were presented as flood vulnerability maps using five (5) categories based on ponding depths, namely, Shallow Localized Ponding or No Ponding, Localized Ponding/Fringe Flooding (6" - 1'), Shallow Flooding (1' - 2'), Moderate Inundation Susceptibility (2' - 3'), and High Inundation Susceptibility (>3'). The following subsections describe the key findings of each selected subwatershed. More details about the modeling methodology and results can be found in **Appendix B.**

4.4.1 Marcus Hook Creek

The drainage area of the Marcus Hook Creek subwatershed is approximately 2.5 square miles and is located in the central west portion of Delaware County across Aston and Upper Chichester Townships and includes the following ten (10) problem areas: R008, R069, R070, R071, R072, R073, R074, R075, R076, and S127. Modeling of this subwatershed served as an initial pilot study to test the effectiveness of using HEC-RAS 2D modeling as a screening method to compare modeled pluvial flooding at problem areas and to explore the potential for broader application in flood risk assessment across other problem areas within Delaware County. One (1) major culvert was included in the model to allow for flow passage across Weir Road. The culvert connects the main Marcus Hook Creek channel across the road and a large residential development. Culvert dimensions were estimated based on field observations.

Model results validated well against the FEMA FIS values. The methodology was deemed appropriate for other subwatersheds as general flooding patterns and potential flood-prone areas throughout the subwatershed were well represented by the model. Marcus Hook modeling results are presented in **Appendix B.1**.

4.4.2 Muckinipattis Creek

The drainage area of the Muckinipattis Creek subwatershed is approximately 4.4 square miles and is located in the central east portion of Delaware County across Springfield, Ridley, Darby, and Upper Darby Townships as well as Glenolden, Norwood, and Folcroft Boroughs. The following nine (9) problem areas are located in the Muckinipattis Creek subwatershed: S046, S111, S113, S116, S118, S119, S150, S151, and S166. During normal flow conditions, Muckinipattis Creek joins Darby Creek at the downstream limit of the hydraulic model. However, for the 10- and 100-year events, the Delaware River controls the water surface elevations along Darby Creek at the confluence with Muckinipattis Creek. Therefore, the Delaware River transect data from the FEMA FIS was used to set the boundary conditions for Muckinipattis Creek. Muckinipattis Creek has a low head dam just upstream of the Delmar Drive in the lower reach of the watershed. Model results show that the Delaware River boundary conditions do not impact the results

upstream of the dam. Therefore, any tidal effects or downstream boundary assumptions are mitigated by the instream dam.

Model results along Muckinipattis Creek show backwater from the main railroad and bridge crossings, as anticipated. Overland flooding and road overtopping occurred in the middle and upper portions of the subwatershed. Muckinipattis Creek modeling results are presented in **Appendix B.2**.

4.4.3 Naylors Run

The drainage area of the Naylors Run subwatershed is approximately 4.6 square miles and is located in the northeast portion of Delaware County spanning Upper Darby and Haverford Townships as well as Lansdowne and East Lansdowne Boroughs. The following five (5) problem areas are located within the Naylors Run subwatershed: S080, S027, S031, S032, and S033. Three (3) major culverts along Naylors Run were included in the model to allow for flow passage in areas where the stream is culverted beneath development. The simplified shape and size of the culverts were modeled based on as-built drawings provided by Upper Darby Township. Two (2) additional culverts upstream of the problem areas were modeled as open channels burned into the terrain as detailed information was not available. The Naylors Run Dam was not explicitly modeled. Dam features and storage were included to the extent that they are represented by the terrain and breaklines along elevated reaches.

Model results demonstrate that the existing culverts along Naylors Run exacerbate flooding at the problem areas by backing up flow and raising upstream water levels as the culverts reach capacity. The elevated water levels increase overland flow into the topographical depression near S027 and increases ponding depths. Culvert flow hydrographs in the model suggest that the culvert from Marshall Road to the confluence with Cobbs Creek reaches capacity for both the 10-year and 100-year events but may have some capacity for the 5-year event. Naylors Run modeling results are presented in **Appendix B.3**.

4.5 SCALGO Modeling

Detailed HEC-RAS modeling was limited to three evaluations, for additional areas a SCALGO tool was utilized for analysis. SCALGO is a web-based analysis tool that provides terrain and surface-water data to support flood-prone area analysis. This tool was used to visualize water accumulation and flow based on detailed terrain models, enabling identification of flood vulnerability areas, drainage patterns, and water accumulation points. SCALGO was used to provide flood vulnerability maps showing high priority problem areas susceptible to inundation. The 100-yr, 24-hr storm event depth was modeled using SCALGO's flash flooding analysis tool. Refer to **Section 7.3** for further information on its implementation at high priority problem areas.

4.6 Stream Gage Locations

As part of this Plan, potential stream gage locations were developed with the goal to enable a comprehensive monitoring plan and improve understanding of flood conditions across the County's watersheds. Eighty-seven (87) potential stream gage locations were identified based on critical factors including watershed location, site ownership, site accessibility, problem areas identified in this study, and locations of existing gages. This criteria is summarized in **Table 3**. A map of potential stream gage locations is presented in **Figure 4**. The potential stream gage locations were classified as primary, secondary, or tertiary based on how well they met prioritization criteria. Primary locations were identified where sites best satisfied the following criteria: watershed location, site ownership, and site access. Stream gages were proposed at strategic confluence points upstream and downstream of where a tributary creek joins a main

watershed stream for both modeling and evaluation purposes. Priority was given to larger watershed streams, with fewer gages being placed on tributary creeks.

Stream gage locations considered site ownership, prioritizing county- or municipal-owned land where feasible. Site suitability was also evaluated at a desktop level to avoid vulnerable locations. This included areas upstream of bridges where flow can back up, as well as locations susceptible to vandalism or debris impacts. Locations at County-owned bridges were prioritized for easier installation and maintenance. By proposing stream gages at these locations, a more complete and reliable picture of watershed behavior can be achieved.

Secondary locations were driven by the following criteria: supplemental stream gages between primary locations and presence of problem areas. Stream gage placement considered problem areas identified within this Plan to gain further insight into the problems identified and potential solutions.

Lastly, tertiary locations were proposed along smaller tributaries. While these locations would further enhance understanding of flood conditions across the County, they are not critical to the overall monitoring network.

There are two National Oceanic and Atmospheric Administration (NOAA) precipitation gages located within the County. The initial goal was to co-locate stream gages with existing precipitation gages to facilitate coordinated data collection. However, the locations of existing precipitation gages within the County were not suitable for stream gage installation based on the other criteria developed.

Stream gages were placed to overlap with existing USGS stream gage locations within the County, if the location was strategic based on the other factors considered. USGS gages having the same location as County-owned gages can be advantageous for comparison and redundancy purposes.

Ten proposed locations have designated backup locations, that have been included in case the preferred locations prove to be suboptimal or infeasible. Nine stream locations are identified as "Removed," these were eliminated during internal reviews, but have been retained in case there is future interest. Refer to **Appendix C** for a zoomed-in maps of the proposed stream gages and descriptions of proposed locations.

Table 3. Criteria for Potential Stream Gage Locations

Factor	Criteria
1	Cover strategic confluence points upstream and downstream of where a tributary meets a main watershed stream, for modeling and evaluation purposes. The larger watershed stream will be prioritized, with fewer gages being placed on tributaries.
2	Site ownership
3	Site access: where possible, place at county owned bridges, ideally directly adjacent / downstream. Consider avoiding vulnerable locations upstream of bridges where flow can back up, be vandalized, hit by debris, etc.
4	Consider problem areas identified.
5	Supplement NOAA precipitation gages, where applicable.
6	Locations may overlap with USGS stream gage locations, if the location is strategic per the other factors. USGS gages having the same location as County owned gages can be advantageous for having a shared network and comparison purposes.

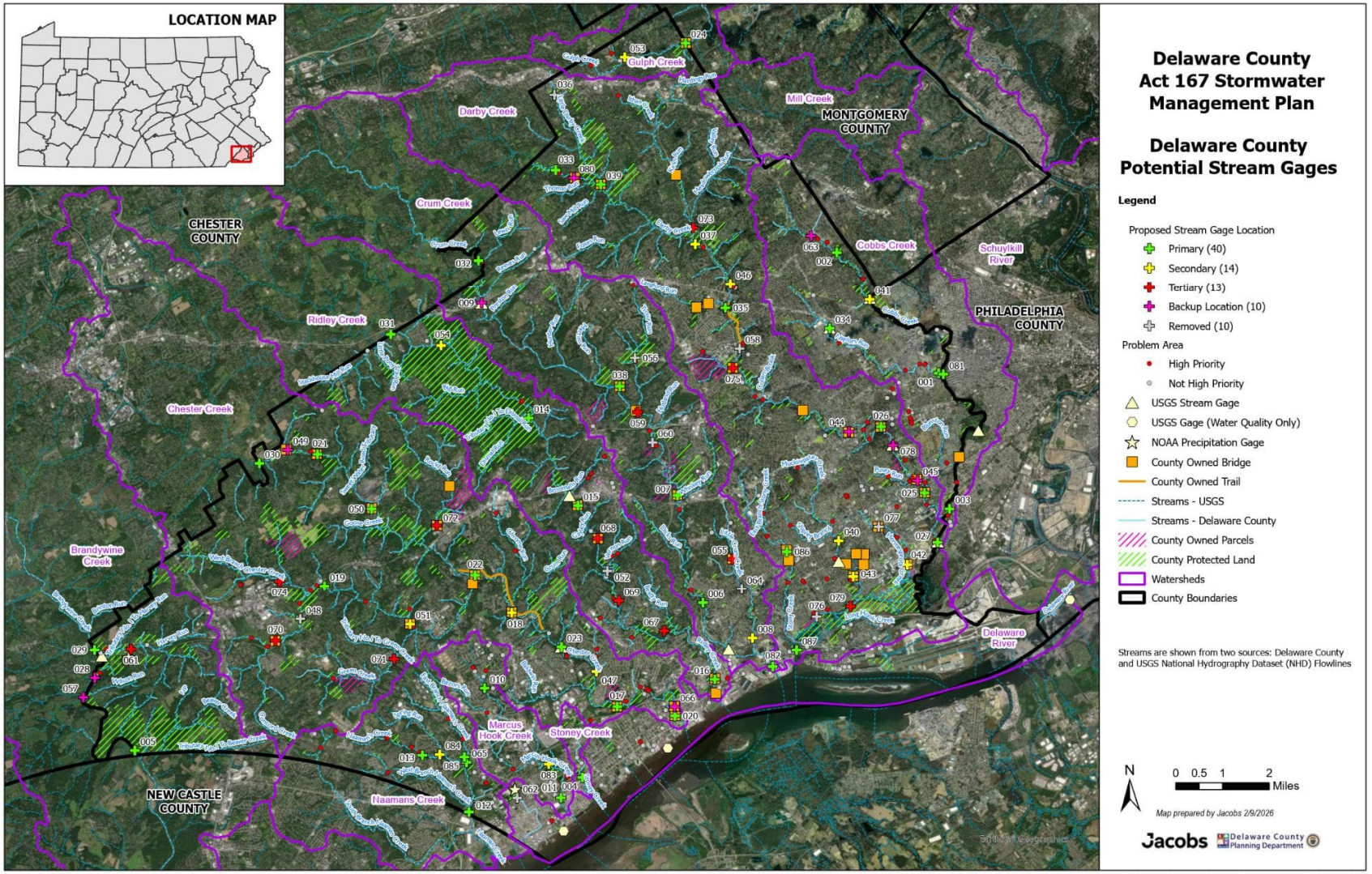


Figure 4. Potential Stream Gage Locations

5. Standards and Criteria for Stormwater Control

5.1 Introduction

An increase in development, and in turn, an increase in impervious surfaces, results not only in an increase in peak runoff, but also an increase in runoff volume (decreased infiltration), water quality degradation, and streambank erosion. The goal of Act 167 and this stormwater management plan is to encourage planning and management of stormwater runoff that is consistent with sound water and land cover practices. In addition, the Act calls for a comprehensive stormwater management program designated to preserve and restore flood carrying capacities of streams; preserve, to the maximum extent practical, natural stormwater runoff regimes and alignment; maintain current stream cross-sections and conveyance capacity; and protect and conserve groundwater and infiltration areas. Maintaining and restoring the natural hydrologic regime in the watershed is the best means to accomplish this goal. The technical standards and criteria developed as a part of this task are watershed centric in their interpretation and/or application. In order to attempt to achieve this goal and to address flooding, runoff volume control, water quality, and streambank erosion, development and redevelopment sites must consider the five (5) objectives listed below:

- Maintain, restore, and protect infiltration of groundwater
- Maintain or improve water quality to water quality standards
- Reduce channel erosion
- Manage overbank flood events
- Manage extreme flood events

The standards and criteria presented in **Section 5.3** address these items. In addition, the standards and criteria presented here are designed to be consistent with PADEPs proposed Post Construction Stormwater Management (PCSM) Manual (Draft version dated January 28, 2023 with edits through August 2026) and the National Pollutant Discharge Elimination System (NPDES) Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) Pennsylvania Storm Water Management Act (Act 167) 2028 Model Stormwater Ordinance (Draft dated January 2025 with revisions through August 2026). These documents are commonly referred to as the PCSM Manual and 2028 MS4/Act 167 Model Ordinance.

The term "Stormwater Control Measure" (SCM) as used in this document represents all stormwater best management practices including both structural elements (basins, trenches, water quality structures, etc.) and non-structural practices (land management practices for example). This definition is consistent with PADEPs Draft PCSM Manual. This terminology is equivalent to the term "Best Management Practice" (BMP) used in the previous PADEP guidance document titled "Pennsylvania Stormwater Best Management Practices Manual."

5.2 National Pollutant Discharge Elimination System (NPDES), Phase II Requirements

As indicated in **Section 5.1**, this plan and the associated model ordinance are designed to be consistent with the 2028 MS4/Act 167 Model Ordinance. Federal regulations approved in December 1999 required

operators of small MS4s to obtain NPDES Phase II permits from PADEP by March 2003. This program applies to all municipalities in Delaware County. Municipal MS4 programs are required to address the following six minimum control measures (MCMs):

- Public Education and Outreach
- Public Involvement/Participation
- Illicit Discharge Detection and Elimination
- Construction Site Stormwater Runoff Control
- Post-Construction Stormwater Management in New Development and redevelopment.
- Pollution Prevention/Good Housekeeping for Municipal Operations

At a minimum, municipal entities regulated under MS4 must satisfy the following four basic requirements:

- Specify SCMs and implement them to the "maximum extent practicable"
- Identify measurable goals for control measures
- Develop an implementation schedule of activities or frequency of activities, and
- Define the entity responsible for implementation

The affected municipalities must, if they already do not have one in place, develop a stormwater management program. If a municipality has an established stormwater management program and is subject to the provisions of the Phase II Rule, provisions of the Rule must be implemented to satisfy the federal requirements.

Adoption/implementation of the Delaware County Stormwater Management Plan and Model Ordinance provisions will, at a minimum, satisfy the four basic requirements noted above and one of the six required elements of the NPDES II program, specifically, PCSM in new development and redevelopment. The Plan can also help partially address other MCMs such as IDDE, construction, and good housekeeping.

Site disturbance up to one acre is allowed before water quality and peak rate controls are required per Pennsylvania State Code requirements. This stormwater management plan proposes lower thresholds for earth disturbance, and new impervious area limits that require water quality and peak rate controls. All projects within regulated municipalities will be required to comply with the water quality and quantity measures set forth in this plan. Exemption criteria are outlined in **Section 5.8** and in Section 306 of the Model Ordinance (**Appendix D**). The exemption criteria describe the requirements a given regulated activity must meet for a range of proposed impervious and earth disturbance areas. In summary, the implementation of this plan and ordinance will ensure that municipalities automatically meet the relevant federal NPDES requirements.

5.3 Standards and Criteria

Achieving the objectives outlined in **Section 5.1** requires that design standards be developed and implemented to assist municipal officials in the management of land development activities and ultimately the achievement of the stormwater management goals for county watersheds. The standards and criteria presented here meet the groundwater, water quality, streambank stabilization, and flood control objectives outlined in **Section 5.1** and provide for the application of a consistent stormwater

management methodology throughout county watersheds with the overriding goal of achieving watershed objectives throughout Delaware County.

A person proposing earth disturbance activities that will require a PCSM Plan and an NPDES permit or Erosion and Sedimentation (E&S) permit must complete a stormwater analysis that is consistent with the standards contained in 25 Pa. Code § 102.8(g) unless the project qualifies as a site restoration project per 25 Pa. Code 102.8(n), as determined by PADEP or the Delaware County Conservation District. The stormwater analysis will determine the volume, rate, and pollutant loads that must be managed by PCSM SCMs. If a PCSM Plan is prepared for the purpose of obtaining an NPDES permit or E&S permit, the stormwater analysis completed for the PCSM Plan that is submitted to the Municipality must be consistent with the stormwater analysis that is submitted to DEP or the Conservation District.

A person preparing an Earth Disturbance Plan not requiring an NPDES Permit must complete a stormwater analysis consistent with the modified standards and exemptions outlined in **Section 5.8** below and Section 306 of the Model Ordinance. Submission requirements for projects not requiring an NPDES permit are outlined in Article IV of the Model Ordinance.

Design Standards for managing the five stormwater objectives - infiltration, water quality, streambank protection, overbank flood events, and extreme flood events – are presented in the following sections.

5.3.1 Infiltration

Infiltrating rainfall into the ground replenishes the groundwater that provides base flow to streams (a process that keeps streams flowing during drier periods) and maintains groundwater for drinking water purposes. As traditional development occurs and impervious areas increase, less rainfall reaches the groundwater systems, resulting in lower base flow and reduced groundwater recharge. Although detention basins can reduce the post-development peak rate of flow to the pre-development levels, the increase in runoff volume, caused by the typical increase in the amount of post-development impervious surface, still largely gets passed downstream unless special provisions are designed into the basin to infiltrate the increase in runoff volume.

Thus, in highly developed watersheds, it is not uncommon to see dry streams and severely depleted groundwater supplies during periods of drought. Stormwater management measures such as infiltration basins, rain gardens/bioretention, underground infiltration beds, infiltration/recharge structures, and other applicable stormwater control measures (SCMs) as defined in the current version of the Pennsylvania PCSM Manual can be designed to meet infiltration requirements.

For projects requiring an NPDES Permit and those projects that are not exempt or permitted to use an alternate volume control method as defined in **Table 5.9** below, the volume control standards defined in the current version of the Pennsylvania PCSM Manual shall be followed (the standards in the current version of the Pennsylvania Stormwater Best Management Practices Manual [BMP Manual] shall be used until the Pennsylvania PCSM Manual are formally adopted). These standards are outlined in Section 504 D of the Model Ordinance in **Appendix D**.

For projects that have the option of using the simplified approach as designated in **Table 5.9**, the standards outlined in **Appendix B** of the Model Ordinance can be followed.

Providing for infiltration consistent with the natural hydrologic regime is required. The goal of the infiltration standards defined in the Model Ordinance is to compensate for the reduction in the recharge that occurs when the ground surface is disturbed or impervious surface is created.

If infiltration is not feasible, then the design professional shall be responsible for demonstrating to the satisfaction of PADEP and the municipality why infiltration cannot be physically accomplished on the site (e.g., shallow depth to bedrock or limiting zone, open voids, steep slopes, etc.). The justification shall be based on a pre-development site characterization as defined in Section 503 of the Model Ordinance. For sites where infiltration is not feasible, managed release concept (MRC) approaches as defined in the current version of the Pennsylvania PCSM Manual shall be used to mitigate the lack of onsite infiltration capacity.

Infiltration SCMs shall be designed in accordance with standards outlined in the current version of the Pennsylvania PCSM Manual. Infiltration SCMs intended to receive runoff from developed or redeveloped areas shall be selected based on suitability of soils and site conditions and shall be constructed on soils that will permit the facility to dewater completely within timeframes defined in the Pennsylvania PCSM Manual. Site characterization and a detailed soil evaluation of the project site are required and shall be performed in accordance with the standards in the current version of the Pennsylvania PCSM Manual.

The following additional considerations shall apply to all infiltration facilities in Delaware County:

A. Infiltration facilities should, to the greatest extent practicable, be located to avoid introducing contaminants via groundwater, and where applicable be in conformance with an approved source water protection assessment or source water protection plan.

B. Roadway drainage systems should provide an opportunity to capture accidental spills. Road de-icing material storage facilities shall be designed to avoid salt and chloride runoff from entering waterways and infiltration facilities. The qualified design professional shall evaluate the possibility of groundwater contamination from the proposed infiltration facility and perform a hydrogeologic study, if necessary.

C. Antidegradation analysis found in State Code Chapter 93 shall be applied in HQ or EV streams.

D. An impermeable liner may be required in detention basins where the possibility of groundwater contamination exists. The municipality may require a detailed hydrogeologic investigation.

E. The applicant should provide safeguards against groundwater contamination for higher-risk land uses that may cause groundwater contamination should there be a mishap or spill.

5.3.2 Water Quality

Pollutants normally accumulate on impervious surfaces between rainfall events. Pollutant concentrations in runoff from developed land tend to be greatest at the beginning of a storm event or during the first one-half to one inch of runoff, a phenomenon commonly known as the “first flush.” Typically, approximately eighty percent of the rainfall events consist of one-half inch of rainfall or less and are storms that essentially create only a “first flush.” Therefore, most nonpoint source pollutants are washed into streams during this first flush. To be effective at treating nonpoint source pollution contained in the first flush, projects must construct SCMs to capture and treat the runoff from these smaller storm events.

For projects requiring an NPDES Permit and those projects that are not exempt or are permitted to use an alternate water quality control method as defined in **Table 5.9** below, the water quality standards defined in the current version of the Pennsylvania PCSM Manual shall be followed. These standards are outlined in Section 504 D of the Model Ordinance in the appendix and involve controlling increased pollution discharges from storms characterized above as “first flush.”

For projects that have the option of using the simplified approach as designated in **Table 5.9**, the standards outlined in **Appendix B** of the Model Ordinance can be followed.

To control post-construction stormwater impacts from regulated activities and conform to state water quality requirements, stormwater control measures (SCMs) shall be provided that control post construction site pollutant discharges to pre-development levels or better. Design standards for water quality control measures are defined in the current version of the Pennsylvania PCSM Manual and include infiltration facilities and other measures that reduce chemical and physical pollutants in stormwater runoff. In addition, the temperature of receiving waters shall be protected through the use of management practices that moderate temperature such as riparian buffers. Riparian Buffer standards are included in Section 605 of the Model Ordinance.

Stormwater Hotspots

Stormwater hotspots, defined in the model ordinance as "areas where land use or activities generate highly contaminated runoff with concentrations of pollutants in excess of those typically found in stormwater," are another water quality concern. If a site is designated as a hotspot, it has important implications for how stormwater is managed. First and foremost, untreated stormwater runoff from hotspots shall not be directed to infiltration facilities where it may contaminate groundwater supplies. The infiltration volume shall be pretreated prior to infiltration to minimize the potential for contamination of groundwater. Second, a greater level of stormwater treatment shall be considered at hotspot sites to prevent pollutant wash off after construction. The Environmental Protection Agency's (EPA's) NPDES Stormwater Program requires some industrial sites to prepare and implement a stormwater pollution prevention plan.

Model Ordinance Section 301 indicates that stormwater runoff from hotspots shall be pretreated prior to surface or groundwater infiltration to reduce the risk of contamination. Industrial sites referenced in 40 CFR 125 are examples of hotspots. A list of example hotspots follows:

- Vehicle salvage yards and recycling facilities
- Vehicle fueling stations
- Vehicle service and maintenance facilities
- Vehicle and equipment cleaning facilities
- Fleet storage areas (bus, truck, etc.)
- Industrial sites based on Standard Industrial Classification Codes
- Marinas (service and maintenance areas)
- Outdoor liquid container storage
- Outdoor loading/unloading facilities
- Public works storage areas
- Facilities that generate or store hazardous materials
- Commercial container nursery
- Contaminated sites/brownfields

- Other land uses and activities as designated by an appropriate review authority

The following are not normally considered hotspots:

- Residential streets and rural highways
- Residential development
- Institutional development
- Office developments
- Non-industrial rooftops
- Pervious areas, except golf courses and nurseries (which may need an integrated pest management (IPM) plan)

While streets and highways (average daily traffic volume (ADT) greater than thirty thousand (30,000) are not considered stormwater hotspots, it is important to ensure that highway stormwater management facilities are designed to adequately protect receiving streams and/or groundwater.

The EPA NPDES Stormwater Program requires some industrial sites to prepare and implement a stormwater pollution prevention plan.

5.3.3 Streambank Erosion

Preservation of stream geomorphology is an important aspect of sustainable flood protection and water quality preservation. Comprehensive stormwater management cannot be attained without considering the impact of stormwater on the fluvial geomorphology of a watercourse.

Normally as storm flow increases, velocities in the stream also increase and can create stream bank erosion problems within a watercourse. Typically, the greatest stream velocities and stream bank erosion occurs during near-bank-full and bank-full flow events. Studies on watersheds in Southeast Pennsylvania, including those in Delaware County, have shown bank-full flow to typically occur between the 1- and 2-year storm events.

The majority of Delaware County and its watersheds are underlain by the geologic formation known as the piedmont physiographic province. In the United States Geologic Survey Scientific Investigation Report (USGS SIR) 2005-5147 *Development of Regional Curves Relating Bankfull-Channel Geometry and Discharge to Drainage Area for Streams in Pennsylvania and Selected Areas of Maryland*, it was determined that bankfull flow in Delaware County watersheds occurs during the 1.2-year runoff event based on the underlying geology. Therefore, controls to keep stream flows between the 1.2- and 2-year runoff events to or below the 1- year event, would aid in minimizing stream bank erosion.

Often development within a watershed can aggravate stream bank erosion problems by creating more runoff and correspondingly increasing the frequency of meeting or exceeding bank-full flows. This need not be the case if stormwater management controls are designed to mitigate this condition. With the proper design of stormwater management controls, stormwater runoff from frequent events, such as the 1.5-year event, can be detained and discharged from a control facility

over an extended period of time thus reducing discharge volumes and velocities during near bank-full and bank-full flows.

Stream bank erosion criteria based upon the above discussion is incorporated into the standards and criteria of the Model Ordinance in Section 504. The streambank erosion standard across all watersheds in Delaware County is control peak runoff from the post-development 2-year 24-hour storm event to the pre-development 1-year 24-hour storm peak runoff magnitude.

5.3.4 Overbank Events

Flooding and stormwater problems are caused by excess stormwater quantity. Storm events which result in water overflowing the natural bank of a stream are termed as "overbank" events and are typically defined as storm events exceeding a specified expected frequency of occurrence. Based on USGS SIR 2005-5147, bankfull flow in the Crum Creek occurs at the 1.2-year runoff event. Thus, events greater than this event result in "overbank" flooding. Normally, storm events between the 2-year to 10-year return periods are classified as "overbank" events. Effective management of these "overbank" events requires a detailed knowledge of the interrelationship between all contributing areas of a watershed. Analysis of peak runoff, timing of runoff, and duration of runoff from the various areas of a watershed is critical for establishing an effective stormwater management plan. The Management District concept and resulting peak runoff rate control standards discussed in **Section 5.3.6** document the approach for overbank event runoff control for all county watersheds.

5.3.5 Extreme Events

"Extreme" flooding events are separated from "overbank" flooding events by the severity of damage that is incurred. Typically, 25-, 50- and 100-year events are classified as "extreme" as they cause more substantial damage than the flooding associated with "overbank" events.

While some overbank and extreme flooding events are inevitable, the goal of stormwater management is to control stormwater in a way that development within the watershed does not increase the incidence of "overbank" flooding and the extent of damages to property and infrastructure associated with extreme events. To accomplish this stormwater management objective, different management criteria are established for the "overbank" and "extreme" event floods.

It must be recognized that there is a difference between the definition of terms "storm" and "flood." Although a certain quantity of rain may classify a rainfall event as a 5-year storm, this does not mean that same amount of rain will result in a 5-year flood. For example, if the event occurs during a drought, a 5-year storm may result in only a 2-year flood because of the greater capacity of the soil and ground to absorb water. If the same event occurred on top of a snowmelt or at a time when the ground is saturated, a 10-year flood may occur because of the extra water volume present in the melting snow or decreased capacity of the soil to absorb the precipitation.

Similarly, the term "5-year flood" does not mean that this event will occur once every five years. Nor does it mean that once a 5-year event occurs, it will be another five years until that event may occur again. A 5-year event refers to the probability (as a fraction) that the event will occur in any

given year, which is the inverse of the frequency of the event. Therefore, a 5-year event has a 20% probability of occurring in any given year.

The Management District concept and resulting peak runoff rate control standards discussed in **Section 5.3.6** document the extreme event runoff control strategy for county watersheds.

5.3.6 Peak Runoff Rate Management

A watershed level runoff control philosophy has been used to establish runoff rate control standards for several County watersheds. This approach considers the effect of runoff timing and volume such that peak rates of runoff throughout watersheds are not increased. This differs from site control standards which pose the risk of increasing peak rates in some parts of a watershed due to cumulative impacts or the delay in subwatershed runoff timing associated with the construction of detention facilities. Using the watershed level runoff control methodology, release rate districts were developed having specific runoff reduction criteria that were established to meet the overall watershed objective of not increasing peak rates anywhere within the watershed.

Peak Runoff Release Rates

Watersheds for which peak runoff release rate standards were previously established in Delaware County include (See **Figure 5**):

- Darby/Cobbs Creeks (2005 – Watershed Act 167 Plan for Delaware, Chester, Montgomery, and Philadelphia Counties)
- Crum Creek (2011 – Watershed Act 167 Plan for Delaware and Chester Counties)
- Ridley Creek (1988 – Watershed Act 167 Plan for Delaware County)
- Chester Creek (2002 – Watershed Act 167 Plan for Delaware and Chester Counties)
- Mill Creek (1997 – Part of Lower Merion Drainage Area Act 167, Montgomery County)

A little more than 80% of the county is covered by the release rate standards identified in the Act 167 plans listed above.

Watersheds without prior applicable peak release rate studies include:

- Delaware River Direct
    - Brandywine Creek (Tributary to Delaware River mostly in Chester County)
    - Gulph Mill Creek (Tributary to Schuylkill River, mostly in Montgomery County)
- Marcus Hook Creek (Tributary to Delaware River)
- Stoney Creek Watershed (Tributary to Delaware River)
- Naamans Creek (Tributary to Delaware River, split with New Castle County, Delaware)

Reevaluation of the release rate standards established as part of prior watershed-based Act 167 plans was not undertaken as part of this study. Prior Act 167 release rate studies used rigorous calibrated hydrologic models defining runoff responses from various parts of the watershed to establish release rate districts. There has not been a significant change in available rainfall data since most of these models were

developed. In addition, a full reevaluation would require that significant newer developments and SCMs built using the previous release rate standards be included in any revised modeling. This would require that all such data be collected for use in the revised model, and that the model be expanded to include the smaller drainage areas tributary to these SCMs. Such an analysis is beyond the scope and schedule of this current plan and the benefits are not expected to be significant in most watersheds, beyond the potential future update to the Ridley Creek model given its age and changing rainfall data since 1988.

In addition, the previously unmodeled watersheds (Marcus Hook Creek, Stoney Creek, Naamans Creek, and the Delaware County portions of Brandywine and Gulph Creeks) are too small to warrant release rate district modeling. In these watersheds the difference in runoff travel time for sub watershed areas is not sufficient to produce meaningful release rate districts. In these small watersheds a 100% release rate standard is applied (i.e. post development peak runoff rates are held to pre-development levels). In other portions of the Delaware River Direct watershed a no detention standard has been adopted if it can be demonstrated that there is a safe conveyance path to the Delaware River. A safe conveyance path is defined as a conveyance path that has adequate carry a 10-year design event without inducing flooding. If the conveyance path does not have adequate capacity, a 100% release rate standard is applied.

Existing Release Rate Summary

As indicated above, existing release rates have been established for a little more 80% of the county. Release rates for each of the watershed areas are identified in the Model Ordinance included in **Appendix D** of this plan. Release rates are presented as either "Percent Reduction," or "Design Storm" based.

The percent reduction approach establishes post-development peak runoff rates as a percentage of the pre-development runoff peak rate. For any development scenario within a given district (group of sub watershed areas), the post-development peak runoff rate cannot exceed a given percentage of the pre-development peak runoff rate. The percentage is defined as the release rate. For example, Chester Creek Watershed has three release rate districts, 100%, 75%, and 50%. For project sites in the 100% release rate district post development peak flows cannot exceed 100% of the predevelopment peak runoff rate. For sites in a 50% release rate district, post development peak runoff rates cannot exceed 50% of the pre-development peak runoff rate.

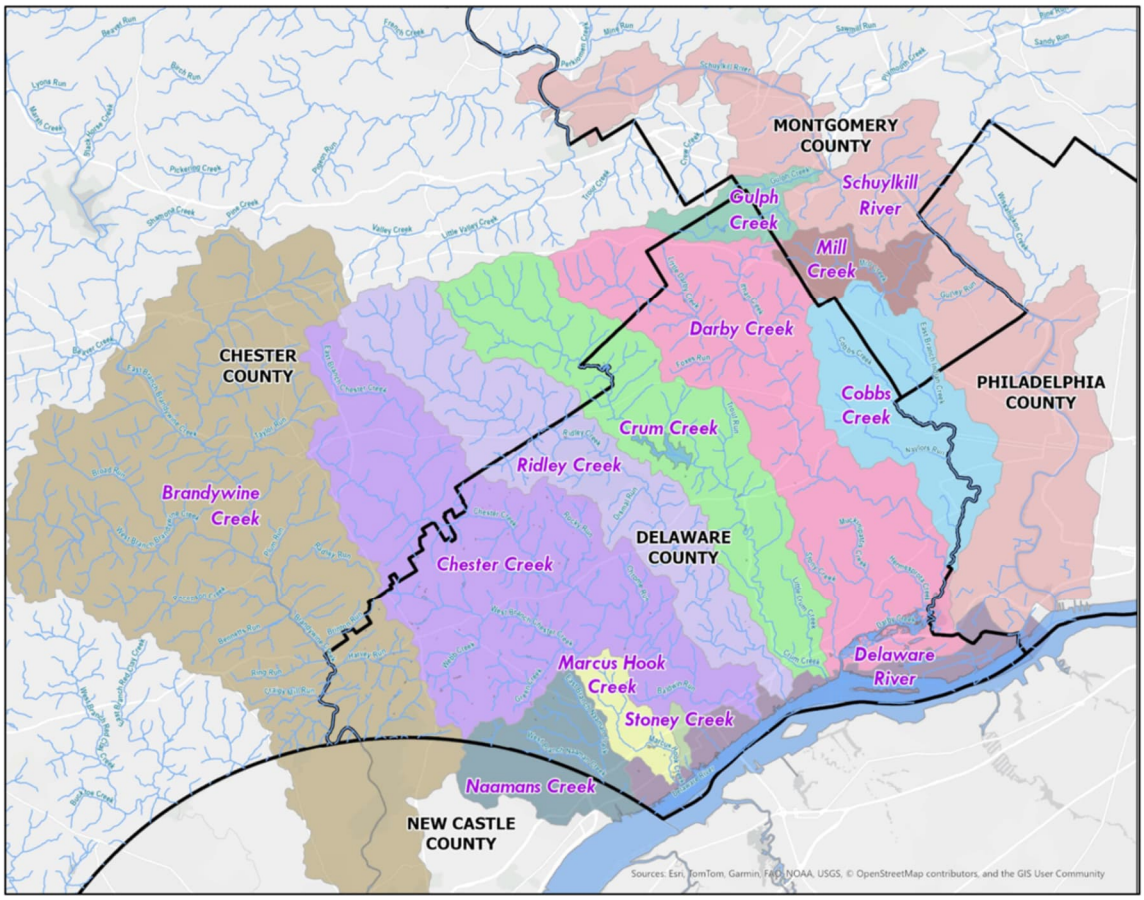


Figure 5. Delaware County Watersheds

The Design Storm approach limits post-development peak runoff rates based on design storm pre-development peak runoff rates. For development scenarios within a given district (group of subwatershed areas), the post development peak runoff rate cannot exceed the pre-development runoff for the same or a more frequent design storm. **Table 4** presents the Crum Creek Watershed design storm based release rates as an example.

Standards for Areas not Covered by Previous Plans

As mentioned above, approximately 20% of the County is not currently covered by release rate standards. Watersheds not covered by released rates include small watersheds where release rate evaluations would not produce meaningful results, and watersheds where only a small portion is in Delaware county. These watersheds include a portion of Brandywine Creek in the western part of the County, Gulf Creek and Mill Creek in the northeastern portion of the County, and Marcus Hook Creek, Stoney Creek, and Naamans Creek which are small watersheds directly tributary to the Delaware River. The recommendation from this study is to use a 100% release rate in these areas. That is, the post development peak runoff rate cannot exceed the pre-development rate in these watersheds for all design storm events.

Table 4. Stormwater Management District Standards in the Crum Creek Watershed

District	Proposed Condition Design Storm	Reduced to	Existing Condition Design Storm
A	2-year 5-year 10-year 25-year 50-year 100-year		1-year 5-year 10-year 25-year 50-year 100-year
B	2-year 5-year 10-year 25-year 50-year 100-year		1-year 2-year 5-year 25-year 50-year 100-year

The recommended standard for other areas directly tributary to the Delaware River but not included in the one of the named watersheds above is "Conditional No Detention" with the qualification that adequate conveyance capacity must exist or be provided between the site and the Delaware River. An adequate conveyance system is one that can pass the 10-year storm without exceeding the drainage system's gravity conveyance capacity. The capacity analysis must also consider tidal impacts.

Tidal Impacts

Areas along the Delaware River experience tidal conditions that increase flooding concerns. Tidal conditions are to be assessed through application of an appropriate tailwater condition as part of the engineering analysis and design for sites located in tidal areas. The tailwater to be applied shall be the average of the NOAA Mean Higher High Water (MHHW) level reported for the Marcus Hook and Philadelphia Stations in the most recently reported NOAA Tides and Currents Data. The current MHHW value for this area is 3.95 ft. NAVD 88. Municipalities can add an additional factor for future sea level rise at their discretion.

Future Update Considerations

Although this plan does not propose modifying release rate standards from earlier watershed Act 167 studies, there are several Delaware County Watersheds that may warrant future study for release rate considerations as follows:

1. **Brandywine Creek Watershed:** A watershed-based Act 167 Plan has not been performed for the Brandywine Creek Watershed. It is recommended that future release rate analysis be performed on this watershed in collaboration with Chester County (and New Castle County, DE as needed).

2. **Ridley Creek Watershed:** The Ridley Creek Watershed Act 167 plan completed in 1988 did include a release rate analysis. However, the rainfall data used as part of the Ridley Creek Watershed analysis was data from pre-1980. It is recommended that this study be updated in collaboration with Chester County using more current rainfall data.

Although release rate studies have not been performed on Mill Creek, Gulf Mill Creek, Marcus Hook Creek, Stoney Creek, and Naamans Creek Watersheds, additional study to define release rates for these watersheds is not recommended due to their size. Release rate studies do not provide meaningful results on small watersheds due to the relatively small differences in subwatershed travel times within the overall watershed.

5.4 Redevelopment

It is not the intent of this plan to create a disincentive to redevelopment in existing urbanized areas of the watershed since this type of development may result in fewer environmental impacts than development on vacant undeveloped land. The plan is designed to present an equitable approach to both redevelopment and new development on vacant land. As the stormwater management criteria contained in this plan is based upon not exceeding the existing flow at a site and not on an absolute value disconnected from the pre-development condition, the targeted stormwater management objective for a site within a given management district is established by the site and set relative to its existing conditions. Since existing conditions include any impervious area on the site prior to the proposed development, the criteria, by default, relaxes the stormwater quantity peak rate of flow by allowing 80% of the existing impervious area to be included in the pre-development analysis. To encourage the addition of new green space as part of redevelopment projects, the applicant may choose to reduce the total impervious surface area on a site in lieu of meeting the stormwater quantity control criteria established in this chapter. In order to satisfy this criteria and eliminate the requirements regarding stormwater quantity control, an applicant must demonstrate that the total impervious area at the site is reduced by more than twenty percent (20%) based upon a comparison of existing impervious surface to proposed impervious surface.

5.5. Process to Accomplish Standards and Criteria

Table 5 provides a process to accomplish the required standards and criteria, on a priority basis, looking at means other than detention to promote infiltration, improve water quality, prevent streambank erosion and to reduce post-development peak flows to the required existing conditions rate.

Table 5. Process to Achieve the Standards and Criteria - Order of Required Consideration (Ultimate Goal - Match Existing Conditions Hydrograph)

1. Maximize use of Non-structural Stormwater Management Alternatives
   - Minimize disturbance of natural features
   - Minimize grading
   - Minimize impervious surfaces, maximize pervious surfaces
   - Break up large impervious surfaces
2. Satisfy groundwater recharge (infiltration) objective
3. Satisfy water quality
4. Satisfy streambank erosion requirements
5. Apply SCMs near the source of the runoff
6. Satisfy the runoff peak attenuation objective considering all measures other than detention basins
7. After satisfying the above requirements, incorporate dual-purpose detention measures, if necessary, to attenuate peaks. Dual-purpose detention is recommended, e.g., recycling water, wetland basins, water storage for fire flow, etc.

Stormwater Management standards and criteria required by this plan are summarized in **Table 6**, while recommended standards and criteria are listed in **Table 7**. Although reducing the post-development peak rate of runoff to indicated levels is a mandatory element of this stormwater management plan, the ultimate stormwater management goal is to match the hydrograph, not just the peak rate of runoff. To achieve this objective requires innovative planning and design of both structural and non-structural stormwater management measures. Non-structural measures are also referred to as conservation design or Low Impact Development (LID). Conservation design focuses on preserving those areas of a project that are most beneficial to environmental conservation and directing development to those areas of a site that are less environmentally significant. This type of design usually includes development of an opportunity and constraints map, which shows areas of a site with environmentally sensitive features and areas suitable for development. Various conservation design measures are discussed in more detail in **Section 5.6** of this chapter. Another reference on this subject is the current version of the *Pennsylvania Stormwater Best Management Practices Manual / Pennsylvania Post Construction Stormwater Management Manual.*

Table 6. Required Criteria and Standards

Required Standard	Benefit
Peak Rate Control Manage peak runoff rates as specified.	Prevents increases in peak rates on a watershed wide basis and provides stormwater attenuation.
Recharge/Infiltration/Retention All proposed development shall investigate the implementation of infiltration or retention structures for the stormwater control measures as opposed to surface detention (in all Hydrologic Soils Groups) and adhere to the recharge requirements of the Model Ordinance. Recharge structures installed close to the source of runoff (prior to tapping into storm sewers) are recommended where soils and physical conditions permit. If applicable, impacts on subsurface mine pools should be evaluated before using this type of practice.	Augments groundwater recharge and stream base flow providing flow attenuation.
Water Quality Provide adequate storage and treatment facilities necessary to capture and treat the Water Quality Volume.	Reduces pollutants thus providing improved water quality.
Riparian Buffer The minimum desired width is 50 to 100 feet measured from the top of bank on both sides of the stream, and may only be reduced for existing lots depending on site conditions and municipal approval.	Water quality and water temperature improvement, flood damage reduction, habitat enhancement, erosion reduction.
Streambank Protection Reduce 2-year post-development flow to 1-year pre-development flow.	Reduces the number of erosive storms thereby reducing streambank erosion.
Erosion and Sediment Pollution Control Sequence and control earth disturbance sites to maintain and protect areas designated for recharge or leave areas of native vegetation intact.	Infiltration, structure integrity, surface water quality, safe conveyance, stream, culvert, and channel capacity.
Existing Storm Sewers or Culverts Discharge into existing sewer networks or culverts shall be based on system capacity or design storm(s), whichever is more restrictive.	Reduce flooding, preserve sewer/culvert capacity thereby reducing operation and maintenance and replacement costs.

Discharge of Accelerated Runoff All stormwater control criteria must be met before runoff is safely discharged into existing drainage patterns and storm sewers without adversely affecting properties or causing channel scouring and erosion.	Safe conveyance, continued surface and groundwater quality, flow attenuation.
Outlets If discharging stormwater conveyance systems from a development site to a stream, tributary, stabilized channel, or storm sewer is not possible, runoff shall be collected in a SCM and discharged at a non-erosive rate. Proposed developments discharging runoff onto adjacent properties must have adjacent property owner(s)' written permission, prior to design and construction of outlets.	Safe conveyance, reduced environmental impacts, and reduced property damage.
Minimize Wetland Impacts Refer any potential wetland impacts to state agency for review.	Maintain aquatic ecosystems and habitat, water quality improvements.

Note: *See the Model Ordinance in* ***Appendix D*** *for more detailed standards and criteria.*

Table 7. Recommended Criteria and Standards

Recommended Standard	Benefit
Floodplains Those floodplains in which the floodplain stores floodwaters shall not be filled or covered with impervious surface so as to not reduce the storage capacity.	Natural stormwater detention/flood control downstream.
Roof Drains, Residential/Commercial When feasible, prevent roof drains from discharging into storm sewers, roadside ditches, or channels. Discharge to lawn; recharge basin or storage facilities for re-use.	Promotes infiltration, flow attenuation, and increases runoff time of concentration, flow attenuation.
Pervious Surfaces The use of pervious materials will be encouraged for parking surfaces and sidewalks. Compaction of soils is discouraged and natural or undisturbed areas onsite are encouraged to keep open space pervious. Infiltration beds are encouraged.	Infiltration, groundwater recharge.
Structures Concentrate on locating stormwater facilities within areas conducive to recharge and accommodate recharge to meet management district requirements. No stormwater structures are allowed in floodplains that would reduce floodplain storage.	Infiltration, groundwater recharge, stream base flow, floodplain storage.
Steep Slopes Regulate activities in critical slope areas where management of stormwater by structure is inappropriate. Slopes should be stabilized and vegetated with native vegetation where feasible.	Stream base flow, flow attenuation, conveyance integrity, surface water quality.
Green Roofs Construct green/vegetated roofs, rooftop gardens	Flow attenuation and small storm retention, improved water temperature.

Note: *See the Model Ordinance in* ***Appendix D*** *for more detailed standards and criteria.*

5.6 Alternative Runoff Control Techniques

Each developer must not allow the runoff from their site to exceed the applicable release rate applied to the subwatershed where the site is located. This runoff control can be obtained in a number of different ways. The following tables indicate an overview of general measures that can be applied to reduce or delay stormwater runoff as well as the advantages and disadvantages for several types of runoff control measures. It is the responsibility of the developer or the developer's engineer to select the technique that is the most appropriate to the type of project and physical characteristics of the site.

In determining what measures or combination of measures to install, the following parameters should be considered:

- Soil characteristics (HSG, etc.)
- Subsurface conditions (high water table, depth to bedrock, etc.)
- Topography (steepness of slope, etc.)
- Existing drainage patterns
- Economics
- Land use
- Ownership, maintenance capacity
- Advantages and disadvantages of each technique

Some runoff control techniques are classified as "structural" stormwater management controls, meaning they are physical facilities for runoff abatement. Others are "non- structural" controls, referring to land cover management techniques geared toward minimizing storm runoff impacts through control of the type and extent of new development throughout the study area. This Stormwater Management Plan is based on the assumption that new development of various types will occur throughout the study area (except as regulated by floodplain regulations) and that structural controls may be required to minimize the runoff implications of the new development.

Non-structural Runoff Controls - Non-structural methods of controlling stormwater runoff quantity and quality, such as innovative site planning, impervious area and grading reduction, protection of natural depression areas, temporary ponding on-site, and other techniques are recommended. Non-structural SCMs are increasingly recognized as a critical feature of stormwater SCM plans, particularly with respect to site design. In most cases, non-structural SCMs shall be combined with structural SCMs to meet all stormwater requirements. The key benefit of non-structural SCMs is that they can reduce the generation of stormwater from the site, thereby reducing the size and cost of structural SCMs. In addition, they can provide partial removal of many pollutants. The non-structural SCMs have been classified into broad categories including, but not limited to:

Natural area conservation including riparian buffers

- Limiting disturbed areas and reducing impervious cover
- Conservation design

A list of non-structural stormwater management measures and a description of each are shown in **Table 8.**

It should be noted that maintaining or restoring natural buffers has many stormwater related benefits. Refer to **Table 9**.

Table 8. Non-structural Stormwater Best Management Practices

Non-structural Stormwater Management Measure	Description
Natural Area Conservation	Conservation of natural areas such as forest, wetlands, riparian buffers, or other sensitive areas in a protected easement thereby retaining their existing conditions hydrologic and water quality benefits.
Disconnection of Rooftop Runoff	Rooftop runoff is disconnected and then directed over a suitable vegetated area where it may either infiltrate into the soil or filter over it.
Disconnection of Non-Rooftop Runoff	Disconnect surface impervious cover by directing it to suitable vegetated areas where it is either infiltrated or filtered.
Riparian Buffers	Riparian buffers can effectively treat stormwater runoff. Effective treatment constitutes capturing runoff from pervious and impervious areas adjacent to the buffer and treating the runoff through overland flow across an undisturbed vegetated area.
Grass Channel (Open Section Roads)	Open grass channels are used to reduce the volume of runoff and pollutants during smaller storms.
Environmentally Sensitive Development	Environmental site design techniques are applied to development.

Table 9. Benefits of Riparian Buffers

1. Reduce watershed impervious area.
2. Maintain distance from impervious cover.
3. Help prevent small drainage problems and complaints.
4. Provide for lateral movement of stream "right-of-way".
5. Provide effective flood water storage.
6. Protect from streambank erosion.
7. Increase property values.
8. Increase pollutant removal.
9. Provide space for present or future greenways.
10. Provide food and habitat for wildlife.
11. Mitigate stream warming.
12. Protect Wetlands.
13. Prevent disturbance of steep slopes near waterways.
14. Preserve important terrestrial habitat.
15. Create conservation corridors.
16. Enhance essential habitat for amphibians.
17. Reduce barriers to fish migration.
18. Discourage excessive storm drain enclosures/channel hardening.

Structural Runoff Controls - Structural controls for managing storm runoff can be categorized as either volume controls or rate controls. Volume controls are designed to prevent a certain amount of the total rainfall from becoming runoff by providing an opportunity for the rainfall to infiltrate into the ground. Greater opportunities for infiltration can be provided by minimizing the amount of impervious cover associated with development, by draining impervious areas over undisturbed areas or into specific infiltration devices and by using grassed swales or channels to convey runoff in lieu of storm sewer systems. Rate controls are designed to regulate the peak discharge of runoff by providing temporary storage of runoff that would otherwise leave the site at an unacceptable peak value. Rate controls, much more so than volume controls, are adaptable to regional considerations for controlling much larger watershed areas than just one development site.

Innovative SCMs - The use of traditional and innovative stormwater control measures (SCMs) are encouraged to meet the recharge, water quality, and water quantity criteria established in this plan. The PA PCSM Manual should be used to design and maintain these practices/facilities.

SCMs that Moderate Temperature - Runoff from blacktop during hot summer months can provide a "slug" of warm water into the streams, which could affect trout. For areas within defined Special Protection subwatersheds, which include Exceptional Value (EV) and High Quality (HQ) waters, the temperature of receiving waters shall be protected using SCMs that moderate temperature. SCMs that reduce temperature, provide shading, or temporary underground storage. A list of some techniques that moderate temperature and the source for further information on them can be found in **Table 10**.

Table 10. Techniques that Moderate Temperature

To minimize temperature increases caused by new development in watersheds Stormwater SCM designs should: • Provide shading for pools and channels (particularly south side) • Maintain existing forested buffers • Bypass available base flow and/or spring flow • Utilize underground storage where possible • Utilize infiltration • Implement green roofs

Quantity Control - Proposed conditions development runoff from a site must not exceed the applicable existing conditions rate applied to the subwatershed where the site is located. This runoff control can be obtained in a number of different ways. The following tables indicate an overview of general measures that can be applied to reduce or delay stormwater runoff as well as the advantages and disadvantages for several types of runoff control measures. The applicant must select the technique that is the most appropriate to the type of project and physical characteristics of the site. Stormwater SCMs can be utilized to manage water quality, infiltration, streambank erosion, and quantity (peak and volume). The runoff control(s) most applicable to a development site may vary widely depending upon site characteristics, such as:

- Type of development proposed
- Soil characteristics (HSG, etc.)
- Subsurface conditions (high water table, bedrock, etc.)
- Topography (steepness of slope, etc.)
- Existing drainage patterns
- Economics
- Advantages and disadvantages of each technique
- Applicable performance standard

Table 11 provides assorted on-site stormwater control methods. Please refer to the current version of the PADEP PCSM manual <Insert Specific Section when PCSM is available> for advantages and disadvantages of various stormwater control measures.

Table 11. Possible On-site Stormwater Control Methods

AREA	REDUCING RUNOFF	DELAYING RUNOFF
Rooftops	1. Cistern storage 2. Rooftop gardens 3. Pool storage or fountain storage	1. Ponding on roof by constricted downspouts
Parking Lots	1. Porous pavement 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas around parking lots 4. Gravel trenches	1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measures for impervious areas a. Rippled pavement b. Depressions c. Basins
Residential	1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Infiltration: a. Perforated pipe b. Gravel (sand) c. Trench d. Dry wells 5. Vegetated depressions	1. Retention or detention basins 2. Planting a high delaying grass (high roughness) 3. Grassy gutters or channels 4. Increased length of travel of runoff by means of vegetated swales, diversions, etc.

5.7 Sub-Regional (Combined Site) Storage

Traditionally, the approach to stormwater management has been to control the runoff on an individual site basis. There is a growing commitment to finding cost-effective comprehensive control techniques that both preserve and protect the natural drainage system. In other words, two developers developing sites adjacent to each other could pool their capital resources to provide for a community stormwater facility in the most hydrologic advantageous location.

The goal should be the development and use of the most cost-effective and environmentally sensitive stormwater runoff controls. These controls will significantly improve the capability and flexibility of land developers and communities to control runoff consistent with this Stormwater Management Plan.

There is also the possibility that the stormwater could be managed "off-site;" that is, in a location off the property(ies) in question. These stormwater management facilities could be constructed in an offsite location more hydrologically advantageous to the watershed. These facilities could be publicly owned detention, retention, lake, pond, or other physical facilities to serve multiple developments. The design and release rate would need to be consistent with the plan.

5.8 Exemptions

Table 12 summarizes the exemptions specified in the Model Ordinance. Exemptions are for the items noted in **Table 12** only and shall not relieve the Applicant from implementing any other applicable requirements or from implementing such measures as are necessary to protect public health, safety, and property. An exemption shall not relieve the Applicant from complying with any applicable special requirements for watersheds draining to identified high quality (HQ) or exceptional value (EV) waters or any other applicable current or future federal, state or municipal water quality protection requirements. If a drainage problem is documented or known to exist downstream of, or is expected from the proposed activity, then the Municipality may withdraw exemptions listed in the Exemptions Table and require the Applicant to comply with all requirements of the Municipal Ordinance.

Table 12. Ordinance Exemptions

Ordinance Article or Section	Type of Project	Proposed Impervious Surface			Earth Disturbance		
		0-499 sq. ft.	500-999 sq. ft.	1,000+ sq. ft.	0-4,999 sq. ft. disturbance	5,000 sq. ft. - < 1 acre	≥1 acre
Article IV SWM Site Plan Requirements	Development Redevelopment	Exempt	Not Exempt Simplified Approach	Not Exempt	Exempt	Modified[1]	Not Exempt
Section 304 Nonstructural Project Design	Development Redevelopment	Exempt	Not Exempt Simplified Approach	Not Exempt	Exempt	Not Exempt	Not Exempt
Section 305 Infiltration Volume Requirements	Development Redevelopment	Exempt	Not Exempt Simplified Approach	Not Exempt	Exempt	Exempt	Not Exempt
Section 306 Water Quality Requirements	Development Redevelopment	Exempt	Not Exempt Simplified Approach	Not Exempt	Modified[2]	Modified[2]	Not Exempt
Section 307 Streambank Erosion Requirements	Development Redevelopment	Exempt	Not Exempt Simplified Approach	Not Exempt	Exempt	Exempt	Not Exempt
Section 308 Stormwater Peak Rate Control and Management Districts	Development Redevelopment	Exempt	Exempt	Not Exempt	Exempt	Not Exempt	Not Exempt
Erosion and Sediment Pollution Control Requirements	Must comply with Title 25, Chapter 102 of the PA Code and other applicable state and municipal codes, including the Clean Streams Law.						Not Exempt

Legend:

- **"Proposed Impervious Surface" in Table 9 [tables and section numbers refer to the Model Ordinance] includes new, additional, or replacement impervious surface/cover as part of development or redevelopment.**
- Exempt - Exempt from required section provision only – SWM site plan submission may still be required if other section provisions are applicable.

- Modified[1] - Modified SWM site plan need only consist of items in Ordinance Sections 402.A.2 and 4; 402B.7, 8, 11, and 22; and 402.D.1 and 3 and related supportive material needed to determine compliance with Sections 304 and 308. Modified SWM site plan is required that includes all elements of Section 304 as applicable, except sections; 304.B.6, 304.B.7, and 304.B.8.
- Modified[2] - Modified SWM site plan need only consist of items and related material needed to determine compliance with Ordinance section 306.C.
- Simplified Approach – Have the option to comply with provisions of Appendix B of the Ordinance.
- Redevelopment – See Ordinance Section 308.I for alternate stormwater peak rate control criteria.

Requirements vary based on size and nature of development and are meant to be protective without being overly burdensome. They are as follows:

1. Regulated activities with proposed impervious surfaces between 0 and 499 square feet and earth disturbance between 0 and 4,999 square feet are exempt from fulfilling any requirements of the Model Ordinance, with the exception of existing erosion and sedimentation requirements, and in the case of earth disturbance, Section 306.C of the Ordinance.
2. Regulated activities involving earth disturbance between 5,000 square feet and 1 acre are required to submit a modified Stormwater Management (SWM) plan that only needs to consist of the items in Ordinance Sections 402.A.2 and 4; 402.B.7, 8, 11, and 22; and 402.D.1 and 3. Additionally, the SWM site plan also needs to contain any related supportive material needed to determine compliance with Sections 304, 306, and 308, as applicable. It must satisfy the nonstructural project design, stormwater peak rate control, and management district requirements of the Model Ordinance, but is exempt from all other stormwater or performance requirements of the Model Ordinance.
3. All regulated activities with proposed impervious surfaces between 500 and 999 square feet have the option to use the simplified approach found in Appendix B of the Model Ordinance. The simplified approach requires that the first one inch of runoff from all new impervious surfaces be captured. The simplified approach includes a description of several different types of SCMs that can be used to capture the first one inch of runoff and step by step instructions used to determine the size of the SCMs based on the amount of proposed impervious surface. The simplified approach requires the submission of a worksheet showing calculations for SCM sizing, a simple sketch plan, and a signed operations and maintenance agreement, all of which are found in Appendix B of the Model Ordinance.
4. All regulated activities that have 1,000 square feet or more of impervious surfaces and/or having 1 acre or more of earth disturbance must meet all requirements of the Model Ordinance.

Any regulated activity that is exempt from some provisions of the Ordinance is exempt only from those provisions. If development is to take place in phases, the developer is responsible for implementing the requirements of the Ordinance as the impervious cover/earth disturbance threshold is met. The date of the municipal Ordinance adoption shall be the starting point from which to consider tracts as "parent tracts" in which future subdivisions and respective impervious area and earth disturbance computations shall be cumulatively considered. Exemptions shall not relieve the applicant from implementing such measures as are necessary to protect health, safety, and property.

For example:

If a property owner proposes a 150 square foot shed after adoption of the municipal stormwater management Ordinance, the property owner would be exempt from water quality and quantity requirements of the Ordinance as noted in Table I-1. If, at a later date, the property owner proposes to construct a 499 square foot room addition, the applicant would be required to comply with the requirements for the Simplified Method for the full 649 square feet of impervious cover created since adoption of the municipal Ordinance. If an additional 700 square foot swimming pool/patio is proposed later, the property owner would be required to implement the full stormwater quantity and quality control submission requirements of the Model Ordinance for the total 1,349 square feet of additional impervious surface added to the original property since adoption of the municipal Ordinance.

Exemptions for Specific Activities:

The following activities are exempt from the requirement to submit a stormwater management plan in accordance with the model ordinance:

1. Use of land for gardening for home consumption.

2. Agriculture, when operated in accordance with a conservation plan, nutrient management plan, or erosion and sedimentation control plan approved by the County Conservation District. This includes activities such as growing crops, rotating crops, tilling soil, and grazing animals. For agriculture with an approved conservation plan, installation of new or expansion of existing farmsteads, animal housing, waste storage, and production areas having impervious surfaces that result in a net increase in impervious surface of between 500-999 square feet may apply the simplified approach. Net increases in impervious surface of greater than or equal to 1,000 square feet shall be subject to the provisions of this Ordinance.

3. Forest management operations which are following PADEP management practices contained in its publication, "Soil Erosion and Sedimentation Control Guidelines for Forestry," are operating under an approved erosion and sedimentation plan, and comply with the stream buffer requirements in Ordinance Section 306.C.

4. Repaving without reconstruction.

5. Emergency Exemption - Emergency maintenance work performed for the protection of public health, safety, and welfare. A written description of the scope and extent of any emergency work performed shall be submitted to the Municipality within two (2) calendar days of the commencement of the activity. If the Municipality finds that the work is not an emergency, then the work shall cease immediately and the requirements of this Ordinance shall be addressed as applicable.

6. Maintenance Exemption - Any maintenance to an existing stormwater management system made in accordance with plans and specifications approved by the municipal Engineer or Municipality.

7. Recreational trails, facilities, and appurtenances subject to review provided they comply with all federal, state, and local floodplain policies and regulations.

8. Interior building renovations.

5.9 Small Project Standards

Pennsylvania Act 167 was authorized on October 4, 1978 (32 P.S., P.L. 864) and gave Pennsylvania municipalities the power to regulate activities that affect stormwater runoff and surface and groundwater quantity and quality. Appendix B of the Model Ordinance (Plan **Appendix D**) outlines procedures to allow small projects to comply with stormwater management criteria for new projects meeting the requirements of the Act 167 Stormwater Management Ordinance of the Municipality including sizing, designing, locating, and installing on-lot measures, referred to herein as "Stormwater Control Measures" (SCMs).

Projects which result in between 500 square feet and 999 square feet of impervious area (including the building footprint, driveway, sidewalks, and parking areas) are not required to submit formal stormwater management plan to the Municipality or County; however, they are still required to address water quality and infiltration goals as outlined in the Simplified Approach in the Model Ordinance. If the guidelines presented in Appendix B of the Model Ordinance are followed, an individual homeowner should not need to acquire professional services to comply with these water quality and infiltration goals.

Section B.1 of the Model Ordinance describes requirements and a simplified method for designing a suitable SCM, and a description of what needs to be included on the simple sketch plan. Section B.2 presents definitions of key terms. Section B.3 presents options for SCMs that can be considered for on-lot stormwater management. An example of how to obtain the size and dimensions of a SCM is explained in Section B.4. Section B.5 describes the requirements to be met for the modified Operation, Maintenance, and Inspection Plan.

The Simplified Approach requires:

- The first 1" of rainfall runoff from new impervious surfaces to be captured (see definition in Section B.2 of the Model Ordinance).

The purpose of this is to help reduce stormwater runoff in the community, to maintain groundwater recharge, to prevent degradation of surface and groundwater quality, and to otherwise protect water resources and public safety.

Even though a formal drainage plan is not required for small projects, the Simplified Method worksheet found in Table B-4 of the Model Ordinance and a simple sketch plan containing the features described in Step 5 of Section B.1 needs to be submitted to the Municipality, and if applicable, the contractor prior to construction. The Operation and Maintenance Agreement found in Section B.5 needs to be signed and submitted with the simple sketch plan to the Municipality for approval.

6. Delaware County Model Ordinance

Municipalities within the Commonwealth of Pennsylvania are empowered to regulate land use activities that affect runoff by the authority of the Act of October 4, 1978, 32 P.S., P.L. 864 (Act 167) Section 680.1 et seq., as amended, "The Storm Water Management Act." Act 167 requires that:

- Counties prepare a watershed stormwater management plan in conformance with the requirements of Act 167 for each watershed within their boundaries. This plan compiles the individual watershed plans into a single County-Wide Stormwater Management Plan (County-wide Plan).
- The individual watershed plans and this County-wide Plan evaluate present and future runoff within the watershed and make technical recommendations for the control and management of runoff from new development (both quantity and quality).
- Municipalities implement the plan via adoption of a stormwater ordinance consistent with the Model Ordinance developed as part of this plan.
- Developers control the quantity and quality of runoff from new development (including redevelopment) in accordance with each municipality's stormwater ordinance.

The Storm Water Management Act emphasizes locally administered stormwater programs with municipalities taking the lead role to execute the provisions of the plan. Implementation and enforcement of the watershed plan standards and criteria require municipalities to adopt the appropriate ordinance provisions that regulate the alteration or development of land, including subdivision and land development within a municipality (Section 13 of Act 167). As part of the preparation of this County-Wide Plan, a model municipal ordinance was created that will serve as a tool to implement the plan provisions. This model ordinance can be adopted by each municipality with only minor municipality specific modifications to fulfill the required stormwater management needs of a particular municipality with respect to Act 167.

In addition to adopting the ordinance itself, municipalities must revise their existing subdivision and land development and zoning ordinances and building codes to incorporate necessary linking provisions into the existing ordinances. These linking provisions are placed in the existing ordinances to refer parties engaging in various activities that may affect stormwater within the watershed to the single purpose ordinance. Key provisions of the model stormwater ordinance include stormwater management standards and criteria, performance standards for stormwater management, and maintenance provisions for stormwater facilities.

The model stormwater ordinance is worded and designed to be understandable, applied fairly and uniformly throughout the County, and to allow for creative solutions to stormwater management problems. It is provided so that the municipalities within Delaware County can adopt a uniform regulatory approach for stormwater management within the County.

The implementation of the runoff control strategy for development within the County will be through municipal adoption of the appropriate ordinance provisions. It is the intent of this County-wide Plan that adoption of an ordinance consistent with the provisions of the plan's model ordinance replace existing municipal stormwater ordinances. **The provisions of this plans model ordinance have been developed to be consistent with PADEPs 2028 MS4/Act 167 Model Ordinance and the draft Post Construction Stormwater Management (PCSM) Manual.**

The model ordinance, presented in **Appendix D** of this plan and summarized below, has been developed specifically for municipalities within Delaware County for implementation of this County-wide Plan.

All the provisions included in this Plan's model ordinance (unless specifically designated otherwise) are required to be part of the municipal stormwater ordinance or other ordinances implementing the requirements of this Stormwater Management Plan.

6.1 Organization

This model ordinance contains the following eleven (11) articles and ten (10) appendices, each with specific provisions.

Article I - General Provisions: This article includes general administrative provisions including applicable land areas and regulated activities. This article also includes the stormwater management exemption criterion.

Article II - Definitions: This article provides a list of common terms and associated definitions used throughout the ordinance.

Article III – General Stormwater Management: This article covers general requirements for erosion and sedimentation (E&S) control and post construction stormwater management (PCSM) control. Exemptions from the general standards are also presented.

Article IV – E&S Plan and Implementation Requirements: This article covers general E&S Plan requirements, protection of site infiltration properties during earth disturbance, discharges to special protection and impaired waters, E&S plan submission requirements, and E&S Plan submission requirements.

Article V – PCSM Plan and Implementation Requirements: This article covers PCSM plan content requirements, Pre-development site characterization, stormwater analysis, erosion potential and stream stability analysis, off-site stormwater stability analysis requirements, Stormwater management in karst terrain, PCSM plan submission, review and approval processes, and requirements at project completion.

Article VI – Stormwater Control Measures: This article introduces the design of stormwater control measures (SCMs) and provides or references appropriate design guidance. It also provides information existing SCM retrofits and riparian buffers.

Article VII – Operation and Maintenance: This article outlines the applicants' responsibilities for operation and maintenance of stormwater facilities. It also outline operation and maintenance agreement requirements.

Article VIII – Easements: This article outlines onsite requirements and easement or other requirements for off-site discharges of stormwater to non-surface waters.

Article IX – Fees and Expenses: This article contains the provisions for a municipal fees associated with stormwater plan review and enforcement.

Article X – Prohibitions: This article outlines prohibited discharges, prohibited connections, roof drain requirements, and requirements concerning the alteration of SCMs.

Article XI - Inspection, Enforcement and Penalties: This article describes municipal post construction inspections, enforcement procedures, remedies, penalties, and appeals processes.

Appendices: The Model Ordinance Appendices are:

A. Stormwater Management Release Rate information.

B. Simplified Approach to Stormwater Management for Small Sites.

C. Sample Stormwater Management Site Plan Application, Proposed Schedule of Fees, and Example Submission Checklist.

D. Implementation Flow Charts.

E. Low Impact Development Design Criteria.

F. Stormwater Management Design Criteria.

G. References.

H. West Nile Virus Guidance.

I. Stormwater Controls and Bets Management Practices Operations and Maintenance Agreement.

J. Riparian Buffer Trail Guidelines.

Please note that the plan and associated ordinance provisions were developed under the authority of, and in strict conformance with, the requirements of Act 167. These documents were prepared in consultation with a Watershed Plan Advisory Committee (WPAC) comprised of designated representatives from each of the Delaware County municipalities, the Delaware County Planning Department, and Conservation District staff, as well as other watershed stakeholder groups.

Within six months following County adoption and PADEP approval of a watershed stormwater management plan, each municipality within the watershed is required to adopt or amend stormwater ordinances as laid out in the plan. These ordinances must regulate development within all County watersheds in a manner consistent with this County-wide stormwater management plan and the provisions of the Act.

For municipalities that issue an occupancy permit, the following amendment is required:

- **An occupancy permit shall not be secured or issued unless the provisions of the Delaware County Stormwater Management Ordinance have been followed. The occupancy permit shall be required for each lot owner and/or developer of all major and minor subdivisions and land development in the municipality.**

Municipalities without an occupancy permit may want to adopt the above or similar language along with other regulatory items or requirements they have related to occupancy.

6.2 MS4 NPDES Requirements

Federal regulations approved October 1999 require operators of small municipal separate storm sewer systems (MS4s) to obtain NPDES Phase II permits from PADEP by March 2003. (NPDES II is an acronym for the National Pollutant Discharge Elimination System Phase II Stormwater Permitting Regulations.) This program affects all municipalities in "urbanized areas" of the state. All 49 municipalities in Delaware County have designated as MS4 communities and are subject to the NPDES Phase II requirements

mandated by the Federal Clean Water Act as administered by PADEP. For more information on NPDES II requirements, contact the PADEP Regional Office.

This plan and model ordinance are consistent with PADEP's post-construction stormwater management requirement as defined in the 2028 NPDES II/MS4 program. Adoption of this plans Model Ordinance will ensure municipalities in Delaware County are compliant with 2028 MS4 requirements.

6.3 Implementation

In order to aid the municipalities and developers in the implementation process, flow charts have been developed as shown in Ordinance **Appendix D**.

6.4 Administration

As stated in Section 105 of the model ordinance, all regulated activities and all activities that may affect stormwater runoff, including land development and earth disturbance activities, within Delaware County are subject to regulation by the Ordinance.

7. Plan Implementation

7.1 Overview

Stormwater problem areas were identified by WPAC members and stakeholders through a GIS-based survey, as described in **Section 4.3** of this Plan. These problem areas were subsequently reviewed and categorized by problem type. A goal of this Plan was to develop an inventory of conceptual potential solutions for all the identified problems and to describe more detailed conceptual strategies for the highest priority problems. The procedures followed to achieve this goal are outlined in the following sections.

7.2 County Action Items

The Delaware County Planning Department has assumed a supportive role for several decades facilitating stormwater planning throughout the County. The adoption of this plan will provide a starting point for additional countywide strategies that support municipal compliance with Act 167 and MS4 requirements as well as other County specific stormwater related efforts.

Delaware County Act 167 Plan Actions:

1. Continue to support the WPAC through the organizing of annual WPAC meetings to meet PADEP Act 167 Phase I requirements (in the event an update is required). Additionally, the Planning Department will explore synergies between Act 167 and Hazard Mitigation Plan efforts. Refer to **Section 7.7 Plan Review, Revision, and Update Procedures**, for more information.
2. Continue to support municipalities through actively providing necessary model ordinance update language as required by PADEP.
3. Evaluate County properties for opportunities to mitigate stormwater and flooding impacts.
4. Seek funding for County property stormwater and flood mitigation projects including modeling, design, and construction. Refer to **Section 7.6 Funding & Grant Opportunities**, for more information.
5. Support municipal flood mitigation projects including modeling, design, and construction as well as municipal efforts to seek necessary funding.
6. Develop an ongoing countywide GIS tool to continue to identify/capture newly recognized flood problem areas.
7. Coordinate and communicate with neighboring counties and the City of Philadelphia to identify collaborative stormwater modeling and/or project efforts as well as funding streams/mechanisms to support said efforts. Coordinate with surrounding counties to develop/update release rates for applicable shared watersheds.
8. Explore, in partnership with the Delaware County Conservation District, the opportunity to develop a countywide MS4/stormwater steering committee.
9. Develop a countywide system of flood gauges and, in the future, add life safety alert capabilities and water quality monitoring features.

10. Compile and develop a countywide MS4 GIS layer of grey stormwater infrastructure and maintain said layer for County and municipal use.
11. Support municipal efforts to develop multi-municipal stormwater collaboratives.

7.3 High Priority Problem Areas

A total of 273 sites were identified as a part of the problem area survey and additional research. These sites were evaluated with respect to their reported level of severity based on the types and number of properties impacted and if loss of life was reported. Areas with several high severity problems and areas with noted emergency service responses were reviewed for the following:

- Severity and type of problem
- Number and type of properties impacted
- Noted impacts to health and safety
- Feasibility of required solutions

Based on the above criteria, 130 problem areas were identified as high priority. These areas and their specific type of stormwater problem(s) are depicted in **Figure 6**. Solution forms for each high priority problem area are provided in **Appendix F**. Each solution form provides an overview of the problem, location, watershed, and other pertinent site information, including photographs taken during field visits. Additionally, 2D flooding images are included which have been generated from either one of the three HEC-RAS evaluations captured in **Section 4**, or the SCALGO analysis tool (**Section 4.5**) which also provides a planning level depiction of vulnerable flood areas for the 100-year event. Lastly, the problem area solution forms contain recommendations on next steps and potential solutions to pursue further.

Solutions for the high priority problem areas were selected to provide coverage of a variety of problem types across the County. Most problems reported in the survey were caused by flooding. Additionally, more sites were reported in the lower areas of the watersheds and therefore more flooding sites in the southeast portion of the County are included in the high priority areas

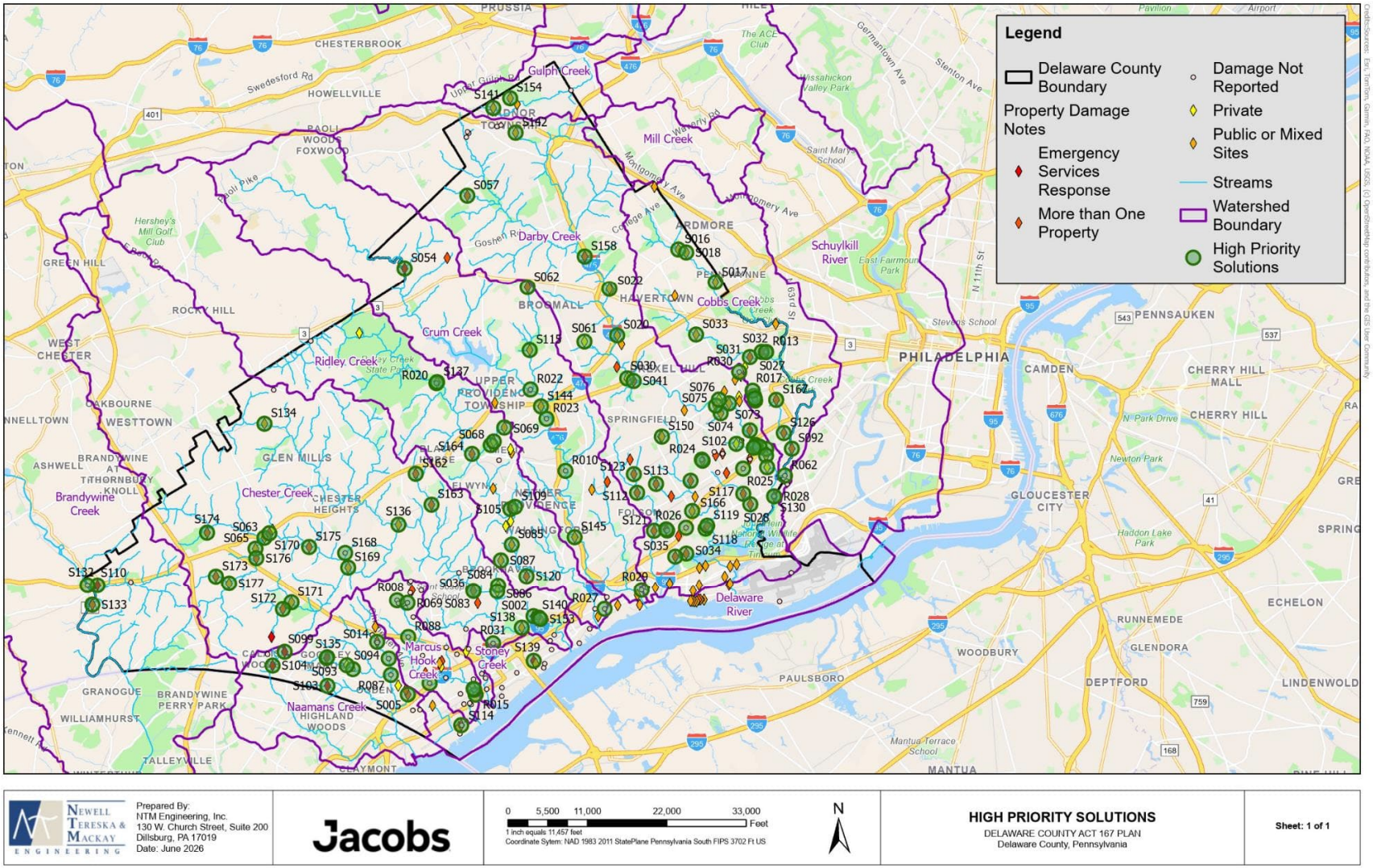


Figure 6. High Priority Problem Areas Map

7.4 Proposed Solutions for Highest Priority Stormwater Problem Areas

Of 130 problem areas identified as high priority, 20 flooding problems were further identified as "highest" priority based on their noted frequency, severity, and impacts to emergency services, roads, and structures. More refined recommendations for additional analyses and/or potential constructed improvements for these selected highest priority problems were developed to facilitate further project definition in future efforts.

Based on a combination of professional judgement, project experience, and a review of completed flood project costs in Pennsylvania (as documented in *Pennsylvania Flood Resiliency Success Stories*, PA Silver Jackets Team, September 2023), planning-level cost ranges were developed for solutions addressing the highest priority problems. Each proposed solution was assigned low, medium, and high cost ranges, and these ranges were then applied to each problem area. Note that these estimated cost ranges are intended to allow for relative comparisons between different levels of solution implementation, accounting for solution type, scale, and complexity, rather than provide absolute cost values.

The cost categories and their associated estimate ranges are summarized as follows:

- **Range of costs for additional evaluation:**
    - Low – < $50k
    - Medium – $50k-250k
    - High - > $250k
- **Range of costs for local improvements (includes both engineering and construction costs):**
    - Low – <$500k
    - Medium – $500k-$2M
    - High – > $2M
- **Range of costs for watershed-level blue/green stormwater infrastructure improvements (includes both engineering and construction costs):**
    - Low – < $3M
    - Medium – $3M-$10M
    - High - > $10M

This section provides a description of the recommended strategy for addressing each of these problem areas, whether it is additional analyses (e.g., detailed flood studies), local drainage improvements (e.g., new storm inlets and pipes), and/or watershed-level blue/green stormwater infrastructure improvements (e.g., nature-based solutions such as constructed wetlands or large-scale underground stormwater storage / infiltration systems). **Figure 7** depicts the 20 locations that were deemed to be the "highest" priority problems. **Table 13** provides a summary of the estimated recommended solution costs for these problems. The information summarized below is also contained in the solution forms for the highest priority problem area, which can be found **Appendix G**.

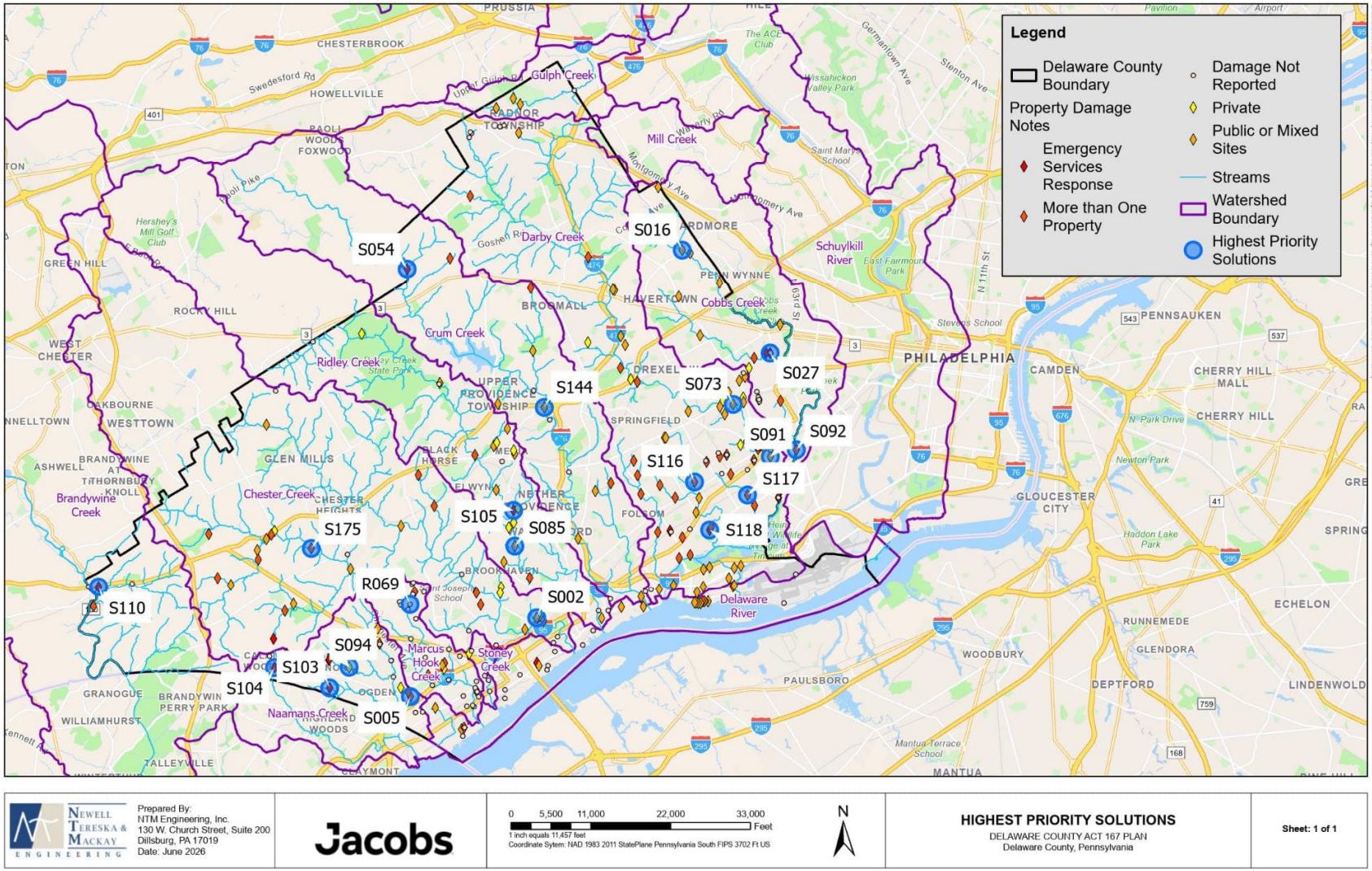


Figure 7. Highest Priority Stormwater Problem Area

Table 13. Estimated Recommended Solution Cost Ranges for Highest Priority Problem Areas

Problem Area ID	Additional Evaluation	Local Improvements	Watershed-level Improvements
R069	N/A	Medium	N/A
S002	Medium	Low	Medium
S005	N/A	Medium	N/A
S016	N/A	Medium	Medium
S027	Medium	High	High
S054	Low	Medium	N/A
S073 / S091	High	High	High
S085	High	Medium	High
S092	Medium	High	High
S094	High	Medium	High
S103	Low	Medium	N/A
S104	Low	Medium	Medium
S105	High	High	N/A
S110	Medium	High	N/A
S116	High	Medium	N/A
S117	High	Medium	High
S118 / S119	Low	Medium	N/A
S144	N/A	High	N/A
S175	N/A	High	Medium

Highest Priority Solution: R069 – Newsome Park and Weir Road Culvert

R069 is located within the Marcus Hook watershed and was therefore included in the 2D HEC-RAS analysis developed for the Marcus Hook Creek Pilot Study, which can be found in **Appendix B.1**. Refer to **Figure 8** for the location of R069. Flooding of Weir Road and several residential properties in this area is likely the result of the existing culvert being insufficient to efficiently convey uncontrolled runoff from development in the watershed. The recommended strategy for this problem location is twofold (see the associated mapping in **Appendix G.1)**:
1) Create enhanced retention / detention storage at Newsome Park
2) Provide enhanced conveyance under Weir Road and into the open channel at Weir Park.

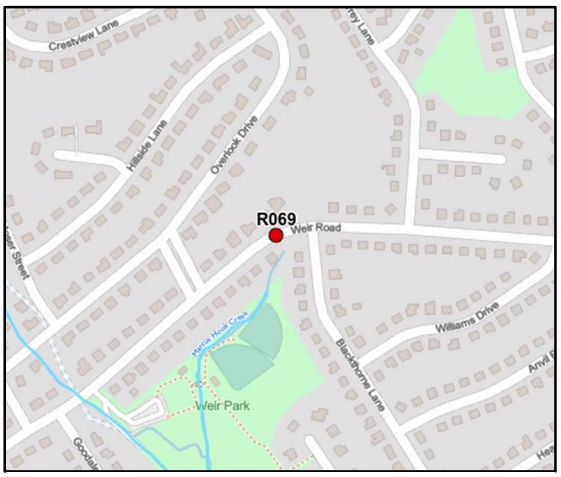


Figure 8. R069 Location

There are several opportunities for enhancing retention / detention storage at Newsome Park. An approximately10,000 square foot bioretention basin (potential capacity of about 38,000k cubic feet) can be placed at the location of the existing paved loop on the south end of the park. Additionally, more significant storage volume within the wooded areas of the park can be achieved via strategies such as berms, retentive grading, and/or constructed wetlands. Improvements to the creek itself can also help mitigate the flooding, including: widening, step pools, and/or check dams. These improvements within the park would require coordination with stakeholders such as the Aston Township Parks and Recreation Committee, alignment with Township plans for the park, feedback from local residents, and input from a certified arborist to ensure minimal impacts to healthy mature trees. Downstream conveyance from the park would be improved by upsizing/improving the existing storm culvert (approximately 500 linear feet) extending southward under Weir Road and into Weir Park. Detailed hydraulic modeling would be required to better understand the required sizing of both the storage improvements in the park and the improved culvert to improve local flooding conditions and minimize the risk of negative impacts to downstream properties and roadways. The Marcus Hook Creek Pilot Study model located in **Appendix B.1** may be of use towards additional and more detailed modeling efforts.

<u>Estimated Cost Ranges:</u>

1) Additional analysis: N/A (hydraulic modeling is included as part of the engineering for the local improvements in #2).

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: N/A

Highest Priority Solution: S002 – Kerlin Street Bridge and Nearby Upland Borough Problem Areas

The problem at S002 is in Upland Borough in the Chester Creek watershed, and was reported as both a flooding and sedimentation problem. Site visits (refer to **Appendix G.2**) confirmed a high degree of sediment deposition in the vicinity of Kerlin Street Bridge. Refer to **Figure 9** for the location of this problem area. Though additional analysis is needed, S002 appears to be a stream deterioration situation wherein segments of Chester Creek are continually eroded and excess sediment is then naturally deposited at downstream locations where the physical conditions lead to decreases in velocity, such as at the Kerlin Street bridge and possibly even further downstream at locations S140 and S153 (see associated mapping in **Appendix G.2**). The accumulation of sediment at these locations may be a factor in the observed flooding here, as it limits the conveyance capacity of the creek. There are potentially other factors at play in addition to sedimentation that also may be contributing to the flooding.

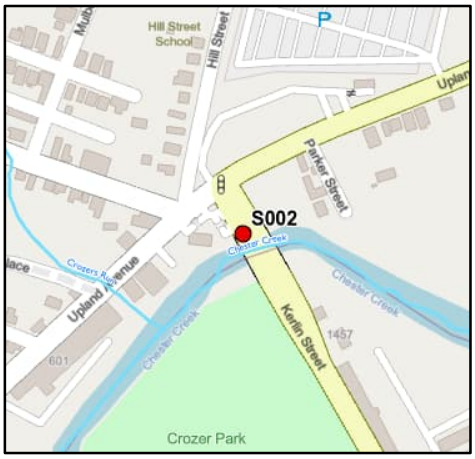


Figure 9. S002 Location

More detailed evaluations are recommended to better understand both the flooding at this location and the source of the observed sedimentation, and how they can be mitigated. A HEC-RAS model of Chester Creek can be adapted or else developed to analyze shear stress / stream power. Such a model would provide insights into the relationship between the creek's shear stresses and velocity profiles, and could be used to determine how much sediment would need to be removed to achieve lowered flood depths. It is further recommended to couple HEC-RAS with the Bank Stability and Toe Erosion Model (BSTEM) to simulate the relationship between creek bed and bank processes, which could further illuminate the likely source / mechanism of sedimentation and how it can be reduced. The recommended additional model study area is depicted in **Appendix G.2** mapping. It should be noted that removing sediment from the creek will likely require multiple permits and entail fairly substantial costs, including: site clearing and tree removal costs for access to the creek, excavation and removal of unsuitable material, erosion control, temporary construction entrances, permanent seeding, site restoration, and dewatering. Isolated removal of sediment is essentially a temporary measure. Following any activity to remove sediment, and without implementing any permanent sediment mitigation measures, it can be expected that sediment will immediately begin to collect again at these locations during subsequent storm events. Continued maintenance may be required to consistently maintain mitigatory flood reduction effects provided by the sediment removal. Therefore, in addition to the development of robust maintenance protocols, it is recommended to identify opportunities for permanent opportunities to reduce the source of sediment such as outfall energy dissipation, streambank stabilization, and/or forebay creation outside of the floodplain.

Lastly, it should be noted that Crozer Park, which is a public park immediately upstream of S002, could be re-imagined as a "floodable park" and evaluated as an opportunity to create significant flood and/or stormwater storage. With over six acres of apparent open space, Crozer Park appears capable of temporarily storing 500,000 to 1.3M cubic feet of water. Other large publicly owned spaces upstream of S002, such as Upland County Park and the Pusey Lease Area, should also be explored for similar opportunities.

Estimated Cost Ranges:

1) Additional analysis: Medium: ($50k-$250k)

2) Local improvements: Low (<$500k)

3) Watershed improvements: Medium ($3M-$10M)

Highest Priority Solution: S005 – Boothwyn Town Center

Multiple properties on Malatesta Ave, 2nd Ave, and 3rd Ave in Boothwyn were reported to experience standing water and saturated grasses. Refer to **Figure 10** for the location of problem area S005. The ponding water has become a hazard to animals in the area. The field visit observed existing drainage infrastructure is inadequate to capture and convey stormwater runoff from the roadways in this area. The National Resources Conservation Service soil maps show this area to have a shallow water table (2-3 ft below the surface) and hydrologic soil group 'D', which indicates low infiltration capacity. Flooding in this area appears to be the result of the runoff from impervious areas and natural hydrology at the site based on preliminary analysis and site assessment.

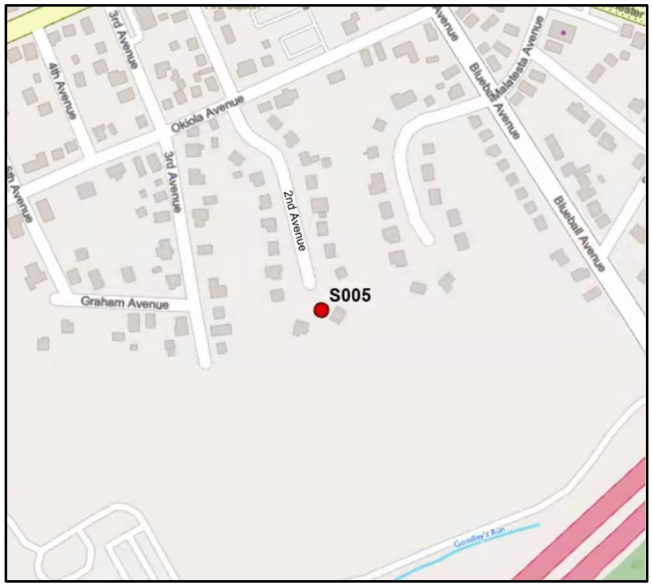


Figure 10. S005 Location

The solution to flooding at this site will require the installation of conveyance measures to redirect water away from the area and directly into a stormwater management facility. Stormwater conveyances that discharge behind the homes at the end of the cul-de-sacs on these roadways are recommended. The outfalls of these drainage networks should be directed towards a non-infiltrating SCM. Upper Chichester Township owns a 4.1-acre plot of land in this area that abuts a wooded site owned by the Upper Chichester School District. Site conditions may be well-suited to the installation of an engineered stormwater treatment wetland, which can provide flood mitigation and ecological benefits. Engineered wetlands require several acres of open space, and while this area generally appears large enough, the presence of wooded areas may limit the required extents of a treatment wetland. Alternatively, bioretention or regenerative step pool conveyance systems could be considered, as they do not require as much open space as a treatment wetland. Please refer to the associated mapping in **Appendix G.3.**

Estimated Cost Ranges:

1) Additional analysis: N/A

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: N/A

Highest Priority Solution: S016 – Wynnefield Drive Properties

S016 is in Haverford Township along Cobbs Creek and within its watershed. Refer to **Figure 11** for the location of this problem area. S016 is characterized by a tight stream channel directly adjacent to a private alley which is situated along the backyard of several residential homes with frontages along Wynnefield Drive. Both the alley and the back portions of most of the homes fall within the FEMA 100-year floodway of Cobbs Creek, making this problem area a particularly dangerous and vulnerable site for the residents during larger rainfall events. It should also be noted that the SCALGO analysis tool (utilized for high level flood vulnerability mapping) shows flood waters within the vicinity of these properties for more frequent storms, including the 1-year and 5-year rainfall events (see the associated mapping in **Appendix G.4)**.

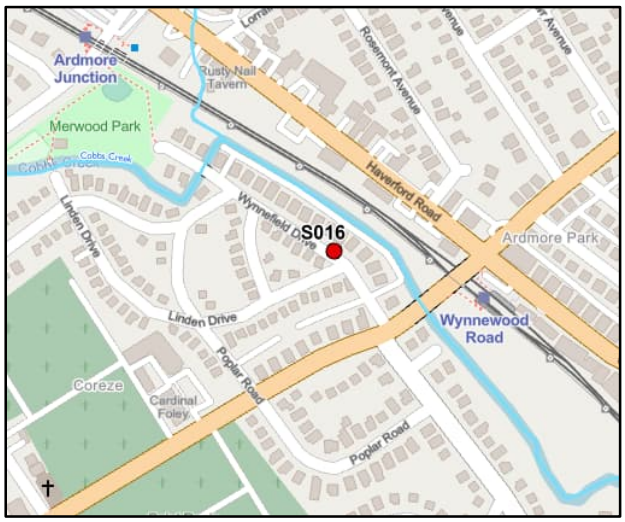


Figure 11. S016 Location

The recommended strategy for this problem location is threefold:
1) Create more capacity in the stream channel
2) Consider the use of an automatic / hydrodynamic flood barrier
3) Explore upstream opportunities for stormwater storage at publicly owned sites.

Additional capacity in the approximately 1000-foot-long channel segment could be created by removing accumulated sediment and vegetation, as well as widening the channel by cutting back on the slope and/or constructing a retaining wall on the SEPTA railroad side. There is also potential for providing auxiliary flood storage below the alley itself using high-capacity and traffic-rated storage media. A flood barrier using a passive hydrodynamic mechanism (approximately 950 feet long) could be installed along the creek-side of the alley to protect the adjacent houses along Wynnefield Drive from flood surges, though further evaluation would be required to ensure that the local storm drains would not be unduly impacted by the flood barrier. Upstream public parks (Merwood Park, Normandy Park, and Elwell Field) and one public school (Chestnutwold Elementary School) could provide good opportunities for stormwater capture, most likely in the form of underground systems constructed with high-capacity storage media, that could be especially effective for smaller, more frequent storms while reducing the impacts for larger storms. Implementing these recommended strategies would entail extensive coordination with stakeholders such as the residents on Wynnefield Drive, SEPTA, Haverford Township Parks and Recreation, and the Haverford Township School District if the school was involved. Detailed hydraulic modeling would be required to better understand existing flooding extents and frequency, and to evaluate the effectiveness of the proposed solutions at minimizing the risk to both adjacent and downstream properties.

<u>Estimated Cost Ranges:</u>

1) Additional analysis: N/A

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: Medium ($3M-$10M)

Highest Priority Solution: S027 – Naylors Run Problem Areas

S027 is one of several high priority problem areas within the Naylors Run watershed, which is part of the larger Cobbs Creek watershed. Refer to **Figure 12** for the location of S027. Naylors Run watershed is of high interest due to its downstream contributions to the floodwaters impacting the Eastwick community located within the City of Philadelphia. However, this area of Upper Darby Township is also prone to multiple instances of flooding along the approximate the length of the culverted portion of Naylors Run. The most significant flooding occurs at the intersection of S 69th Street and Marshall Road, where at least one fatality has been recorded. This intersection is particularly susceptible to flooding due to it being in a 'bowl' at the bottom of several streets, some of which are very steeply sloped with insufficient drainage, as well as it being directly above the culverted portion of Naylors Run. For these reasons, Naylors Run was selected for an additional 2D flood modeling analysis which is presented in **Appendix B.3**.

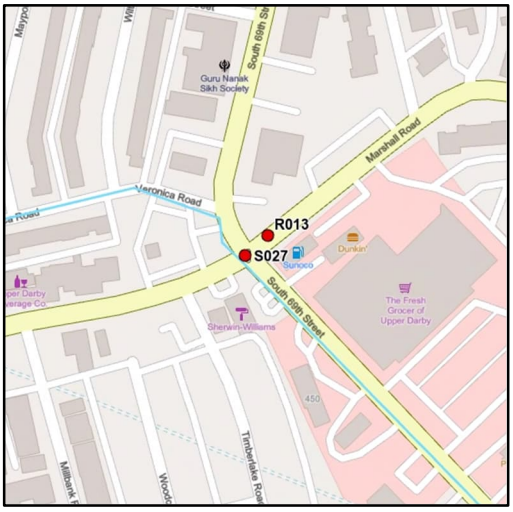


Figure 12. S027 Location

The recommended flood mitigation strategy for S027 would be multi-phased and would (at least partially) address the other high priority problem locations in the Naylors Run watershed (S031, S032, and S033). The three phase approach would include:
Phase 1) Detailed hydrologic and hydraulic (H&H) Model
Phase 2) Local Drainage Improvements
Phase 3) Blue/Green Stormwater Infrastructure

Phase 1 would entail the development of a more detailed hydraulic model that would incorporate existing storm pipes, the pump station in the vicinity of S031, and the Naylors Run Dam. This model, which would be further refined by higher quality datasets and topographic surveys, would be used to better evaluate existing flood conditions and the potential benefits/impacts associated with various proposed drainage solutions. The planning-level model described in **Appendix B.3** could serve as a valuable tool for designating future modeling steps or as a basis for more detailed modeling.
Phase 2 would entail the implementation of local drainage improvements in the vicinity of S027. Specifically, an auxiliary drainage network is proposed consisting of various new catch basins and approximately 2,000 feet of new storm pipe extending from Veronica Road to the 69th Street Recreation Area. This drainage network is envisioned to be relatively shallow, mildly sloped, and sized to convey smaller, more frequent storms or to provide auxiliary conveyance for larger flood events. The new storm pipe would extend along S 69th Street, potentially integrated with stormwater tree trenches, and into the recreation area where it would drain into an underground storage / infiltration system (up to 5 acres in size and approximately 5 feet thick with a potential storage capacity of 1M cubic feet) that would overflow into Naylors Run. Given that S027 is located at a low point at the intersection of S 69th Street and Marshall Road, the proposed storm pipe would have to "buck" grade, which would result in the underground storage system at the recreation center being relatively deep (20-25 feet). A thorough geotechnical investigation would be required to confirm the feasibility of this concept.

In addition to the above local drainage improvements, it is also recommended to add street inlets to S 69th Street and Marshall Road, north and east of S027, respectively. This will allow for more efficient use of the existing storm pipes on these streets, especially S 69th Street, which is very steep and likely experiences significant flow bypass during intense rainfall events.

Phase 3 would entail the implementation of several large-scale blue/green stormwater infrastructure projects at various large "open" spaces throughout the watershed, with a potential combined storage capacity of 1.6M cubic feet.
Potential projects on publicly owned land include:

- Constructed wetlands/bioretention basin and/or underground stormwater storage / infiltration systems at Upper Darby High School and Naylors Run Park (potentially 760,000 cubic feet of storage)
- An underground storage / infiltration system at the Beverly Hills Recreation Area (potentially 400,000 cubic feet of storage)
- An underground storage / infiltration system at the Cardington Recreation Area Park (potentially 100,000 cubic feet of storage)

Potential projects on privately owned land include:

- An auxiliary drainage network (650 feet) and constructed wetlands/bioretention basin at a PECO electrical substation (potentially 175,000 cubic feet of storage)
- An underground storage / infiltration system at the shopping center located southeast of the intersection of S 69th Street and Marshall Road (potentially 200,000 cubic feet of storage) that could be connected to the drainage network proposed in the Phase 2.

Please refer to the associated mapping in **Appendix G.5.**

Estimated Cost Ranges:

1) Additional analysis: Medium ($50k-$250k)

2) Local improvements: High (>$2M)

3) Watershed improvements: High (>$10M)

Highest Priority Solution: S054 – Confluence of Crum Creek and Lewis Run

S054 is in Newtown Township at the intersection of Boot Rd and Goshen Rd as shown in **Figure 13**. The problem area is characterized by extreme roadway flooding at the intersection which is located directly downstream of the confluence of Lewis Run Creek with Crum Creek. The location is also close to the Delaware-Chester County border. The recommended strategy for this problem area is twofold:
1) Develop a detailed flood model to better understand the flooding causes, extents, and frequency
2) Provide additional flow capacity, stabilization, and roadway traffic safety measures.

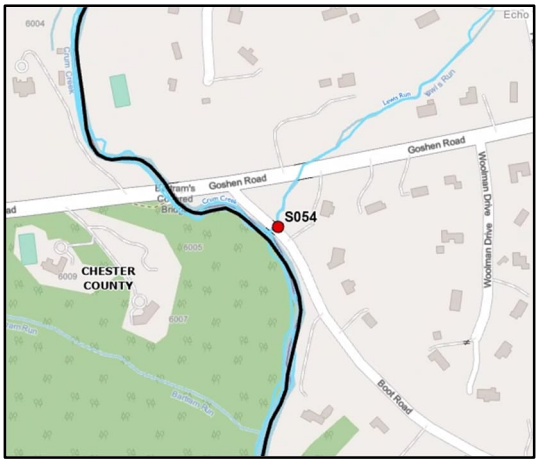


Figure 13. S054 Location

The point of interest for the recommended flood model would be the confluence of the Crum Creek and Lewis Run, the former of which includes significant drainage area within Chester County. The purpose of the study would be to determine what storm conditions cause the yearly flooding noted in the problem survey and to evaluate the benefits and potential downstream impacts of any proposed mitigation solutions. Lewis Run is a small sub-watershed which should be easily characterized for modeling. Per **Section 4.6** of this Plan, there are proposed stream gages directly upstream and downstream of the area of interest which, once operational, would potentially make this modeling effort substantially easier. Model scenarios should also capture upstream storage opportunities within both Delaware County and Chester County to determine their flood reduction potential.

Potential local improvements include: widening the stream, stabilizing the banks via vegetative and/or structural means, and enhancing or expanding the wetlands area at the southeast corner of the intersection of Goshen Road and Boot Road. In addition, traffic calming and safety improvements should be implemented along the creek-side of Boot Road, for approximately 500 feet south of the intersection. Currently, this stretch of roadway is exposed with little visual or physical markers to separate it from the riparian corridor. A multidisciplinary approach should be taken for any future stormwater project to be collaborative with transportation engineering improvements. Additional signage warning of potential flooding at this location are also recommended. Please refer to the associated mapping in **Appendix G.6.**

<u>Estimated Cost Ranges:</u>

1) Additional analysis: Low (<$50k)

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: to be determined

Highest Priority Solution: S073 / S091 – Darby Creek Problem Areas

S073 is one of several locations of high-profile roadway flooding along the Darby Creek. Scottsdale Road at the intersection of Hilldale Ave next to the Shrigley Woods Park, has significant flooding reported to be occurring more than once per year and lasting for multiple days at a time. Scottsdale Road is located close to the Darby Creek, and the flooding there is also associated with Problem Areas S074 and S075. Refer to **Figure 14** for the locations of S073 and S091. Video footage of Hurricane Irene in 2011 provided by the municipalities shows the entire roadway and nearby parks engulfed within Darby Creek floodwaters. There are other locations in the Darby Creek watershed with significant roadway flooding, including: S088, S089, S091, and S106. These are in multiple boroughs (Clifton Heights, Lansdowne, Darby, and Collingdale). Similar to S073, it was reported at S091 (which is Pine Street and its bridge where it crosses the Darby Creek) that flood waters have impacted nearby structures, roadways, and park land, though the reported frequency was less than once per year and the duration was less than one day. Delaware County EMS reported that during Hurricane Floyd in 1999, the water level reached the top of this bridge.

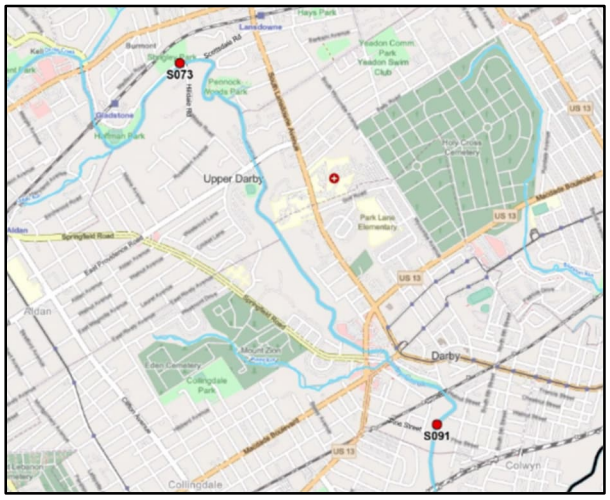


Figure 14. S073 / S091 Location

Before meaningful flood solutions can be developed for these problems, it is recommended that a detailed, watershed-wide HEC RAS model be developed for the Darby Creek, using reports and video from Hurricanes Floyd (1999) and Irene (2011) as validation points, alongside available USGS stream gage data and FEMA flood insurance study data, as well as any other collaborative modeling initiatives taking place with other stakeholders. The exhibits in **Appendix G.7** show the area including strategic proposed stream gages from the Stream Gage Locations Analysis in **Section 4.6** which would also be very beneficial to a future modeling analysis of Darby Creek.

While roadway/bridge flooding was noted at a number of locations, at locations S073, S074, and S075, flooding was reported to occur with a relatively high frequency of more than once per year, meaning that Darby Creek is flooding significantly in storms far less than the 100-year event. The detailed flood model would be used to verify what conditions are causing roadway flooding, which level storm event results in observed flooding occurrences, and facilitate scenarios to be run for potential solutions such as floodplain benching / expansion, clearing of channel obstructions, watershed-wide storage opportunities, and other nature-based solutions. The downstream boundary conditions for the model should be closely coordinated with the previously completed detailed modeling efforts and proposed solutions developed for the Eastwick neighborhood further downstream, southeast of the confluence of the Darby and Cobbs Creeks.

A key focus of the evaluation will be to determine what degree of upstream storage or infiltration projects can alleviate the downstream instances of roadway flooding. The Delco Woods County Park is in a good location, midway through the Darby Creek watershed, and it could be a suitable host to a variety of stormwater measures such as; wetlands, stream restoration, and green stormwater infrastructure. It is recommended that this site be evaluated further for future potential. Please refer to the associated mapping in **Appendix G.7.**

Additionally, it is strongly recommended that this evaluation be included with other Darby-Cobbs initiatives that the County is proposing for inclusion within the upcoming Pennsylvania Water Resources Development Act (WRDA). Refer to **Section 7.5 Funding and Grant Opportunities** for more information.

Estimated Cost Ranges:

1) Additional analysis: High (>$250k)

2) Local improvements: High (>$2M)

3) Watershed improvements: High (>$10M)

Highest Priority Solution: S085 - Brookhaven Memorial Park

Erosion was reported at point S085 along Ridley Creek between Parkview Drive and Cambridge Road at Brookhaven Memorial Park. The location of S085 is shown in **Figure 15**. Erosion and sedimentation, flooding, and water rescues were reported throughout the length of the stream in Delaware County. As such, the solution at S085 includes local improvements, additional analysis, and watershed-scale improvements.

The stream erosion has led to the undermining of stormwater infrastructure at this location and further erosion has potential to cause damage to homes. Recommended local improvements include restoration of existing infrastructure for stormwater conveyance and streambank armoring.

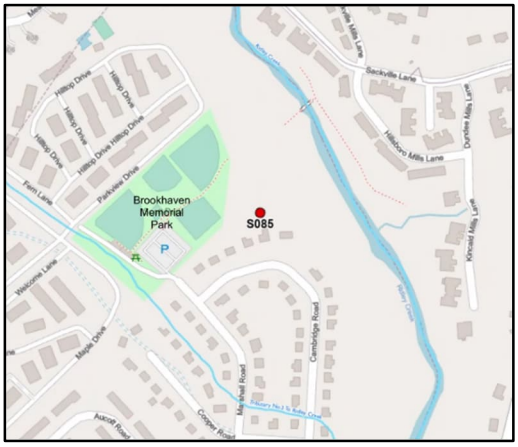


Figure 15. S085 Location

An in-depth analysis of the stream is recommended in coordination with Chester County to identify potential stormwater management controls throughout the watershed, including within the headwaters in Chester County where less development has been established. Analysis can help determine the best areas for stream restoration, as well as areas for stormwater infiltration/retention basins to reduce peak rates and volume in the watershed. Bethel Township owns property upstream of S094 that could be used for such facilities. Please refer to the associated mapping in **Appendix G.8.**

Estimated Cost Ranges:

1) Additional analysis: High (>$250k)

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: High ($10M)

Highest Priority Solution: S092 - Eastwick Problem Areas



Figure 16. S092 Location

S092 is along Woodland Avenue within the Cobbs Creek watershed at the location of the stream itself which is just west of the intersection with South Cobbs Creek Parkway and is also at the border of Delaware County and the City of Philadelphia. Refer to **Figure 16** for the location of S092. This problem area is in Darby Borough, and is characterized by Cobbs Creek floodwaters entering roadways and structures. Most notably, this is one of a cluster of reported problem areas that fall within the Eastwick flooding area which is the focus of a number of current flood mitigation studies in partnership with USACE, the City of Philadelphia (Philadelphia Water Department (PWD) and Office of Sustainability), Delaware County, Drexel University, Flood Mitigation Council of Eastwick (FMCE), US Fish and Wildlife Service, and a variety of other stakeholders and organizations. Other high priority problem areas reported from the WPAC survey within this region include S152, which is a privately owned and abandoned warehouse property along the Darby Creek just south of the Amtrak railroad in a heavily wooded and floodable area along the creek. Another problem area is R062, which is the potential site of a flood barrier. R062 is located within the City of Philadelphia. Please see **Appendix F** and **Appendix G.1** for an exhibit of the aforementioned problem areas and Eastwick region.

Analysis incorporated review of the following sources: *Draft Integrated Feasibility Report & Environmental Assessment* (USACE and PWD 2023); *Accumulating climate change influences on extreme coastal, fluvial, and compound flooding in the upper transition zone* and *Modeling the Effectiveness of Alternative Flood Adaptation Strategies Subject to Future Compound Climate Risk* (Drexel University, 2025); and *The Eastwick Flood Resilience Strategy* (City of Philadelphia's Office of Sustainability, 2026). The available FEMA Floodplains were reviewed, as well as 2D flooding, SCALGO analysis, and several takeaways from the (upstream) analysis of the Naylors Run H&H 2D Flood Model.

Due to the focus on the Eastwick community, the "flood barrier" solution being reviewed at R062 may not necessarily alleviate flooding conditions observed at the problem areas located within Delaware County. Water surface elevations may be increased at the immediate upstream and downstream spans of Cobbs Creek surrounding problem areas S152 (upstream at the abandoned warehouse) and S130 at Hook Road which is directly downstream. It is unclear if flooding at S092 would be negatively impacted by a proposed flood barrier at R062.

Given the potential impacts upstream and downstream associated with a proposed flood barrier project, an additional study is recommended to continue investigating mitigative solutions for these areas. Per the exhibit in **Appendix G.9**, floodplain benching/restoration and additional wetlands scenarios can be further refined and modeled. It should also be noted that field visits to the S152 abandoned site observed that this location is particularly dangerous in its current condition (lots of trash & debris, overgrown vegetation, potential onsite hazards, unsafe pedestrian access). It is recommended that Delaware County investigate future public acquisition of this property so that it may be dedicated to stream restoration, floodplain

restoration/expansion, and improved safety. Similar stakeholder discussions on the topic of land acquisition can also be conducted for other key properties along Cobbs Creek and Darby Creek immediately upstream and downstream of their confluence. Floodplain improvements and expansion, particularly in anticipation of upstream impacts from the potential flood barrier project should be prioritized as a localized measure.

However, as evident from the research conducted by Drexel University, an emphasis on upstream watershed improvements such as nature-based solutions and green stormwater infrastructure, may also play a crucial role in reducing flows occurring close to the confluence of Darby Creek and Cobbs Creek. It is therefore recommended that the next phase investigation review scenarios for upstream storage/infiltration/detention/restoration practices, with a focus on specific project sites throughout Delaware County. Project sites would ideally include parks, wooded areas, stream restoration sites, county-owned properties, and other publicly owned sites. A goal of the analysis should be to model realistic storage volumes and other design metrics for downstream benefits, since many of the studies completed to date have utilized broader, planning level-estimations. The future analysis should be collaborative with applicable municipalities to facilitate successful selection and implementation of project sites.

Additionally, it is strongly recommended that this evaluation be included with other Darby-Cobbs initiatives that the County is proposing for inclusion within the upcoming Pennsylvania Water Resources Development Act (WRDA). Refer to **Section 7.5 Funding and Grant Opportunities** for more information.

Estimated Cost Ranges:

1) Additional analysis: Medium ($50k-$250k)

2) Local improvements: High (>$2M)

3) Watershed improvements: High (>$10M)

Highest Priority Solution: S094 - Larkin Road

Erosion was reported at point S094, south of Charles Griffin Drive and approximately 0.2 miles upstream of the crossing with Larkin Road. The location of S094 is shown in **Figure 17**. The Delaware River Conservation Plan notes flooding from storms above the 25-year storm at the East Branch Naamans Creek crossing with Naaman's Creek (R090). Erosion and sediment are prevalent throughout the length of the stream from S094 to R090. The stream erosion threatens to undermine homes adjacent to the creek at S094. An immediate solution to the erosion at S094 would be to armor the streambank to prevent future erosion. Given the condition of Naamans Creek and the multiple points of concern along the length of the stream, an in-depth analysis of the stream is recommended. Such as analysis could help determine the best areas for stream restoration, areas for



Figure 17. S094 Location

stormwater infiltration/retention basins to reduce peak rates in the watershed, and if structural changes to the impacted roadways will need to be made to resolve the observed issues. Bethel Township owns property upstream of S094 that could be used for these facilities. Please refer to the associated mapping in **Appendix G.10.**

Estimated Cost Ranges:

1) Additional analysis: High (>$250k)

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: High ($10M)

Highest Priority Solution: S103 – Marsh Road

S103 is located at the confluence of West Branch Naaman Creek and a UNT to West Branch Creek at Marsh Road. Refer to **Figure 18** for the location of S103. The field visit observed the stream bed to have significant sedimentation at the crossing preventing two of the four culvert boxes from conveying flow. Sediment removal and stream restoration is recommended at this location to re-establish full use of the existing culverts and to provide a stable streambank. An HY-8 or HEC-RAS analysis is required to determine if the existing culverts are sufficient to pass the desired flow safely when functioning full capacity. Please refer to the associated mapping in **Appendix G.11.**

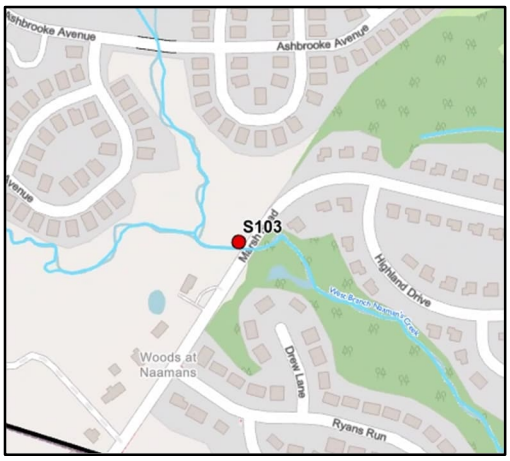


Figure 18. S103 Location

Estimated Cost Ranges:

1) Additional analysis: Low (< $50k)

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: N/A

Highest Priority Solution: S104 – Zebley Road

S104 is located where Naamans Creek South Branch crosses under Zebley Road. The location of S104 is shown in **Figure 19**. The primary mechanism of flooding at this location appears to be the capacity of the culvert at the crossing. A larger culvert should be designed to convey the full volume of flow at this location. Of course, improving the conveyance capacity at this location would result in increased flows downstream, which would have to be mitigated through the use of watershed-level blue/green stormwater management improvements. Fortunately, Bethel Township owns over 10 acres of open space that could potentially be suitable for watershed-level improvements such as constructed wetlands, bioretention/retention basins, and/or infiltration systems. Please refer to the associated mapping in **Appendix G.12.**

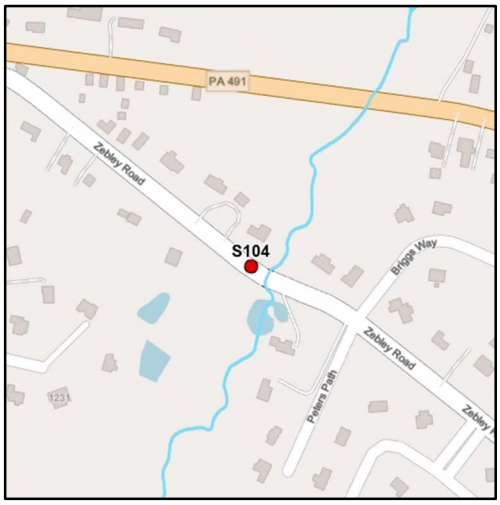


Figure 19. S104 Location

Estimated Cost Ranges:

1) Additional analysis: Low (< $50k)

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: Medium ($3M-$10M)

Highest Priority Solution: S105 – Vernon Run at Rose Valley Rd

The flooding at S015 appears to be the result of an undersized culvert for Vernon Run at Rose Valley Road (SR 3019) along with the presence of a low-head dam and high velocity channelized flow entering the Vernon Run immediately upstream of the roadway crossing. Refer to **Figure 20** for the location of S105. The recommended solution at this point is twofold. First, replace the culvert to convey greater flows. Second, provide streambank armoring to reduce erosive flows at this location and install energy dissipaters at the incoming channels. Finally, additional analysis is recommended given that flooding at this location, which is 0.2 miles upstream of the confluence of Vernon Run and Ridley Creek, is likely to be influenced by backflow from flooding in Ridley Creek. Please refer to the associated mapping in **Appendix G.13.**

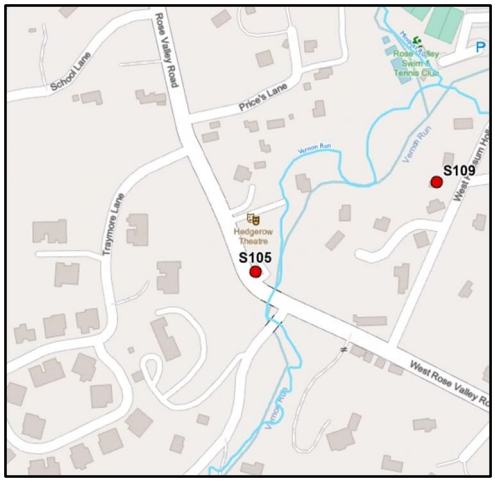


Figure 20. S105 Location

Estimated Cost Ranges:

1) Additional analysis: High (>$250k)

2) Local improvements: High (>$2M)

3) Watershed improvements: N/A

Highest Priority Solution: S110 – Brandywine Creek at US 1

Three problem areas were reported in this area: S110, S132, and R033. All three points are within the FEMA flood zone AE and are located in the vicinity of the Baltimore Pike/U.S. Route 1 crossing of Brandywine Creek. Refer to **Figure 21** for a map of these problem areas. The watershed of the Brandywine to this point includes Montgomery, Chester, and Lancaster Counties, and therefore watershed-scale solutions will require significant coordination with other counties. Some of this work has already begun – the Brandywine Flood Study completed in 2025 evaluated 300 individual sites throughout the watershed. This study entailed in-depth modeling of the flooding at this location and provided specific recommendations for mitigating it.



Figure 21. S110 Location

There are 3 structures in the vicinity of S110 that were found to constrict flow in the Brandywine in the 2025 Flood Study. The field visit to this site confirmed evidence of roadway overtopping and erosion at these structures. The study recommended removal of both the East Penn Railroad Bridge downstream of the problem area and the existing dam upstream of it. The study also recommended replacing the Baltimore Pike/U.S. Route 1 bridge to remove flow obstructions. Given the nature of the proposed projects and stakeholders involved, there are multiple funding sources that can be explored. Please refer to the associated mapping in **Appendix G.14.**

Estimated Cost Ranges:

1) Additional analysis: Medium ($50k-250k) - Analysis from 2025 Brandywine Flood Study is assumed to cover concept level analysis

2) Local improvements: High(>$2M)

3) Watershed improvements: N/A

Highest Priority Solution: S116 – S. Academy Ave

Flooding, erosion, and sedimentation were reported in the section of the Muckinipattis Creek north of the crossing of S Academy Drive. Refer to **Figure 22** for the location of S116. The area upstream of S116 is currently used as open park space, basketball courts, and the creek bed. The park is 100-ft wide at the narrowest point making it a good candidate for stream restoration to address sedimentation and erosion issues at S116. Stream restoration can help reduce peak flow rates; however, additional improvements are recommended to resolve the flooding problem at this location. Obstructions of the stream crossing at S Academy Drive were observed during the field visit and should be removed as a first step to resolving flooding at this location. Additional analysis of the existing flow capacity of the culvert under S Academy Drive is also recommended. Open space at the southern end of the park area north of S116 is available to provide approximately 16k cubic feet of storage within an infiltration/retention basin. Please refer to the associated mapping in **Appendix G.15.**

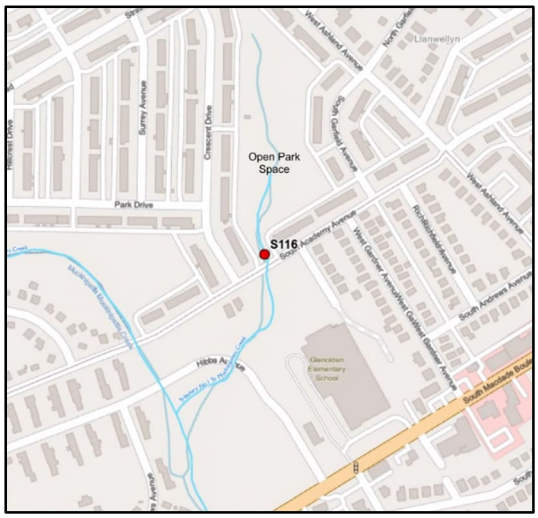


Figure 22. S116 Location

Estimated Cost Ranges:

1) Additional analysis: Low (< $50k)

1) Additional analysis: High (> $250k)

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: N/A

Highest Priority Solution: S117 - Linden Ave

Linden Ave crosses Hermesprota Creek at S117. The point is located adjacent to Conway Park, owned by Darby Township. The location of S117 is depicted in **Figure 23**. The park provides opportunities for structural stormwater management to help relieve downstream flooding concerns. There appears to be an existing stormwater management basin at this location that could be evaluated for additional retention capacity. Conway Park north of Linden Ave has the capacity for an infiltration/retention basin to provide approximately 30k cubic feet of storage to manage peak rates at this location. This stormwater basin would be best implemented as part of a watershed-scale plan.



Figure 23. S117 Location

The SCALGO analysis for S117 depicts flooding along the Hermesprota Creek at several roadway crossings upstream and downstream from S117. Flooding was also indicated at points R024, R036, S024, S028, and S096, and several water rescues were reported in the upper portion of the watershed. It is recommended that the first phase of this project entail the development of a more detailed hydraulic model that would incorporate existing storm infrastructure, roadway crossings, and more detailed topographic information. The output of this model could be used to determine the best locations within the watershed for implementation of several stormwater retention and/or infiltration basins, wetlands, or stream restoration, as well as to prioritize sections of the stream for floodway restoration. There are several public parks along the length of the stream that could support stormwater infiltration/retention systems for peak rate management, including approximately 60k cubic feet at 1599 Llanwellyn Ave, Folcroft, 30k cubic feet north of Linden Ave (discussed above), 50k cubic feet south of Linden Ave at Conway Park, 60k cubic feet north of Hook Rd at Conway Park, and 100k cubic feet in the area owned by Darby Townshipp between Noblet Ave and Forrester Ave. Survey responses indicate that Darby Township is already looking into the feasibility of implementing stream restoration and stormwater retention measures between Noblet and Forrester. Many of these sites are actively used as park areas, and multi-use stormwater management measures should be considered to allow for continued recreation opportunities. Please refer to the associated mapping in **Appendix G.16.**

Estimated Cost Ranges:

1) Additional analysis: High (> $250k)

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: High (> $10M)

Highest Priority Solution: S118 / S119 – Delmar Drive

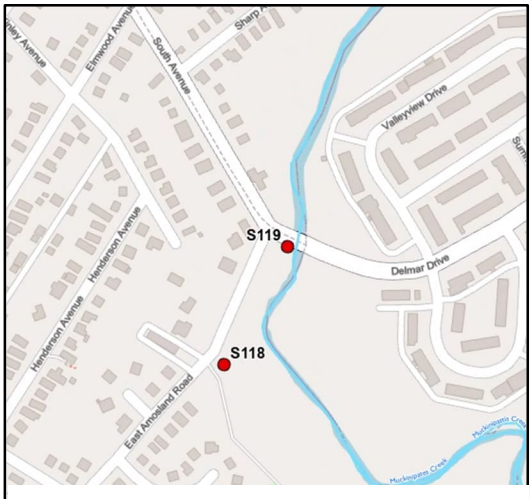


Figure 24. S118 / S119 Location

S118 and S119 were reported on different sides of the intersection of South Ave, Delmar Drive, and E Amosland Road. None of these roads are owned by PennDOT. All three roads are sloped towards the intersection and have residential structures along them. During the site visit, the outfall of one of the culvert pipes was observed to have collapsed, which limits the flow capacity of the structure. This outfall structure should be replaced to restore the intended capacity of the culvert. In addition, the existing vegetated areas on the north and south sides of Delmar Drive can be used for stream restoration or for regenerative step pools/bioswales to capture water being conveyed from the roadways. HEC-RAS modelling performed on the Muckinipattis Creek (see **Section 4.4.2**) found velocities through the bridge up to 7.0, 7.6, and 9.6 ft/s for the 5-,

10-, and 100-year storms, respectively. Confirmation of the pipe capacity should be performed. The location of S118 and S119 is depicted in **Figure 24**. Please refer to the associated mapping in **Appendix G.17.**

Estimated Cost Ranges:

1) Additional analysis: Low (< $50k) (Initial modeling performed in this study included in 4.4.2)

2) Local improvements: Medium ($500k-$2M)

3) Watershed improvements: N/A

Highest Priority Solution: S144 – Crum Creek Road

At S144, Crum Creek Road (State Route 2037) is within the flood zone of Crum Creek and has a history of flooding and subsequent impacts to emergency services. The location of S144 is depicted in **Figure 25**. Along this stretch of the road, Crum Creek is relatively shallow and only slightly below the level of the road. On the east side of the road, only a narrow vegetated buffer exists between it and the creek, while on the west side the land is very steep and wooded. The risk of roadway flooding can be mitigated through raising its profile by several feet for an approximate length of 2,200 linear feet starting at State Road. Over this stretch of roadway, there are no driveways or intersecting streets; however, Route 1 does cross over it near its northern end, which may limit how much it can be raised there. Raising the profile of Crum Creek Road would require close coordination with PennDOT, regulatory compliance with FEMA, collaboration with other stakeholders, and detailed engineering analyses to determine the desired new roadway design and profile, target freeboard and clearance, and upstream/downstream flooding impacts. Given the nature of the proposed project and stakeholders involved, there are likely multiple funding sources that can be explored. Please refer to the associated mapping in **Appendix G.18.**

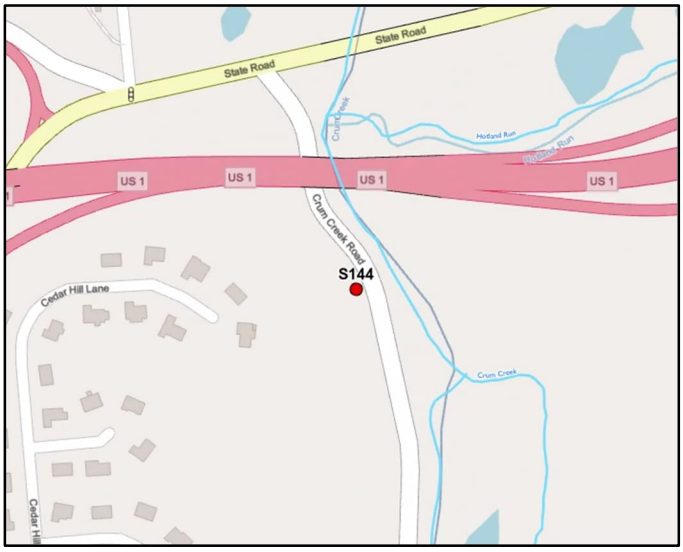


Figure 25. S144 Location

Estimated Cost Ranges:

1) Additional analysis: N/A (assumed to be part of "local improvements" cost)

2) Local improvements: High (> $2M)

3) Watershed improvements: N/A

Highest Priority Solution: S175 – Ivy Mills Road

Ivy Mills Road (SR 3036) is conveyed over the bridge at S175. The location of S175 is shown in **Figure 26**. The problem was identified within the FEMA floodway of West Branch Chester Creek. During the field visit, the bridge was recorded as having a height of approximately 6 feet and a width of 62 linear feet. Debris and sediment were observed under the bridge, reducing its flow capacity. An inlet on Ivy Mills Road was also clogged with debris. The solution for this site must start with removal of the debris and sediment at the site and include floodplain restoration and streambank stabilization to prevent future sediment deposition.

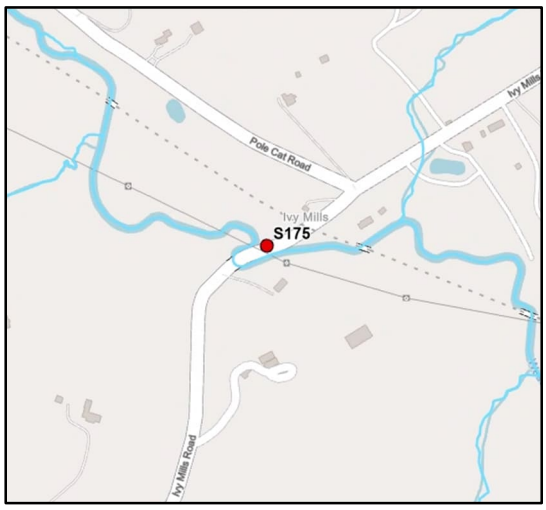


Figure 26. S175 Location

Additional studies should be performed to determine if the bridge structure is sized appropriately for the existing flow of the West Branch Chester Creek. There is a private access drive southwest of the Ivy Mills Road bridge structure. A historic mill conservation site is located northeast of the bridge. Designers should consider alternative bridge configurations that will increase the capacity at the bridge crossing, including raising the elevation of the roadway surface. Raising the profile of Ivy Mills Road would require close coordination with PennDOT, regulatory compliance with FEMA, collaboration with other stakeholders, and detailed engineering analyses to determine the desired new roadway design and profile, target freeboard and clearance, and upstream/downstream flooding impacts. Given the nature of the proposed project and stakeholders involved, there are likely multiple funding sources that can be explored. Please refer to the associated mapping in **Appendix G.19.**

Estimated Cost Ranges:

1) Additional analysis: N/A (assumed to be part of "local improvements" cost)

2) Local improvements: High (> $2M)

3) Watershed improvements: Medium ($3M-$10M)

7.5 Problem-Potential Solutions Matrix

All identified problem areas, except for those deemed "highest" priority, were evaluated using a Problem-Potential Solution Matrix, as seen in **Figure 27**. A map depicting all non-high priority problem areas is shown in **Figure 28**. The Problem-Potential Solution Matrix is a planning-level tool that is organized according to problem type (flooding, water quality, erosion / sedimentation, and groundwater) and, in the case of flooding, associated problem causes (tidal, restricted capacity due to either clogging / obstruction(s) or insufficient natural channel capacity, insufficient / aging drainage infrastructure, and other / unspecified due to limited available information). Based on the identified problem type and causes, recommended standardized potential solutions such as drainage improvements, floodplain reconnection, green stormwater infrastructure (GSI), and stabilization were assigned to each problem area. The list of recommended potential solutions is not intended to be all-inclusive, it is meant to provide guidance for planning purposes. More refined information on the causes and potential solutions for the high priority problems is provided in the solution forms in **Appendix F**. Some problems were considered to

have more than one problem type and cause and therefore show up in more than one solution category. As indicated in the matrix, most if not all the recommended solutions will require some type of additional analysis, whether for flooding, water quality, sedimentation, groundwater, or a combination of these, either prior to or as an integral part of detailed design. This additional analysis may result in a different combination of problem types, causes, and solutions. It should also be noted that although not explicitly indicated in the matrix, most of the identified problems can be at least partially mitigated by a watershed-wide deployment of GSI.

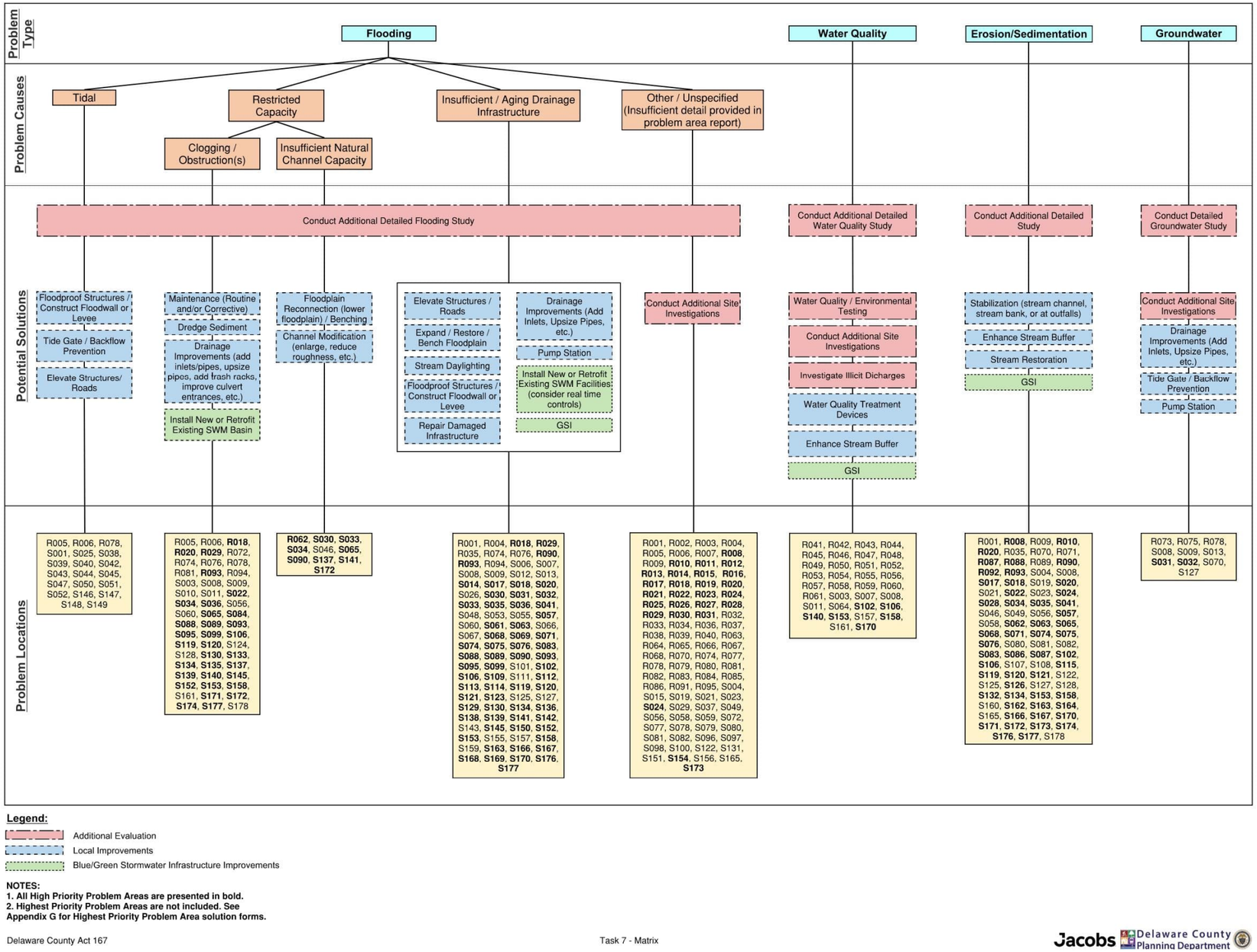


Figure 27. Problem-Potential Solutions Matrix

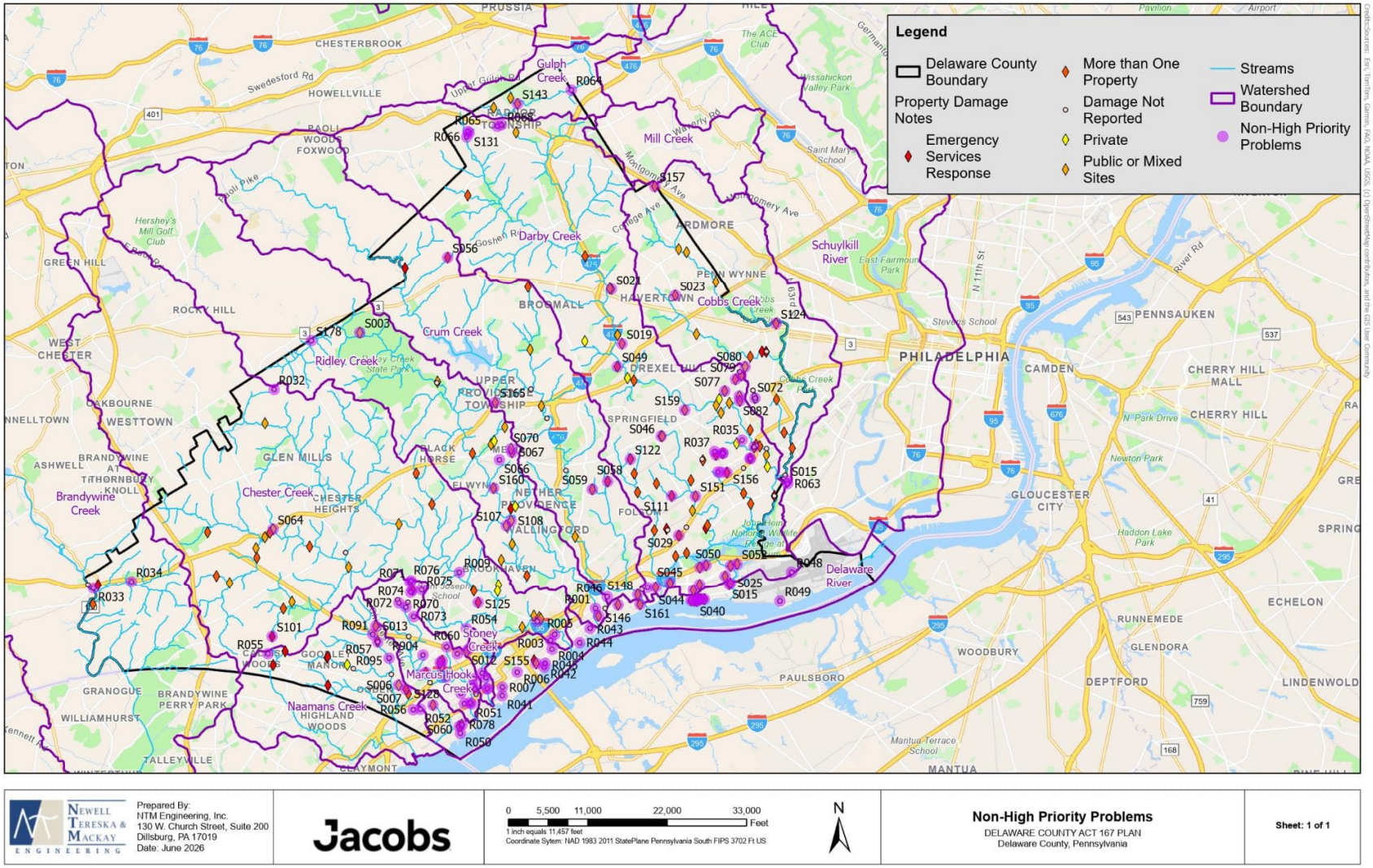


Figure 28. Non-High Priority Problem Areas Map

7.6 Funding & Grant Opportunities

To support the implementation of the project solutions developed in this Plan, a table of funding programs was developed (**Table 14**). The Funding Table includes a list of grants and loans from federal, state and private programs, currently available at the time of document preparation.

Table 14. Grant and Loan Summary Table

Agency	Grant Name	Funding Source	Funding Type	Description of Grant and Uses	Eligible Applicant	Minimum Award Amount	Maximum Award Amount	Minimum Match Requirement	Application Deadline	Website
PA Department of Environmental Protection	Growing Greener (Watershed Restoration and Protection)	State	Grant	The purpose is to restore Pennsylvania's impaired waters and protect waterways from nonpoint source pollution.	Incorporated Watershed Association County or Municipality County Conservation District 501(c)(3) Tax Exempt Organization Educational Institution Municipal Authority	None	$500,000	5%; No match if located in Environmental Justice area	Between April 22 and June 22, annually	https://www.pa.gov/services/dep/water/bwrnsm/apply-for-a-department-of-environmental-protection-growing-greener-plus-grant
PA Department of Environmental Protection	Coastal Zone Management (CZM)	State	Grant	The Coastal Zone Management Grant Program provides funding to implement its policies and focus areas in the Delaware Estuary and Lake Erie Coastal Zones, including hazards, wetlands, public access, intergovernmental coordination, ocean resources, and nonpoint source pollution. Typical projects funded through grant awards range from studies, planning, design, and research to land acquisition and minor construction projects.	Local Governments Counties and Municipalities Area-wide agencies – county and regional planning agencies Incorporated non-profits Educational Institutions – School Districts, Intermediate Units, Universities and Colleges Incorporated Conservation and Educational Organizations State Agencies Conservation Districts Port Authorities Public Authorities	None	$75,000	unknown	Between August 26 and October 14, Annually	https://www.pa.gov/services/dep/grants/apply-for-a-coastal-zone-grant
PA Department of Conservation and Natural Resources	Community Conservation Partnerships Program (C2P2)	State	Grant	Park rehabilitation and development, recreation and conservation planning, land acquisition and conservation, trail projects, river conservation and development, and community and watershed forestry	County or Municipal Government Higher Educational Institution Other Educational Institution Non-profit with 501(c)3 IRS Status Non-profit with PA Bureau of Charitable Organizations Status	None	$500,000	50%	Between January 12 and April 30, Annually	https://apps.dcnr.pa.gov/grants/Default.aspx?rtn=CRM365/CRMHelp.aspx?Tag=Opportunities.Planning
Department of Community & Economic Development (DCED) Commonwealth Financing Authority (CFA)	Greenways, Trails and Recreation Program (GTRP)	State	Grant	Projects which involve development, rehabilitation and improvements to public parks, recreation areas, greenways, trails, and river conservation. Planning, acquisition, development, rehabilitation and repair of greenways, recreational trails, open space, parks and beautification projects	Municipality Councils of Governments 501(c) (3) Organization Institution of Higher Education Watershed Organization For Profit Businesses	None	$250,000	15%	Between February 1st and May 31st of each year	https://dced.pa.gov/programs/greenways-trails-and-recreation-program-gtrp/

Agency	Grant Name	Funding Source	Funding Type	Description of Grant and Uses	Eligible Applicant	Minimum Award Amount	Maximum Award Amount	Minimum Match Requirement	Application Deadline	Website
Department of Community & Economic Development (DCED) Commonwealth Financing Authority (CFA)	H2O PA - Flood Control Projects	State	Grant	Projects which involve construction, improvement, repair or rehabilitation of all or part of a flood control system.	Commonwealth Independent Agency Municipality Municipal Authority	$500,000	$20,000,000	50%	Not listed	https://dced.pa.gov/programs/flood-mitigation-program-fmp/
Department of Community & Economic Development (DCED) Commonwealth Financing Authority (CFA)	PA Small Water and Sewer	State	Grant	construction, improvement, expansion, repair, or rehabilitation of a water supply system, sanitary sewer system, storm sewer system, or flood control projects that are owned and maintained by an eligible applicant. An eligible project also includes consolidation or regionalization of two or more water supply systems or sanitary sewer systems which are managed or operated as an integrated system regardless of whether the system is physically connected.	Municipalities Municipal Authority	$30,000	$500,000	15%	Between February 3, 2025 and April 30, 2025.Check website for future years	https://dced.pa.gov/download/small-water-and-sewer-guidelines/?wpdmdl=58151
Department of Community & Economic Development (DCED) Commonwealth Financing Authority (CFA)	Flood Mitigation Program (FMP)	State	Grant	Projects authorized by a flood protection authority, the PA Department of Environmental Protection (DEP), the U.S. Army Corps of Engineers (Corps) or the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) or identified by a local government for flood mitigation.	Municipality Councils of Governments Authorized Organization Institution of Higher Education Watershed Organization For Profit Businesses	$50,000	$500,000	15%	Between February 1st and May 31st of each year	https://dced.pa.gov/programs/flood-mitigation-program-fmp/
Department of Community & Economic Development (DCED) Commonwealth Financing Authority (CFA)	H2O PA - High Hazard Unsafe Dam Projects	State	Grant	Projects which involve the repair, rehabilitation, or removal of all or a part of a high hazard unsafe dam	Commonwealth Independent Agency Municipality Municipal Authority	$500,000	$20,000,000	25%	Rolling - see website	https://dced.pa.gov/programs/h20-pa-high-hazard-unsafe-dam-projects/
PA Department of Transportation	Multimodal Transportation Funding (MTF)	State	Grant	Funds may be used for the development, rehabilitation and enhancement of transportation assets to existing communities, streetscape, lighting, sidewalk enhancement, pedestrian safety, connectivity of transportation assets and transit-oriented development.	Municipality Council of Governments Businesses Economic Development Organizations Public Transportation Agencies Port and Rail freight entities	$100,000	$3,000,000	30%	Between March 1 and July 31	https://dced.pa.gov/programs/multimodal-transportation-fund/

Agency	Grant Name	Funding Source	Funding Type	Description of Grant and Uses	Eligible Applicant	Minimum Award Amount	Maximum Award Amount	Minimum Match Requirement	Application Deadline	Website
US Army Corp of Engineers	Planning Assistance to States Program (PAS) - Comprehensive Plans	Federal	Grant	Under Section 22 of WRDA1974, can provide comprehensive planning or technical assistance for development, use, and conservation of water and related resources, incl. water supply, water conservation, water quality, wetlands restoration, dam safety, flood damage reduction, coastal zone protection and harbor planning.	State Local Government Regional coalition of Governmental Entities Federally-recognized Tribes US Territories 501(c) (3) Organizations working with a State	None	Typically, $500,000 per project	50%	None Listed	https://www.usace.army.mil/Missions/Civil-Works/Technical-Assistance/Planning-Assistance/ https://www.nap.usace.army.mil/Portals/39/docs/Civil/Factsheets/PAS_Factsheet_February2025.pdf
US Army Corp of Engineers	Planning Assistance to States Program (PAS) - Technical Assistance	Federal	Grant	Under Section 22 of WRDA1974, can provide comprehensive planning or technical assistance for development, use, and conservation of water and related resources, incl. water supply, water conservation, water quality, wetlands restoration, dam safety, flood damage reduction, coastal zone protection and harbor planning.	State Local Government Regional coalition of Governmental Entities Federally-recognized Tribes US Territories 501(c) (3) Organizations working with a State	None	Typically, $500,000 per project	50%	None Listed	https://www.usace.army.mil/Missions/Civil-Works/Technical-Assistance/Planning-Assistance/ https://www.nap.usace.army.mil/Portals/39/docs/Civil/Factsheets/PAS_Factsheet_February2025.pdf
Department of Community & Economic Development (DCED) Commonwealth Financing Authority (CFA)	Local Share Account (LSA)	State	Grant	Projects that improve the quality of life in the community.	County Municipality Municipal Authority Economic Development Agency Redevelopment Authority Land Banks Council of Government	$25,000	$1,000,000	Not Required	Between September 1 to November 30	https://dced.pa.gov/programs-funding/local-share-account-lsa-statewide-frequently-asked-questions/
Department of Community & Economic Development (DCED) Commonwealth Financing Authority (CFA)	Watershed Restoration and Protection Program (WRPP)	State	Grant	Projects which involve the construction, improvement, expansion, repair, maintenance or rehabilitation of new or existing watershed protection Best Management Practices (BMPs)	Municipalities Councils of Governments Authorized Organization Institution of Higher Education Watershed Organization For-Profit Businesses	None	$300,000	15%	Between February 1 and May 31, Annually	https://dced.pa.gov/programs/watershed-restoration-protection-program-wrpp/
Pennsylvania Infrastructure Investment Authority (PennVEST)	Traditional Construction Funding	State	Low Interest Loan	PENNVEST provides low-interest loans and grants for new construction or for improvements to publicly or privately-owned drinking water, storm water or sewage treatment facilities, as well as non-point source pollution prevention best management practices.	Any municipality, authority or private entity that is an owner and/or operator of a drinking water, wastewater, or non-point source pollution prevention project is eligible under the PENNVEST program	See Guidelines	See Guidelines		Quarterly, see guidelines	https://www.pa.gov/agencies/pennvest

Agency	Grant Name	Funding Source	Funding Type	Description of Grant and Uses	Eligible Applicant	Minimum Award Amount	Maximum Award Amount	Minimum Match Requirement	Application Deadline	Website
Pennsylvania Infrastructure Investment Authority (PennVEST)	Small Project Program	State	Low Interest Loan	Eligible projects include the acquisition, construction, improvement, expansion, extension, repair, or rehabilitation of all or part of any system or facility, whether publicly or privately owned, including stormwater.	Small Project Program funds are available to public or private entities implementing small eligible projects, defined as projects: Serving communities with a population of no more than 12,000 people. Having hookups of no more than 1,000. Involving an agriculture operation.	None	$500,000	Not Required		https://www.pa.gov/agencies/pennvest/programs-and-services/funding-programs/small-project-program
PA Emergency Management Agency (PEMA)	Hazard Mitigation Grant Program (HMGP)	State	Grant	The Hazard Mitigation Grant Program (HMGP) is a grant that requires a federal disaster declaration. The key purpose of this grant program is to enact mitigation measures that reduce the risk of loss of life and property from future disasters.	Municipality or Local Government					https://www.pa.gov/services/pema/hazard-mitigation-grant https://www.pa.gov/content/dam/copapwp-pagov/en/pema/documents/grants/hmgp/forms/documents/02-hmgp-application-guide.pdf
Federal Emergency Management Agency (FEMA)	Flood Mitigation Assistance Grant	Federal	Grant	The federal Flood Mitigation Assistance Grant Program helps states, local communities, tribes, and territories reduce or eliminate the risk of repetitive flood damage to buildings and structures insured under the National Flood Insurance Program. Funds can be used in the following categories: Advance Assistance: Develop mitigation strategies and obtain data to prioritize, select, and develop viable community flood mitigation projects. This design work will facilitate viable projects for future grant applications. Community Flood Mitigation Projects: Projects that integrate cost-effective, natural floodplain restoration solutions and improvements to National Flood Insurance Program-insured properties. Flood Mitigation Planning Grants: Funds not exceeding $25,000 that can	Municipality or Local Government	Varies; See website	Varies; See website	See Application	Varies; See website	https://www.pa.gov/services/pema/flood-mitigation-grant

Agency	Grant Name	Funding Source	Funding Type	Description of Grant and Uses	Eligible Applicant	Minimum Award Amount	Maximum Award Amount	Minimum Match Requirement	Application Deadline	Website
				only be used for the flood hazard component of hazard mitigation (meeting planning critical outlined in 44 CFR, Part 201).						
Federal Emergency Management Agency (FEMA)	Building Resilient Infrastructure and Communities Grant (BRIC)	Federal	Grant	This program awards planning and project grants and provides opportunities for raising public awareness about reducing future losses before disaster strikes The overall goal of this non-disaster grant is to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on federal funding in future disasters.	Municipality or Local Government	Varies; See website	Varies; See website	Cost Share: 75% federal/25% non-federal share for eligible jurisdictions and a 90% Federal/ 10% non-Federal share for identified Small and Impoverished Communities.	LOI due April 24, 2026; Application due June 19, 2026.See website for future years	https://www.pa.gov/services/pema/resilient-infrastructure-grant
National Fish and Wildlife Foundation (NFWF), in partnership with the U.S. Fish and Wildlife Service (FWS)	Delaware Watershed Conservation Fund (DWCF)	Private	Grant	conserve, restore, and protect habitats on public and private land, across rural, urban, and Tribal areas, that contribute to the overall health of the Delaware River watershed—as well as benefit the quality of life and economic vitality of the communities in the Delaware River watershed. Funding awarded across four grant categories, including: Implementation Grants; Planning Grants, Capacity Building Grants; and Research, Monitoring & Evaluation Grants	Non-profit 501(c) organizations Federal, State, Interstate Local and Municipal Governments Tribal governments and organizations Educational Institutions	$75,000	$1,500,000	1:1 encouraged but not required; Non-federal matches are preferred	March 26, see Website for future years	https://www.nfwf.org/programs/delaware-river-program/delaware-watershed-conservation-fund-2026-request-proposals
William Penn Foundation	Multiple, see website	Private	Grant	Grantees respond to RFPs within several categories, including Environment and Public Space – typically for Philadelphia only. Confirm guidelines	Nonprofit organizations and government entities	Varies; See website	Varies; See website	Varies by Grant type	Quarterly, see guidelines	https://williampennfoundation.org/funding/funding-opportunities
Foundation for Pennsylvania Watersheds	Conservation Grants	Private	Grant	On-the-ground restoration/conservation projects that demonstrate measurable impact on water quality. Projects that leverage additional funding or involve strong collaboration. Applications that demonstrate increased or improved public access to recreational water resources.	Nonprofit organizations and government entities	None	$20,000	Yes, not defined	LOI due September 18; Once Accepted, Full application due October 16, 2026	https://thefpw.org/grant-programs

Agency	Grant Name	Funding Source	Funding Type	Description of Grant and Uses	Eligible Applicant	Minimum Award Amount	Maximum Award Amount	Minimum Match Requirement	Application Deadline	Website
Open Space Institute	Delaware River Watershed Protection Fund	Private	Grant Low Interest Loan	Supports land protection, restoration, and water quality monitoring in eight regions of the watershed. Capital Grants for the purchase of land and easements to permanently protect important watershed lands; Transaction Grants to jumpstart land conservation efforts; and Catalyst Grants to integrate water quality science into strategic conservation or forest management plans, such as Open Space Plans, ordinances, or other mechanisms for the protection and stewardship of water resources.	Varies by grant program	Varies; See website	Varies; See website	3:1 or greater is preferred; Varies by Grant type	Rolling - see website	https://www.openspaceinstitute.org/funds/delaware-river-watershed-fund
Open Space Institute	Delaware River Watershed Revolving Fund	Private	Low Interest Loan	Forest protection and agricultural restoration in eight sub-watershed "clusters" within the Delaware River Watershed Initiative; Reducing stormwater run-off through the installation of green infrastructure in Philadelphia and elsewhere; Creation and enhancement of the Circuit Trail network; Increasing and diversifying the constituency for watershed protection through support for capital projects in the 23 environmental education centers participating in the Alliance for Watershed Education network; Demonstrating innovation in use of new sources of funding, creative utilization of debt, new tools for land protection and stewardship, engagement of underserved communities	Non-profit organizations Local governments (counties and municipalities) State or federally recognized tribes	$100,000	$1,000,000	None required	Rolling - see website	https://www.openspaceinstitute.org/funds/delaware-river-watershed-revolving-fund
US Army Corp of Engineers	Water Resources Development Act (WRDA)	Federal	Appropriations	Congress also has authorized USACE to assist nonfederal public entities with their environmental infrastructure (EI; e.g., design and construction assistance for public drinking water and wastewater infrastructure) in designated communities, counties, and states.	Nonfederal public entities	None	None	50% federal, 50% non-federal	Biennial; 2026 projects submitted to House Representatives and Senators in March.	https://www.congress.gov/crs-product/IF13112 https://transportation.house.gov/wrda-2026/

7.7 Plan Review, Revision, and Update Procedures

Act 167 Section 5.b(13) specifies that the County must include provisions for the periodic review, revision and updating of the plan. Act 167 stipulates this review must occur every five years at a minimum. The review of the plan may result in revisions; however, revisions to the plan may not be necessary. Any proposed revisions to the plan would require implementation as outlined in the Plan Implementation section of this document including municipal and public review prior to County adoption. An important aspect of the plan is a procedure to monitor the implementation of the plan and initiate review and revisions in a timely manner. The review, revision and implementation of the plan will be performed according to the process as outlined below:

1. Monitoring of Plan Implementation – Responsibility for monitoring the implementation of the plan will be shared between the County and Municipalities. The monitoring will include the maintenance of a record of development activities within the County. Development activities to be recorded are defined in the Model Ordinance and summarized below. The responsible parties for the maintenance of the development activities to be recorded is included in this summary:

    a. All known subdivision and land developments subject to review per the plan which have been approved within the County are to be recorded by municipalities.

    b. All building permits subject to review per the plan which have been approved within the County are to be recorded by municipalities.

    c. All PADEP permits issued in the County under Chapter 105 (Dams and Waterway Management) and Chapter 106 (Floodplain Management), including location and design capacity (if applicable) are to be recorded by the County.

2. Review of Adequacy of the plan - The WPAC membership list will be updated and the group convened periodically to review the plan and determine if the plan is adequate for minimizing the runoff impacts of new development and addressing problem areas. At a minimum, the information to be reviewed by the WPAC will be as follows:

    a. Development activity data as monitored by the County and/or municipalities.

    b. Information regarding new or changed storm drainage problem areas as provided by the WPAC members or other stakeholders (e.g., County Emergency Services).

    c. Relevant zoning amendments within the County.

    d. Information associated with any regional detention alternatives implemented within the County along with any other projects implemented to better understand or address problem areas (e.g., potential solutions identified in this plan).

    e. Adequacy of the administrative aspects of regulated activity review.

    f. Relevant changes to PADEP documents such as the Model Ordinance, Stormwater Manual, and Chapter 102 permit requirements.

More specifically, Delaware County Planning Commission will maintain the WPAC through annual meetings to review the Act 167 Plan and assess the need for revisions. These meetings will be held concurrently with the County's Hazard Mitigation Plan (HMP) meetings to help streamline communications. The Hazard Mitigation Plan includes discussion of urgent stormwater concerns within the County, and therefore overlapping interests will help both WPAC members and municipal managers involved in the HMP to better understand the importance of the Delaware County Act 167 Plan. These regular meetings will serve as an opportunity for the WPAC stakeholders to provide feedback on relevant components of the current Act 167 Plan and identify additional stormwater management needs if/when they arise. At the end of five years, the County will compile a five-year assessment and submit a letter to PADEP documenting the status of the plan and annual feedback that has been collected from WPAC meetings. This will be utilized to determine whether an update is needed to the Act 167 Plan upon its renewal period. PADEP has indicated that these annual meetings are an acceptable approach to demonstrate ongoing evaluation of the Act 167 Plan.

A revised plan would be subject to the same procedure of adoption as the original plan preparation. Should the County determine that no revisions to the plan are required after five years, the County will submit a letter to PADEP stating that the plan was evaluated and has been found to satisfactorily meet the requirements of Act 167.

8. References

Table 15. Act 167 Plan References

Dataset	Publication Year	Data Description
Chester County Model Ordinance	2013	Chester County Act 167 Stormwater Management Model Ordinance
Chester County Matrix	2013	Chester County Matrix of Minimum Mandatory Standards for Municipal Ordinances
Chester County Watersheds Plan	2013	Chester County Watersheds Plan
Chester County Watershed Plan Figures	2013	Supporting figures for Chester County Act 167
Chester County Act 167 File	2013	Chester County Act 167 Plan Addendum and Appendices
Chester Creek Act 167 Files	2002	Act 167 Plan for Chester Creek Watershed
Chester Creek Act 167 Plates	2002	Chester Creek Act 167 supporting figures
Chester Creek Act 167 Plates Figure	2002	Chester Creek Act 167 - Project Location Map
Chester Creek Act 167 Vol1 Plate 3	2002	Chester Creek Act 167 - Future Land Use Map
Chester Creek Act 167 Vol 1 Plate 5	2002	Chester Creek Act 167 - Subwatersheds and Stream Cross-Section Locations
Chester Creek Act 167 Vol 2 Plate 1	2002	Chester Creek Act 167 - Subwatersheds and Stream Cross-Section Locations
Chester Creek Act 167 Vol 2 Plate 4	2002	Chester Creek Act 167 - Plate 4: Future Land Use Vol 2
Chester Creek Act 167 Vol 1 Plate 1	2002	Chester Creek Act 167 - Release Rate Map
Chester Creek Act 167 Vol 1 Plate 2	2002	Chester Creek Act 167 - Existing Land Use Map
Chester Creek Act 167 Vol 2 Plate 2	2002	Chester Creek Act 167 - Hydrologic Soils Group
Chester Creek Act 167 Plate 4	2002	Chester Creek Act 167 - Stormwater Problem Areas
Crum Creek Act 167 Vol I II III Files	2011	Crum Creek Act 167 Plan - Volume I, II, and III
Crum Creek Act 167 Figures	2011	Crum Creek Act 167 - supporting figures
Crum Creek Directs Vs Natural Figure 2007	2011	Crum Creek Act 167 -Model results
Crum Creek Directs Vs Natural Figure 2007	2011	Crum Creek Act 167 -Model results
Crum Creek Figure	2011	Crum Creek Act 167 -Model results
Darby-Cobbs Creek Act 167 Files	2005	Darby and Cobbs Creek Act 167 Plan and files
Darby-Cobbs Creek Act 167 Models		Darby-Cobbs Creek Act 167- Model files
Darby HEC-HMS Files	2008	Model file for Darby-Cobbs Act 167 in the Darby HEC-HMS files folder. Within this folder there are supporting files, along with rainfall hydrograph .met files
Darby Cobbs Modeling Files	2008	Model file for Darby-Cobbs Act 167 in the DarbyCobbsModelingBortonLawson folder.
Delaware Countywide Act 167 Plan Phase I	2024	Delaware County Act 167 Scope of Study
Lower Merion Drainage Area Act 167	1997	Lower Merion Drainage Area Act 167 Plan
Drainage Area Subwatersheds Map	1997	Lower Merion Township Watershed Map with release rates
Lower Merion Drainage Area Appendix	1997	Lower Merion Drainage Area Act 167 Plan Appendices

Dataset	Publication Year	Data Description
Lower Merion Drainage Area Plan	1997	Lower Merion Drainage Area Act 167 Plan
Peak Rates per Lower Merion Ordinance	2007	Lower Merion Ordinance peak rates
Ridley Creek Act 167 Files	1988	Act 167 Plan for Ridley Creek Watershed and supporting figures
Ridley Creek Subarea Map	1988	Ridley Creek Act 167 - Subarea Map
Ridley Creek Release Rates	1988	Ridley Creek Act 167 - Release Rate - Chester
Ridley Creek Release Rate - Peak Rates	1988	Ridley Creek Act 167 - Release Rate - Chester-Crum Peak Rate
Ridley Creek Release Rate Map	1988	Ridley Creek Act 167 -Release Rate Map

Table 16. Studies & Models References

Dataset	Publication Year	Data Description
Brandywine Flood Study Final Report	2025	Brandywine Flood Study Final Report
Delaware County 2035 - Comprehensive Land Use Plan	2017	Economic Development Plan section of the Delaware County 2035 - Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2017	Executive Summary of the Economic Development Plan section of the Delaware County 2035 - Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2018	Historic Plan section of the Delaware County 2035 - Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2018	Executive Summary of the Historic Plan section of the Delaware County 2035 - Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2020	Website Link URL for Housing Plan Story Map (part of the Delaware County 2035 - Comprehensive Land Use Plan)
Delaware County 2035 - Comprehensive Land Use Plan	2020	Housing Plan section of the Delaware County 2035 - Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2013	Delaware County 2035 consists of a central, Land Use Policy Framework Plan and a number of related, interconnected, but more detailed component plans. Some of these component plans – addressing additional planning-related elements within the County – have already been developed, others are currently underway, and more will be developed in the future, but all will use the same framework and build off of the Land Use policies laid out in the Framework Plan.
Delaware County 2035 - Comprehensive Land Use Plan	2015	Delaware County's Open Space, Recreation, and Greenway Plan examines the open space policies and trends identified in Delaware County 2035.
Delaware County 2035 - Comprehensive Land Use Plan	2017	Transportation plan from Delaware County's Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2017	Transportation plan executive summary from Delaware County's Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2015	Open Space and Recreation Plan from Delaware County's Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2015	Countywide Greenway Plan from Delaware County's Comprehensive Land Use Plan

Dataset	Publication Year	Data Description
Delaware County 2035 - Comprehensive Land Use Plan	2015	County Parks and Recreation Plan Appendices from Delaware County's Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2015	Chapter 2: Clayton County Park County Parks and Recreation Plan from Delaware County's Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2015	Chapter 3: Glen Providence County Park County Parks and Recreation Plan from Delaware County's Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2015	Chapter 4: Kent County Park County Parks and Recreation Plan from Delaware County's Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2015	Chapter 5: Rose Tree County Park County Parks and Recreation Plan from Delaware County's Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2015	Chapter 6: Smedley County Park County Parks and Recreation Plan from Delaware County's Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2015	Chapter 7: Upland County Park County Parks and Recreation Plan from Delaware County's Comprehensive Land Use Plan
Delaware County 2035 - Comprehensive Land Use Plan	2015	County Parks and Recreation Plan from Delaware County's Comprehensive Land Use Plan
Delaware River Watershed Conservation Plan	2014	Delaware River Watershed Conservation Plan for the Delaware River Corridor and Naamans, Marcus Hook, and Stoney Creek Watersheds
The City of Chester Vision 2020 Climate Adaptation Planning Elements	2014	The City of Chester Vision 2020 Climate Adaptation Planning Elements (report)
Delaware County Mitigation Plan	2022	Delaware County Hazard Mitigation Plan
Accumulating climate change influences on extreme coastal, fluvial, and compound flooding in the upper transition zone	2025	Accumulating climate change influences on extreme coastal, fluvial, and compound flooding in the upper transition zone. Eastwick is the study area.
Radnor Township Climate Resiliency Plan	2025	Radnor Township Climate Resiliency Plan and their sustainable approach to green stormwater infrastructure
Brandywine Flood Study Final Report	2025	Brandywine Flood Study Technical Compendium. Section 3: Climate Projections and Storm Event Analysis. There's also an email with links to reference material saved in the same folder.
Brandywine Models	2025	Folder with files of Brandywine models and flood study
Brandywine Model Lower Reach Files	2025	Lower Reach model files from Brandywine
Brandywine Model US Reach Files	2025	US Reach model files from Brandywine
Brandywine Model Files	2025	Existing model files from Brandywine
GSI Plan City of Chester	2017	GSI Plan City of Chester
Delco Roadmap for Adapting to Coastal Risk		Delco Roadmap for Adapting to Coastal Risk (Vulnerability Assessment & Planning Workshop Results & Recommendations)
Brandywine Model East Branch Files	2025	East Branch model files in Brandywine
Eastwick Flood Risk Management	2023	Eastwick Flood Risk Management Draft Integrated Feasibility Report and Environmental Assessment
Eastwick Flood Risk Management	2024	Eastwick Cap Section 205 Flood Risk Management Feasibility Study Fact Sheet

Dataset	Publication Year	Data Description
EDCSC Load Reduction Summary	2025	Eastern Delaware County Stormwater Collaborative provided to DelCo
Summary of Site Meeting on Erosion and Flooding at Eden and Mt. Zion Cemeteries, Collingdale Borough	2022	Erosion and Flooding Eden and Mt. Zion Cemeteries- Summary of Site Meeting on 2/15/2022
Modeling the Effectiveness of Alternative Flood Adaptation Strategies Subject to Future Compound Climate Risks	2025	Modeling the Effectiveness of Alternative Flood Adaptation Strategies Subject to Future Compound Climate Risks. Eastwick is the study site.
Flooding Locations in Collingdale Borough	2024	NPDES Outfall/Storm Sewer Map
Assessment of the Spatial Distribution of Brownfield sites in Chester, PA At Risk of Flooding and Releasing Pollutants to the Delaware River	2016	Assessment of the Spatial Distribution of Brownfield sites in Chester, PA At Risk of Flooding and Releasing Pollutants to the Delaware River (report)
Harvey Run Brandywine Model Files	2025	Harvey Run model files in Brandywine
Geomorphic Signature of Urbanization: An Analysis of Four Streams in Southeastern Pennsylvania, USA	2024	River Research and Applications (article): Geomorphic Signature of Urbanization: An Analysis of Four Streams in Southeastern Pennsylvania, USA
DVRPC Multi-Municipal Stormwater Planning	2025	Delaware Valley Regional Planning Commission Multi-Municipal Stormwater Planning Summary Report
PASeaGrantStudies_07162025		Folder with PA Sea Grant College Program files
Effect of Human Mobility Changes due to COVID-19 on Stream Water Quality in Watersheds with Different Predominant Land Uses	2023	ASCE Case Study (journal): Effect of Human Mobility Changes due to COVID-19 on Stream Water Quality in Watersheds with Different Predominant Land Uses
When Pollution is Subjected to Dilution: Tracing the Impact of Watershed Development on Stream Baseflow and Stormflow Water Quality	2025	ASCE Case Study (journal): When Pollution is Subjected to Dilution: Tracing the Impact of Watershed Development on Stream Baseflow and Stormflow Water Quality
Eastwick Flood Risk Management	2024	Link to Eastwick Flood Resilience Strategy resources from the City of Philadelphia
PHL Surface SMP Locations	2025	Map of surface stormwater management practices at the Philadelphia International Airport
Photos of flooding in Collingdale Borough	2025	Photos of flooding within Collingdale Borough
Video of flooding at 330 Pusey Ave, Collingdale Borough	2025	Video of flooding/runoff within Collingdale Borough
Video of flooding at 330 Pusey Ave, Collingdale Borough	2025	Video of flooding/runoff within Collingdale Borough
Video of flooding at 330 Pusey Ave, Collingdale Borough	2025	Video of flooding/runoff within Collingdale Borough
Sea Level Rise-Induced Transition from Rare Fluvial Extremes to Chronic and Compound Floods	2023	Sea Level Rise-Induces Transition from Rare Fluvial Extremes to Chronic and Compound Floods. Eastwick is the study area.
Evaluating the comprehensive impacts of urbanization and restoration on stream process	2022	Pennsylvania Sea Grant College Program Final Report: Evaluating the comprehensive impacts of urbanization and restoration on stream process

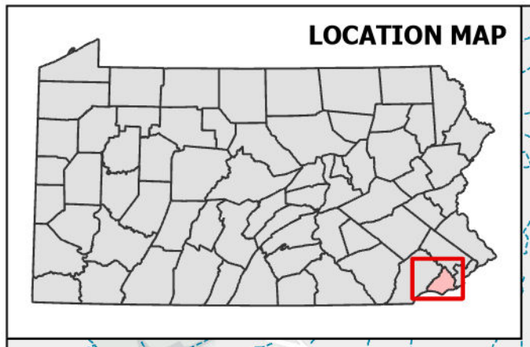
Dataset	Publication Year	Data Description
Upper Merion Township Stormwater Management Plan	2019	Upper Merion Township stormwater management plan
Eastwick Flood Risk Management	2024	Link to US Army Corps of Engineers Eastwick Flood Risk Management Study
Brandywine Model West Branch US Reach Files	2025	Brandywine Creek West Branch US Reach model files
Brandywine Model West Branch Files	2025	Brandywine Creek West Branch model files
AWE Wetland Report	2023	Wetland study that supplements Naylors Run Model
Pennsylvania Flood Resiliency Success Stories	2023	Pennsylvania Flood Resiliency Success Stories developed by the Pennsylvania Silver Jackets Team
Pennsylvania Flood Resiliency Success Stories: Costs Summary	2023	Summary of project costs from Pennsylvania Flood Resiliency Success Stories
The Eastwick Flood Resilience Strategy	2026	Flood resilience strategy for Eastwick area developed by the City of Philadelphia Office of Sustainability in partnership with the Flood Mitigation Council of Eastwick
Engineering Practice Guides for Natural Infrastructure	2025	Collection featuring technical guides for planning and design of inland and coastal water resources development projects

Appendix A – Maps

Appendix A.1 – Watersheds

Delaware County Act 167 Stormwater Management Plan

Watersheds



MONTGOMERY COUNTY
CHESTER COUNTY
DELAWARE COUNTY
PHILADELPHIA COUNTY
NEW CASTLE COUNTY

Gulph Creek
Schuylkill River
Mill Creek
Darby Creek
Crum Creek
Cobbs Creek
Ridley Creek
Chester Creek
Brandywine Creek
Naamans Creek
Marcus Hook Creek
Stoney Creek
Delaware River

Legend

- Streams - USGS
- Streams - Delaware County
- County Boundaries
- Surface Water

Major Watersheds

- Brandywine Creek
- Chester Creek
- Cobbs Creek
- Crum Creek
- Darby Creek
- Delaware River
- Gulph Creek
- Marcus Hook Creek
- Mill Creek
- Naamans Creek
- Ridley Creek
- Stoney Creek
- Schuylkill River (Philadelphia County)

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

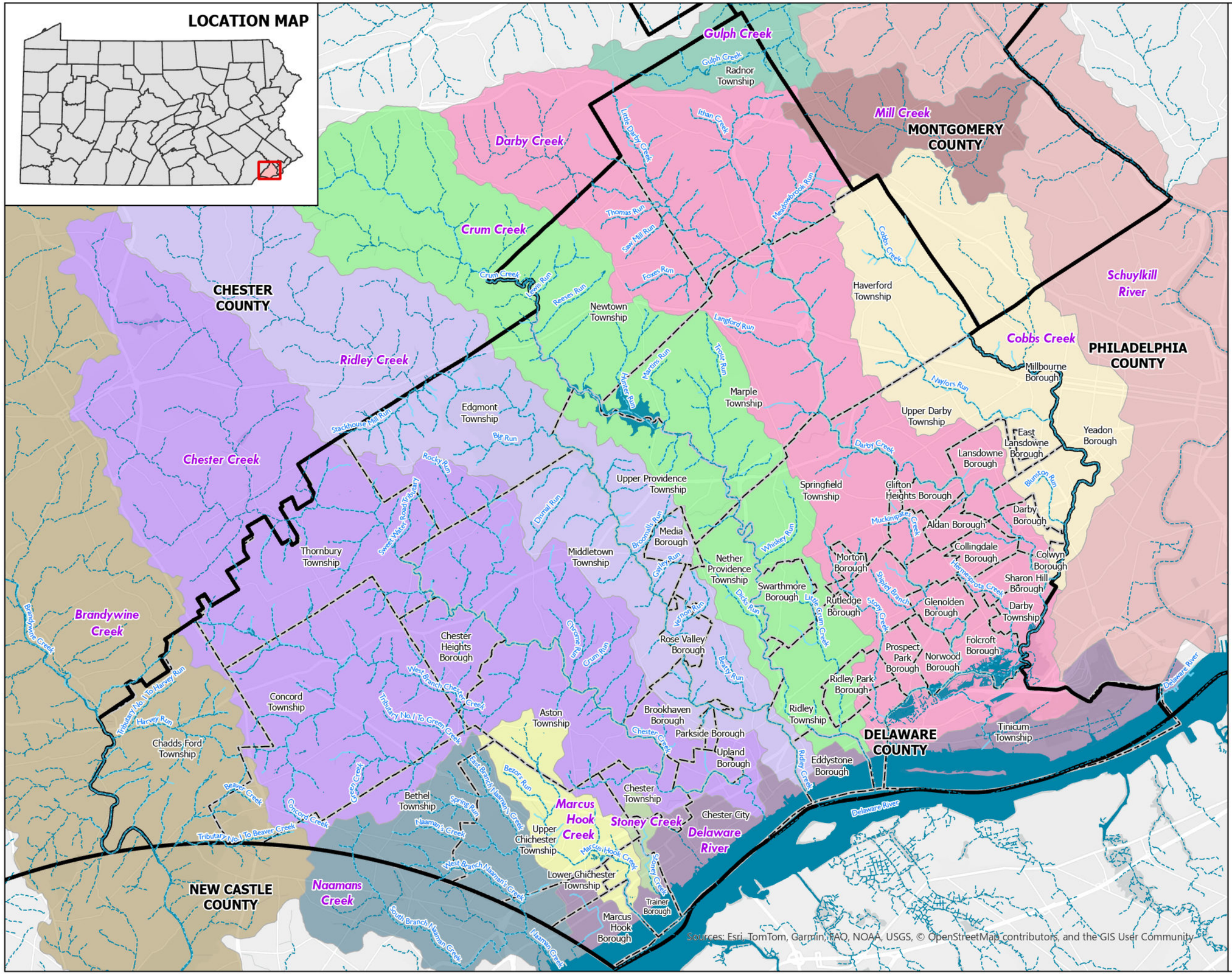
0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 7/6/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix A.2 – Watersheds and Municipalities



Delaware County Act 167 Stormwater Management Plan

Watersheds and Municipalities

Legend

- Streams - USGS
- Streams - Delaware County
- County Boundaries
- Municipal Boundaries
- Surface Water

Major Watersheds

- Brandywine Creek
- Chester Creek
- Cobbs Creek
- Crum Creek
- Darby Creek
- Delaware River
- Gulph Creek
- Marcus Hook Creek
- Mill Creek
- Naamans Creek
- Ridley Creek
- Stoney Creek
- Schuylkill River (Philadelphia County)

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

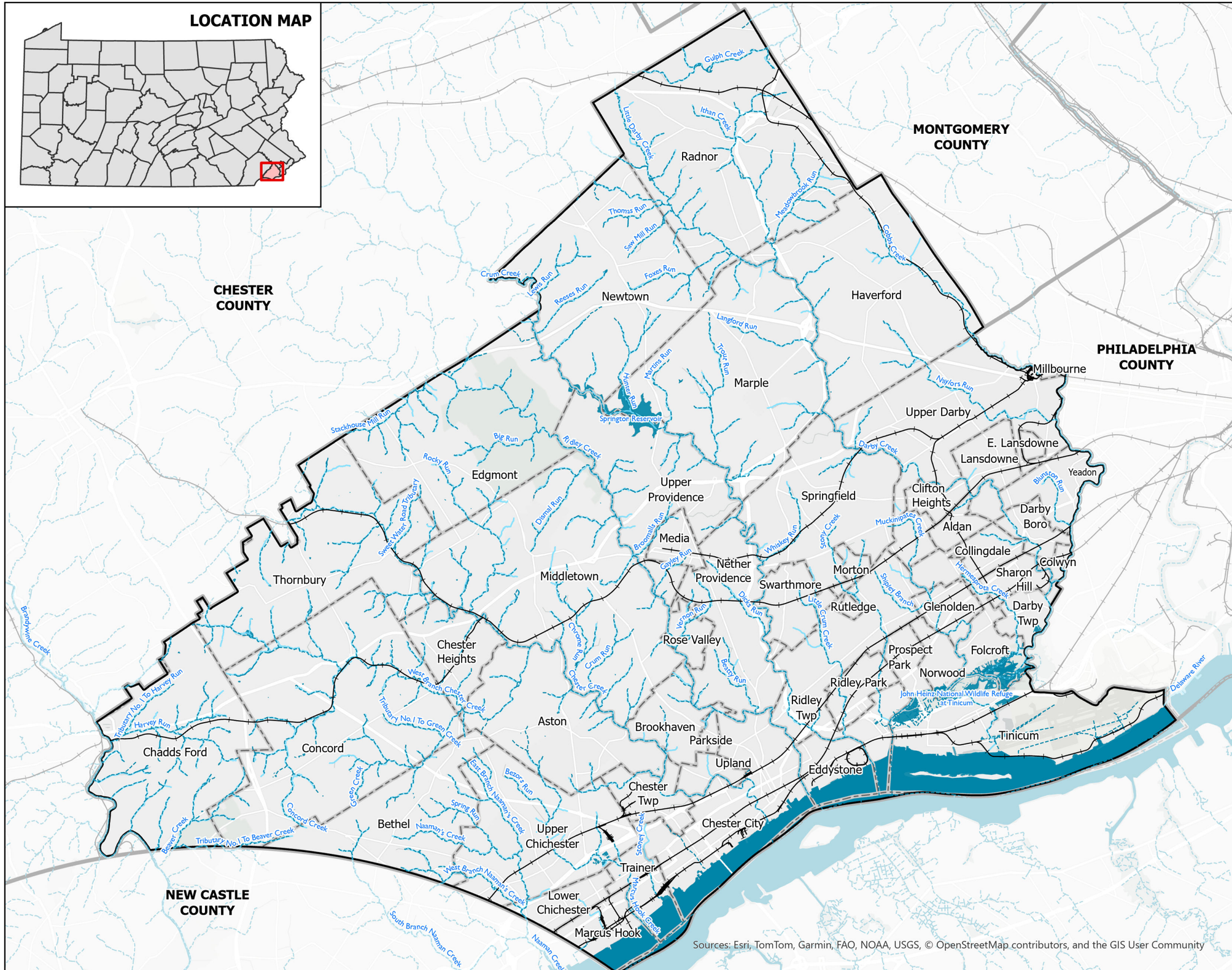
N

0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 7/6/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Appendix A.3 – Base Map



Delaware County Act 167 Stormwater Management Plan

Base Map

Legend

- Streams - USGS
- Streams - Delaware County
- Major Roads
- Railroad Lines
- Municipal Boundaries
- County Boundaries
- Surface Water

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

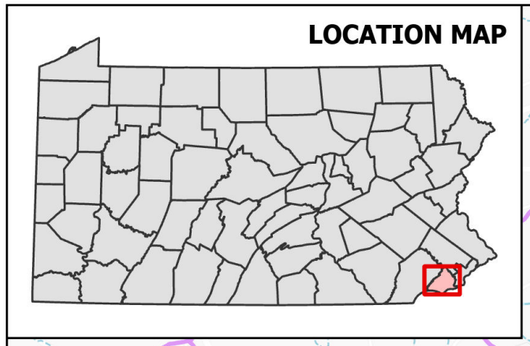
N

0 0.5 1 2 Miles

Map prepared by Jacobs and NTM on: 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Appendix A.4 – Digital Elevation Model



Delaware County Act 167 Stormwater Management Plan

Digital Elevation Model (DEM)*

Legend

- Streams - USGS
- Streams - Delaware County
- County Boundaries
- Watersheds
- Surface Water

Elevation (ft)

160

-60

*Digital Elevation Model (DEM) source: PASDA

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 0.5 1 2 Miles

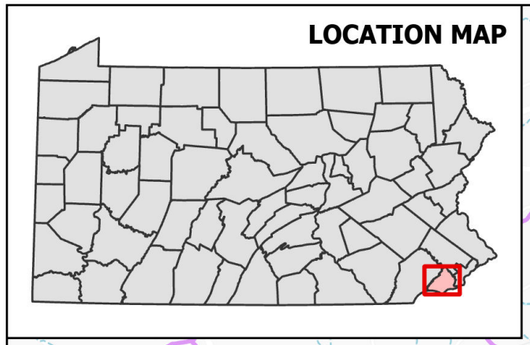
Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix A.5 – Existing Stormwater and Flood Control Facilities

Delaware County Planning Department
Jacobs
Newell Tereska & Mackay Engineering



Delaware County Act 167 Stormwater Management Plan

Existing Stormwater and Flood Control Facilities

Legend

- Combined Sewer Outfalls
- Dams
- Green Stormwater Infrastructure (GSI) Locations*
- Existing Stormwater and GSI Projects**
- Streams - USGS
- Streams - Delaware County
- County Boundaries
- Municipal Boundaries
- Watersheds
- DELCORA Combined Sewer Area
- Surface Water

*Source: Delaware County. Note that this data layer is incomplete and does not include all GSI locations within the County.

**Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

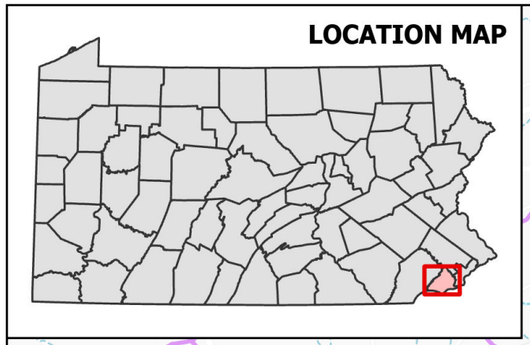
0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community

Appendix A.6 – Floodplains and Flood Hazard Areas



Delaware County Act 167 Stormwater Management Plan

Floodplains and Flood Hazard Areas

Legend

- Streams - USGS
- Streams - Delaware County
- County Boundaries
- Watersheds

FEMA Flood Zones (FIS data 11/2017)*

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone AO
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

*The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

Flood Zone Descriptions:
A: Areas subject to inundation by the 1-percent-annual-chance flood event, determined using approximate methods

AE: Areas subject to inundation by the 1-percent-annual-chance flood event, determined by detailed methods

Floodway: The channel of a river or other watercourse and that adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot

AO: Areas subject to inundation by the 1-percent-annual-chance shallow flooding, usually sheet flow on sloping terrain, where average depths are between one and three feet

X: Areas of moderate flood hazard between limits of the 1 -percent-annual-chance floodplain and the 0.02-percent-annual-chance floodplain

Description sources: firststreet.org; lacity.gov

N

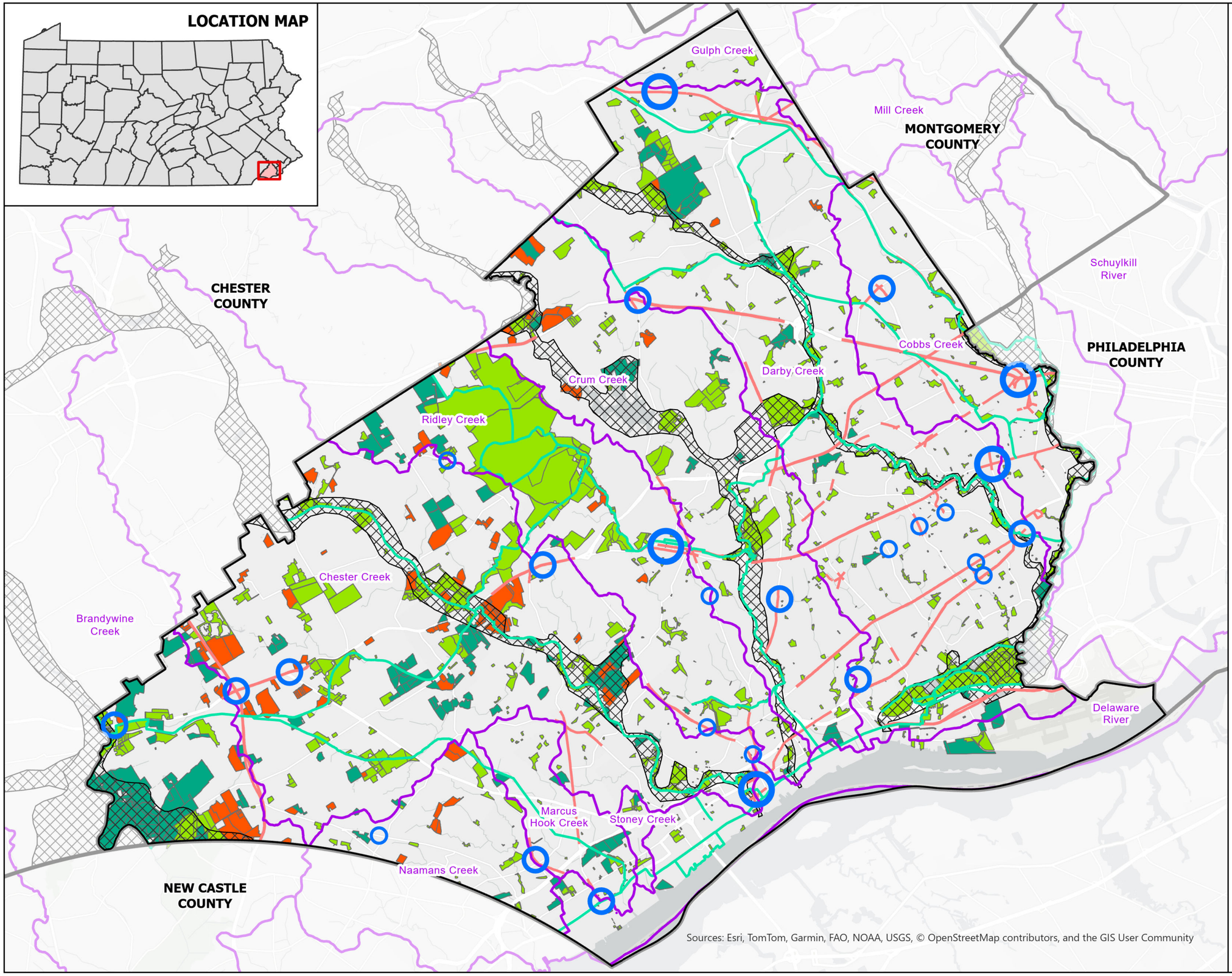
0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix A.7 – Future Land Use



Delaware County Act 167 Stormwater Management Plan

Future Land Use*

Legend

Central Places (Type)*

- Neighborhood Center
- Town Center
- Urbanized Centers
- Primary Trail Networks*
- Activity Corridors**
- County Boundaries
- Watersheds
- Greenspace Network (DVRPC Connections 2050)
- Protected Lands*
- Delaware County 2035 Potential Development Lands*
- Delaware County 2035 Conservation Priorities*

***

*Source: Delaware County 2035 Comprehensive Plan

**Activity Corridors are linear Central Places that flank major transportation corridors or highway interchanges, that feature intense development, and where public transport facilities, mixed land uses, and people are centrally focused.

***The Delaware County 2035 Comprehensive Plan designates all land not labeled "Greenspace Network", "Protected Lands", "Potential Development Lands", or "Conservation Priorities" as Infill Development.

N

0 0.5 1 2 Miles

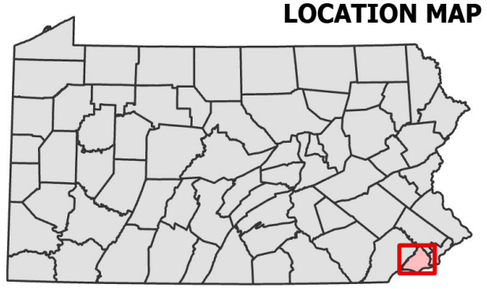
Map prepared by Jacobs and NTM on: 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Appendix A.8 – Impaired Water Bodies

Delaware County Act 167 Stormwater Management Plan

Impaired Water Bodies*



Legend

- Attaining Streams

Non-Attaining (Impaired) Stream Source Pollutant

- Agriculture
- Habitat Modification
- Landfills
- Source Unknown**
- Urban Runoff/Storm Sewers
- No Impairment Information Available***
- County Boundaries
- Watersheds
- Surface Water

*Source: PADEP, Water Quality - Integrated List, Attaining Streams and Non-Attaining Streams

**Source pollutant is unknown, but impairment causes include Fecal coliform, Metals, TSS, Pathogens, and PCBs

***Stream segments are from Delaware County Streams data and do not have available impairment information

N

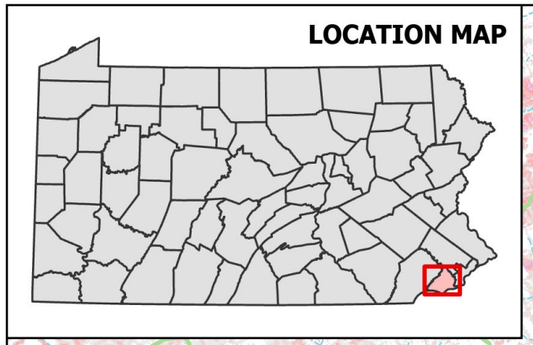
0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 2/9/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix A.9 – Impervious Cover



Delaware County Act 167 Stormwater Management Plan

Impervious Cover

Legend

- Streams - USGS
- Streams - Delaware County
- County Boundaries
- Watersheds
- Surface Water

USGS NLCD Impervious Cover Percentage*

0% 50% 100%

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

*Source: United States Geological Survey (USGS) National Land Cover Database (NLCD), 2019

N

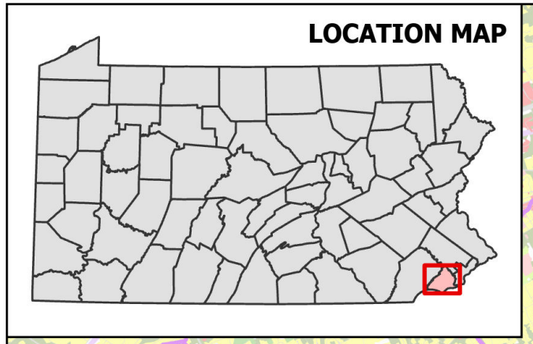
0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & MacKay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix A.10 – Existing Land Use



Delaware County Act 167 Stormwater Management Plan

Existing Land Use

Gulph Creek
Mill Creek
MONTGOMERY COUNTY
Schuylkill River
CHESTER COUNTY
PHILADELPHIA COUNTY
Cobbs Creek
Darby Creek
Crum Creek
Ridley Creek
Chester Creek
Brandywine Creek
Marcus Hook Creek
Stoney Creek
Naamans Creek
Delaware River
NEW CASTLE COUNTY

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Legend

- County Boundaries
- Watersheds

DVRPC Land Use (2023)

- Agriculture
- Commercial
- Industrial
- Institutional
- Military
- Mining
- Recreation
- Residential
- Transportation
- Undeveloped
- Utility
- Water
- Wooded

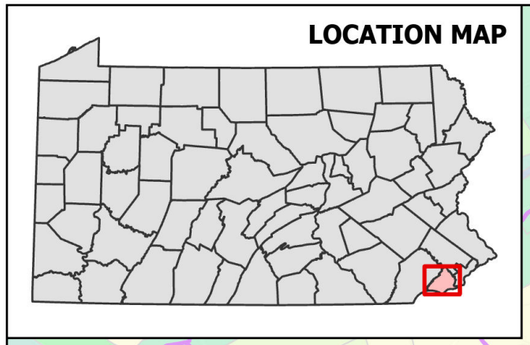
N

0 0.5 1 2 Miles

Map prepared by Jacobs and NTM on: 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Appendix A.11 – Socioeconomically Distressed Areas



Delaware County Act 167 Stormwater Management Plan

Socioeconomically Distressed Areas

Legend

- County Boundaries
- Watersheds
- Municipal Boundaries
- EJ Area**

Socioeconomic Score Percentile (DEP PennEnviroScreen 2024)*

- 91 - 100
- 81 - 90
- 71 - 80
- 61 - 70
- 51 - 60
- 41 - 50
- 31 - 40
- 21 - 30
- 11 - 20
- 0 - 10

*Areas with scores in higher percentiles are considered more socioeconomically distressed.

**The model combines Pollution Burden and Population Characteristics data in order to identify Environmental Justice (EJ) Areas

N

0 0.5 1 2 Miles

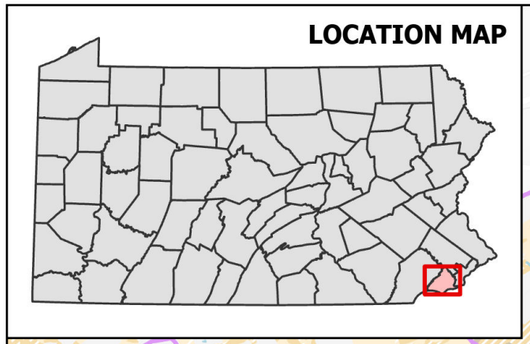
Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & MacKay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

CHESTER COUNTY
MONTGOMERY COUNTY
PHILADELPHIA COUNTY
NEW CASTLE COUNTY
Gulph Creek
Mill Creek
Radnor Township
Newtown Township
Haverford Township
Schuylkill River
Cobbs Creek
Crum Creek
Marple Township
Darby Creek
Millbourne Borough
Upper Darby Township
Ridley Creek
Edgmont Township
East Lansdowne Borough
Lansdowne Borough
Yeadon Borough
Upper Providence Township
Springfield Township
Clifton Heights Borough
Aldan Borough
Darby Borough
Collingdale Borough
Colwyn Borough
Media Borough
Morton Borough
Sharon Hill Borough
Thornbury Township
Chester Creek
Middletown Township
Swarthmore Borough
Rutledge Borough
Glenolden Borough
Darby Township
Nether Providence Township
Rose Valley Borough
Ridley Township
Prospect Park Borough
Norwood Borough
Folcroft Borough
Brandywine Creek
Chester Heights Borough
Ridley Park Borough
Concord Township
Aston Township
Brookhaven Borough
Parkside Borough
Delaware River
Tinicum Township
Chadds Ford Township
Upland Borough
Eddystone Borough
Chester Township
Chester City
Bethel Township
Marcus Hook Creek
Stoney Creek
Upper Chichester Township
Naamans Creek
Lower Chichester Township
Trainer Borough
Marcus Hook Borough

Appendix A.12 – Hydrologic Soil Groups



Delaware County Act 167 Stormwater Management Plan

Hydrologic Soil Groups*

Legend

- County Boundaries
- Watersheds

Hydrologic Soil Group

- A/D
- B
- B/D
- C
- C/D
- D
- Urban
- Water

*Source: Web Soil Survey, Soil Survey Geographic (SSURGO) database

N

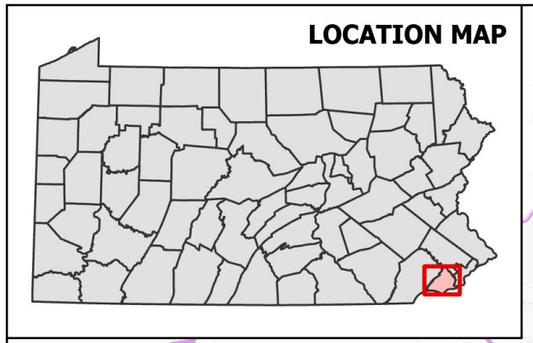
0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix A.13 – Wetlands and Surface Water



Delaware County Act 167 Stormwater Management Plan

Wetlands and Surface Water*

Legend

- County Boundaries
- Watersheds

Wetland Type

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Riverine

*Source: US Fish and Wildlife Service, National Wetlands Inventory

N

0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix B – Modeling Technical Data

Appendix B.1 – Marcus Hook Creek Model Memo

Marcus Hook Creek – Pilot Study

Delaware County Act 167 Stormwater Management Plan

Prepared for: Delaware County Planning Department

Jacobs Engineering Group Inc.

November 11, 2025

Delaware County Planning Department

Jacobs

Challenging today.
Reinventing tomorrow.

Contents

Objective 2
Methodology and Data Assimilation 2
Model Setup 3
Modeling Limitations 5
Conclusion 6

Appendices

Appendix A – 5-Year Flood Vulnerability Map

Appendix B – 10-Year Flood Vulnerability Map

Appendix C – 100-Year Flood Vulnerability Map

Appendix D – Flow Path Enforcement Modifications Map

Appendix E – Problem Area Attribute Table

Marcus Hook Creek – Pilot Study

Date: 11/11/2025
Project name: Delaware County Act 167 Stormwater Management Plan
Project no: D3999400

Objective

A small-scale pilot study was conducted to test the effectiveness of using HEC-RAS two-dimensional (2D) modeling as a screening method to compare modeled pluvial flooding at locations where Problem Areas have been submitted by stakeholders and WPAC (Watershed Plan Advisory Committee) members to the Delaware County Act 167 project survey. Data for the survey was collected from July-August 2025, and is comprised of logged problem areas as well as other problem areas summarized from studies and publications shared by the stakeholders (See Appendix E). This study serves to evaluate the model's reliability and potential for broader application in flood risk assessment across other problem areas within the county. Due to limitations outlined in this memo, this model cannot serve as a definitive flood study which yields precise flood mapping locations with well defined depths per event.

Methodology and Data Assimilation

The hydrologic and hydraulic model was developed using the USACE HEC-RAS 2D model version 6.6 with the rain-on-grid boundary condition within HEC-RAS. In the 2D rain-on-grid methodology, rainfall data is applied directly on the 2D model grid. The infiltration losses are calculated within the HEC-RAS 2D model using the SCS (Soil Conservation Service) curve number method. The best publicly available datasets are utilized in the analysis including: terrain, land use, soils, and rainfall data. The sources of the data used are listed in the table below:

Table 1. Data Source

Data Type	Source	Notes
1m Resolution Digital Elevation Model (DEM)	USGS 3DEP; dated April - November 2015; Published March 2020	Downloaded from: https://apps.nationalmap.gov/downloader/. Data is identical to PASDA data from DVRPC for Delaware County.
Land Use Data	Delaware Valley Regional Planning Commission (DVRPC); 2023 Land Use File, Published 2024	Downloaded from: https://catalog.dvrpc.org/dataset/land-use-2023; 2023 land use file is based on digital orthophotography created from aerial surveillance completed in the spring of 2023.
Soils Data	USDA NRCS Web Soil Survey; Published 2024	Downloaded from: https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Data Type	Source	Notes
Roadway Centerline Data	Delaware County (Delaware County Roads); Published 2022; PennDOT (PA State Roads); Published 2025	Delaware County roadway centerline data provided by Delaware County
Precipitation	NOAA; Published 2006	Downloaded from: https://hdsc.nws.noaa.gov/pfds/ Median NOAA Atlas 14, 24-hr Rainfall Depth (inch). Temporal distribution is NOAA Type C
Building Footprints	Delaware County; Published 2022	Referenced from the Delaware County online Portal: https://gis.delcopa.gov/arcgis/rest/services/DataLayers_911/Delaware_County_Building_Footprints/FeatureServer

Model Setup

The following assumptions were made to build the model:

- The 2D model grid was established with an initial mesh size of 50 ft x 50 ft. Mesh breaklines were created based on the roadway centerline data to improve the cell orientation, with a smaller grid size.

- Additional breaklines were added based on the aerials and topography, to represent the major channel centerlines, significant flow paths, and any significant topographic features adjacent to the study areas.

- Localized, small low spots in the terrain were hydrologically filled in the terrain using the geospatial "fill sinks" process. Upon review of contours derived from the terrain, a fill depth of 6 inches was selected.

- The National Hydrography Dataset for streamlines was checked and used as a guide along with topography and aerial photography to see if roadways or other topographic features behave as dams in the terrain data. This review process did find that there are topographic considerations that would limit downstream modeled flow in various locations. Where appropriate, flow paths were topographically enforced in the model using techniques that included the following:

    - Small channels, such as shallow ditches up to 20 ft wide, were manually 'burned in' to the model surface to convey flow downstream. The burned flow paths followed logical flow paths. Examples of these include: connecting visible stream elements across roadways (inlet to inlet); connecting stream areas where the modeled mesh does not pick up a clearly defined channel but aerial photography and/or contours indicate one likely exists, and draining deep ponded areas in subdivisions or topographic bowls in roadways that are likely drained to the stream with localized storm drains. Because limited information is available for storm sewers along streets, modifications for topographic bowls on streets were only made when bowls were located near streams, or a nearby overland/shallow

flow path could be identified. As such, some ponding areas remain in bowls and are mapped as potential flooding areas; for large storm events it is feasible that the storm drain system could become clogged or that rainfall would exceed the storm drain capacity and the mapping legend has been recoded to reflect that flooding potential.

  - To the north of Marcus Hook Creek, it appears from aerial imagery, Google Streetview imagery, and the topographic data that the main stream has been buried as part of the land development that has occurred in this area. Modification of the terrain data to include that streamline did not seem reasonable. Assumptions were made to provide connectivity of the flow to the main streamline.

  - Mapped locations of all model DEM adjustments (breaklines and stream flow paths) can be found in Appendix D.

- One (1) major culvert in the watershed was included in the model to allow for flow passage across Weir Road. The culvert connects the main Marcus Hook Creek channel across the road and a large residential development. The shape and size of the culvert was estimated from field investigation. This culvert is also visible in Appendix A-C.

- Losses are calculated based on SCS Curve Number methodology. These curve numbers were established corresponding to land use and soils categories. An initial abstraction of 0.2 inch is used with a minimum infiltration rate of 0.05 in/hr. See Table 2 for reference.

- Land use roughness values, represented by the model Manning's n value, was determined using available land use data. In addition to the land use data, the building footprints data was used as a manning's coefficient refinement region. An artificially high value of 0.4 was used to represent the loss of conveyance at building footprints. See Table 2 for reference.

- The calculations are performed using HEC-RAS unsteady flow analysis based on the 2D Saint Venant shallow water equations (SWE) setting (SWE-ELM).

- The model was run using the 24-hour NOAA Type C rainfall distribution. Rainfall depths were obtained from NOAA Atlas 14 for the 5-year (4.11 inches), 10-year (4.84 inches) and 100-year (7.82 inches) frequency storm events. See Appendices A, B, and C for mapped results of the 5, 10, and 100-year rainfall events, respectively. The simulations were performed using the variable time step starting with a 2 second computation interval, with a maximum courant value of 1.2. Courant number is calculated as the product of fluid velocity and time step, divided by the cell length. Limiting the courant number ensures that flow does not travel more than one grid cell per time step and calculations are performed at every cell.

Table 2. SCS Curve Numbers and Manning's N Roughness Coefficients

DVRPC Landuse Category	Landuse Category	Curve Number Value				Manning's N
		Soil Type A	Soil Type B	Soil Type C	Soil Type D	
Agriculture	Row crops - Straight row (SR) - Poor	72	81	88	91	0.035
Commercial	Urban districts - Commercial and business (85% imp.)	89	92	94	95	0.15
Industrial	Urban districts - Industrial (72% imp.)	81	88	91	93	0.08
Institutional	Open space (lawns, parks, golf courses, cemeteries, etc.) - Poor condition (grass cover <50%)	68	79	86	89	0.03
No Data	No Land Cover Data available	98	98	98	98	0.03
Recreation	Open space (lawns, parks, golf courses, cemeteries, etc.) - Fair condition (grass cover 50 to 75%)	49	69	79	84	0.03
Residential	Residential districts by average lot size - 1/4 acre (38% imp)	61	75	83	87	0.08
Transportation	Streets and roads - Paved; curbs and storm sewers (excluding right-of-way)	98	98	98	98	0.025
Undeveloped	Open space (lawns, parks, golf courses, cemeteries, etc.) - Fair condition (grass cover 50 to 75%)	49	69	79	84	0.03
Utility	(Drainage channels) Desert shrub - Fair	55	72	81	86	0.03
Water	Water	98	98	98	98	0.04
Wooded	Woods - Fair Condition	43	65	76	82	0.16
-	Buildings	-	-	-	-	0.4

Modeling Limitations

This approach includes the following limitations:

- **Local Storm Drainage Systems.** The HEC-RAS 2D model performs surface water routing and does not simulate the storm drainage system explicitly. As a result, the flooding depths and extents in roadways are likely to be conservative-larger than they would be if the piped network was included. This means the model is useful as a guide to locations that may be susceptible to ponding and flooding, and it is not a highly detailed flood map with flood elevations (although it could be representative of ponding if the storm drainage system became clogged). There are model adjustments that can be implemented to account for this omission of capacity, including subtracting the rainfall depth equivalent to the piped system capacity from the rainfall input. This was not performed for this particular model due to uncertainty in both the extent, capacity, and design criteria of the local storm drainage systems.

  The modeling approach includes conservative processes and assumptions in upstream areas, including omission of the local storm drainage system. As a result, some runoff volume remains in upland areas that actually convey directly to the stream via the storm sewer system. This introduces some uncertainty to the flooding extents along the main channels.

- **Topography.** The LiDAR data collection process, which forms the topographical basis for the model, does not typically capture the openings (bridges/culverts) below roadways, only the road surface. Consequently, unless the topography or flow paths are manually edited, the model sees these roads as "dams". If there is a large volume in the channel upstream of the dam, it can interfere with the results of 2D rain-on-grid models such as these. This was not a major concern for the Marcus Hook watershed, since it has a relatively simple channel network and, as described in this memorandum, adjustments and assumptions were made to the model along major flow paths and major stream alignments to enforce flow paths through topographical barriers. As described above, public datasets such as the National Hydrography Dataset, topography, and aerial photography were used to identify these crossings along major flow paths and adjust them. These adjustments were found to be beneficial, and future modeling efforts should plan for similar adjustments to allow for passage of water in the model.

- **Roadway Crossing Sizing.** Assumptions were made about the sizes of roadway crossings for this trial modeling effort without extensive field verification. While these assumptions allow for continuous downstream flow and allow for mapping of pluvial areas susceptible to ponding and flooding, it should be understood that overestimating or underestimating culvert sizes adds uncertainty to mapping results.

- **Data in Developing Areas.** Using data sets collected at different times in rapidly developing areas, such as in parts of Delaware County, can sometimes lead to mismatches in data (for example between the terrain and the roadway centerlines) which can affect model results. Refer to Table 1 for data set sources and applicable dates.

- **Model Resolution.** The model results seem to improve with a finer grid size defined at 15 x 15-foot resolution. The grid size refers to the spatial resolution of the computational mesh used in 2D flow areas. It defines how finely the terrain is divided for hydraulic calculations. The smaller grid allows the simulation to better capture subtle changes in the terrain, leading to a reduction in the magnitude of the model's calculated mass balance error. Mass balance error refers to the discrepancies between the mass entering and exiting the grid. The model as a whole has a small overall mass balance error regardless of the grid cell resolution with some isolated pockets of higher error values. When the model resolution was increased the size of these errors decreased but the location of the isolated pockets of higher error was largely unchanged. A smaller grid size also significantly adds to the calculation time and the output file sizes become very large. The test undertaken with the 15-foot x 15-foot grid took over 31 hours to run, and created an output file size of 750 megabytes, which is three times as large as the output using the 50-foot x 50-foot mesh. A compromise was made where breaklines were used to provide higher resolution along key flow paths and where beneficial to understanding known problem areas. This provides higher resolution in locations where it is important to understand potential areas of flooding and facilitate continuous flow paths.

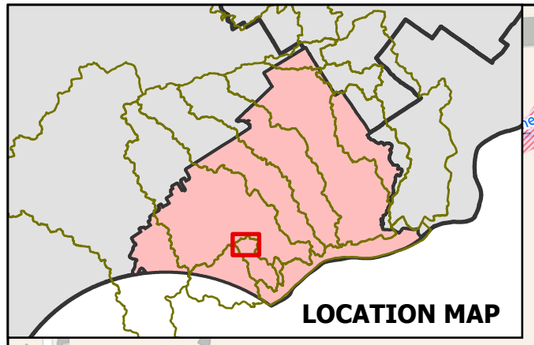
Conclusion

The proposed model offers a preliminary insight into the general flooding patterns across the study area. While it serves as a useful tool for identifying potential flood-prone zones, its predictive accuracy is constrained by the limited resolution and reliability of the input data, including topography and the existing storm sewer network. Consequently, the results should be interpreted with caution and the figures presented in the appendix accompanying this memorandum exclude shallow flooding and floodplain fringe areas where model output indicates maximum water depths of below six inches. This model is best suited for initial screening and prioritization efforts, rather than for detailed planning or decision-making. Further refinement and validation using high-quality datasets and topographic surveys would be necessary to enhance its applicability for more rigorous analyses.

Attachments:

1. Screening Model results
    - Appendix A – 5-Year Flood Vulnerability Map
    - Appendix B – 10-Year Flood Vulnerability Map
    - Appendix C – 100-Year Flood Vulnerability Map
    - Appendix D – Flow Path Enforcement Modifications Map
    - Appendix E – Problem Area Attribute Table

Appendix A – 5-Year Flood Vulnerability Map



Delaware County Act 167 Stormwater Management Plan

Marcus Hook Creek Screening Modeling Results (5-Year Flood Vulnerability)

Legend

Stormwater Problem Areas (Site Visit Priority)
- High
- Low
- Site Visit Not Prioritized
- Culvert
- Streams*
- Watersheds
- Delaware County Building Footprints

5-year Flood Vulnerability Category**
- Shallow Localized Ponding or No Ponding***
- Localized Ponding/Fringe Flooding (6" - 1')
- Shallow Flooding (1' - 2')
- Moderate Inundation Susceptibility (2' - 3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones (FIS data 11/2017)
- Flood Zone A (100-Year)
- Flood Zone AE (100-Year)
- Floodway

*Stream data layer is provided by Delaware County and aligns best with model results and FEMA flood zones. Other data sources displayed differing alignments and extents for the Marcus Hook Creek Watershed.

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

N

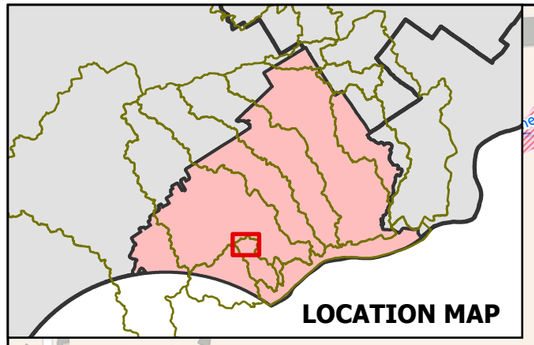
0 500 1,000 Feet

Map prepared by Jacobs and NTM 11/11/2025

Jacobs | Newell Tereska & MacKay | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix B – 10-Year Flood Vulnerability Map



Delaware County Act 167 Stormwater Management Plan

Marcus Hook Creek Screening Modeling Results (10-Year Flood Vulnerability)

Legend

Stormwater Problem Areas (Site Visit Priority)
- High
- Low
- Site Visit Not Prioritized
- Culvert
- Streams*
- Watersheds
- Delaware County Building Footprints

10-year Flood Vulnerability Category**
- Shallow Localized Ponding or No Ponding***
- Localized Ponding/Fringe Flooding (6" - 1')
- Shallow Flooding (1' - 2')
- Moderate Inundation Susceptibility (2' - 3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones (FIS data 11/2017)
- Flood Zone A (100-Year)
- Flood Zone AE (100-Year)
- Floodway

*Stream data layer is provided by Delaware County and aligns best with model results and FEMA flood zones. Other data sources displayed differing alignments and extents for the Marcus Hook Creek Watershed.

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

N

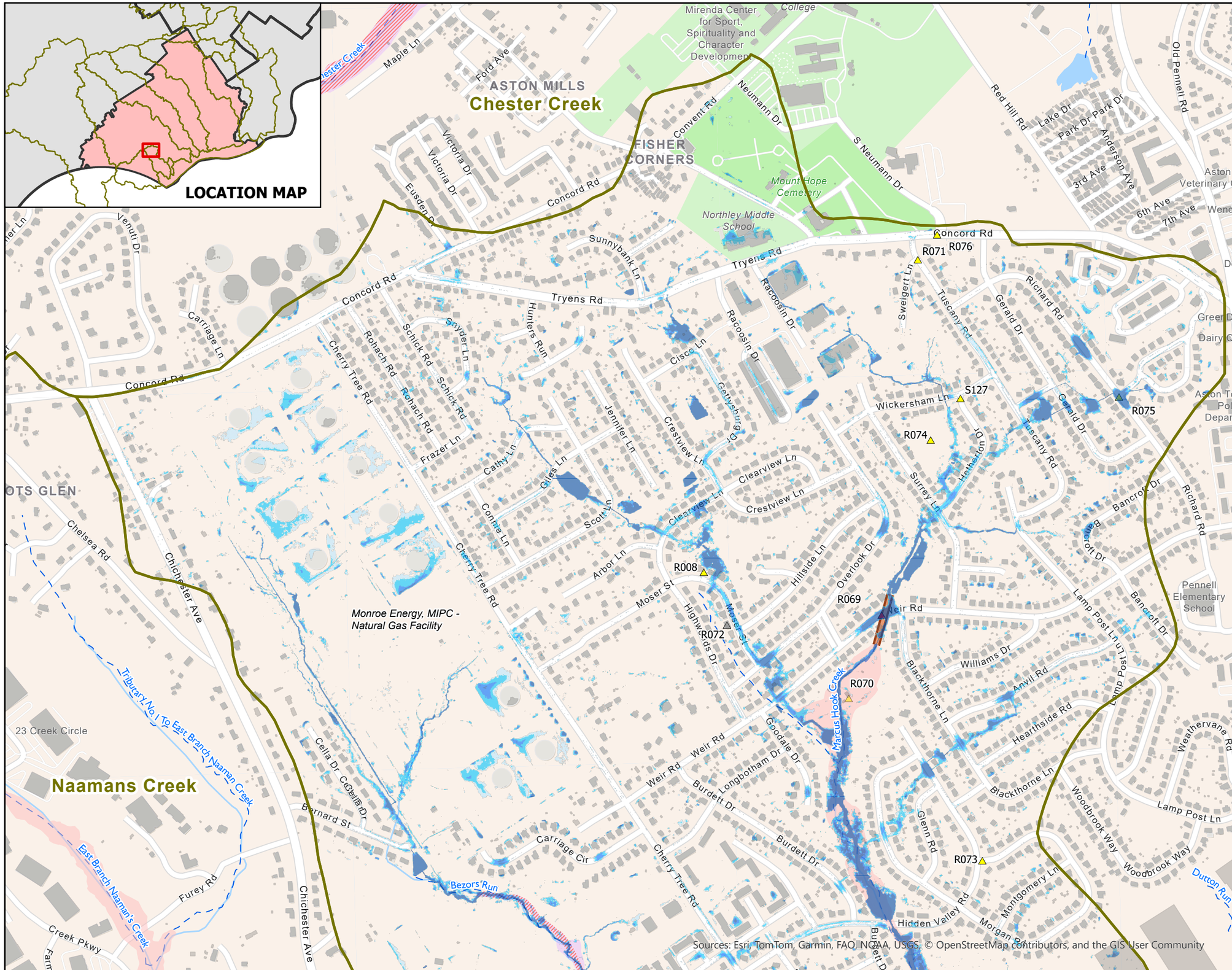
0 500 1,000 Feet

Map prepared by Jacobs and NTM 11/11/2025

Jacobs | Newell Tereska & MacKay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix C – 100-Year Flood Vulnerability Map



Delaware County Act 167 Stormwater Management Plan

Marcus Hook Creek Screening Modeling Results (100-Year Flood Vulnerability)

Legend

Stormwater Problem Areas (Site Visit Priority)

- High
- Low
- Site Visit Not Prioritized
- Culvert
- Streams*
- Watersheds
- Delaware County Building Footprints

100-year Flood Vulnerability Category**

- Shallow Localized Ponding or No Ponding***
- Localized Ponding/Fringe Flooding (6" - 1')
- Shallow Flooding (1' - 2')
- Moderate Inundation Susceptibility (2' - 3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones (FIS data 11/2017)

- Flood Zone A (100-Year)
- Flood Zone AE (100-Year)
- Floodway

*Stream data layer is provided by Delaware County and aligns best with model results and FEMA flood zones. Other data sources displayed differing alignments and extents for the Marcus Hook Creek Watershed.

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

N

0 500 1,000 Feet

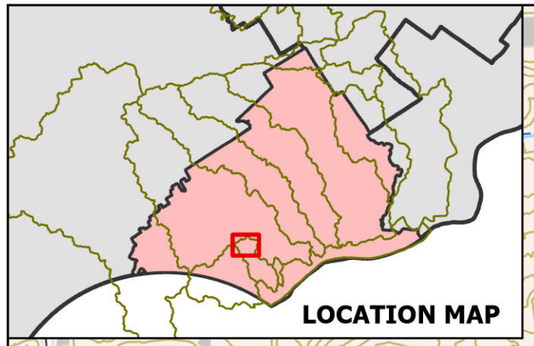
Map prepared by Jacobs and NTM 11/11/2025

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Appendix D – Flow Path Enforcement Modifications Map

Delaware County Act 167 Stormwater Management Plan

Marcus Hook Creek DEM Adjustments



Legend

- Flow Path Breaklines
- Road Breaklines
- Burn Lines (Stream Flow Path Adjustment)
- Culvert (Modeled Structure)
- Streams*
- Contours (5 ft)
- Watersheds
- Delaware County Building Footprints

*Stream data layer is provided by Delaware County and aligns best with model results and FEMA flood zones. Other data sources displayed differing alignments and extents for the Marcus Hook Creek Watershed.

N

0 500 1,000 Feet

Map prepared by Jacobs and NTM 11/11/2025

Jacobs | Newell Teresko & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix E – Problem Area Attribute Table

Problem Area ID*	Watershed	Municipality	Problem Type	Problem Notes	Problem Causes	Property Type	Property Damage Notes	Problem Cause Category	Follow-up Field Notes
R008	Marcus Hook Creek	Aston Township	Flooding			Residential, Rightofway	Stormwater behind the houses completely fills up & causes the entire backyards to fill with water and has entered homes at times. Also has flooding roads during very large storm events.	Unknown	The stream daylights in a small section. Evidence of overtopping and the outlet flooding in the backyard. Streambank erosion.
R069	Marcus Hook Creek	Aston Township	Flooding	Flooding occurs due to undersized culvert and additions, patios, expanded driveways, decks, and sheds in the watershed without stormwater control				Infrastructure	Newsome Pond Park appears to be a paved loop. Behind the paved loop is a depression of about 4 ft depth and is behind a number of homes. The depression floods and causes build up of debris at the entrance of a rock banked channel entering another depression to the west of the paved loop with no apparent outlet pipe. Adjacent to both depressions is a stream with some bank erosion. The stream enters a culvert of 50" height and 80" width. About 20 ft into the culvert, an approximately 8 inch PVC pipe enters the culvert from the direction of the depression in the park. The culvert crosses Weir Road, as seen from above in two inlets on the road, underneath private property, and out a wall into Marcus Hook Creek in Weir Park. Property owner at 2335 Weir Road testifies that during intense storms, water flows over her yard, the neighbors' yard, and floods the entire baseball fields in Weir Park. She recently replaced her fence that was damaged by flood.
R070	Marcus Hook Creek	Aston Township	Flooding, Erosion		Creek was observed to have large pools of standing water despite in not having rained recently, appearing to have multiple obstructions from trees (black walnuts). Erosion on banks and gabion walls in poor condition. Obstruction bridge in middle of par	Open space	Threatening foundation of concession stand and bathroom facility at baseball fields	Unknown	Flooding and erosion occurs just downstream. Streambank erosion is threatening the foundation of the concession stand and bathroom facility at the baseball fields.
R071	Marcus Hook Creek	Aston Township	Erosion		Topography of the area has a lot of overland flow with minimal stormwater inlets to collect runoff along Swigart lane. Presence of willows and silver maples suggest prolonged saturation of area. Unable to locate capped springs.	Residential	Erosion in rear yards	Infrastructure	Improperly capped springs and frequent excessive overland flow is directed into rear yards of the properties on Tuscany Rd, causing erosion of yards and sinkholes.
R072	Marcus Hook Creek	Aston Township	Flooding	Floods when culvert is impacted by tree limbs and forest debris from open space behind residential properties		Residential	Basement flooding	Obstruction	
R073	Marcus Hook Creek	Aston Township	Groundwater	Houses along Morgan Road have groundwater issues.		Residential	Entire yards have settled damaging ingound pools and possibly affecting house foundations, yard areas have formed sinkholes.	Unknown	Some evidence of subsidence in yards, some new sidewalk and some construction apparent in backyards. New fences. Most of the street is a hill and inlets at the intersection of Hidden Valley Road and Morgan Road appear clear of sediment. Some areas along the curb show sediment marks and one curb appears to have subsided slightly.
R074	Marcus Hook Creek	Aston Township	Flooding	Flooding at park; sinkholes form periodically		Open space	Sinkholes	Unknown	Park sits in a depression with no inlets to drain runoff. Inlets on outside of berm are clogged and appears to be flooding along the outside berm. Runoff ponds adjacent to 2 outlet structures.
R075	Marcus Hook Creek	Aston Township	Groundwater			Residential		Unknown	Significant groundwater problems affecting homes on Richard Rd.
R076	Marcus Hook Creek	Aston Township	Flooding	Roadway flooding occurs due to undersized culvert being blocked				Obstruction	48" tall outlet structure with 5 (five) 6 inch orifices at 27" off basin surface. Basin receives water from the culvert under Neumann Drive and then discharges into a wooded area adjacent to another stormwater basin on the school property. Culvert under Newman Drive is 32" CMP. There is sediment that settled out at the intersection of the driveway and Concord Road. Possible that cemetery driveway and hill runoff also likely make it to the intersection. Possible undersized or inadequate number of inlets and possibly undersized culvert.
S127	Marcus Hook Creek	Aston Township	Flooding, Groundwater	Multiple ephemeral streams confluescing behind 2620 wickersham lane leading to a large storm sewer pipe crossing wickersham lane leading to concord square park. Confluence area behind stated address exhibits some bank erosion. Ditch behind houses	Storm Water Volume	Residential,Open Space	Erosion and basement flooding		Pond present in backyard of 140 Sweigart Lane. Would overflow to confluence area behind 2620 Wickersham Lane.

*Problem Area ID's beginning in letter R were collected and summarized from available studies and publications. Problem Area IDs beginning in letter S were submitted to the Delaware County Act 167 project survey from WPAC and Stakeholder Committee members.

Appendix B.2 – Muckinipattis Creek Model Memo

Muckinipattis Creek Pluvial Model

Delaware County
Act 167 Stormwater Management Plan

Prepared For:

Delaware County Planning Department

&

Jacobs

Challenging today.
Reinventing tomorrow.

February 2026

NTM Engineering, Inc.
130 West Church Street, Suite 200
Dillsburg, PA 17019

Newell Tereska & Mackay Engineering

NEWELL TERESKA & MACKAY ENGINEERING

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

TABLE OF CONTENTS

Page

I. Objective 1

II. Methodology and Data 2

III. Model Setup 3

IV. Modeling Limitations 7

V. Results 8

VI. Validation 10

VII. Conclusion 12

VIII. References 13

LIST OF APPENDICES

Appendix A: 5-Year Flood Vulnerability Map

Appendix B: 10-Year Vulnerability Map

Appendix C: 100-Year Vulnerability Map

Appendix D: FEMA Information

Appendix E: Darby and Cobbs Creek Watershed Act 167 Information

Appendix F: HEC-RAS Input Figures

Appendix G: Problem Area Attribute Table

NEWELL TERESKA & MACKAY ENGINEERING

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

MEMORANDUM

TO: DELAWARE COUNTY PLANNING DEPARTMENT

FROM: NTM ENGINEERING, INC.

SUBJECT: MUCKINIPATTIS CREEK PLUVIAL FLOODING MODEL

I. Objective

The purpose of this memorandum is to document the HEC-RAS two-dimensional (2D) pluvial flooding model study for the Muckinipattis Creek watershed and provide the technical findings from the modeling efforts. NTM was tasked with using HEC-RAS to build a pluvial model to represent surface flooding for the Muckinipattis Creek watershed in Delaware County. The HEC-RAS pluvial model results are conservative and may overestimate flood depths due to its limitations, but the results can be used to identify locations for potential flooding. Muckinipattis Creek is a tributary to Darby Creek and is located in southeast Delaware County. The location of the Muckinipattis Creek watershed is provided in **Figure 1**.

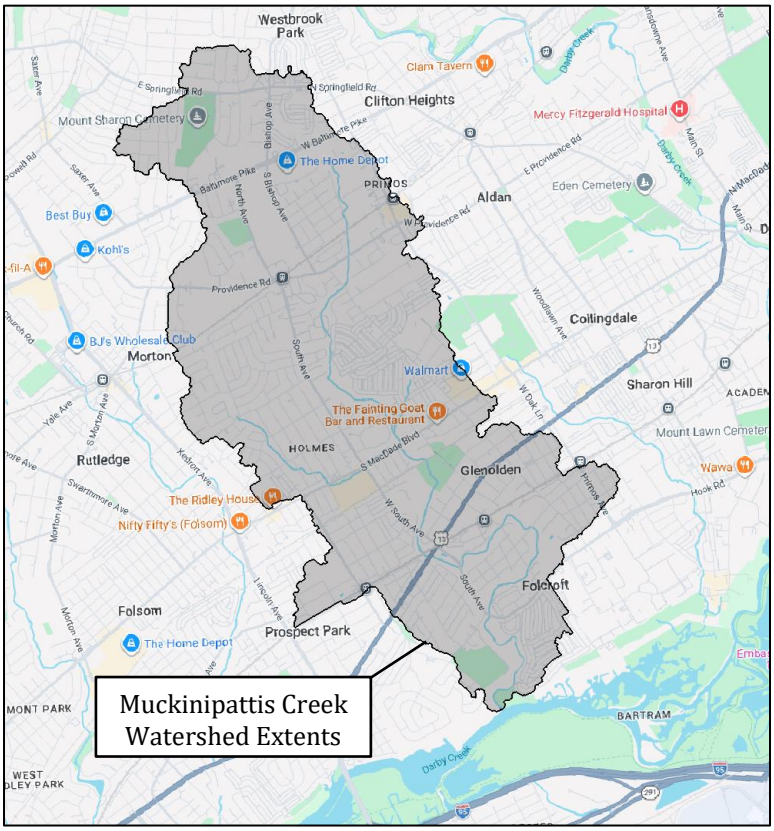


Figure 1: Muckinipattis Creek Watershed

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

Jacobs previously performed a small-scale pilot study to test the effectiveness of using HEC-RAS 2D modeling as a screening method to compare modeled pluvial flooding at locations where Problem Areas have been submitted by stakeholders and WPAC (Watershed Plan Advisory Committee) members to the Delaware County Act 167 project survey. Data for the survey was collected from July-August 2025 and was comprised of logged problem areas as well as other problem areas summarized from studies and publications shared by the stakeholders. Jacobs prepared a pilot study pluvial model in HEC-RAS to represent surface flooding for the Marcus Hook Creek watershed in Delaware County. The study performed for the Muckinipattis Creek watershed follows the procedure performed for the pilot study and the memo prepared by Jacobs for the Marcus Hook Creek watershed. Any assumptions that deviate from the pilot study are described in the subsequent sections of this report.

II. Methodology and Data

The hydrologic and hydraulic model was developed using the USACE HEC-RAS 2D model version 6.6 with the rain-on-grid boundary condition within HEC-RAS. In the 2D rain-on-grid methodology, rainfall data is applied directly on the 2D model grid. The infiltration losses are calculated within the HEC-RAS 2D model using the SCS (Soil Conservation Service) curve number method. ArcGIS Pro version 3.6 and Watershed Modeling System (WMS) version 11.2 were also used as supporting software. The best publicly available datasets are utilized in the analysis, including: terrain, land use, soils, and rainfall data. The sources of the data used are listed in **Table 1**.

Table 1: Data Source

Data Type	Source	Notes
1 meter resolution Digital Elevation Model (DEM)	USGS 3DEP; dated April - November 2015; Published March 2020	Downloaded from: https://apps.nationalmap.gov/downloader/ Data is identical to PASDA data from DVRPC for Delaware County.
Land Use Data	Delaware Valley Regional Planning Commission (DVRPC); 2023 Land Use File, Published 2024	Provided by Jacobs. Origin of file from: https://catalog.dvrpc.org/dataset/land-use-2023; 2023 land use file is based on digital orthophotography created from aerial surveillance completed in the spring of 2023.
Soils Data	USDA NRCS Web Soil Survey; Published 2025	Provided by Jacobs. Origin of file from: https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Roadway Centerline Data	Delaware County (Delaware County Roads); Published 2022; PennDOT (PA State Roads); Published 2025	Provided by Jacobs. Delaware County roadway centerline data provided by Jacobs (via Delaware County)
Building Footprints	Delaware County; Published 2022	Provided by Jacobs. Origin of file from the Delaware County online Portal:

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

Data Type	Source	Notes
		https://gis.delcopa.gov/arcgis/rest/services/DataLayers_911/Delaware_County_Building_Footprints/FeatureServer
Precipitation	NOAA; Published 2006	Obtained from: https://hdsc.nws.noaa.gov/pfds/ Median NOAA Atlas 14, 24-hr Rainfall Depths. Temporal distribution is NOAA Type C.
FEMA DFIRM	Delaware County Flood Insurance Study, Published 11/03/2017	Obtained from: https://msc.fema.gov/portal/home FEMA water surface elevations were referenced for the watershed model boundary conditions. FEMA peak flows used for comparison.

Software Used:

- *HEC-RAS Version 6.6*
- *ArcGIS Pro Version 3.6*
- *Watershed Modeling System (WMS) 11.2*

III. Model Setup

The HEC-RAS rain-on-grid hydraulic model was performed using the following procedure:

- The drainage area of Muckinipattis Creek is approximately 4.36 square miles, as calculated with USGS StreamStats[1] and verified in WMS 11.2 using the terrain DEM.
- The watershed extents from WMS 11.2 were exported as a polygon shapefile and used to set a boundary limit for the hydraulic model. A 200-foot buffer zone was used to set the mesh limits of the HEC-RAS hydraulic model.
- Localized, small low spots in the DEM/terrain were hydrologically filled in the terrain using the geospatial "fill sinks" process in ArcGIS up to 0.5 feet. The modified terrain was imported into HEC-RAS using a 1-meter DEM cell resolution.
- The Terrain DEM was modified in HEC-RAS using the channel modification tool in RAS Mapper for bridge and culvert crossings. The terrain modifications assumed "channel" widths of 10, 15, 20, and 50 feet to match the average stream widths immediately upstream and downstream from the crossings. The locations of the terrain modifications are provided in **Appendix F**.
    - HEC-RAS Channel Modifications 43, 44, 45, and 46 represent long culvert crossings underneath developed areas. Structure information was not available for these long culverts; therefore, the channel modification tool was used to provide hydraulic connectivity. The exact culvert locations was not available; therefore the channel

[1] https://www.usgs.gov/streamstats

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

modifications were set based on the existing terrain and aerial imagery. Note that this approach does not account for the backwater effects due to the culvert capacity.

- The terrain with channel modifications was exported from HEC-RAS as a 3-meter DEM and imported into WMS to calculate flow accumulation arcs up to 0.1 square miles. The flow accumulation provided accurate connectivity where existing structures and channels convey flow that matches the Terrain DEM. The flow accumulation arcs were exported into a shapefile and smoothed to avoid sharp angles. The flow accumulation shapefile was imported into HEC-RAS model to set channel mesh elements and channel roughness coefficients. The National Hydrography Dataset for streamlines and Delaware County streams GIS layer were used to validate the calculated flow accumulation lines. A figure showing the calculated flow accumulation arcs is provided in **Appendix F**.

- The HEC-RAS 2D Flow Area geometry was constructed using the watershed buffer along with break lines for the channel and streets. The channel breaklines used the flow accumulation shapefile generated in WMS and a 10-foot mesh resolution. Additional stream breaklines were added to Tributaries to Muckinipattis Creek where a channel was identified in the terrain. The street breaklines used the Delaware County Streets shapefile and used a 20-foot mesh resolution. The rest of the 2D flow area geometry assumed a 50x50-foot mesh.

- Bridges and culverts were not modeled in HEC-RAS due to lack of information for the structure sizes.

- The Delaware County land use shapefile was used to set the "Land Use" characteristics throughout the watershed. The land use categories under "LU23catn" were used to set the land type and are referred as "Land Use" for the purposes of this memo. A figure showing the land use is provided in **Appendix F**.

- The Delaware County Soils shapefile provided by Jacobs was used to set the soil type characteristics throughout the watershed. A figure showing the soils in the watershed is provided in **Appendix F**.

- Losses are calculated based on SCS Curve Number methodology. The curve numbers were established corresponding to land use and Hydrologic Soil Group (HSG) categories to create an infiltration layer in HEC-RAS. **Table 2** shows the curve number assumptions for each land use and HSG category. Soils classified as urban, water, or no data were set to match the curve numbers of HSG D as a conservative approach and to match the pilot study. An initial abstraction of 0.2 inch is used with a minimum infiltration rate of 0.05 in/hr.

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

Table 2: SCS Curve Numbers

DVRPC Land Use Category	Land Use Category Description	Curve Number Value			
		HSG Type A	HSG Type B	HSG Type C	HSG Type D
Agriculture	Row crops - Straight row (SR) - Poor	72	81	88	91
Commercial	Urban districts - Commercial and business (85% imp.)	89	92	94	95
Industrial	Urban districts - Industrial (72% imp.)	81	88	91	93
Institutional	Open space (lawns, parks, golf courses, cemeteries, etc.) - Poor condition (grass cover <50%)	68	79	86	89
Military	Urban districts - Commercial and business (85% imp.)	89	92	94	95
Mining	Open space (lawns, parks, golf courses, cemeteries, etc.) - Poor condition (grass cover <50%)	68	79	86	89
Recreation	Open space (lawns, parks, golf courses, cemeteries, etc.) - Fair condition (grass cover 50 to 75%)	49	69	79	84
Residential	Residential districts by average lot size - 1/4 acre (38% imp)	61	75	83	87
Transportation	Streets and roads - Paved; curbs and storm sewers (excluding right-of-way)	98	98	98	98
Undeveloped	Open space (lawns, parks, golf courses, cemeteries, etc.) - Fair condition (grass cover 50 to 75%)	49	69	79	84
Utility	(Drainage channels) Desert shrub—major plants include saltbush, geasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus. - Fair	55	72	81	86
Water	Water	98	98	98	98
Wooded	Woods - Fair Condition	43	65	76	82

- Roughness coefficients were applied to the 2D mesh using the Delaware County land use layer. Since the land use layer doesn't include a detailed channel, the flow accumulation arc was used to generate a channel polygon assuming a 20 feet wide channel. In addition, the building footprints were added to the roughness coefficient layer using the Delaware County buildings. An artificially high value of 0.4 was used to represent the loss of conveyance at building footprints. **Table 3** shows the roughness coefficient assumptions for each category. A figure showing the roughness coefficient areas is provided in **Appendix F**. Roughness coefficients used for Muckinipattis Creek vary slightly from the Pilot Study by Jacobs. The roughness coefficients in bold in **Table 3** vary from the values used in the Pilot Study due to slight differences in the land use area particular to this watershed. The category descriptions in **Table 3** provide backup information for the roughness chosesn on each Land Use Category.

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

Table 3: Roughness Coefficients

DVRPC Land Use Category	Category Description	Manning's n
Agriculture	Cultivated Crops	0.035
Commercial	Developed High Intensity	0.15
Industrial	Developed Medium Intensity	0.08
Institutional	Pasture/Hay	0.03
Military	Developed Medium Intensity	**0.08**
Mining	Barren Land	**0.025**
Recreation	Developed Open Space	**0.04**
Residential	Developed Low Intensity	**0.1**
Transportation	Roads	0.015
Undeveloped	Developed Open Space	**0.04**
Utility	Shrub/Scrub	**0.1**
Water	Open Water	0.04
Wooded	Deciduous Forest	0.16
Roads	Roads	0.015
Buildings	Buildings	0.4

- Rainfall precipitation used the 24-hour NOAA Type C rainfall distribution. Rainfall depths were obtained from NOAA Atlas 14 for the 5-year (4.09 inches), 10-year (4.81 inches) and 100-year (7.7 inches) frequency storm events.

- Downstream boundary conditions used a known water surface from the FEMA FIS for the 10- and 100-year events. During normal flow conditions, Muckinipattis Creek joins Darby Creek at the downstream limit of the hydraulic model. However, for the 10- and 100-year events, the Delaware River controls the water surface elevations along Darby Creek at the confluence with Muckinipattis Creek. Therefore, the Delaware River transect data from the FEMA FIS was used to set the boundary conditions for Muckinipattis Creek. Excerpts from the FEMA FIS showing the water surface elevations for the Delaware River are provided in **Appendix D**. For the 5-year event, a normal depth boundary condition was assumed using a slope of 0.001 ft/ft. The boundary condition on the watershed edge used a normal slope of 0.01 ft/ft. **Table 4** shows the downstream boundary conditions used in the hydraulic model.

    - Muckinipattis Creek has a low head dam just upstream of the Delmar Drive in the lower reach of the watershed. According to the DEM terrain, the dam creates an approximate 10 feet drop in elevation from upstream to downstream. The hydraulic model results show that the Delaware River boundary conditions do not impact the

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

results upstream of the dam. Therefore, any tidal effects or downstream boundary assumptions are mitigated by the instream dam.

Table 4: Boundary Conditions at Confluence with Darby Creek

Event	Downstream Boundary Condition
5-year	Normal Depth S = 0.001 ft/ft
10-year	Known WS = 7.2 feet*
100-year	Known WS = 8.6 feet*

*Water elevation obtained from the FEMA FIS Delaware River transect elevations.

- The simulations were performed using the variable time step starting with a 2 second computation interval, with a maximum courant value of 1.2. Courant number is calculated as the product of fluid velocity and time step, divided by the cell length. Limiting the courant number ensures that flow does not travel more than one grid cell per time step and calculations are performed at every cell.

- The calculations are performed using HEC-RAS unsteady flow analysis based on the 2D Saint Venant shallow water equations (SWE) setting (SWE-ELM).

IV. Modeling Limitations

This approach includes the following limitations:

- **Local Storm Drainage Systems.** The HEC-RAS 2D model performs surface water routing and does not simulate the storm drainage system explicitly. As a result, the flooding depths and extents in roadways are likely to be conservative-larger than they would be if the piped network was included. This means the model is useful as a guide to locations that may be susceptible to ponding and flooding, and it is not a highly detailed flood map with flood elevations (although it could be representative of ponding if the storm drainage system became clogged). There are model adjustments that can be implemented to account for this omission of capacity, including subtracting the rainfall depth equivalent to the piped system capacity from the rainfall input. This was not performed for this particular model due to uncertainty in both the extent, capacity, and design criteria of the local storm drainage systems.

  The modeling approach includes conservative processes and assumptions in upstream areas, including omission of the local storm drainage system. As a result, some runoff volume remains in upland areas that would convey directly to the stream via the storm sewer system. The disconnect between the modeling of the sewer system and the surface runoff flooding can contribute to significant differences in the modeled floodplain extents within the watershed. It should be noted that the Muckinipattis Creek watershed is highly urbanized.

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

- **Topography.** The LiDAR data collection process, which forms the topographical basis for the model, does not typically capture the openings (bridges/culverts) below roadways, only the road surface. Consequently, unless the topography or flow paths are manually edited, the model sees these roads as "dams". If there is a large volume in the channel upstream of the dam, it can interfere with the results of 2D rain-on-grid models such as these. Similar to the Marcus Hook watershed Pilot Study, adjustments and assumptions were made to the model along major flow paths and major stream alignments to enforce flow paths through topographical barriers. Public datasets, such as the National Hydrography Dataset, topography, FEMA floodplain comparisons, and aerial photography were used to identify these crossings.

- **Roadway Crossing Sizing.** Structures were not coded into this HEC-RAS model. Assumptions were made about the sizes of bridges and culverts. While flow paths were adjusted to be consistent with the location of structures, the lack of true hydraulic capacity from structures adds uncertainty to mapping results.

- **Data in Developing Areas.** Using data sets collected at different times in rapidly developing areas, such as in parts of Delaware County, can sometimes lead to mismatches in data (for example between the terrain and the roadway centerlines) which can affect model results. Refer to **Table 1** for data set sources and applicable dates.

- **Model Resolution.** To be consistent with the settings for the pilot study, the Muckinipattis Creek model did not consider a finer resolution mesh size. The mesh for the watershed has 118,642 computational points which is within the limit for typical 2D models.

V. Results

Results from the HEC-RAS 2D hydraulic model for the 5-, 10-, and 100-year events are provided in **Appendix A, B, and C**, respectively. The HEC-RAS model results along Muckinipattis Creek shows backwater from the main railroad and bridge crossings, as anticipated. For instance, in the lower portion of the watershed the 100-year backwater channel flow depth upstream of the SEPTA Regional Rail line near Norwood, is approximately 10.2 feet. In the middle portion of the watershed, the results of the HEC-RAS model show overland flooding along the urban watershed. Upstream of the Secane SEPTA Regional Rail Station the model shows 10- and 100-year depths up to 6.2 and 6.4 feet, respectively. In the upper portion of the watershed, the results of the HEC-RAS model show overland flooding and overtopping near 550 West Baltimore Pike with 10-, and 100-year depths up to 5.0 and 6.5 feet, respectively.

The Delaware County “Road Flooding Locations” and “Water Rescues” GIS layers were referenced for the analysis. The Delaware County GIS files have no instances of road flooding or flood water rescues within the Muckinipattis Creek watershed. This doesn’t mean road

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

flooding and water rescues have not occurred; however, they are not available in the GIS layers provided by Delaware County.

The Problem Areas identified from this project's Act 167 WPAC Survey ("Problem_Area_Site_visits" GIS layer) include nine (9) locations within the Muckinipattis Creek watershed. The stormwater problem areas IDs are listed below along with the problem type and the HEC-RAS model notes. Additional information for each stormwater problem area is provided in **Appendix G**.

1. S046 – Flooding Accelerated Erosion
   HEC-RAS Model Notes: The 5-, 10- and 100-year results shows water depths in the overbank near a residence up to 1.7, 2.5, and 3.5 feet, respectively.
2. S150 – Flooding
   HEC-RAS Model Notes: Flooding at this location seems to be related to the capacity of the existing bridge carrying South Bishop Avenue. The hydraulic model results show backwater generated by the bridge crossing. The hydraulic model shows overtopping for the 100-year event but does not overtop of the 5- or 10-year events.
3. S113 – Flooding
   HEC-RAS Model Notes: Model results show overland flooding along Quince Lane and Armstrong Ave. The 5-, 10-, and 100-year results shows water depths averaging between 2 to 3 feet at the roadway intersection, and maximum depths up to 3.5, 3.8, and 4.5 feet, respectively.
4. S116 – Flooding Accelerated Erosion
   HEC-RAS Model Notes: The 5-, 10-, and 100-year results shows velocities near the culvert up to 7.5, 7.5, and 10.5 ft/s, respectively.
5. S111 – Flooding
   HEC-RAS Model Notes: Flooding at this location may be related to the capacity of the existing bridge carrying Lawnton Terrace. Hydraulic model shows overtopping over the road for all modeled events.
6. S151 – Flooding
   HEC-RAS Model Notes: No structures in the west floodplain. Flooding is noticed on the eastern floodplain along Glenolden Park. The 5-, 10-, and 100-year results show water depths in the channel up to 7.2, 8.0, and 11.0 feet, respectively.
7. S166 – Flooding
   HEC-RAS Model Notes: Flooding at this location seems to be related to the capacity of the existing bridge carrying the SEPTA Regional Railroad. The 5-, 10-, and 100-year results show water depths along the residences on Harrison Avenue up to 1.8, 2.2, and 2.6 feet, respectively.

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

8. S119 – Flooding Accelerated Erosion
   HEC-RAS Model Notes: The 5-, 10-, and 100-year results shows velocities through the bridge up to 7.0, 7.6, and 9.6 ft/s, respectively.
9. S118 – Flooding
   HEC-RAS Model Notes: Hydraulic model results at East Amosland Road do not show surface flooding. However, the floodplain for Muckinipattis Creek is approximately 200 feet east of the problem area location. Flooding problem is unclear.

The hydraulic model results are conservative due to its limitations; therefore, flood depths and floodplain results from the HEC-RAS model are overestimated. However, the results of the hydraulic model can be used to identify potential flood prone locations beyond the mapped floodplains. Figures in **Appendix A, B, and C** provide the vulnerability maps for the events modeled.

VI. Validation

Multiple data sources were used to compare the peak flows along the Muckinipattis Creek HEC-RAS 2D. The overall pluvial flooding extents that were occurring for the peak flooding were also compared to available data sources as a form of calibration and for rough model validation purposes.

The Federal Emergency Management Agency (FEMA) published a Flood Insurance Study (FIS) for Delaware County on 11/3/2017. A subsequent Flood Insurance Rate Map (FIRM) was published on 9/2/2015. A portion of the Muckinipattis Creek watershed (from the downstream corporate limits of the Borough of Glenolden to a point approximately 0.7 mile upstream) is in an area studied by detailed methods with published peak flows and base flood (100-year) elevations. The hydrology contained in the FEMA FIS was based on the USACE Special Flood Hazard Report (USACE, 1977). The hydrology from the USACE study was developed using discharge-frequency relationships from a log-Pearson Type III analysis of stream gage data from Darby Creek and Cobbs Creek gage stations. It should be noted that the FEMA hydrology may be outdated since it was performed in 1977. **Table 5** provides a comparison between the peak flows in the FEMA FIS study with the peak flows from the current HEC-RAS study at the same location (Drainage area ~1.7 square miles). A copy of the flood maps and pertinent excerpts from the FIS are in **Appendix D**.

An Act 167 (Stormwater Management Plan) for the Darby and Cobbs Creeks Watersheds was published in May 2005 by Borton Lawson and Delaware, Chester, Montogomery, and Philadelphia Counties. The design discharges for Muckinipattis Creek watershed were determined using the US Army Corps of Engineering Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS). The model was calibrated to USGS gauge data, regression analysis of design peak flows, and FEMA FIS information. The Muckinipattis Creek watershed in the HEC-HMS model includes subareas 74 through 78. Note that the 2005 Act 167 was performed 20 years prior to this study and changes in the watershed are expected in the

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

last 20 years; however, the published peak flows from 2005 are used for comparison purposes. **Table 5** provides a comparison between the peak flows in the Act 167 HEC-HMS study with the peak flows from the current HEC-RAS study at a similar location. Subarea 74 in the 2005 Act 167 has a drainage area of 2.1 square miles and is approximately at the same location as the FEMA FIS Cross Section A. A copy of pertinent excerpts from the Act 167 are in **Appendix E**.

Table 5: Peak Flow Comparison

	Peak Flows (cfs)	
	10-year	100-year
FEMA FIS*	720	1,550
Delaware County Act 167 HEC-HMS**	672	1,281
HEC-RAS*	1,330	2,590

*FEMA FIS and HEC-RAS have a drainage area of 1.7 square miles
** Act 167 Subwatershed 74 has a drainage area of 2.1 square miles

The 100-year peak flows from the FEMA FIS and Act 167 study are lower than the calculated peak flow from the current HEC-RAS study. The drainage area of Subwatershed 74 from the Act 167 report is only 25 percent higher than the subject study, yet the 100-year discharge from the current HEC-RAS model is more than double the flow from the previous Act 167 HEC-HMS study. It should be noted that the FEMA FIS study was performed in 1977 and the previous Act 167 HEC-HMS study was performed in 2005. Differences in the watershed are expected since the previous studies are more than 20 years old. Due to the urban nature of the watershed changes in the land use cover can affect the model results. In addition, the current HEC-RAS model uses the latest topography and rainfall data which also contributes to differences in the results. The current study results may be conservative due to the model limitations, urban land use, and omission of the local sewer network. A sensitivity analysis was performed to manipulate the land use parameters (curve number, Manning's n values) to account for better storage capabilities and less runoff potential, but the changes had minimal effect to the overall peak flow results (within 5 percent). Therefore, without the hydraulic effects from the storm drainage network and more detailed modeling capabilities, the results from this analysis are limited in accuracy and, despite the input parameters being suitable for the watershed, the hydraulic results may be considered conservative.

The FEMA FIS Profile for Muckinipattis Creek was used to estimate flood depths to compare with the results of the current HEC-RAS model. At FEMA Cross Section A, the 100-year depth is approximately 4.0 feet, whereas the maximum 100-year depth from HEC-RAS is approximately 9.8 feet. At FEMA Cross Section B, the 100-year depth is approximately 7.3 feet, while the HEC-RAS 100-year depth is approximately 10.0 feet. The comparison between the FEMA profile and the HEC-RAS results indicate that the HEC-RAS model flood depths and floodplains are conservative when compared to FEMA. Although the FEMA study was performed in 1977 and may be outdated, the regulatory FEMA floodplains are used for comparison purposes.

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

Furthermore, the current HEC-RAS study uses the latest topographic terrain, land use, soils, and rainfall data that may result in higher peak flows and flow depths.

HEC-RAS errors, warnings, and notes were reviewed for the hydraulic models. No errors were reported, and all warnings and notes were deemed acceptable for this study. Final model notes for the 100-year event indicated an overall volume accounting error of 1.1% which was deemed appropriate for the study. The maximum cell water surface elevation error was reported to be 1.67 feet at cell 103199. The cell location was reviewed, and the error was deemed appropriate as the location of the cell is at a small tributary upstream of Baltimore Pike. The maximum water surface elevation error was reviewed elsewhere and was deemed appropriate for the study.

VII. Conclusion

The Muckinipattis Creek HEC-RAS model developed for this study offers insight into the general flooding patterns across the watershed. While it serves as a useful tool for identifying potential flood-prone zones, its predictive accuracy is constrained by the limited resolution and reliability of the input data, including topography and the existing storm sewer network. The model also does not fully account for hydraulic effects from bridges and culverts. Consequently, the results should be interpreted with caution and may not be used for determining floodplain limits along Muckinipattis Creek. The results from this analysis are not intended to replace the FEMA floodplain boundaries. The peak flows and floodplain extents from the HEC-RAS 2D pluvial analysis are conservative in comparison to FEMA and the previous Act 167 study; however, those studies are outdated which may contribute to some differences in the results. The figures presented in the appendix accompanying this memorandum exclude shallow flooding and floodplain fringe areas where model output indicates maximum water depths below six inches. The results from the HEC-RAS model are best suited for initial screening and prioritization efforts, rather than for detailed planning or decision-making. Further refinement and validation using high-quality datasets and topographic surveys would be necessary to enhance its applicability for more rigorous analyses.

NTM Engineering, Inc.
130 W. Church St.
Suite 200
Dillsburg, PA 17019-1278

VIII. References

1. Aquaveo. (2024). Watershed Modeling System (WMS) Version 11.2

2. Delaware County Planning Commission. (2005). *Darby and Cobbs Creek Watershed Act 167 Stormwater Management Plan.*

3. Delaware Valley Regional Planning Commission. (n.d). *DVRPC Data Center*. Retrieved 12/2025 from https://www.dvrpc.org

4. Federal Emergency Management Agency. (Sept 2015). *Flood Insurance Study Delaware County, Pennsylvania.*

5. NOAA. (n.d.) *Precipitation Frequency Data Server (PFDS).* NOAA National Weather Service Hydrometeorological Design Studies Center. Retrieved 12/2025 from https://hdsc.nws.noaa.gov/pfds/

6. Pennsylvania State University. (n.d.). *PASDA*. Retrieved 12/2025, from http://www.pasda.psu.edur/

7. U.S. Department of the Interior, U.S. Geological Survey. (n.d.). *USGS Streamstats in Pennsylvania*. Retrieved 12/2025, from https://streamstats.usgs.gov/ss/

8. U.S. Army Corps of Engineers, Hydrologic Engineering Center. (09/2024). HEC-RAS River Analysis System Version 6.6.

Muckinipattis Creek
Delaware County, PA

APPENDIX A

5-Year Vulnerability Map

NEWELL TERESKA & MACKAY
ENGINEERING

Legend

Stormwater Problem Areas (Site Visit Priority)
- High
- Low
- Site visit not needed

Streams*

Watershed

Building Footprints

5-Year Flood Vulnerability Category **
- Shallow Localized Ponding or No Ponding ***
- Localized Ponding/Fringe Flooding (6" -1')
- Shallow Flooding (1'-2')
- Moderate Inundation susceptibility (2'-3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones
- Flood Zone A (100-year)
- Flood Zone AE (100-year)
- Floodway

*Streams layer obtained from a flow accumulation arc using the Modified Terrain DEM

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

Credits:Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community, Esri, NASA, NGA, USGS, FEMA

Location Map

Prepared By:
NTM Engineering, Inc.
130 W. Church Street, Suite 200
Dillsburg, PA 17019
Date: February 2026

0 750 1,500 3,000 4,500 Feet

1 inch equals 1,500 feet

Coordinate Sytem: NAD 1983 2011 StatePlane Pennsylvania South FIPS 3702 Ft US

N

Delaware County Act 167 Stormwater Management Plan

Muckinipattis Creek

Screening Modeling Results (5-Year Flood Vulnerability)

Muckinipattis Creek
Delaware County, PA

APPENDIX B

10-Year Vulnerability Map

NEWELL TERESKA & MACKAY
ENGINEERING

Legend

Stormwater Problem Areas (Site Visit Priority)
- High
- Low
- Site visit not needed

Streams*

Watershed

Building Footprints

10-Year Flood Vulnerability Category **
- Shallow Localized Ponding or No Ponding ***
- Localized Ponding/Fringe Flooding (6" -1')
- Shallow Flooding (1'-2')
- Moderate Inundation susceptibility (2'-3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones
- Flood Zone A (100-year)
- Flood Zone AE (100-year)
- Floodway

*Streams layer obtained from a flow accumulation arc using the Modified Terrain DEM

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

Credits:Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community, Esri, NASA, NGA, USGS, FEMA

Location Map

Prepared By:
NTM Engineering, Inc.
130 W. Church Street, Suite 200
Dillsburg, PA 17019
Date: February 2026

0 750 1,500 3,000 4,500 Feet

1 inch equals 1,500 feet
Coordinate Sytem: NAD 1983 2011 StatePlane Pennsylvania South FIPS 3702 Ft US

N

Delaware County Act 167 Stormwater Management Plan

Muckinipattis Creek
Screening Modeling Results (10-Year Flood Vulnerability)

Muckinipattis Creek
Delaware County, PA

APPENDIX C

100-Year Vulnerability Map

NEWELL TERESKA & MACKAY
ENGINEERING

Legend

Stormwater Problem Areas (Site Visit Priority)
- High
- Low
- Site visit not needed

Streams*

Watershed

Building Footprints

100-Year Flood Vulnerability Category **
- Shallow Localized Ponding or No Ponding ***
- Localized Ponding/Fringe Flooding (6" -1')
- Shallow Flooding (1'-2')
- Moderate Inundation susceptibility (2'-3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones
- Flood Zone A (100-year)
- Flood Zone AE (100-year)
- Floodway

*Streams layer obtained from a flow accumulation arc using the Modified Terrain DEM

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

Credits:Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community

Location Map

Prepared By:
NTM Engineering, Inc.
130 W. Church Street, Suite 200
Dillsburg, PA 17019
Date: February 2026

0 750 1,500 3,000 4,500 Feet

1 inch equals 1,500 feet
Coordinate Sytem: NAD 1983 2011 StatePlane Pennsylvania South FIPS 3702 Ft US

N

Delaware County Act 167 Stormwater Management Plan

Muckinipattis Creek
Screening Modeling Results (100-Year Flood Vulnerability)

Muckinipattis Creek
Delaware County, PA

APPENDIX D

FEMA FIS Information

NEWELL TERESKA & MACKAY
ENGINEERING

FLOOD INSURANCE STUDY



VOLUME 1 of 2

DELAWARE COUNTY, PENNSYLVANIA (ALL JURISDICTIONS)

COMMUNITY NAME	COMMUNITY NUMBER	COMMUNITY NAME	COMMUNITY NUMBER	COMMUNITY NAME	COMMUNITY NUMBER
ALDAN, BOROUGH OF	420401	GLENOLDEN, BOROUGH OF	420416	ROSE VALLEY, BOROUGH OF	420431
ASTON, TOWNSHIP OF	421602	HAVERFORD, TOWNSHIP OF	420417	RUTLEDGE, BOROUGH OF	420432
BETHEL, TOWNSHIP OF	421606	LANSDOWNE, BOROUGH OF	420418	SHARON HILL, BOROUGH OF	420433
BROOKHAVEN, BOROUGH OF	420403	LOWER CHICHESTER, TOWNSHIP OF	421604	SPRINGFIELD, TOWNSHIP OF	420434
CHADDS FORD, TOWNSHIP OF	420402	MARCUS HOOK, BOROUGH OF	420419	SWARTHMORE, BOROUGH OF	420435
CHESTER, CITY OF	420404	MARPLE, TOWNSHIP OF	420420	THORNBURY, TOWNSHIP OF	425390
CHESTER, TOWNSHIP OF	420405	MEDIA, BOROUGH OF	420421	TINICUM, TOWNSHIP OF	421605
CHESTER HEIGHTS, BOROUGH OF	420406	MIDDLETOWN, TOWNSHIP OF	420422	TRAINER, BOROUGH OF	420437
CLIFTON HEIGHTS, BOROUGH OF	420407	MILLBOURNE, BOROUGH OF	422408	UPLAND, BOROUGH OF	420438
COLLINGDALE, BOROUGH OF	420408	MORTON, BOROUGH OF	420423	UPPER CHICHESTER, TOWNSHIP OF	420439
COLWYN, BOROUGH OF	420409	NETHER PROVIDENCE, TOWNSHIP OF	420424	UPPER DARBY, TOWNSHIP OF	420440
CONCORD, TOWNSHIP OF	420410	NEWTOWN, TOWNSHIP OF	420991	UPPER PROVIDENCE, TOWNSHIP OF	420441
DARBY, BOROUGH OF	420411	NORWOOD, BOROUGH OF	420425	YEADON, BOROUGH OF	420442
DARBY, TOWNSHIP OF	421603	PARKSIDE, BOROUGH OF	420426		
*EAST LANSDOWNE, BOROUGH OF	420412	PROSPECT PARK, BOROUGH OF	420427		
EDDYSTONE, BOROUGH OF	420413	RADNOR, TOWNSHIP OF	420428		
EDGMONT, TOWNSHIP OF	420414	RIDLEY, TOWNSHIP OF	420429		
FOLCROFT, BOROUGH OF	420415	RIDLEY PARK, BOROUGH OF	420430		

* No Special Flood Hazard Areas Identified

REVISED:

NOVEMBER 3, 2017

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
42045CV001D

Due to its small drainage area, the discharges for Lobbs Run were calculated by the rational method. The discharges for the 0.2-percent annual chance flood were determined by straight-line extrapolation of flood discharges computed for frequencies up to 100-years.

For Muckinipattis Creek, the peak discharges were taken from the USACE Special Flood Hazard Report (USACE, 1977). For Stony Creek, the peak discharges were based on discharge-drainage area relationships for Darby and Muckinipattis Creeks.

The PSU-IV Rational Method was used to develop flood frequency discharges for Bezor's Run and Spring Run (PSU, 1981).

No new hydrologic analysis was developed for the November 18, 2009, and September 2, 2015, countywide revisions.

For the July 5, 2017, FIS revision, detailed hydrologic analysis was performed on portions of Brandywine Creek, Harvey Run, and Harvey Run Branch as part of Brandywine-Christina Watershed Study.

The hydrologic analyses for Harvey Run and Harvey Run Branch involved determination of peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events using Pennsylvania Regression Equations. The peak discharges for Pennsylvania Regression Equations were computed using methodology presented in the publication "Regression Equations for Estimating Flood Flows at Selected Recurrence Intervals for Ungaged Streams in Pennsylvania" (SIR 2008-5102).

The hydrologic analyses for Brandywine Creek involved determination of peak flood discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events using gage weighted regression methodology presented in SIR 2008-5102. Log-Pearson Type III analysis for USGS 01481000 was performed by following the methodology presented in USGS Bulletin 17B using PeakFQ software program. The results of gage analysis were transferred to ungaged locations where drainage areas were between 50 and 150 percent of the gaging station drainage area. The peak discharges computed using gage analysis were weighted with regression equation peak discharges to obtain final peak flows using the methodology presented in SIR 2008-5102.

Drainage basin area delineations for this hydrologic study were performed using hydro corrected 10 feet Digital Elevation Model (DEM) created by mosaicking 3-meter DEM from Pennsylvania Digital Base Mapping Program (PAMAP) and USGS 10-meter Digital Elevation Models (DEMs). The DEMs were mosaicked using ESRI's ArcGIS 10.0 and basin area delineations were performed using ArcHydro Version 2.0.

TABLE 4 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharges (cfs) 10-percent annual chance	2-percent annual chance	1-percent annual chance	0.2-percent annual chance
LOBBS RUN					
At confluence with Darby Creek	0.6	796	1,021	1,154	1,400
MARCUS HOOK CREEK					
At confluence with the Delaware River	5.4	1,350	2,300	2,700	3,700
MUCKINIPATTIS CREEK					
At Academy Avenue[1]	1.7	720	1,250	1,550	2,600
NAAMAN CREEK					
Upstream of confluence of West Branch Naaman Creek	4.9	1,350	2,350	3,060	4,750
Upstream of confluence of East Branch Naaman Creek	2.3	660	1,220	1,600	2,500
Upstream of confluence of Spring Run	1.1	340	570	810	1,550
NAYLORS RUN					
At confluence with Cobbs Creek	4.5	1,300	2,300	3,000	5,000
At Garrett Road	3.4	1,200	2,100	2,700	4,600
Approximately 290 feet downstream of U.S. Route 13 bypass	2.8	880	1,550	2,000	3,400
Approximately 370 feet, upstream of Bond Avenue	2.6	880	1,550	2,000	3,400
At West Chester Pike	1.1	410	720	920	1,520
OLD BARN DRIVE TRIBUTARY					
At confluence with West Branch Chester Creek	0.3	20	150	300	1,550
PONY TAIL RUN					
At confluence with Ridley Creek	0.4	270	360	390	450
RIDLEY CREEK					
At confluence with the Delaware River	38.2	3,700	7,200	9,500	17,400

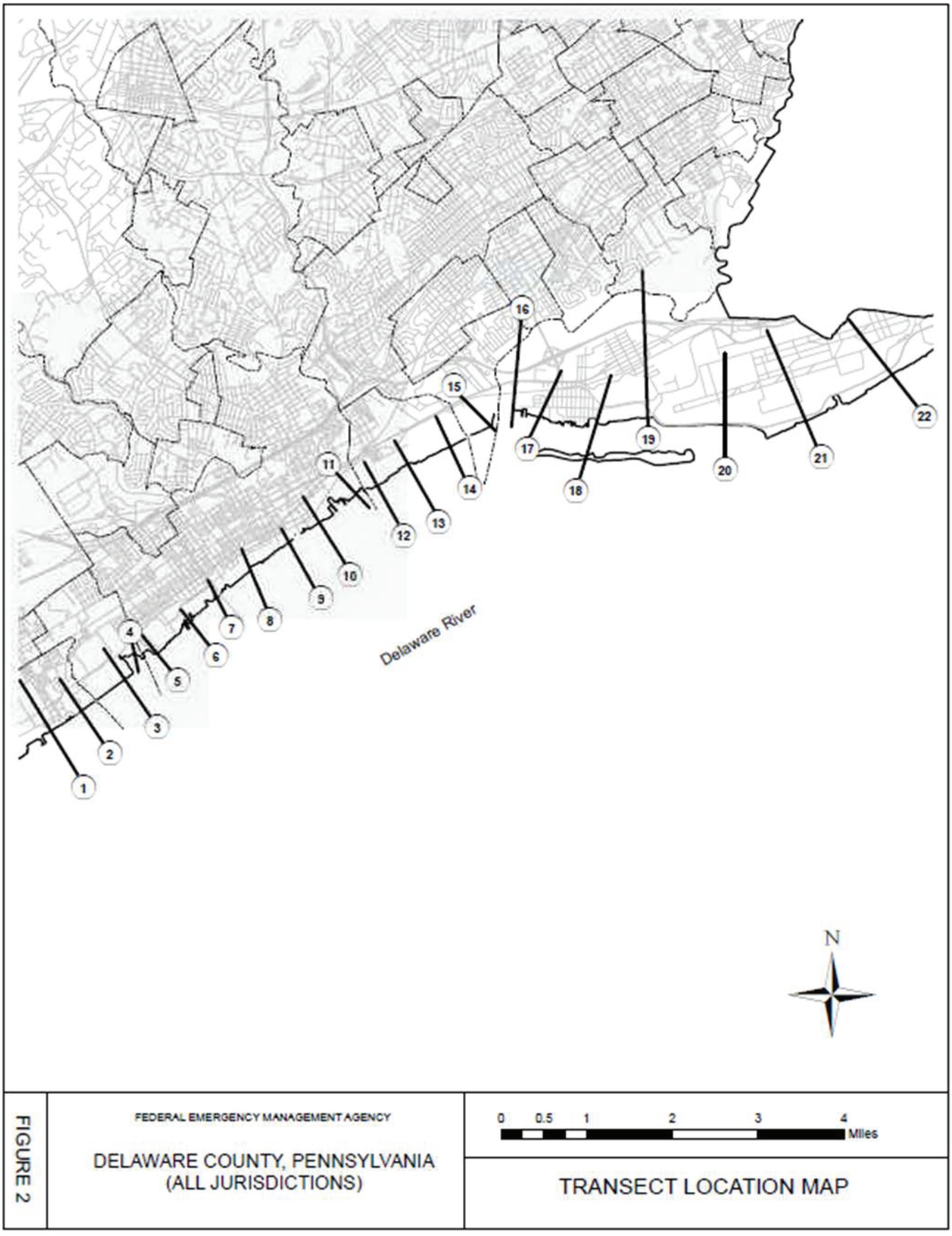


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PENNSYLVANIA
(ALL JURISDICTIONS)

TRANSECT LOCATION MAP

TABLE 8 – TRANSECT DATA – continued

Flood Source	Transect	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)			
		Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Delaware River	12	N 39.850486 W -75.340144	3.0	3.4	7.1	7.8	8.4	11.1
Delaware River	13	N 39.853760 W -75.332630	3.0	3.4	7.1	7.8	8.5	11.1
Delaware River	14	N 39.856320 W -75.324720	3.2	3.6	7.1	7.9	8.5	11.1
Delaware River	15	N 39.859398 W -75.316730	3.0	3.4	7.1	7.9	8.5	11.2
Delaware River	16	N 39.862102 W -75.309616	3.0	3.4	7.1	7.9	8.6	11.2
Delaware River	17	N 39.860950 W -75.305649	3.2	3.5	7.1	7.9	8.6	11.2
Delaware River	18	N 39.860322 W -75.293249	2.8	3.1	7.2	8.0	8.6	11.2
Delaware River	19	N 39.860071 W -75.280662	2.7	3.1	7.2	8.0	8.6	11.2
Delaware River	20	N 39.858486 W -75.264709	2.4	2.9	7.3	8.1	8.6	11.2
Delaware River	21	N 39.858663 W -75.246564	2.2	2.9	7.2	8.1	8.7	11.2
Delaware River	22	N 39.866149 W -75.227340	2.4	2.8	7.4	8.2	8.8	11.3

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Lobbs Run								
A	25[1]	231	1,335	0.8	54.2	54.2	54.2	0.0
B	938[1]	91	208	5.6	64.7	64.7	64.7	0.0
C	1,844[1]	34	137	8.4	82.2	82.2	82.2	0.0
D	2,312[1]	164	322	3.6	90.6	90.6	90.6	0.0
Marcus Hook Creek								
A	2,010[2]	135	710	3.8**	*	5.6**	6.6**	1.0**
B	4,110[2]	68	400	6.7	11.4	11.4	11.7	0.3
C	4,720[2]	197	1,130	2.4	13.6	13.6	13.8	0.2
D	7,550[2]	73	244	10.2	34.4	34.4	34.4	0.0
E	9,874[2]	46	262	9.9	48.2	48.2	49.2	1.0
F	13,992[2]	70	647	4.3	68.0	68.0	68.8	0.8
G	18,269[2]	89	569	3.7	77.1	77.1	77.8	0.7
H	20,592[2]	28	185	7.8	82.5	82.5	83.5	1.0
Muckinipattis Creek								
A	500[3]	70	200	7.7	66.5	66.5	66.5	0.0
B	1,700[3]	70	190	6.7	79.9	79.9	79.9	0.0

[1]Feet above confluence with Darby Creek
[2]Feet above confluence with Delaware River
[3] Feet above downstream corporate limits of Borough of Glenolden

* Data superseded by updated coastal analyses

** Coastal flooding effects control NFIP regulatory Base Flood Elevations in this area. Riverine floodway data are provided for the purpose of a no-rise analysis in accordance with floodway determinations for development within the SFHA

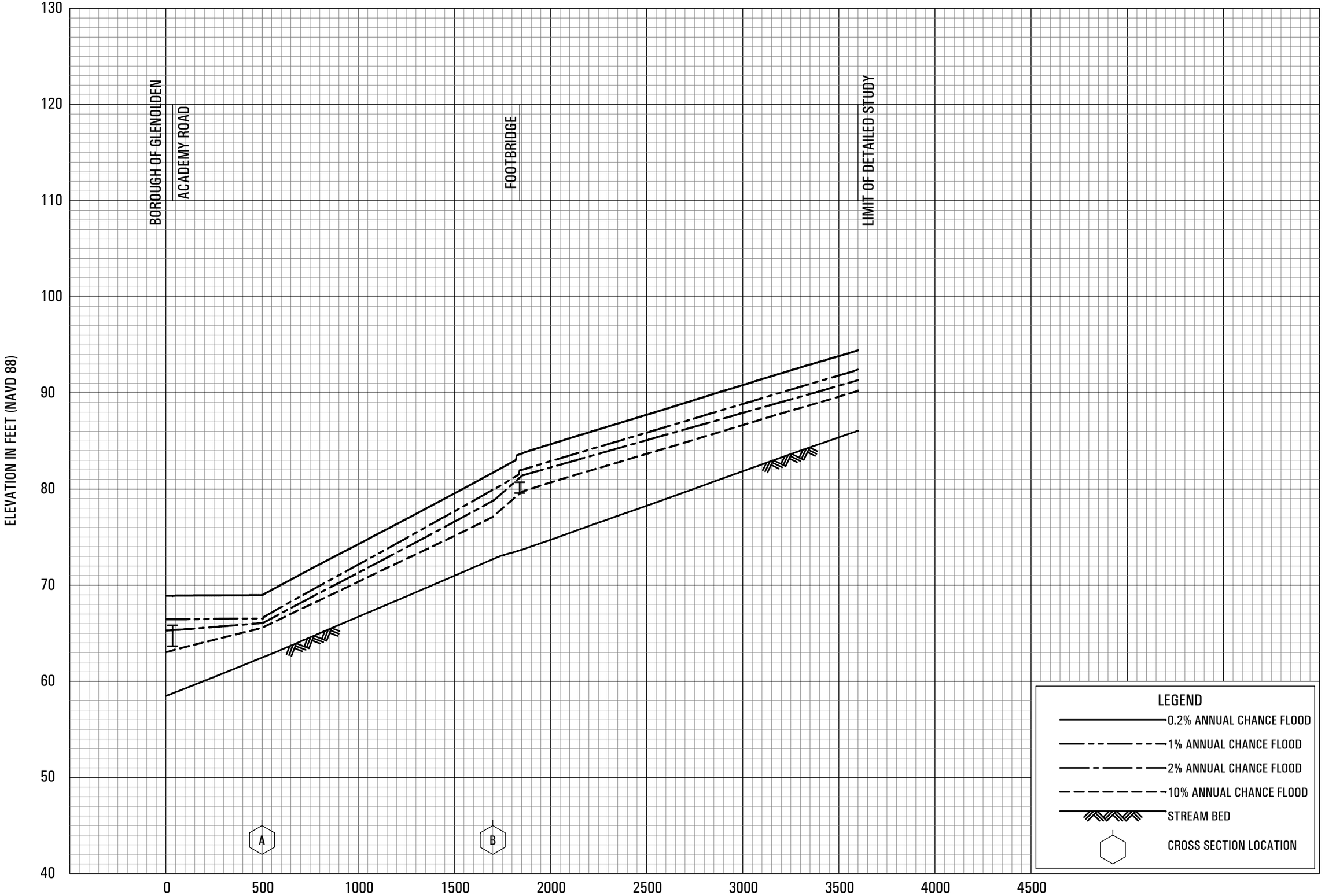
TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA
(ALL JURISDICTIONS)

FLOODWAY DATA

LOBBS RUN – MARCUS HOOK CREEK – MUCKINIPATTIS CREEK



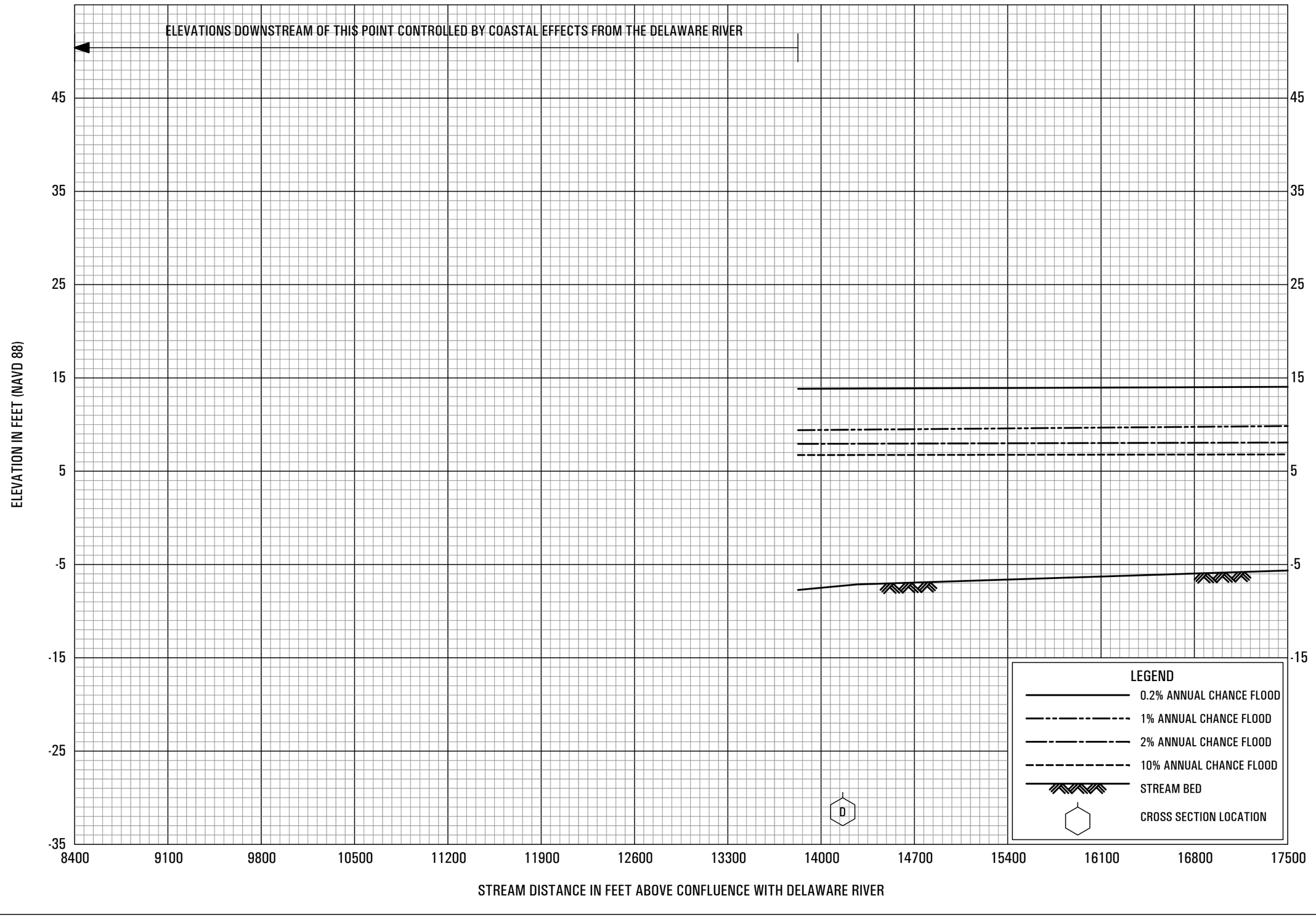
FLOOD PROFILES

MUCKINIPATTIS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA

(ALL JURISDICTIONS)



FLOOD PROFILES

DARBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA

(ALL JURISDICTIONS)

35P

AD A104102

LEVEL II

SPECIAL FLOOD HAZARD REPORT

DARBY CREEK AND MUCKINIPATTIS CREEK

DELAWARE COUNTY, PA

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.



DTIC
ELECTE
SEP 11 1981
S D
D

AUG 77

PREPARED FOR
DELAWARE COUNTY PLANNING COMMISSION
BY
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

FILE COPY

81 9 10 220

REPT. NO. 4 / DAEN/NAP-82040/SFH02-77/08

SPECIAL FLOOD HAZARD INFORMATION REPORT

DARBY AND MUCKINIPATTIS CREEKS,

DELAWARE COUNTY, PENNSYLVANIA

1.0 AUTHORITY FOR STUDY

This Special Flood Hazard Information Report was undertaken at the request of the Delaware County Planning Commission with the indorsement of the Pennsylvania Department of Environmental Resources. This report was prepared by the Philadelphia District, U. S. Army Corps of Engineers, under continuing authority provided in Section 206 of the 1960 Flood Control Act as amended.

2.0 DESCRIPTION OF AREA AND LIMITS OF STUDY

This report covers the Darby Creek within Delaware County, Pennsylvania, from its confluence with the Delaware River near Essington to the upstream study limit at the Delaware-Chester County Line, a distance of approximately 21.4 miles. Darby Creek flows in a generally southeasterly direction from its headwaters in Easttown Township, Chester County, and drains a watershed of 77.2 square miles. Within the study area, Darby Creek slopes an average of 13.9 feet per mile.

Muckinipattis Creek, a major tributary to Darby Creek, was also studied in this report. Muckinipattis Creek, with a drainage area of 4.3 square miles, has its headwaters in Springfield Township, Delaware County. It flows in a southeasterly direction through a heavily developed residential area. The stream slopes an average of 36.6 feet per mile in the study area.

The flood plains in the lower portions of Darby Creek and all of Muckinipattis Creek are primarily residential or industrial. In these areas the banks are fairly steep with trees and vegetation overgrowing the streambed. In the central reach, the flood plains are still rather heavily developed with the exception of some wooded areas located along the steep banks. In the upper reach, the flood plains are occupied with scattered residential structures. In this area, the overbanks become heavily wooded with many trees

4.2 Hydrology

A stream gaging station has been maintained on Darby Creek at the Providence Road Bridge by the U. S. Geological Survey since 1964. These gage records along with those of three other gages in the adjoining Cobbs Creek Basin were analyzed by the Log Pearson Type III Method to determine discharge-frequency relationships. A rainfall-runoff model of the basin was constructed using the Corps' HEC-I Computer Program and the HEC Regional Frequency Study of the Upper Delaware and Hudson River Basins was also investigated. The resulting recommended peak flows for the 10-, 50-, and 100-year floods were based on composite data developed by these three methods. The 100-Year Flood is defined as the flood which occurs once in 100 years on the average and has a 1% chance of being equalled or exceeded in any year.

Peak flows for the 500-Year Flood were based on Corps' Standard Project Flood calculations and extrapolation of discharge-frequency curves computed for flood events up to the 100-Year Flood. A tabulation of peak flows for Darby and Muckinipattis Creeks can be found in Table 2.

4.3 Hydraulics

Water surface profiles for the 10-, 50-, 100-, and 500-Year Flood events for Darby and Muckinipattis Creeks were computed using the Corps of Engineers' HEC-II Backwater Program. Starting water surface elevations for Darby Creek were obtained through analysis of coincident occurrences of fluvial flood events on Darby Creek and corresponding tidal flood events on the Delaware River. Starting water surface elevations for Muckinipattis Creek were obtained through analysis of coincident occurrences of fluvial flood events on Muckinipattis Creek and corresponding tidal events on the Darby Creek. Water surface profiles shown in this report were based on existing conditions of the watershed at the time field surveys were performed. During an actual flood, debris collecting on bridges and culverts could decrease their water-carrying capacity and cause backwater effects upstream of these structures. However, since the location and extent of debris accumulation are impossible to predict, it was necessary, for the purposes of this report, to assume that bridge and culvert openings would remain unobstructed.

Muckinipattis Creek
Delaware County, PA

APPENDIX E

Darby & Cobbs Creeks Watershed Act 167 Information

NEWELL TERESKA & MACKAY
ENGINEERING

DARBY AND COBBS CREEKS WATERSHED ACT 167 STORMWATER MANAGEMENT PLAN



VOLUME III – TECHNICAL APPENDIX

DELAWARE, CHESTER, MONTGOMERY, AND PHILADELPHIA COUNTIES, PENNSYLVANIA

May 2005

DARBY – COBBS CREEK WATERSHED
ACT 167
STORMWATER MANAGEMENT PLAN

DELAWARE, MONTGOMERY, CHESTER & PHILADELPHIA COUNTIES, PENNSYLVANIA

VOLUME III TECHNICAL APPENDIX

DEP ME# 350208
FILE NO. SWMP 086:23
BLE PROJECT NO. 99613.01

PREPARED FOR:

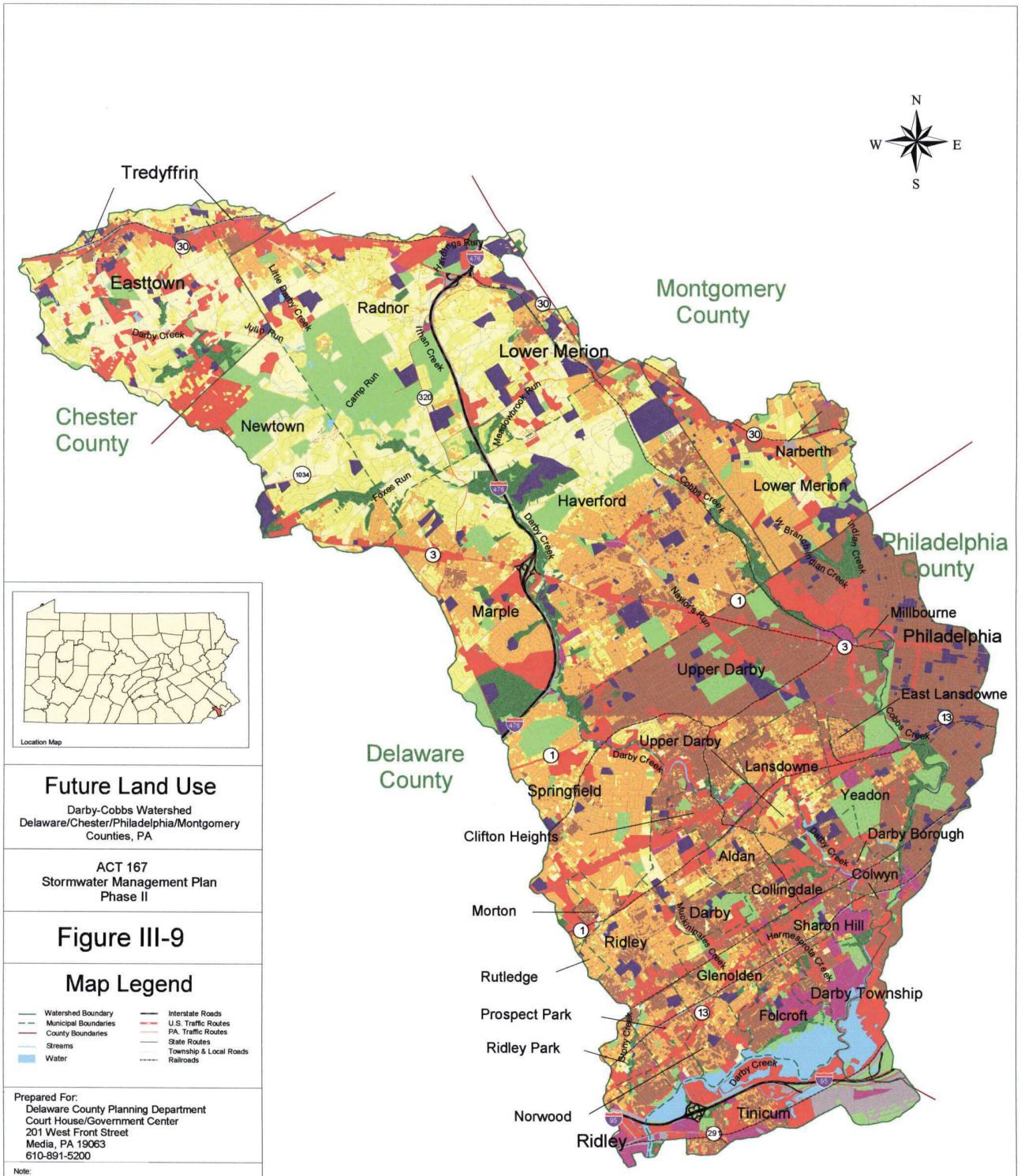
DELAWARE COUNTY COMMISSIONERS
Government Center
Media, PA 19063

PREPARED BY:

DELAWARE COUNTY
Government Center
Media, PA 19063

ENGINEERING CONSULTANT

BORTON-LAWSON ENGINEERING, INC.
613 Baltimore Drive, Suite 300
Wilkes-Barre, PA 18702-7903
VOLUME III – TECHNICAL APPENDIX



Future Land Use

Darby-Cobbs Watershed
Delaware/Chester/Philadelphia/Montgomery Counties, PA

ACT 167
Stormwater Management Plan
Phase II

Figure III-9

Map Legend

- Watershed Boundary
- Municipal Boundaries
- County Boundaries
- Streams
- Water
- Interstate Roads
- U.S. Traffic Routes
- PA. Traffic Routes
- State Routes
- Township & Local Roads
- Railroads

Land Use/Land Cover

- COMMERCIAL
- FOREST
- OPENSPACE/MEADOW
- FARMSTEAD
- INDUSTRIAL
- INSTITUTIONAL
- GRAVEL
- PAVED
- R-A (1/8 Acre or less)
- R-B (1/8 to 1/3 Acre)
- R-C (1/3 to 1 Acre)
- R-D (1 to 4 Acres)
- WATER

Prepared For:
Delaware County Planning Department
Court House/Government Center
201 West Front Street
Media, PA 19063
610-891-5200

Note:

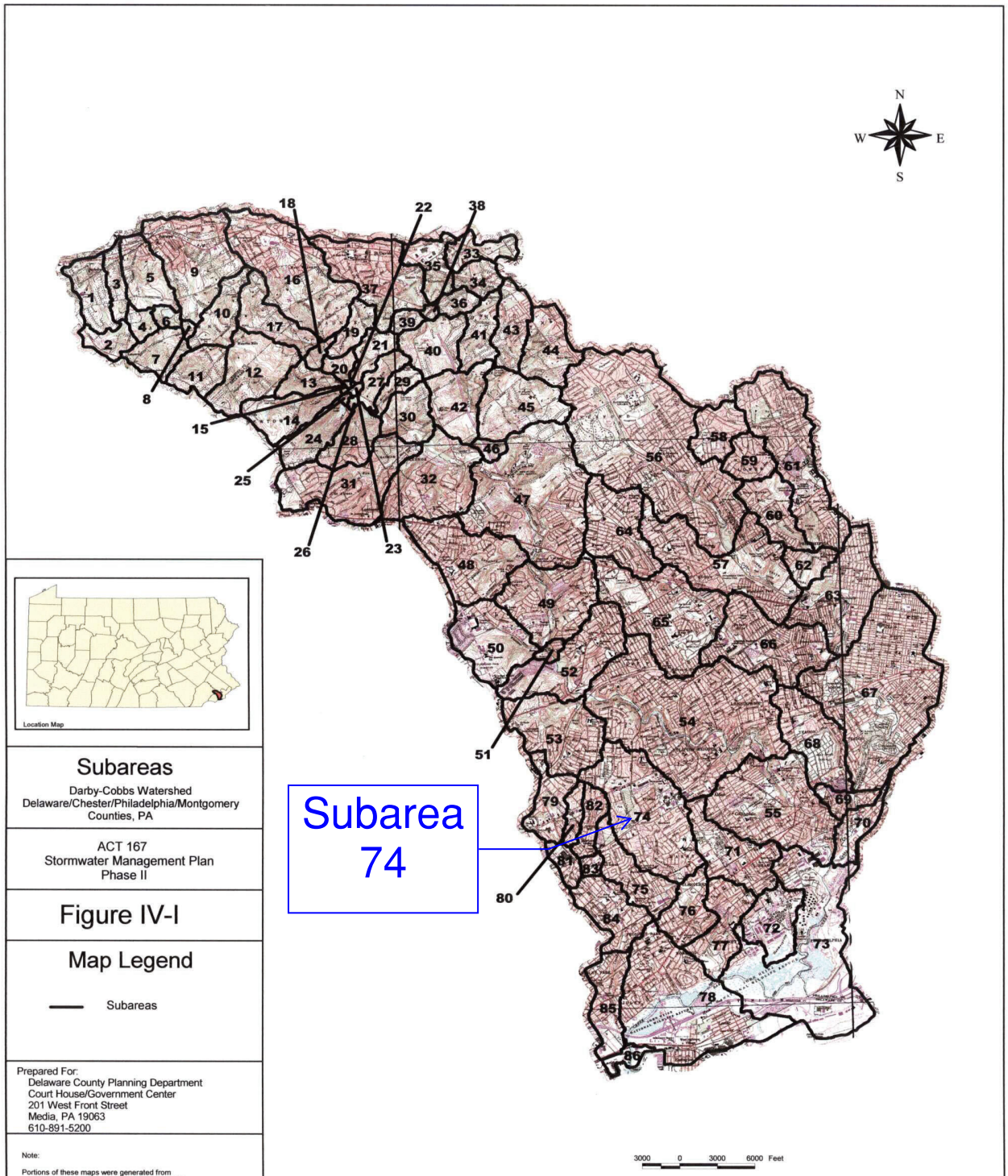
Portions of these maps were generated from existing data sources as listed below. This existing data was utilized for base mapping purposes and is shown on the maps for spatial reference only. This data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of this data and has corrected the data in locations where these discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the base data.

Data Sources:
Roads - PennDOT & BLE
Water - PennDOT & BLE
Boundaries - PennDOT & BLE
Future Land Use - DCPD & BLE

Borton Lawson ENGINEERING
613 Baltimore Drive
Suite 300
Wilkes-Barre, PA 18702-7903
570-821-1999 Fax 570-821-1990
6814 Chinsphalt Drive
Suite 200
Bath, PA 18014
610-837-5916 Fax 610-837-5918
World Wide Web : http://www.borton-lawson.com

Prepared By: WSB | Check By: WSB
Project Number: 99613.01 | Date: 12/13/2004

file: p:\99613\00\data\gis\avprojects\wshed.apr\FLU



Location Map

Subareas

Darby-Cobbs Watershed
Delaware/Chester/Philadelphia/Montgomery Counties, PA

ACT 167
Stormwater Management Plan
Phase II

Figure IV-I

Map Legend

Subareas

Prepared For:
Delaware County Planning Department
Court House/Government Center
201 West Front Street
Media, PA 19063
610-891-5200

Note:

Portions of these maps were generated from existing data sources as listed below. This existing data was utilized for base mapping purposes and is shown on the maps for spatial reference only. This data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of this data and has corrected the data in locations where these discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the base data.

Data Sources:
DRGs - USGS
Subareas - BLE

Borton Lawson ENGINEERING
613 Baltimore Drive
Suite 300
Wilkes-Barre, PA 18702-7903
570-821-1999 Fax 570-821-1990
6814 Chisphalt Drive
Suite 200
Bath, PA 18014
610-837-5918 Fax: 610-837-5918
World Wide Web : http://www.borton-lawson.com

Prepared By: CGF
Check By:
Project Number: 99613.01
Date of Plot: July 1, 2003

file: p:\99613\01\data\gis\arcinfo\wshed.apr\Subareas

DARBY-COBBS CREEK
ACT 167 SUMMARY FLOW TABLES

Subbasin	HMS Element	Subarea DA	EXISTING CONDITIONS SUBAREA FLOWS						
			1- Yr	2- Yr	5- Yr	10- Yr	25- Yr	50- Yr	100- Yr
51	Subbasin-51	0.10	13	25	48	68	90	116	142
52	Subbasin-52	1.36	115	198	368	523	677	868	1,068
53	Subbasin-53	1.32	74	134	264	389	513	663	827
54	Subbasin-54	4.42	228	356	625	879	1,123	1,400	1,718
55	Subbasin-55	2.12	194	293	483	653	816	1,010	1,221
56	Subbasin-56	4.64	210	347	646	933	1,212	1,535	1,906
57	Subbasin-57	1.99	142	226	396	553	704	884	1,082
58	Subbasin-58	0.56	130	194	312	411	512	640	761
59	Subbasin-59	0.42	70	113	194	266	338	430	519
60	Subbasin-60	0.68	82	129	218	298	375	472	571
61	Subbasin-61	1.93	189	291	489	665	836	1,042	1,262
62	Subbasin-62	0.33	63	99	166	224	283	358	430
63	Subbasin-63	1.43	251	362	561	731	896	1,106	1,313
64	Subbasin-64	1.13	151	232	386	521	652	817	984
65	Subbasin-65	2.03	191	294	494	673	845	1,053	1,275
66	Subbasin-66	1.52	200	298	481	640	793	984	1,180
67	Subbasin-67	3.73	372	528	822	1,082	1,327	1,616	1,931
68	Subbasin-68	1.10	144	214	346	461	572	710	851
69	Subbasin-69	0.27	84	117	174	221	269	331	388
70	Subbasin-70	0.42	71	101	154	200	244	300	355
71	Subbasin-71	1.00	142	207	327	430	529	653	780
72	Subbasin-72	0.74	114	164	256	335	410	505	601
73	Subbasin-73	3.33	313	429	652	848	1,031	1,243	1,479
74	Subbasin-74	2.12	188	290	491	672	846	1,055	1,281
75	Subbasin-75	0.77	111	167	269	358	445	554	663
76	Subbasin-76	0.62	80	122	201	270	337	421	507
77	Subbasin-77	0.81	86	132	219	296	370	461	556
78	Subbasin-78	2.87	139	195	308	412	509	611	731
79	Subbasin-79	0.59	65	106	185	256	326	413	502
80	Subbasin-80	0.22	30	50	87	120	153	195	236
81	Subbasin-81	0.23	79	113	173	221	270	334	391
82	Subbasin-82	0.34	41	67	118	164	209	266	323
83	Subbasin-83	0.10	29	43	68	88	109	136	161
84	Subbasin-84	0.78	112	164	261	345	426	526	629
85	Subbasin-85	0.71	106	158	254	336	417	518	619
86	Subbasin-86	0.19	122	150	199	236	277	333	380

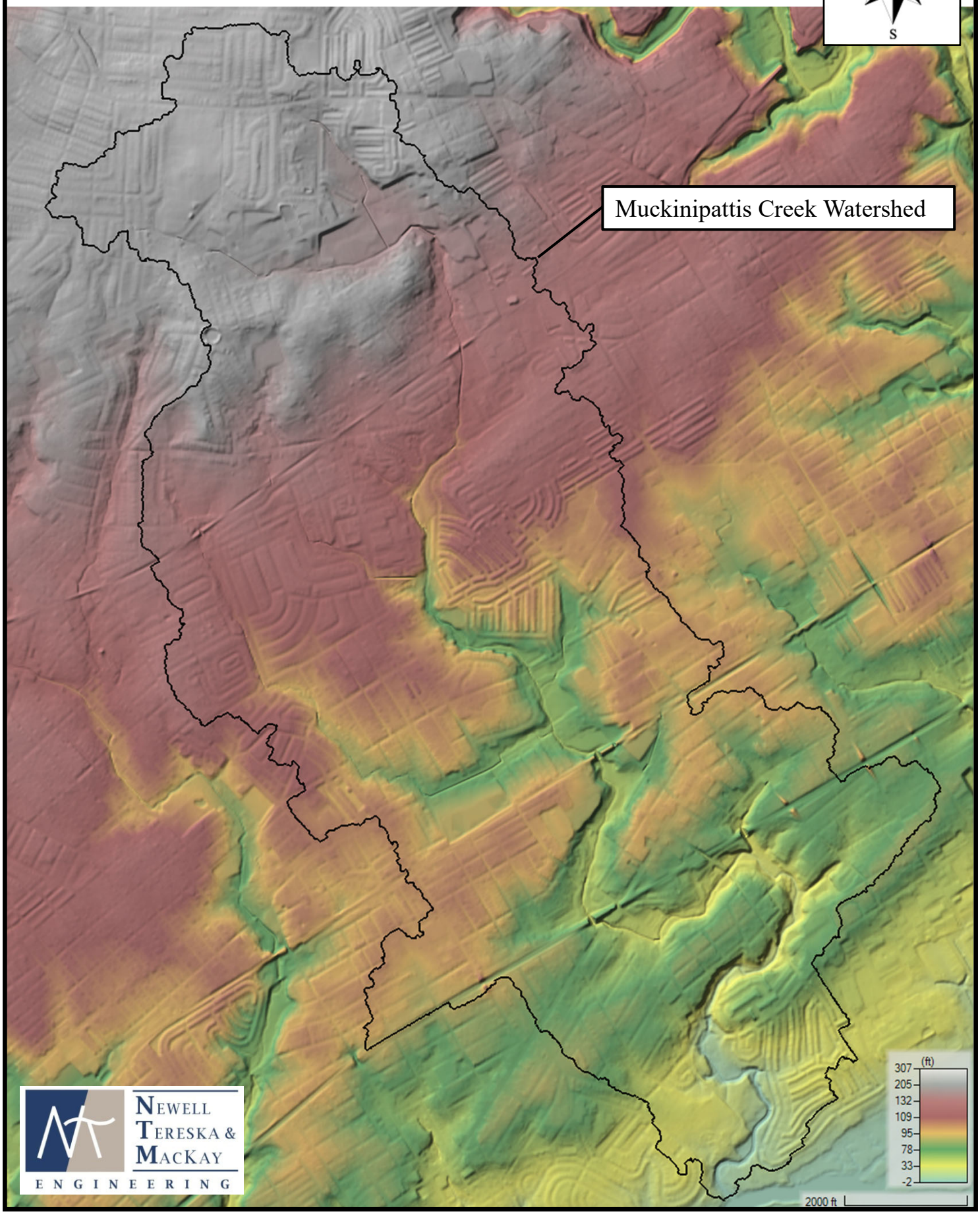
Muckinipattis Creek
Delaware County, PA

APPENDIX F

HEC-RAS Input Figures

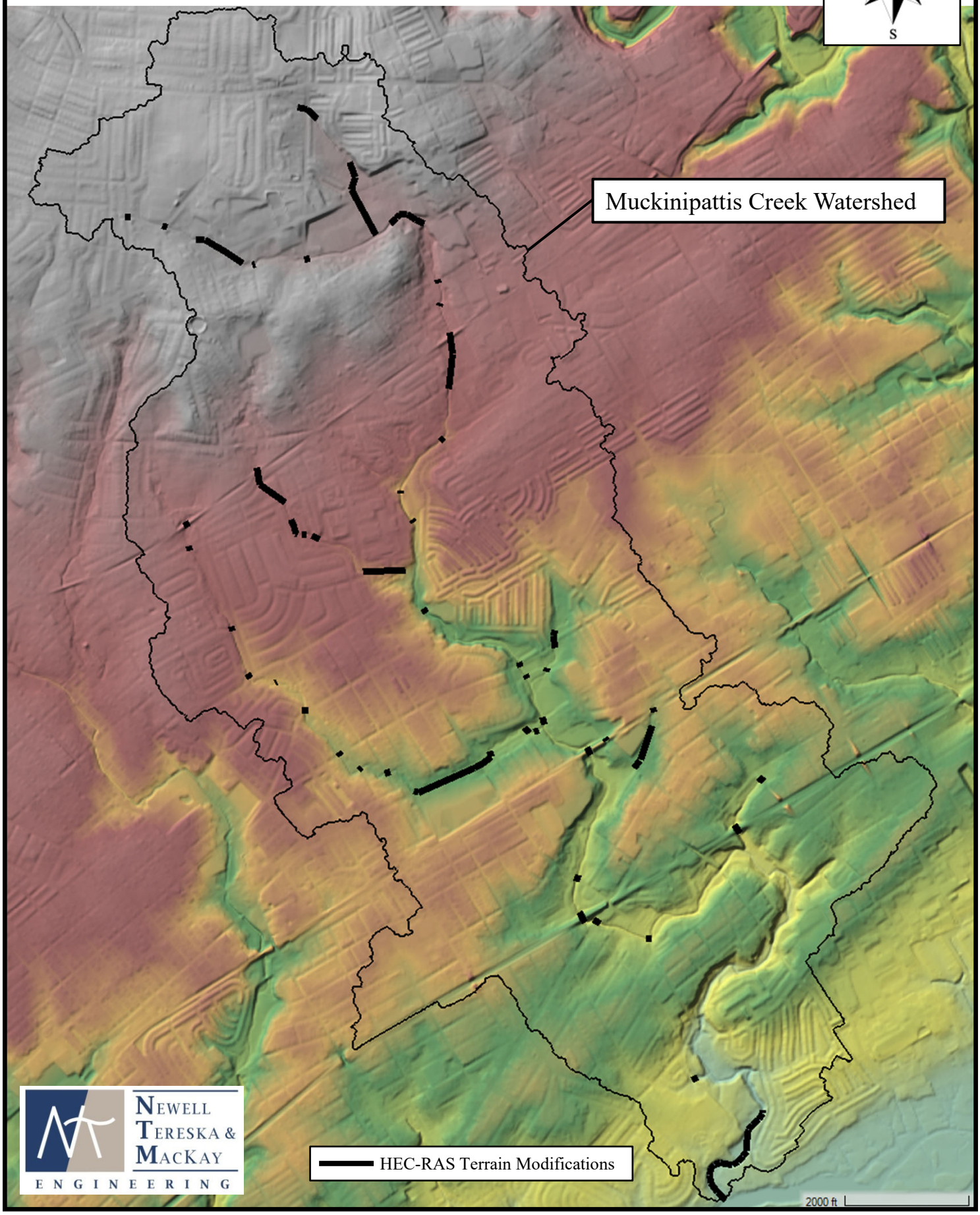
NEWELL TERESKA & MACKAY
ENGINEERING

Terrain



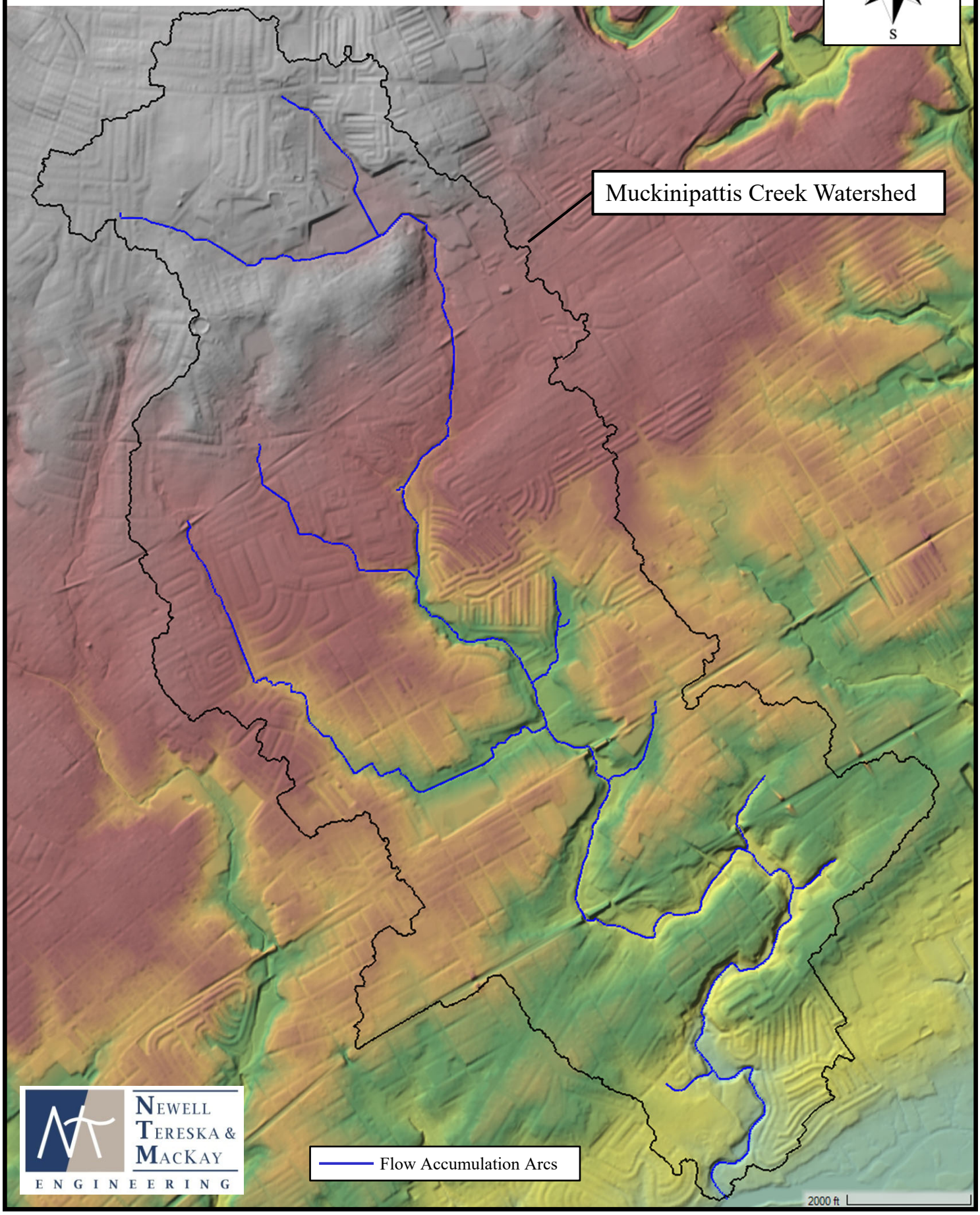
NEWELL TERESKA & MACKAY ENGINEERING

Terrain Modification Locations



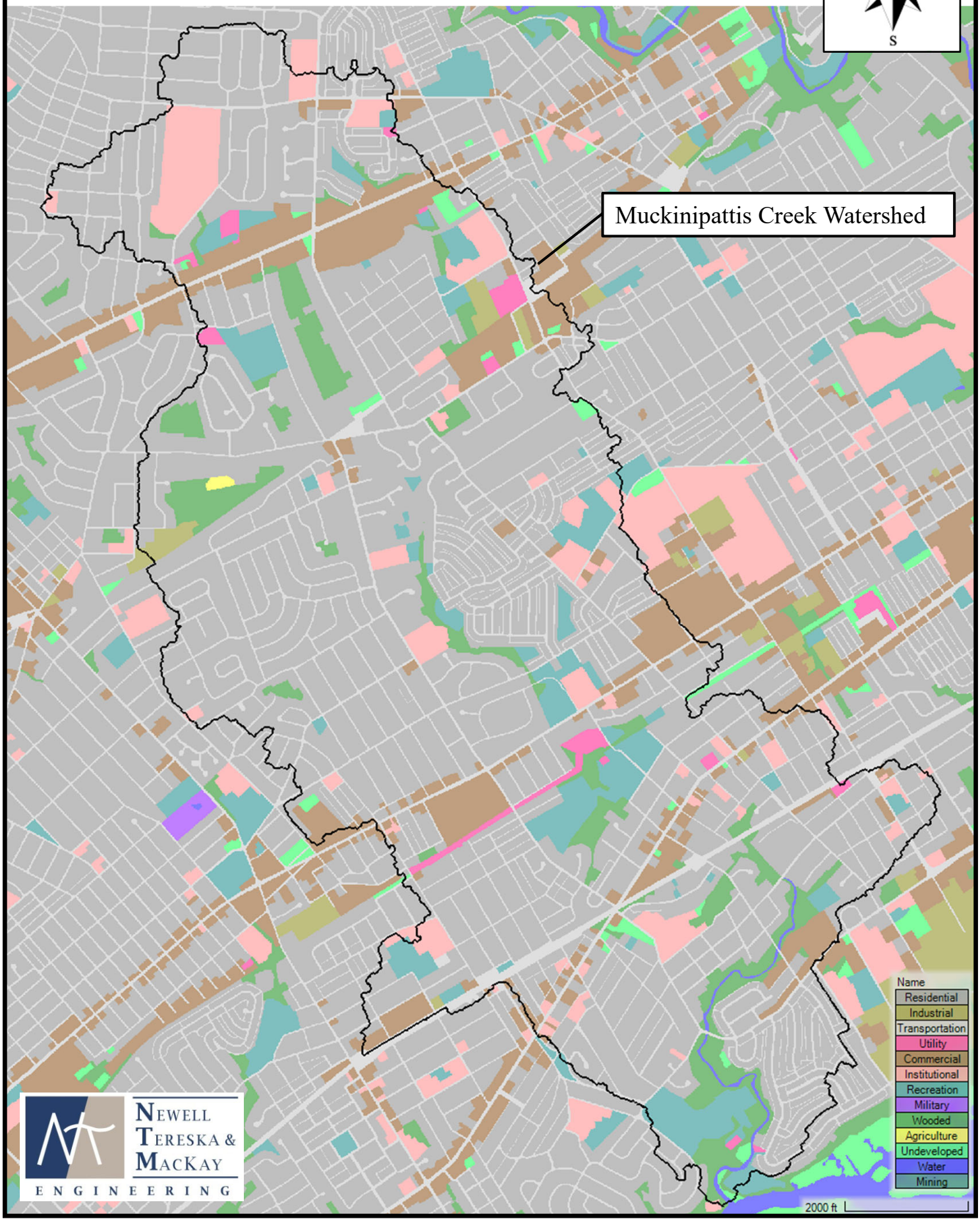
NEWELL TERESKA & MACKAY ENGINEERING

Flow Accumulation Arcs



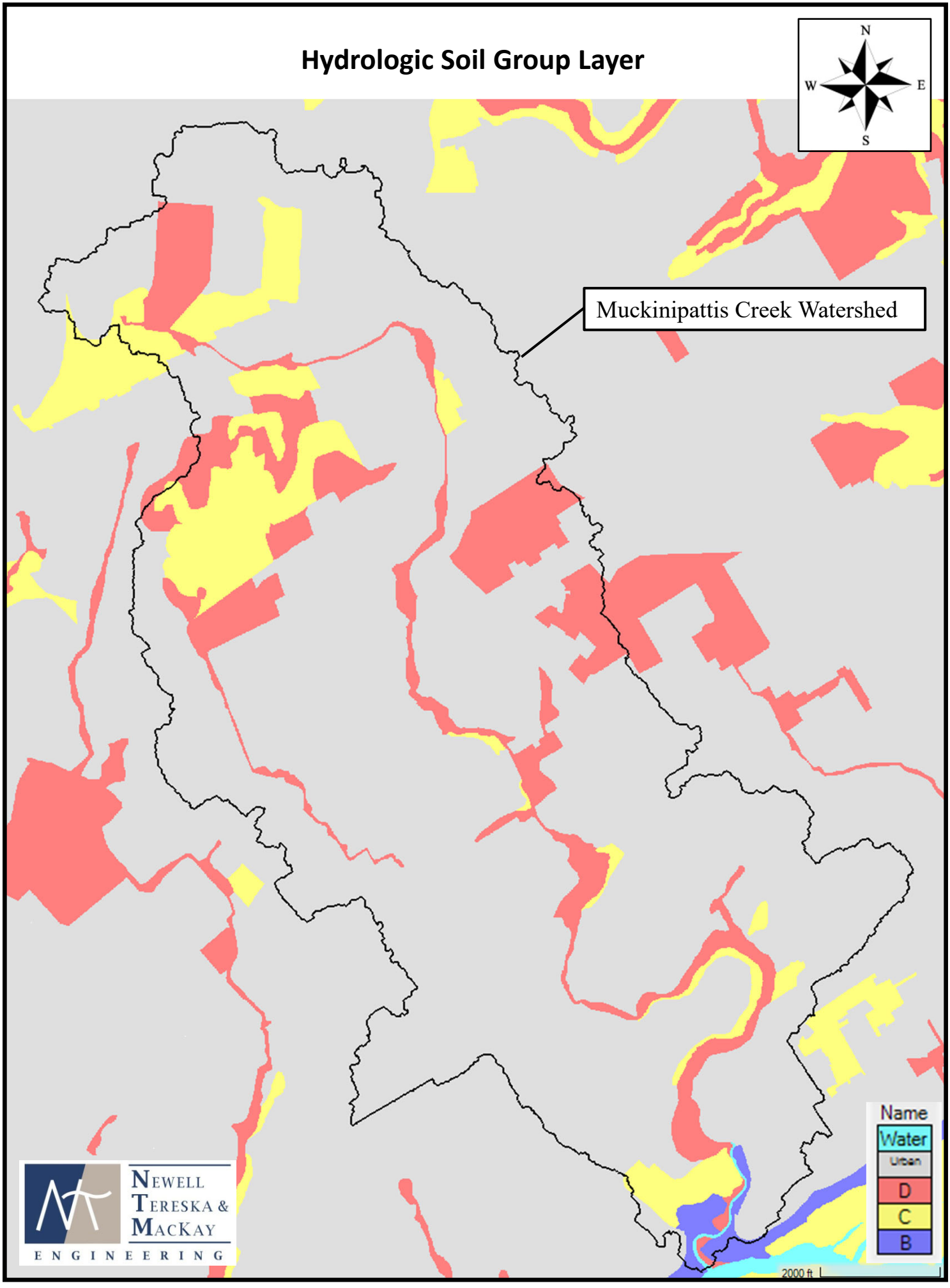
NEWELL TERESKA & MACKAY ENGINEERING

Land Use Layer



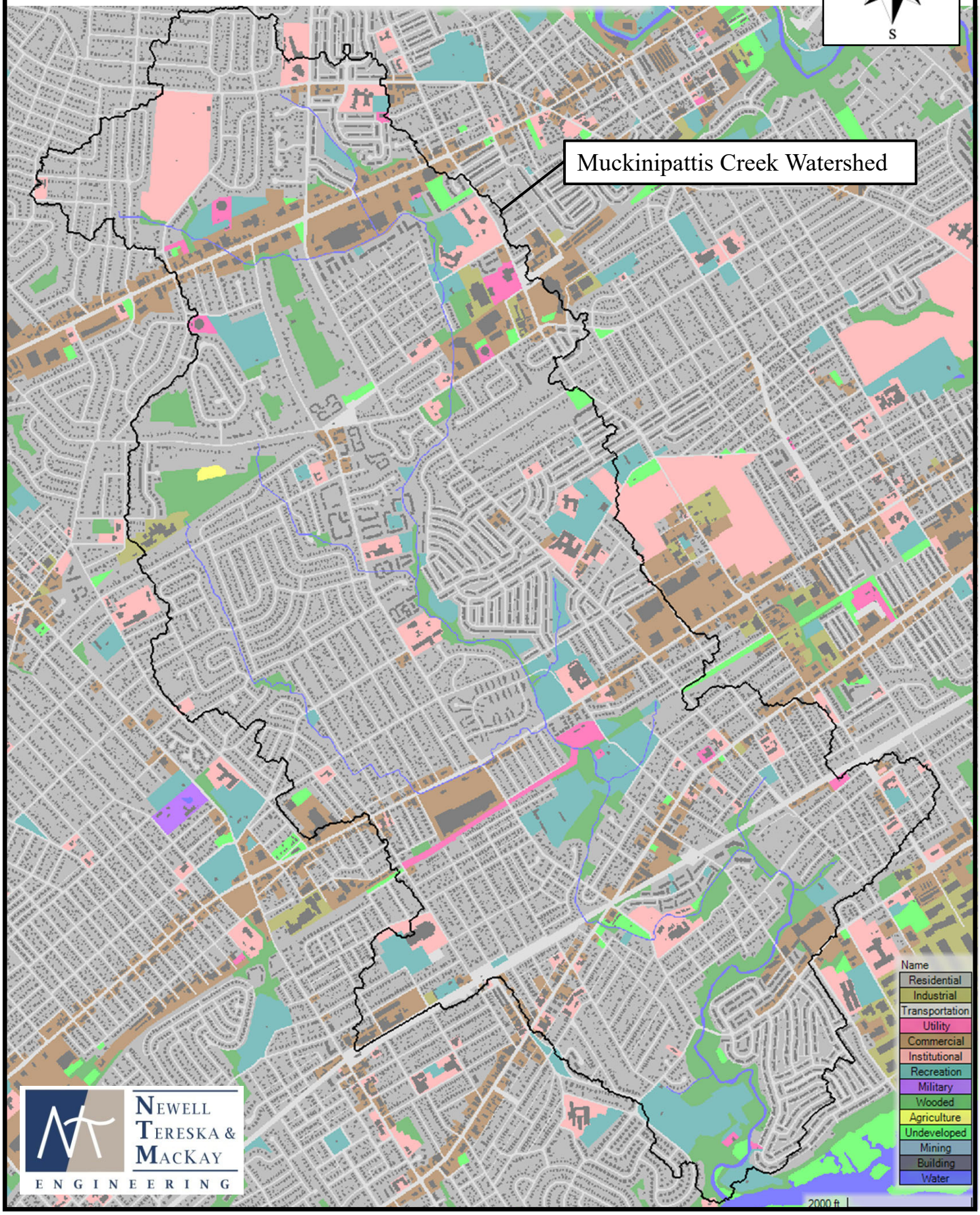
NEWELL TERESKA & MACKAY ENGINEERING

Hydrologic Soil Group Layer



NEWELL TERESKA & MACKAY ENGINEERING

Roughness Layer



NEWELL TERESKA & MACKAY
ENGINEERING

Muckinipattis Creek
Delaware County, PA

APPENDIX G

Problem Area Attribute Table

NEWELL TERESKA & MACKAY
ENGINEERING

Problem Area ID*	Watershed	Municipality	Problem Type	Problem Notes	Problem Causes	Property Type	Property Damage Notes	Follow-up Field Notes
S046	Darby Creek	Springfield Township	flooding, Accelerated_Erosion		Storm_Water_Volume, Storm_Water_Velocity, Storm_Water_Direction, Water_Obstruction	Residential	321 S Bishop Ave dwelling get flooded from creek on property with large Baltimore Pk drainage areas and PennDOT Bishop Ave Bridge obstruction	
S111	Darby Creek	Ridley Township	flooding		Storm_Water_Volume	Residential		Narrow channel with a seemingly older bridge structure. Cracks along the concrete channel. Some debris in the creek and some erosion. Water is flowing along the creek.
S113	Darby Creek	Ridley Township	flooding		Storm_Water_Volume	Residential	Periodic Flooding	There are numerous inlets at the intersection and along the streets. Difficult to assess the degree of flooding.
S116	Darby Creek	Darby Township	flooding, Accelerated_Erosion,Sedimentation		Storm_Water_Volume, Storm_Water_Velocity, Water_Obstruction	Residential, Open_Space, Rightofway	structure damage; loss of land	Tree Obstruction. Major signs of erosion. The creek was low and not flowing. Serious obstruction downstream from trees and plants. Small undersized culvert. Appears to be a lack of drainage capacity. Upstream is a really shallow concrete channel. Large c
S118	Darby Creek	Norwood Borough	flooding		Storm_Water_Volume	Residential, Open_Space, Rightofway, Otherpublic	roadway and structural damage	Intersection is on higher ground. Flood path unclear. No inlets and steep driveways with no direct flow path. Some evidence of damage at maintenance facility. Erosion in vegetated area d/s of point. Exposed sewer pipe.
S119	Darby Creek	Norwood Borough	flooding, Accelerated_Erosion,Sedimentation		Storm_Water_Volume, Storm_Water_Velocity	Industrial, Open_Space	roadway and structural damage; excessive erosion	Outfall pipe collapsed. Intersection is at a low point, good spot for project in road. Review inlet pipe conditions and connectivity.
S150	Darby Creek	Clifton Heights Borough	flooding	Undersized culvert. Year of first known occurrence unknown.	Other	Rightofway		All the area is developed. Stream is flowing in a shallow creek that's not very wide. Homeowner said that last year the Twp said they were thinking of building a basin to contain the stormwater. Kelsey to reach out to Springfield Twp to learn more. Durin
S151	Darby Creek	Glenolden Borough	flooding		Storm_Water_Volume	Open_Space		
S166	Darby Creek	Glenolden Borough	flooding		Storm_Water_Volume	Residential, Open_Space		Residential intersection, private property access, county knocked on door and asked and they permitted viewing of backyard. Inlet across street at intersection, leading to outfall?

*Problem Area ID's beginning in letter R were collected and summarized from available studies and publications. Problem Area IDs beginning in letter S were submitted to the Delaware County Act 167 project survey from WPAC and Stakeholder Committee members.

Appendix B.3 – Naylors Run Model Memo

Naylors Run Pluvial Model

Delaware County Act 167 Stormwater Management Plan

Prepared for: Delaware County Planning Department

Jacobs Engineering Group Inc.

March 10, 2026

Delaware County Planning Department

Jacobs

Challenging today.
Reinventing tomorrow.

Contents

1. Objective 2
2. Methodology and Data Assimilation 2
3. Model Setup 3
4. Modeling Limitations 6
5. Validation 8
6. Results 9
7. Conclusion 10

Appendices

Appendix A – 5-Year Flood Vulnerability Map

Appendix B – 10-Year Flood Vulnerability Map

Appendix C – 100-Year Flood Vulnerability Map

Appendix D – Model Features Map

Appendix E – FEMA FIS Comparison Locations Map

Appendix F – Problem Area Attribute Table

Naylors Run – Pluvial Model

Date: 3/10/2026
Project name: Delaware County Act 167 Stormwater Management Plan
Project no: D3999400

1. Objective

A two-dimensional (2D) hydrologic and hydraulic model of pluvial flooding was developed using HEC-RAS to simulate flooding at locations where Problem Areas have been submitted by stakeholders and WPAC (Watershed Plan Advisory Committee) members to the Delaware County Act 167 project survey. Data for the survey was collected from July-August 2025 and is comprised of logged problem areas as well as other problem areas summarized from studies and publications shared by the stakeholders (See Appendix D). Due to limitations outlined in this memo, this model is not meant to supersede the regulatory flood study which yields precise flood mapping locations with well-defined depths per event. Instead, the model serves to identify the mechanisms of flooding at Problem Areas and to inform the development of adaptation strategies to mitigate flooding along Naylors Run and the surrounding areas.

2. Methodology and Data Assimilation

The hydrologic and hydraulic model was developed using the United States Army Corps of Engineers (USACE) HEC-RAS 2D model version 6.6 with the rain-on-grid boundary condition within HEC-RAS. In the 2D rain-on-grid methodology, rainfall data is applied directly on the 2D model grid. The infiltration losses are calculated within the HEC-RAS 2D model using the SCS (Soil Conservation Service) curve number method. The best publicly available datasets are utilized in the analysis including: terrain, land use, soils, and rainfall data. The sources of the data used are listed in the table below:

Table 1. Data Sources

Data Type	Source	Notes
1m Resolution Digital Elevation Model (DEM)	USGS 3DEP; dated April - November 2015; Published March 2020	Downloaded from: https://apps.nationalmap.gov/downloader/. Data is identical to PASDA data from DVRPC for Delaware County.
Land Use Data	Delaware Valley Regional Planning Commission (DVRPC); 2023 Land Use File, Published 2024	Downloaded from: https://catalog.dvrpc.org/dataset/land-use-2023; 2023 land use file is based on digital orthophotography created from aerial surveillance completed in the spring of 2023.

Data Type	Source	Notes
Soils Data	USDA NRCS Web Soil Survey; Published 2024	Downloaded from: https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Roadway Centerline Data	Delaware County (Delaware County Roads); Published 2022; PennDOT (PA State Roads); Published 2025	Delaware County roadway centerline data provided by Delaware County
Precipitation	NOAA; Published 2006	Downloaded from: https://hdsc.nws.noaa.gov/pfds/ Median NOAA Atlas 14, 24-hr Rainfall Depth (inch). Temporal distribution is NOAA Type C
Building Footprints	Delaware County; Published 2022	Referenced from the Delaware County online Portal: https://gis.delcopa.gov/arcgis/rest/services/DataLayers_911/Delaware_County_Building_Footprints/FeatureServer
FEMA DFIRM	Delaware County Flood Insurance Study, Published 11/03/2017	Obtained from: https://msc.fema.gov/portal/home FEMA water surface elevations and peak discharges used for comparison.

3. Model Setup

The following assumptions were made to build the model:

- The drainage area of the Naylors Run subwatershed is approximately 4.58 square miles, as calculated with ArcGIS Pro and refined manually based on the DEM and contours.
- The 2D model grid was established with an initial mesh size of 50 ft x 50 ft. Mesh breaklines were created based on the roadway centerline data to improve the cell orientation, with a smaller grid size.
- Additional breaklines were added based on the aerials and topography, to represent the major channel centerlines, significant flow paths, and any significant topographic features adjacent to the study areas.
- The National Hydrography Dataset for streamlines was checked and used as a guide along with topography and aerial photography to ensure flow paths were not artificially interrupted. This review process did find topographic representations in the DEM that would limit downstream modeled flow in various locations. Where appropriate, flow paths were topographically enforced in the model using techniques that included the following:
    - Small channels, such as shallow ditches up to 20 ft wide or select culverts, were manually 'burned in' to the model surface to convey flow downstream. The burned flow paths

followed logical flow paths. Examples of these include: connecting visible stream elements across roadways (inlet to inlet) and connecting stream areas where the modeled mesh does not pick up a clearly defined channel but aerial photography and/or contours indicate one likely exists.

    - Mapped locations of all model DEM adjustments (breaklines and stream flow paths) can be found in Appendix D.

- Most bridges, culverts, and stormwater infrastructure were not modeled as distinct hydraulic elements in HEC-RAS due to lack of detailed information and the limitations of the project scope.

- The Naylors Run Dam was not explicitly modeled. Dam features and storage were included to the extent that they are represented by the terrain and breaklines along elevated reaches.

- Three (3) major culverts along Naylors Run were included in the model to allow for flow passage in areas where the stream is culverted beneath development. The simplified shape and size of the culverts were modeled based on as-built drawings provided by Upper Darby Township. Two (2) additional culverts upstream of the problem areas were modeled as open channels burned into the terrain as detailed information was not available.

Table 2. SCS Curve Numbers and Manning's N Roughness Coefficients

DVRPC Land Use Category	Land Cover Category Description	Curve Number Value				Manning's N
		Soil Type A	Soil Type B	Soil Type C	Soil Type D	
Agriculture	Row crops - Straight row (SR) - Poor	72	81	88	91	0.035
Commercial	Urban districts - Commercial and business (85% imp.)	89	92	94	95	0.15
Industrial	Urban districts - Industrial (72% imp.)	81	88	91	93	0.08
Institutional	Open space (lawns, parks, golf courses, cemeteries, etc.) - Poor condition (grass cover <50%)	68	79	86	89	0.03
NoData	No Land Cover Data available	98	98	98	98	0.03
Recreation	Open space (lawns, parks, golf courses, cemeteries, etc.) - Fair condition (grass cover 50 to 75%)	49	69	79	84	0.03
Residential	Residential districts by average lot size - 1/4 acre (38% imp)	61	75	83	87	0.08
Transportation	Streets and roads - Paved; curbs and storm sewers (excluding right-of-way)	98	98	98	98	0.025
Undeveloped	Open space (lawns, parks, golf courses, cemeteries, etc.) - Fair condition (grass cover 50 to 75%)	49	69	79	84	0.03
Utility	(Drainage channels) Desert shrub. - Fair	55	72	81	86	0.03
Water	Water	98	98	98	98	0.04
Wooded	Woods - Fair Condition	43	65	76	76	0.16
-	Open Channels/Streams	-				0.04
-	Green Stormwater Infrastructure (GSI)	-				0.1
-	Buildings	-				0.4

- Soil infiltration losses are calculated based on SCS Curve Number methodology. These curve numbers were established corresponding to land use and soils categories as shown in Table 2. An initial abstraction of 0.2 inch is used with a minimum infiltration rate of 0.05 in/hr.

- Land use roughness values, represented by the model Manning's n value, was determined using available land use data. In addition to the land use data, the building footprints data was used as a manning's coefficient refinement region. An artificially high value of 0.4 was used to represent the loss of conveyance at building footprints. Manning's N values are also shown in Table 2.

- Green stormwater infrastructure (GSI) in Drexel Gardens Park was identified near Problem Area S033 and modeled with a higher Manning's N value as shown in Table 2.

- The model was run using the 24-hour NOAA Type C rainfall distribution. Base Rainfall depths were obtained from NOAA Atlas 14 for each of the modeled annual exceedance probability (AEP) events as shown in Table 3. The first inch of rainfall was removed from each of the events to account for storage in the local storm-sewer systems in this heavily developed subwatershed and to better represent localized flooding in Problem Areas (particularly S027 and S032). See Appendices A, B, and C for mapped results of the 5, 10, and 100-year rainfall events, respectively.

Table 3. Precipitation depths for modeled annual exceedance probability (AEP) events

Frequency Storm Event	Base Precipitation Depth - NOAA Atlas 14 (inches)	Modeled Adjusted Precipitation Depth (inches)
5-year (20% AEP)	4.1	3.1
10-year (10% AEP)	4.81	3.81
100-year (1% AEP)	7.64	6.64

- The downstream boundary of the model is at the confluence with Cobbs Creek and was modeled using a normal depth boundary condition. Resulting water surface elevations were compared with published FEMA FIS values and found to be reasonable for the goals of this study.

- The calculations are performed using HEC-RAS unsteady flow analysis based on the 2D Saint Venant shallow water equations (SWE) setting (SWE-ELM).

- The simulations were performed using the variable time step starting with a 5 second computation interval, with a maximum courant value of 2. Courant number is calculated as the product of fluid velocity and time step, divided by the cell length. Limiting the courant number ensures that flow does not travel more than one grid cell per time step and calculations are performed at every cell.

4. Modeling Limitations

This approach includes the following limitations:

- **Local Storm Drainage Systems.** The HEC-RAS 2D model performs surface water routing and does not simulate the storm drainage system explicitly. As a result, the flooding depths and extents in roadways are likely to be conservatively larger than they would be if the piped network was included. The model is useful as a guide to locations that may be susceptible to ponding and flooding, and it is not a highly detailed flood map with flood elevations (although it could be representative of ponding if the storm drainage system became clogged). The first one inch of rainfall was subtracted from the rainfall depth to diminish the ponding effect and to loosely simulate the piped system capacity.

  The modeling approach includes conservative processes and assumptions in upstream areas, including omission of the local storm drainage system. As a result, some runoff volume remains in upland areas that actually convey directly to the stream via the storm sewer system. This introduces some uncertainty to the flooding extents along the main channels.

- **Topography.** The LiDAR data collection process, which forms the topographical basis for the model, does not typically capture the openings (bridges/culverts) below roadways, only the road surface. Consequently, unless the topography or flow paths are manually edited, the model sees these roads as "dams". If there is a large volume in the channel upstream of the dam, it can interfere with the results of 2D rain-on-grid models such as these. This was not a major concern for the Naylors Run subwatershed, since it has a relatively simple channel network and, as described in this memorandum, adjustments and assumptions were made to the model along major flow paths and major stream alignments to enforce flow paths through topographical barriers. As described above, public datasets such as the National Hydrography Dataset, topography, and aerial photography were used to identify these crossings along major flow paths and adjust them. These adjustments were found to be beneficial, and future modeling efforts should plan for similar adjustments to allow for passage of water in the model.

- **Roadway Crossing Sizing.** Assumptions were made about the sizes of roadway crossings for this modeling effort without extensive field verification. While these assumptions allow for continuous downstream flow and allow for mapping of pluvial areas susceptible to ponding and flooding, it should be understood that overestimating or underestimating culvert sizes adds uncertainty to mapping results.

- **Data in Developing Areas.** Using data sets collected at different times in rapidly developing areas, such as in parts of Delaware County, can sometimes lead to mismatches in data (for example between the terrain and the roadway centerlines) which can affect model results. Refer to Table 1 for data set sources and applicable dates.

- **Model Resolution.** While model results can improve with increased resolution, it is necessary to balance cell sizes with model error and run time. Increased resolution of 10 ft was typically used along important flow paths such as roads and streams in order to improve model accuracy.

5. Validation

The HECRAS model results are validated based on two different data sources including FEMA FIS and one historically recorded flood event, as described below

1. FEMA FIS

Flows and water surface elevations (WSELs) from the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) were compared to results from the Naylors Run model. The FEMA FIS was revised on 11/3/2017 but the analysis for Naylors Run is dated 9/1/1977. Table 4 shows the comparison between the model results and the published 1% annual exceedance probability (AEP) WSELs along Naylors Run and Table 5 shows the comparison of peak flows for the 10% and 1% AEP events. Locations of comparison transects are shown in Appendix E.

Table 4. 1% AEP WSEL Comparison

Location	FEMA FIS (ft - NAVD88)	HEC-RAS (ft - NAVD88)
Confluence with Cobbs Creek	55	55
Briarcliff Road	58	59
Church Lane	85	85
Richfield Road	86	88
Sherbrook Blvd	108	110
South of Garrett Road	120	123

Table 5. Flow Comparison

Location	10% AEP		1% AEP	
	FEMA FIS (cfs)	HEC-RAS (cfs)	FEMA FIS (cfs)	HEC-RAS (cfs)
Confluence with Cobbs Creek	1300	1117	3000	3770
At Garrett Road	1200	1569	2700	4203
Approximately 370 feet upstream of Bond Avenue	880	1489	2000	2765
At West Chester Pike	410	883	920	2172

Modeling results produced flows that were higher than the FEMA FIS values with the exception at the confluence with Cobbs Creek where flows were nearly 200 cfs lower for the 10% event and approximately 900 cfs higher for the 1% event. However, the WSELs were generally much closer to the FEMA FIS values. An exception is where HEC-RAS model produced higher WSELs further upstream in the subwatershed. This modeling effort is focused on the downstream areas near the problem areas and is missing detailed structure information further upstream. The limited detail in the upstream portion of the subwatershed may increase the difference in the modeled results further upstream along Naylors Run.

2. Observed Event

The HEC-RAS model estimated flood depths ranging from approximately 7 to 9 feet near the intersection of 69th Street and Marshall Road for the 20% AEP (5-yr) event, based on 4.1 inches of rainfall with 1 inch reduction to reflect storm sewer conveyance. These results seem appropriate when compared to a recent flooding event (approximately 1.5 inches of rain) which occurred on 8/13/2018 in which flood depths in this area were reported to be around 5 to 6 feet (https://www.delcotimes.com/2018/08/13/flash-floods-and-the-aftermath-puts-delco-through-ringer/).

6. Results

The Problem Areas identified in this project's Act 167 WPAC Survey ("Problem_Area_Site_visits" GIS layer) include four (4) locations within the Naylors Run subwatershed. The stormwater problem areas IDs are listed below along with the problem type and description of the HEC-RAS model observations. Additional information for each stormwater problem area is provided in Appendix F.

3. S027 – Road Closure, Flooding, Steep, Wide Roads

   HEC-RAS Model observation: Flooding at this location in the model is due to a hydraulically disconnected depression where runoff can only drain via the local storm-sewer system. When the system becomes overloaded during larger precipitation events, ponding can become severe as there is no overland pathway for flooding to drain. Model results show this area is in a High Inundation Susceptibility Category for the 5-year, 10-year, and 100-year precipitation events.

4. S031 – Flooding

   HEC-RAS Model observation: Model results show overland flooding near the intersection of Springton Road and Sherbrook Boulevard as the stream overflows from the hardened open channel between the upstream and downstream culverts. The 5-, 10-, and 100-year results show this area is in a High Inundation Susceptibility Category. These results are conservative as they do not include the pump station that drains this area and may reduce the flooding.

5. S032 – Flooding in Basements

   HEC-RAS Model observation: The 5-year results show this problem area to have Shallow Flooding while the 10- and 100-year results show Moderate to High Inundation Susceptibility. Similar to S027, ponding in this area does not have a natural drainage pathway other than into the depression near Marshall Road and 69th St which backs up and creates extensive ponding until the stormwater system has sufficient capacity to drain flood waters.

6. S033 – Flooding

   HEC-RAS Model observation: This problem area spans a fairly large area including Drexel Gardens Park and areas along and north of Bond Avenue. Model results for the ball fields south of Bond Ave range from Localized Ponding/Fringe Flooding for the 5-year, Shallow Flooding across most of the area for the 10-year, and High Inundation Susceptibility for the 100-year precipitation events. The alley north of Bond Avenue shows Localized Ponding/Fringe Flooding to Shallow

Flooding for the 5-year, Localized Ponding/Fringe Flooding to High Inundation Susceptibility for the 10-year, and Moderate to High Inundation Susceptibility for the 100-year precipitation events.

In summary, the existing culverts along Naylors Run exacerbate flooding at the problem areas by backing up flow and raising upstream water levels as the culverts reach capacity. The elevated water levels increase overland flow into the topographical depression near S027 and increases ponding depths. Culvert flow hydrographs in the model suggest that the culvert from Marshall Road to the confluence with Cobbs Creek reaches capacity for both the 10-year and 100-year events but may have some capacity for the 5-year event.

7. Conclusion

The Naylors Run 2D HEC-RAS model presented in this memorandum offers a preliminary insight into the general flooding patterns across the study area. While it serves as a useful tool for identifying potential flood-prone zones, its predictive accuracy is constrained by the limited resolution and reliability of the input data, including topography and the existing storm sewer network. Consequently, the results should be interpreted with caution and the figures presented in the appendix accompanying this memorandum exclude shallow flooding and floodplain fringe areas where model output indicates maximum water depths of below six inches. This model is best suited for initial screening and prioritization efforts, rather than for detailed planning or decision-making. Further refinement and validation using detailed structure and stormwater infrastructure information, high-quality datasets, and topographic surveys would be necessary to enhance its applicability for more rigorous analyses.

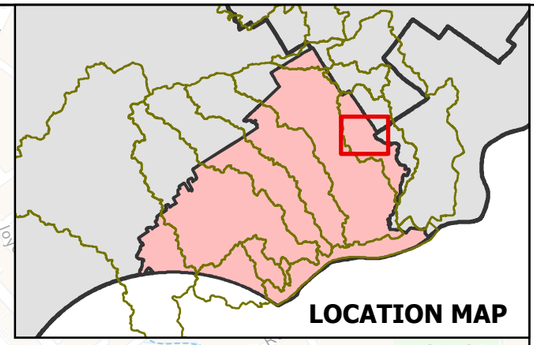
Attachments:

1. Screening Model results
    - Appendix A – 5-Year Flood Vulnerability Map
    - Appendix B – 10-Year Flood Vulnerability Map
    - Appendix C – 100-Year Flood Vulnerability Map
    - Appendix D – Model Features Map
    - Appendix E – FEMA FIS Comparison Location Map
    - Appendix F – Problem Area Attribute Table

Appendix A – 5-Year Flood Vulnerability Map

Delaware County Act 167 Stormwater Management Plan

Naylors Run Upstream Screening Modeling Results (5-Year Flood Vulnerability)



Legend

Stormwater Problem Areas (Priority Level)
- Low
- High
- Streams - USGS*
- Streams - Delaware County*
- Matchline
- Naylors Run Subwatershed
- Municipal Boundaries
- Delaware County Building Footprints

5-year Flood Vulnerability Category**
- Shallow Localized Ponding or No Ponding***
- Localized Ponding/Fringe Flooding (6" - 1')
- Shallow Flooding (1' - 2')
- Moderate Inundation Susceptibility (2' - 3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones (FIS data 11/2017)
- Flood Zone A (100-Year)
- Flood Zone AE (100-Year)
- Floodway

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

N

0 1,000 2,000 Feet

Map prepared by Jacobs 3/24/2026

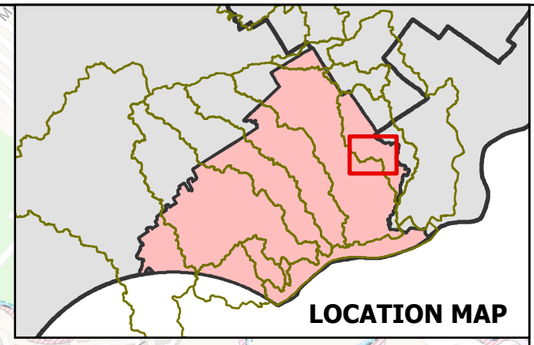
Jacobs

Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

Naylors Run Downstream Screening Modeling Results (5-Year Flood Vulnerability)



Legend

Stormwater Problem Areas (Priority Level)
- Low
- High
- Streams - USGS*
- Streams - Delaware County*
- Matchline
- Naylors Run Subwatershed
- Municipal Boundaries
- Delaware County Building Footprints

5-year Flood Vulnerability Category**
- Shallow Localized Ponding or No Ponding***
- Localized Ponding/Fringe Flooding (6" - 1')
- Shallow Flooding (1' - 2')
- Moderate Inundation Susceptibility (2' - 3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones (FIS data 11/2017)
- Flood Zone A (100-Year)
- Flood Zone AE (100-Year)
- Floodway

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

N

0 1,000 2,000 Feet

Map prepared by Jacobs 3/24/2026

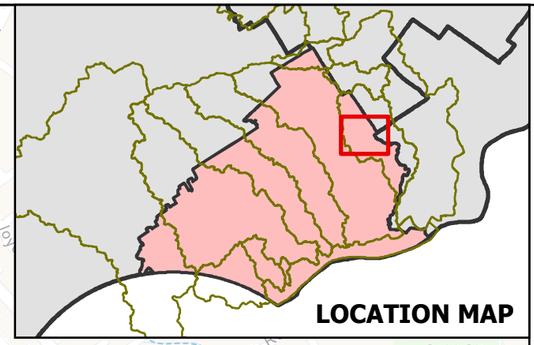
Jacobs Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix B – 10-Year Flood Vulnerability Map

Delaware County Act 167 Stormwater Management Plan

Naylors Run Upstream Screening Modeling Results (10-Year Flood Vulnerability)



Legend

Stormwater Problem Areas (Priority Level)
- Low
- High

Streams - USGS*

Streams - Delaware County*

Matchline

Naylors Run Subwatershed

Municipal Boundaries

Delaware County Building Footprints

10-year Flood Vulnerability Category**
- Shallow Localized Ponding or No Ponding***
- Localized Ponding/Fringe Flooding (6" - 1')
- Shallow Flooding (1' - 2')
- Moderate Inundation Susceptibility (2' - 3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones (FIS data 11/2017)
- Flood Zone A (100-Year)
- Flood Zone AE (100-Year)
- Floodway

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

Naylors Run Upstream

Naylors Run Downstream

S033

N

0 1,000 2,000 Feet

Map prepared by Jacobs 3/24/2026

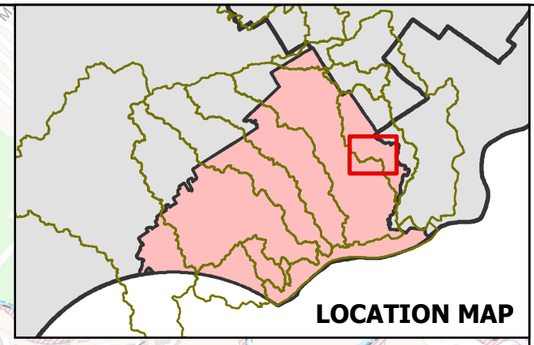
Jacobs

Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

Naylors Run Downstream Screening Modeling Results (10-Year Flood Vulnerability)



Legend

Stormwater Problem Areas (Priority Level)
- Low
- High

Streams - USGS*

Streams - Delaware County*

Matchline

Naylors Run Subwatershed

Municipal Boundaries

Delaware County Building Footprints

10-year Flood Vulnerability Category**
- Shallow Localized Ponding or No Ponding***
- Localized Ponding/Fringe Flooding (6" - 1')
- Shallow Flooding (1' - 2')
- Moderate Inundation Susceptibility (2' - 3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones (FIS data 11/2017)
- Flood Zone A (100-Year)
- Flood Zone AE (100-Year)
- Floodway

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

N

0 1,000 2,000 Feet

Map prepared by Jacobs 3/24/2026

Jacobs

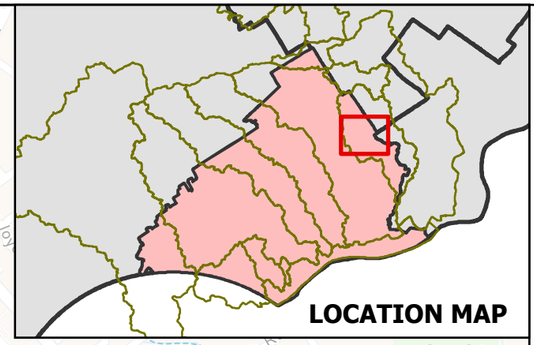
Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix C – 100-Year Flood Vulnerability Map

Delaware County Act 167 Stormwater Management Plan

Naylors Run Upstream Screening Modeling Results (100-Year Flood Vulnerability)



Legend

Stormwater Problem Areas (Priority Level)
- Low
- High
- Streams - USGS*
- Streams - Delaware County*
- Matchline
- Naylors Run Subwatershed
- Municipal Boundaries
- Delaware County Building Footprints

100-year Flood Vulnerability Category**
- Shallow Localized Ponding or No Ponding***
- Localized Ponding/Fringe Flooding (6" - 1')
- Shallow Flooding (1' - 2')
- Moderate Inundation Susceptibility (2' - 3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones (FIS data 11/2017)
- Flood Zone A (100-Year)
- Flood Zone AE (100-Year)
- Floodway

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

Naylors Run Upstream
Naylors Run Downstream

N

0 1,000 2,000 Feet

Map prepared by Jacobs 3/24/2026

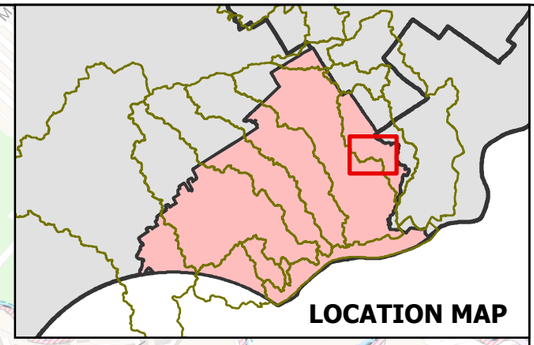
Jacobs

Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

Naylors Run Downstream Screening Modeling Results (100-Year Flood Vulnerability)



Legend

Stormwater Problem Areas (Priority Level)
- Low
- High
- Streams - USGS*
- Streams - Delaware County*
- Matchline
- Naylors Run Subwatershed
- Municipal Boundaries
- Delaware County Building Footprints

100-year Flood Vulnerability Category**
- Shallow Localized Ponding or No Ponding***
- Localized Ponding/Fringe Flooding (6" - 1')
- Shallow Flooding (1' - 2')
- Moderate Inundation Susceptibility (2' - 3')
- High Inundation Susceptibility (>3')

FEMA Flood Zones (FIS data 11/2017)
- Flood Zone A (100-Year)
- Flood Zone AE (100-Year)
- Floodway

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

N

0 1,000 2,000 Feet

Map prepared by Jacobs 3/24/2026

Jacobs

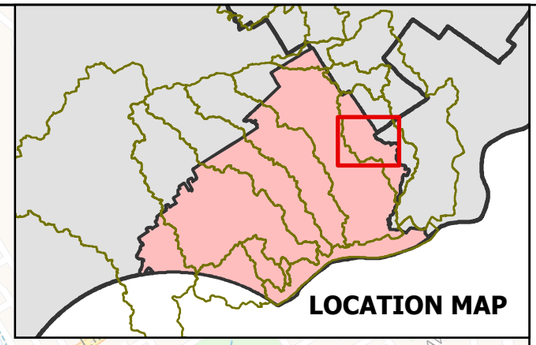
Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix D – Model Features Map

Delaware County Act 167 Stormwater Management Plan

Naylors Run Model Features



Legend

- Flow Path Breaklines
- Road Breaklines
- Contours (5 ft)
- Burn Lines (Stream Flow Path Adjustment)
- Culvert (Modeled Structure)
- Streams - USGS*
- Streams - Delaware County*
- Green Stormwater Infrastructure
- Naylors Run Subwatershed
- Delaware County Building Footprints

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 1,500 3,000 Feet

Map prepared by Jacobs 3/10/2026

Jacobs

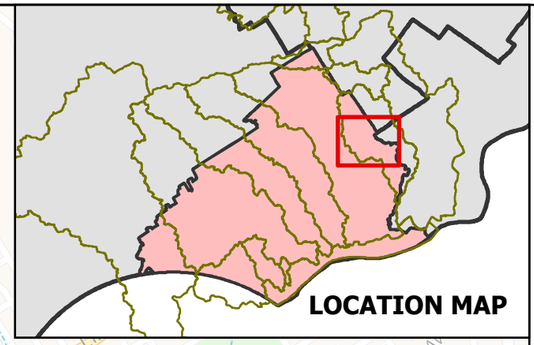
Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix E – FEMA FIS Comparison Locations Map

Delaware County Act 167 Stormwater Management Plan

Naylors Run FEMA FIS Comparison Locations



Legend

- FEMA FIS Comparison Locations
- Streams - USGS*
- Streams - Delaware County*
- Naylors Run Subwatershed
- Delaware County Building Footprints

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

West of Chester Pike

370 feet Upstream of Bond Avenue

Garrett Road South of Garrett Road

Sherbrook Boulevard

Richfield Road

Confluence with Cobb Creek

Briarcliff Road

Church Lane

N 0 1,500 3,000 Feet

Map prepared by Jacobs 3/10/2026

Jacobs

Delaware County Planning Department

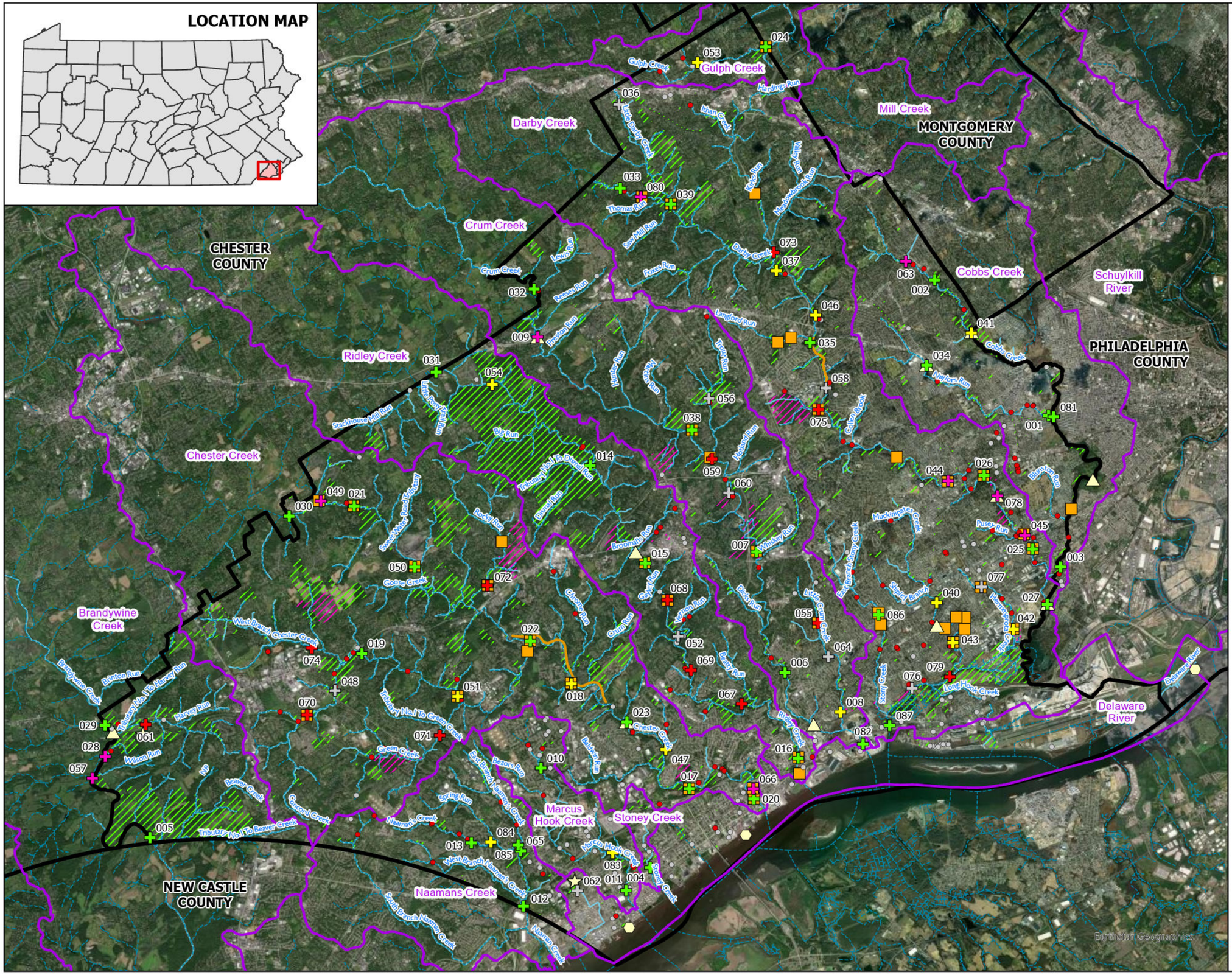
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix F – Problem Area Attribute Table

Problem Area ID	Watershed	Municipality	Problem Type	Problem Notes	Problem Causes	Problem Causes (Other)	Property Type	Property Damage Notes	Field Notes - Observations
S080	COBBS_CREEK	Lansdowne Borough	flooding, Accelerated_Erosion	-	Storm_Water_Volume,Storm_Water_Velocity	-	Residential	Private	-
S027	COBBS_CREEK	Upper Darby Township	flooding	-	Storm_Water_Volume, Water_Obstruction	-	Residential, Commercial, Rightofway, Otherpublic	Flooding	Need more information on the flooding issues. Very steep and wide streets coming down at a low spot on Marshall Rd and S 69th St that would make it easy to flood if it had drainage issues.
S031	COBBS_CREEK	Upper Darby Township	flooding, Groundwater, Other	Flooding of properties when Naylors Run Creek culvert is flowing full from heavy rain events.	Storm_Water_Volume, Storm_Water_Velocity,Water_Obstruction	-	Residential, Commercial, Otherpublic		Naylors Run channel is much wider upstream and gets gradually narrower downstream which could contribute to the flooding.
S032	COBBS_CREEK	Upper Darby Township	flooding, Groundwater	-	Storm_Water_Volume, Other	Naylors Run underground traverses beneath Veronica Rd may be undersized.	Residential, Commercial, Otherpublic	Flooding in basements of residential properties	All private properties, difficult to access
S033	COBBS_CREEK	Upper Darby Township	flooding	-	Storm_Water_Volume	Limited details provided.	Open_Space, Other	-	Improvements in the area were made. Construction was taking place in the park when we arrived. Noticed a bioswale that most likely captures local flooding. Cul de sac by the cemetery that appears unused. A homeowner showed us the area that floods the most during a storm event. The channel floods the park, but it also gets to some of the houses on Bond Avenue. The Conservation Disctrict to look up the permit for the park and forward it to Jacobs.

Appendix C – Stream Gage Locations

Appendix C.1 – Potential Stream Gages Location Map



Delaware County Act 167 Stormwater Management Plan

Delaware County Potential Stream Gages

Legend

Proposed Stream Gage Location
- Primary (40)
- Secondary (14)
- Tertiary (13)
- Backup Location (10)
- Removed (10)

Problem Area
- High Priority
- Not High Priority

- USGS Stream Gage
- USGS Gage (Water Quality Only)
- NOAA Precipitation Gage
- County Owned Bridge
- County Owned Trail
- Streams - USGS
- Streams - Delaware County
- County Owned Parcels
- County Protected Land
- Watersheds
- County Boundaries

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 0.5 1 2 Miles

Map prepared by Jacobs 2/9/2026

Jacobs | Delaware County Planning Department

Appendix C.2 – Potential Stream Gages Location Description Table

Stream Gage ID	Priority Rating	Location Description	Latitude	Longitude	Prioritization	Site Ownership	Accessibility Notes	Description	Google Maps URL
001	Primary	69th St Recreation Area	39.950945	-75.25297	Naylor's Run, downstream of USGS gage, downstream of problem areas	Philadelphia County	Trails throughout park to access stream or access at pedestrian bridge, street parking by trailhead or park's parking lot	County Open Space, Cobbs Creek Park (Philadelphia Owned)	https://www.google.com/maps/@39.9509447,-75.25296638,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
002	Primary	Gest Tract/Karakung Field	39.989448	-75.29269	Downstream of problem areas, other proposed stream gages proposed upstream and downstream of this location along Cobbs Creek	Haverford Township	Accessible along Karakung Dr via bridge	Municipal Open Space, Gest Tract/Karakung Field	https://www.google.com/maps/@39.989448,-75.29269287,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
003	Primary	Cibotti Park	39.908798	-75.25013	Upstream of Eastwick area, nearby problem areas, downstream portion of Cobbs Creek	Colwyn Borough	Close up street view not available but shows possible fence around park/along creek. Assumption that fence may be only blocking the field from the road, if so, the river should therefore be accessible from the field. Park has parking lot.	Municipal Open Space, Frank W. Burr Field	https://www.google.com/maps/@39.90879833,-75.25013117,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
004	Primary	Municipal open space at 7th St	39.82843	-75.40101	Nearby problem areas, downstream along Stoney Creek	PennDOT Owned Bridge	Access at bridge along Post Rd.	Municipal Open Space, 7th Street Park	https://www.google.com/maps/@39.82843015,-75.40101464,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
005	Primary	Dupont Francis/Brandywine Conservancy Easement	39.840322	-75.58092	Downstream portion of Brandywine Creek	Dupont Francis/Brandywine Conservancy Easement	Not visible from street view, but aerials show fields and driveways nearby creek that fall within Non Profit Lands. Seems accessible from road at Smith's Bridge.	Non Profit Lands, Dupont Francis/Brandywine Conservancy Easement	https://www.google.com/maps/@39.84032216,-75.58091887,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
006	Primary	Blackrock Park Field House	39.881598	-75.3506	Municipality owned land, downstream of problem area, downstream portion Crum Creek with proposed gage locations upstream	Ridley Township	Parking available at park, no street view available but aerial shows trails along creek.	Municipal Open Space, William Driadon Park at Black Rock	https://www.google.com/maps/@39.88159772,-75.35059508,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
007	Primary	Smedley Park	39.915287	-75.35962	County owned bridge and land, stream gage locations proposed both upstream and downstream of this location	Delaware County	Pedestrian bridges along this portion of the creek with access points at park. Parking lot at park	County Open Space, Smedley County Park	https://www.google.com/maps/@39.91528704,-75.35961834,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
008	Secondary	Catania County Park along Little Crum Creek	39.870228	-75.33099	County owned land, downstream portion of Little Crum Creek with proposed gages upstream	Delaware County	Parking available at park. Site accessible from park through some brush.	County Open Space, Catania County Park	https://www.google.com/maps/@39.87022777,-75.3309903,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
009	Backup Location	Under bridge along West Chester Pike, wooded area and borders non-profit lands (Brandywine Conservancy Easement, Natural Lands Trust Summerhill Preserve)	39.97665	-75.43657	Upstream portion of Crum Creek, supplementing USGS Stream Gage, backup location to 032	PennDOT Owned Bridge	Commercial parking available along Crum Creek in this area, google street view shows steep slope down.	Municipal Open Space, Hatch's Lane	https://www.google.com/maps/@39.97664975,-75.43657297,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
010	Primary	Weir Park, downstream of baseball fields	39.858387	-75.4402	Upstream portion of Marcus Hook Creek, municipality owned land	Aston Township	Not visible from street view and accessibility hard to tell with tree cover. Parking available at park with a short walk to proposed location. Creek doesn't appear to have steep slopes in this location.	Municipal Open Space, Weir Park	https://www.google.com/maps/@39.85688946,-75.43941837,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D

Stream Gage ID	Priority Rating	Location Description	Latitude	Longitude	Prioritization	Site Ownership	Accessibility Notes	Description	Google Maps URL
011	Primary	Wooded area along Marcus Hook	39.822294	-75.40991	Downstream portion of Marcus Hook Creek	PennDOT Owned Bridge	Possible accessibility from behind Trainer Boro Police Department Building. There appears to be a retaining wall behind the building but cannot see if it extends the full back of the building.	PennDOT Owned bridged along 10th St	https://www.google.com/maps/@39.82229422,-75.40990603,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
012	Primary	Wooded area along Naaman's Creek	39.818623	-75.44702	Most downstream of Naamans Creek within County, municipality owned land	Lower Chichester Township	Access at bridge off of where Hickman Rd meets Naamans Creek Rd and walk in along creek. Street parking not available in this area.	Municipal Open Space, Naamans Creek Road Park	https://www.google.com/maps/@39.8186232,-75.44702179,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
013	Primary	Tara Circle Woods, wooded area along Naaman's Creek	39.836602	-75.46522	Upstream portion of Naaman's Creek, downstream of several problem areas, municipality owned land	Upper Chichester Township	Walk in to creek from street.	Municipal Open Space, Tara Circle Woods	https://www.google.com/maps/@39.83660248,-75.46521859,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
014	Primary	Nearby Ridley Creek Trail Entrance	39.940537	-75.41883	Further downstream of Ridley Creek with other gages proposed both upstream and downstream of this location, downstream of problem areas	State Owned	Not visible from street view and unable to tell accessibility, within Ridley Creek State Park with trails, would likely require hike in	State Open Space, Ridley Creek State Park	https://www.google.com/maps/@39.94053705,-75.41882717,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
015	Primary	County owned bridge along Media Station Rd	39.91301	-75.39988	County owned bridge, state owned land, supplement USGS gage	State Owned	Climb down from bridge, unable to see how steep the slopes are from street view, nearby municipal sewer facility available for parking	State Open Space, Ridley Creek State Park	https://www.google.com/maps/@39.91300984,-75.39988272,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
016	Primary	Sun Village Park, nearby bridge on E 9th St	39.857718	-75.34666	County owned bridge, nearby problem area, downstream portion of Ridley Creek	Delaware County	Would require steep climb down if accessed by bridge, park has trails throughout with assumed easier access to Ridley Creek. Park has parking lot.	County Owned Bridge, Municipal Open Space, Sun Village Park	https://www.google.com/maps/@39.85771765,-75.34665912,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
017	Primary	County owned bridge along Incinerator Rd	39.850081	-75.3862	County owned bridge, along Chester Creek, nearby problem area	Delaware County	Bridge not available on street view, Creek may be accessible at Crozer Park slightly downstream	County Owned Bridge, Municipal Open Space, Crozer Park	https://www.google.com/maps/@39.85008065,-75.38619798,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
018	Secondary	County owned bridge along Mt Alverno Rd	39.880068	-75.42771	County owned bridge, along Chester Creek, downstream of confluence w/ Chrome Run which has high priority problem areas	Delaware County	Chester Creek Trail parking available nearby. Climb/walk down from bridge needed. Short slope area around what seems to be a deep portion of the river.	County Owned Bridge, Municipal Open Space, Old Mill Pointe Open Space	https://www.google.com/maps/@39.88006751,-75.42771073,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
019	Primary	Newlin Grist Mill Park	39.889982	-75.5029	Along West Branch Chester Creek, nearby problem areas	Newlin Grist Mill	Seemingly accessible. No view of river on street view, but there is a dirt road off Pole Cat Rd with parking available at the following coordinates: 39.890430175972945, -75.50255923205441	Non Profit Lands, Newlin Grist Mill	https://www.google.com/maps/@39.88998226,-75.50290144,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
020	Primary	County owned bridge along W 5th St	39.846767	-75.36303	County owned bridge, most downstream location along Chester Creek	Delaware County	May be able to access from Water Street off of 5th St through trees and brush just downstream from the bridge. Street parking available. Steep slope and climb down from bridge	County Owned Bridge, County Open Space, PA Health Department Building	https://www.google.com/maps/@39.84676653,-75.36303372,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D

Stream Gage ID	Priority Rating	Location Description	Latitude	Longitude	Prioritization	Site Ownership	Accessibility Notes	Description	Google Maps URL
021	Primary	County owned bridge along Locksley Rd	39.930975	-75.50432	Municipal open space, county owned bridge, nearby problem area	Delaware County	Imagery from 2012. Most recent views block the river. It seems accessible, but the amount of ground cover makes it difficult to assess existing conditions. Possibility to climb down at bridge with parking available at Bonner Park.	County Owned Bridge, Municipal Open Space, 132 Creek Road	https://www.google.com/maps/@39.93097468,-75.50431839,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
022	Primary	County owned bridge along Convent Rd	39.892192	-75.44208	County owned bridge, nearby problem area, downstream of confluences	Delaware County	Walk/climb down at bridge	County owned bridge	https://www.google.com/maps/@39.89219218,-75.44207799,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
023	Primary	Chester Creek along Chester Creek Rd	39.869046	-75.40804	Overlap with USGS gage, upstream of problem areas	Unknown	Accessible from road, walk down from road, pull-off parking available along Chester Creek Rd	Chester Creek at Dutton Mill Rd	https://www.google.com/maps/@39.86904561,-75.40804396,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
024	Primary	County owned bridge along County Line Rd	40.05552	-75.35145	County owned bridge downstream portion of Gulph Creek within County	Delaware County	Accessible from cobble path. Climb down at bridge.	County owned bridge	https://www.google.com/maps/@40.05551976,-75.3514473,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
025	Primary	County owned bridge along Pine St	39.913971	-75.26007	County owned bridge, nearby problem area	Delaware County	Walk/climb down at bridge, street parking available	County owned bridge	https://www.google.com/maps/@39.91397119,-75.26007368,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
026	Primary	County owned bridge along Hilldale Rd	39.934852	-75.27683	County owned bridge, nearby problem area	Delaware County	Climb down at bridge or Scottdale Rd. Pull off parking available along Scottdale Rd.	County Open Space, Shrigley Park, Darby Creek Parkland	https://www.google.com/maps/@39.934852,-75.27682885,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
027	Primary	Bridge along S 84th St	39.898526	-75.25534	Overlap with USGS gage, Eastwick area, nearby problem areas	PennDOT Bridge	EPA Clearview Landfill Cleanup adjacent to Creek in this area with fencing along road. Accessible but through adjacent property.	Darby Creek at Eastwick	https://www.google.com/maps/@39.89852597,-75.25533595,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
028	Backup Location	Brandywine Conservancy Owned Land along Creek Rd	39.863172	-75.59633	Downstream of Harvey Run confluence with Brandywine, USGS gage is upstream of confluence, nearby problem area, backup location to 029	Brandywine Conservancy	Accessible around the barrier and walk down to river.	Non Profit Lands, Brandywine Conservancy	https://www.google.com/maps/@39.86317223,-75.59632866,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
029	Primary	Bridge along Baltimore Pike	39.871803	-75.59613	Upstream entry point of Brandywine as it enters Delaware County	PennDOT Owned Bridge	Accessible around the barrier and walk down to river.	State Owned Bridge	https://www.google.com/maps/@39.8718028,-75.59612729,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
030	Primary	Cheyney University at Chester Creek	39.928615	-75.52786	Upstream entry point of Chester Creek as it enters Delaware County	Cheyney State Teachers College	Walk in to creek from parking lot.	Private Land	https://www.google.com/maps/@39.92861539,-75.52786499,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
031	Primary	Bridge along Delchester Rd	39.967587	-75.47355	Upstream entry point of Ridley Creek as it enters Delaware County	PennDOT Owned Bridge	Less accessible location, a lot of trees and brush, possibility to climb down at bridge	State Owned Bridge	https://www.google.com/maps/@39.9675868,-75.47355174,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
032	Primary	Bartram's Covered Bridge	39.989919	-75.4374	Upstream entry point of Crum Creek as it enters Delaware County, nearby problem area, county protected land	PennDOT Owned Bridge	Climb down at bridge along Goshen Rd	State Owned Bridge	https://www.google.com/maps/@39.9899191,-75.43739513,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
033	Primary	St. David's Road Bridge	40.017296	-75.40528	Municipality owed land, nearby problem area, upstream entry point of Darby Creek as it enters Delaware County	Newtown Township	Access at bridge. Nearby parking available.	Municipal Open Space, Paper Mill House, State owned bridge	https://www.google.com/maps/@40.01729587,-75.4052761,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
034	Primary	Local bridge along Manor Rd	39.965807	-75.29641	Prioritization of Naylor's Run, supplementing USGS stream gage	Local road, likely municipality owned	Walk to creek at road crossing. Recommend on the upstream end of the bridge that seems accessible. There is also another pedestrian bridge upstream, although may be privately owned.	Naylor's Run at Manor Rd	https://www.google.com/maps/@39.96580695,-75.29641252,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D

Stream Gage ID	Priority Rating	Location Description	Latitude	Longitude	Prioritization	Site Ownership	Accessibility Notes	Description	Google Maps URL
035	Primary	Darby Creek Trail	39.973052	-75.3383	County owned trail, downstream of confluence with Langford Run	Haverford Township	Trails throughout park to access stream or access at pedestrian bridge. Street parking by trailhead or park's parking lot.	Municipal Open Space, Darby Creek Valley Park North	https://www.google.com/maps/@39.9730515,-75.33829942,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
036	Removed	Warren Filipone Memorial Park	40.040578	-75.404957	Munipality owned land, nearby problem areas	Radnor Township	Seems accessible from the adjacent park.However, overgrowth and steep slope to shallow creek may prove inaccesible.	Municipal Open Space, Bo Connor Park/Fillipone Park	https://www.google.com/maps/@40.04057812,-75.40495718,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
037	Secondary	Haverford Community Recreation & Environmental Center	39.993264	-75.34975	Upstream of problem area, downstream of confluence	Haverford Township	Walk/climb down at bridge.	Municipal Open Space, Community Park at Haverford Reserve	https://www.google.com/maps/@39.99326442,-75.34974659,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
038	Primary	County owned bridge along Paxon Hollow Rd	39.949615	-75.38177	County owned bridge, downstream of confluences with Crum Creek & Reservoir, backup location to 059	Delaware County	Seems less accessible at bridge due to height of retaining wall. Possible access through private backyard.	County owned bridge	https://www.google.com/maps/@39.94961488,-75.38176742,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
039	Primary	County owned bridge along Sawmill Rd	40.012516	-75.38723	County owned bridge, downstream of Little Darby Creek confluence, stream gages proposed both upstream and downstream of this location	Radnor Township	Accessible to cross over barrier and walk down to the river.	Municipal Open Space, Wheeler Field	https://www.google.com/maps/@40.01251577,-75.38722839,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
040	Secondary	Glenolden Park along Muckinipattis Creek	39.899861	-75.29519	Municipality owned land, nearby problem area	Glenolden Borough	No clear view to creek from street view. Access to Sanctuary appears to be on Old Mill Ln with a walk down to creek from there.	Municipal Open Space, Glenolden Park	https://www.google.com/maps/@39.89986143,-75.29518684,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
041	Secondary	Cobbs Creek Park	39.974459	-75.27997	Overlap with USGS gage, downstream of problem areas	Philadelphia County	Access via park. Pedestrian bridge available for gage placement as well.	County Open Space, Cobbs Creek Park (Philadelphia Owned)	https://www.google.com/maps/@39.97445908,-75.27996528,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
042	Secondary	County owned bridge along Tribbett Ave	39.89185	-75.26784	County owned bridge and parcel, downstream of problem areas (Gage ID 064 is upstream)	Delaware County	Seems accessible from trails. No street view to confirm.	County owned parcel, Emergency Services Training Center	https://www.google.com/maps/@39.89184987,-75.26783816,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
043	Secondary	County owned bridge along Delmar Dr	39.888642	-75.28975	County owned bridge, nearby problem area	Delaware County	Climb down at bridge.	County owned bridge	https://www.google.com/maps/@39.88864203,-75.28975371,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
044	Backup Location	County owned bridge along Marple Ave	39.933563	-75.28983	County owned bridge, upstream of problem areas and confluences to Darby Creek, backup location to 026	Delaware County	Marple Twp owns country club, stream appears accessible from golf course. No street view to confirm.	County owned bridge	https://www.google.com/maps/@39.9335632,-75.28983427,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
045	Backup Location	County owned bridge along Chester Pike	39.917841	-75.26271	County owned bridge, nearby problem area, backup location to 025	Delaware County	Aerial imagery indicates access from easement, if not, Creek is accessible along Creek Rd with a climb down.	County owned bridge	https://www.google.com/maps/@39.91784102,-75.26270985,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
046	Secondary	Darby Creek Valley Park	39.980596	-75.33601	Municipal owned land, nearby problem areas	Haverford Township	Parking available at park. Accessible from park	Municipal Open Space, Passive Parkland - Darby Creek Road	https://www.google.com/maps/@39.98059564,-75.33600823,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
047	Secondary	Bridgewater Open Space	39.861103	-75.39426	Along Chester Creek, municipality owned land, downstream of multiple confluences	Aston Township	Walk/climb down at bridge.	Municipal Open Space, Bridgewater Open Space	https://www.google.com/maps/@39.86110305,-75.3942587,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
048	Removed	Concord Creek along Concord Townswhip Sewer Plant Property	39.879861	-75.512941	Upstream of several problem areas, municipality owned land	Concord Township	Possibly accessible from Township propoerty but not visible on street view. Climb down at bridge along Concord Rd possible	Municipal Open Space, Concord Township Sewer Plant	https://www.google.com/maps/@39.87986135,-75.51294062,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
049	Backup Location	County owned bridge along Station Rd	39.932584	-75.51631	County owned bridge, upstream along Chester Creek, backup location to 021	Delaware County	Not visible from street view, aerial shows trails throughout park that could allow access to stream	County Owned Bridge, Municipal Open Space, 92 Creek Road	https://www.google.com/maps/@39.93258414,-75.51631213,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D

Stream Gage ID	Priority Rating	Location Description	Latitude	Longitude	Prioritization	Site Ownership	Accessibility Notes	Description	Google Maps URL
050	Primary	County owned bridge along Forge Rd	39.913605	-75.48307	County owned bridge, along Chester Creek	Delaware County	Access from park.	County Owned Bridge, County Open Space, Stoney Bank Rd & Chester Creek	https://www.google.com/maps/@39.9136046,-75.4830664,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
051	Secondary	County owned bridge along Mattson Rd	39.877369	-75.46878	County owned bridge, along Chester Creek, nearby problem area	Delaware County	Access from park.	County Owned Bridge	https://www.google.com/maps/@39.87736944,-75.46877798,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
052	Removed	Longpoint Wildlife Sanctuary	39.892451	-75.38873	Municipality owned land, nearby problem areas	Rose Valley Borough	Access behind field from Ridley Brook Apartments.	Municipal Open Space, Longpoint Wildlife Sanctuary	https://www.google.com/maps/@39.89245126,-75.38873398,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
053	Secondary	Fenimore Woods Park	40.051663	-75.37617	Upstream portion of Gulph Creek, municipality owned land. Downstream from priority areas	Radnor Township	Walk/climb down at bridge along Mill Rd.	Municipal Open Space, Fenimore Woods Park	https://www.google.com/maps/@40.05166269,-75.37617159,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
054	Secondary	Ridley Creek State Park	39.96373	-75.45339	Upstream portion of Ridley Creek, State owned land	State Owned	Doesn't appear to be accessible from bridge, but possibly accessible from fields next to creek.	State Open Space, Ridley Creek State Park	https://www.google.com/maps/@39.96373037,-75.45338999,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
055	Tertiary	County owned bridge along Michigan Ave	39.895069	-75.33818	County owned bridge, municipality owned land, upstream portion of Little Crum Creek with gages proposed further downstream	Ridley Township	Walk/climb down at bridge along Michigan Ave Pkwy.	Municipal Open Space, Georgetown Open Space	https://www.google.com/maps/@39.8950689,-75.33818174,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
056	Removed	Paxon Hollow Country Club	39.958293	-75.375334	Municipality owned land, nearby problem area, upstream along tributary to Crum Creek	Marple Township	Walk/climb down at bridge.	Municpal Open Space, Paxon Hollow Country Club	https://www.google.com/maps/@39.95829256,-75.37533362,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
057	Backup Location	Brandywine Creek along Twin Bridges LTD/Brandywine Con Easement	39.857198	-75.60114	Upstream portion of Brandywine Creek with proposed gages both upstream and downstream of this location, backup location to 029	Twin Bridges LTD/Brandywine Con Easement	Not visible from street view. Assumed access through park with footbridge over creek shown in aerial.	Non Profit Lands, Twin Bridges LTD/Brandywine Con Easement	https://www.google.com/maps/@39.85719825,-75.60114046,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
058	Removed	Merry Place Park	39.960313	-75.332998	Nearby problem areas, more downstream of Darby Creek with proposed gages both upstream and downstream of this location	Haverford Township	Walk/climb down at bridge.	Merry Place Park, Municipal Open Space	https://www.google.com/maps/@39.96031309,-75.33299816,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
059	Tertiary	County owned bridge along Crum Creek Rd	39.941453	-75.37476	County owned bridge, nearby problem area	Delaware County	Climb down at bridge and walk.	County owned bridge	https://www.google.com/maps/@39.94145319,-75.37476107,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
060	Removed	Municipal open space along Crum Creek Rd	39.931908	-75.369125	Nearby problem area, further downstream portion of Crum Creek	Upper Providence Township	Climb down at bridge/Wawa Preserve.	Municipal Open Space	https://www.google.com/maps/@39.93190792,-75.36912459,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
061	Tertiary	Turner's Mill Park	39.871748	-75.58145	Supplementing NOAA rain gage with local stream gage, upstream of Brandywine Creek	Chadds Ford Township	Climb down at bridge.	Municipal Open Space, Turner's Mill/Chadds Ford Twp Hall	https://www.google.com/maps/@39.87174812,-75.58145203,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
062	Removed	Gaspari Park	39.822559	-75.42744	Supplementing NOAA rain gage with local stream gage, nearby problem areas, along smaller tributary	Lower Chichester Township	Climb down at bridge.	Municipal Open Space, Rocco Gaspari Sr Municipal Park	https://www.google.com/maps/@39.82255943,-75.42744268,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
063	Backup Location	Merwood Park	39.994828	-75.30294	Upstream of existing USGS gage, upstream of problem areas, upstream portion of Cobbs Creek, backup location to 002	Haverford Township	Climb down at bridge.	Municipal Open Space, Merwood Park	https://www.google.com/maps/@39.99482817,-75.30293767,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D

Stream Gage ID	Priority Rating	Location Description	Latitude	Longitude	Prioritization	Site Ownership	Accessibility Notes	Description	Google Maps URL
064	Removed	Bissinger Field	39.885679	-75.33481	Municipality owned land, placed along tributary to Crum Creek with proposed gages both upstream and downstream of this location	Ridley Township	Possible access point along Madison Ave or along Fishing Trail at Tinicum Park.	Municipal Open Space, Bissinger Field	https://www.google.com/maps/@39.88567856,-75.33480967,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
065	Primary	Municipal open space along East Branch Naamans Creek	39.834044	-75.44751	Downstream of confluence, along Naamans Creek, municipality owned land	Upper Chichester	Climb down at bridge. Street parking available.	Municipal Open Space, Unnamed Municipal Woods	https://www.google.com/maps/@39.8340444,-75.44751236,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
066	Backup Location	County owned bridge along W 7th St	39.849557	-75.36309	County owned bridge, downstream portion of Chester Creek, backup location to 026	Delaware County	Fencing along creek at park but unable to see how far it stretches, may be able to access & climb down at bridge along W Providence Rd.	County Owned Bridge, Municipal Open Space, Crozer Park	https://www.google.com/maps/@39.84955712,-75.36309481,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
067	Tertiary	Municipal open space along Ridley Creek	39.873198	-75.3665	Downstream of confluence along Ridley Creek, municipality owned land	Chester City	Access point at Tinicum Park along Darby Creek Trail requiring hike in.	Municipal Open Space, Chester City Ridley Creek Open Space	https://www.google.com/maps/@39.87319753,-75.36650068,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
068	Tertiary	County owned bridge along Manchester Rd	39.902616	-75.39224	County owned bridge, along Ridley Creek with proposed gages both upstream and downstream of this location	Delaware County	Climb down at bridge.	County Owned Bridge	https://www.google.com/maps/@39.90261574,-75.39224324,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
069	Tertiary	Brookhaven Memorial Park	39.88295	-75.38443	Nearby problem area, along Ridley Creek	The Mills at Rose Valley/NLT Conservation Easement	Hard to confirm accessibility of site from street views. Location is likely accessible along County owned trail (Darby Creek Trail).	Non Profit Lands, The Mills at Rose Valley/NLT Conservation Easement	https://www.google.com/maps/@39.88294994,-75.38443175,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
070	Tertiary	County owned bridge along Temple Rd	39.873309	-75.5232	Along tributary to Chester Creek, County owned bridge	Delaware County	Walk/climb down at bridge	County Owned Bridge	https://www.google.com/maps/@39.87330863,-75.52320402,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
071	Tertiary	Clayton County Park	39.866664	-75.47557	Along tributary to Chester Creek, County owned land, downstream of problem areas	Delaware County	Walk in, accessible at park	County Open Space, Clayton County Park	https://www.google.com/maps/@39.86666428,-75.47557451,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
072	Tertiary	County owned bridge along Valley Rd	39.907951	-75.45705	County owned bridge, tributary creek, non profit land	Wawa Preserve/Natural Lands Trust	Climb down at bridge/Wawa Preserve	Non Profit Lands, Wawa Preserve/Natural Lands Trust	https://www.google.com/maps/@39.90795103,-75.45704898,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
073	Tertiary	PennDOT Bridge along Darby Rd	39.998343	-75.35047	Along Ithan Creek upstream of confluence with Darby Creek	PennDOT Owned Bridge	Climb down at bridge	Non Profit Lands, Willowstreams/NLT Conservation Easements, PennDOT Owned Bridge	https://www.google.com/maps/@39.99834288,-75.35046944,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
074	Tertiary	Municipal open space along Brinton Lake Rd	39.891839	-75.52095	Downstream of confluences along West Branch Chester Creek	PennDOT Owned Bridge	Climb down at bridge	Municipal Open Space, Brinton Lake Road	https://www.google.com/maps/@39.89183892,-75.52095483,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
075	Tertiary	County owned bridge along Reed Rd	39.954338	-75.33589	County owned bridge	Delaware County	Climb down at bridge	County owned bridge	https://www.google.com/maps/@39.9543383,-75.33589327,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
076	Tertiary	Morton Homestead State Park	39.876276	-75.30492	Darby Creek downstream of confluence of Long Hook Creek, Federal Open Space	Federal	Possible access point along Madison Ave or along Fishing Trail at Tinicum Park	Federal Open Space, John Heinz National Wildlife Refuge at Tinicum	https://www.google.com/maps/@39.87627615,-75.30491725,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
077	Removed	County owned bridge along Folcroft Ave	39.903871	-75.27889	County owned bridge, upstream of problem areas (Gage ID 065 is downstream)	Delaware County	Climb down at bridge, street parking available	County owned bridge	https://www.google.com/maps/@39.90387134,-75.27888625,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
078	Backup Location	Penn Pines Park	39.929073	-75.27218	Overlap with USGS gage, municipality owned land, backup location to 026	Upper Darby Township	Fencing along creek at park but unable to see how far it stretches, may be able to access & climb down at bridge along W Providence Rd	Municipal Open Space, Penn Pines Park	https://www.google.com/maps/@39.92907343,-75.2721829,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
079	Tertiary	Darby Creek Trail at Tinicum Park	39.879184	-75.29119	Municipality owned land	Norwood Borough	Access point at Tinicum Park along Darby Creek Trail requiring hike in	Municipal Open Space, Lower Park	https://www.google.com/maps/@39.87918387,-75.29118613,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D

Stream Gage ID	Priority Rating	Location Description	Latitude	Longitude	Prioritization	Site Ownership	Accessibility Notes	Description	Google Maps URL
080	Backup Location	County owned bridge along Paper Mill Rd	40.014755	-75.39795	County owned bridge, upstream of confluences, Backup location to 033	Delaware County	Climb down at bridge	County owned bridge	https://www.google.com/maps/@40.01475477,-75.3979503,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
081	Primary	Cobbs Creek Playground	39.950576	-75.25113	Along Cobbs Creek downstream of confluence with Naylor's Run	Philadelphia County	Trails throughout park to access stream, street parking by trailhead or park's parking lot	County Open Space, Cobbs Creek Park (Philadelphia Owned)	https://www.google.com/maps/@39.95057568,-75.25113206,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
082	Primary	Boeing Parking Lot	39.861176	-75.32317	Downstream of Crum Creek	Private Property	Seemingly accessible from Boeing parking lot	Private Property	https://www.google.com/maps/@39.86117557,-75.32316832,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
083	Secondary	Henry Johnson Park	39.832798	-75.41443	Along Marcus Hook Creek downstream of confluence, municipality owned land	Trainer Borough	Accessible from park	Municipal Open Space, Henry Johnson Park	https://www.google.com/maps/@39.83279823,-75.41442991,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
084	Secondary	West of BMP along Naamans Creek	39.836683	-75.45819	Upstream of confluences along Naamans Creek	Unknown	Park near 4000 Village Way. Walk north towards the BMP. The location is west of the bmp	BMP	https://www.google.com/maps/@39.83668258,-75.45819234,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
085	Primary	Bridge along Bethel Rd nestled by apartments, neighborhoods, and a senior living facility	39.835712	-75.44837	Nearby problem area, along East Branch of Naamans Creek upstream of confluence	Delaware County	Street parking is not available. Park at Lutheran Knolls North Senior care and walk to bridge	County owned bridge	https://www.google.com/maps/@39.83571236,-75.44837295,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
086	Primary	Frederick L. Mann Memorial Park	39.896897	-75.31625	County owned bridge and land, stream gage along Stony Creek	Delaware County	Park at Frederick L. Mann Memorial Park. Walk southeast to the stream, stream is surrounded by trees.	Municipal Open Space, Frederick L. Mann Memorial Park	https://www.google.com/maps/@39.89689688,-75.31624745,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D
087	Primary	Industrial Highway at Darby Creek	39.866087	-75.313366	Darby Creek downstream of confuence of Stony Creek	PennDOT Owned Bridge	Assumed accessibility from Hotel/Airport parking lots along Darby Creek	Bridge along Industrial Hwy (Route Hwy)	https://www.google.com/maps/@39.866087,-75.3133655,15m/data=3m11e3?entry=ttu&g_ep=EgoyMDI2MDEyMS4wIKXMDSoASAFQAw%3D%3D

Appendix D – Delaware County Model Ordinance

DRAFT

Delaware County
County-wide Model Stormwater Management Ordinance
Blue highlighted text is for municipal edit input

STORMWATER MANAGEMENT ORDINANCE

ORDINANCE NO. _____

MUNICIPALITY OF

_____

DELAWARE COUNTY, PENNSYLVANIA

Adopted at a Public Meeting Held on

_____, 20_____

Table of Contents

ARTICLE I – GENERAL PROVISIONS 7
Section 101. Short Title 7
Section 102. Statement of Findings 7
Section 103. Purpose 8
Section 104. Statutory Authority 9
Section 105. Applicability 9
Section 106. Repealer 10
Section 107. Severability 10
Section 108. Compatibility with Other Requirements 10
Section 109. Erroneous Permit 10
Section 110. Waivers *10*
Section 111. Financial Guarantee 11
ARTICLE II – DEFINITIONS 12
ARTICLE III – GENERAL STORMWATER REQUIREMENTS 27
Section 301. Permit Requirement 27
Section 302. General E&S Requirements 27
Section 303. E&S Plan Preparer Qualifications 28
Section 304. General PCSM Requirements 28
Section 305. PCSM Plan Preparer Qualifications 28
Section 306. Exemptions 29
ARTICLE IV – E&S PLAN AND IMPLEMENTATION REQUIREMENTS 33
Section 401. General 33
Section 402. E&S Plan Contents 33
Section 403. Protection of Site Infiltration Properties During Earth Disturbance 33
Section 404. Discharges to Special Protection and Impaired Waters 33
Section 405. E&S Plan Submission 33
Section 406. E&S Plan Review and Approval Process 34
Section 407. Modification of E&S Plans 34
Section 408. Resubmission of Disapproved E&S Plans 34
ARTICLE V – PCSM PLAN AND IMPLEMENTATION REQUIREMENTS 35
Section 501. General 35
Section 502. PCSM Plan Contents 37
Section 503. Pre-Development Site Characterization 40
Section 504. Stormwater Analysis 40
Section 505. Erosion Potential Analysis 43

DRAFT

Section 506. Stream Stability Analysis 43
Section 507. Off-Site Stormwater Management....43
Section 508. Temporary and Permanent Stabilization 44
Section 509. PCSM Plan Submission 44
Section 510. PCSM Plan Review and Approval Process 45
Section 511. Modification of PCSM Plans....45
Section 512. Resubmission of Disapproved PCSM Plans....45
Section 513. Authorization to Construct and Term of Validity....45
Section 514. Project Completion 46
ARTICLE VI – STORMWATER CONTROL MEASURE REQUIREMENTS 47
Section 601. General Requirements 47
Section 602. SCM Design 47
Section 603. Stormwater Conveyance....50
Section 604. Existing SCMs 50
Section 605. Riparian Buffers 50
ARTICLE VII – OPERATION AND MAINTENANCE (O&M) 52
Section 701. General Requirements 52
Section 702. O&M Agreements....52
ARTICLE VIII – EASEMENTS 54
Section 801. General....54
Section 802. Discharges to Adjacent Property....55
ARTICLE IX – FEES AND EXPENSES 56
Section 901. General....56
ARTICLE X – PROHIBITIONS 57
Section 1001. Prohibited Discharges and Connections....57
Section 1002. Roof Drains and Sump Pumps....57
Section 1003. Notification of Pollution 58
ARTICLE XI – INSPECTION, ENFORCEMENT AND PENALTIES 59
Section 1101. Right of Entry 59
Section 1102. Post-Construction Inspections of SCMs....59
Section 1103. Enforcement....59
Section 1104. Suspension and Revocation 60
Section 1105. Penalties....61
Section 1106. Appeals....61

DRAFT

ORDINANCE APPENDICIES

APPENDIX A – Stormwater Management District Watershed Maps
APPENDIX B – Simplified Approach to Stormwater Management for Small Projects
APPENDIX C – Stormwater Management Design Criteria
APPENDIX D – Stormwater Control Measures Operations and Maintenance Agreement
APPENDIX E – Low Impact Development Practices

NOTES TO MUNICIPAL EDITOR:

1) *This County-wide Model Stormwater Management Ordinance was developed by Delaware County to meet requirements under PADEPs National Pollutant Discharge Elimination System (NPDES) Stormwater Discharges for Small Municipal Separate Storm Sewer Systems (MS4s) and the Pennsylvania Stormwater Management Act (Act 167) of 1978. The basis of this ordinance is PADEPs 2028 MS4/Act 167 ordinance supplemented with information from the 2020 County Model Ordinance which was based in large part on the 2011 Crum Creek Watershed Model Stormwater Management Ordinance.*

2) *As required by Act 167, all municipalities in Delaware County must enact this model ordinance as a stand-alone ordinance. In addition, it is recommended that municipalities review existing subdivision and land development and zoning ordinances and consider amending them to refer to and coordinate with the new stormwater management ordinance. Enactment in this manner is anticipated to provide maximum flexibility and authority for enforcement.*

3) *Municipalities may, at their option, replace the term "Municipal Engineer" with "Municipality" in any or all places where "Municipal Engineer" currently appears throughout the Ordinance.*

4) *The text highlighted in blue indicates the Municipal Editor should enter in municipal-specific information.*

5) *To ensure applicability of this Ordinance to your Municipality, be sure to insert your Municipality's name in each of the following locations:*
    - *a) Ordinance Title*
    - *b) Section 101*
    - *c) Article II, within the definitions of the following terms –*
        - *i. Municipality*
        - *ii. Planning Commission*

ARTICLE I – GENERAL PROVISIONS

Section 101. Short Title

This ordinance shall be known and may be cited as the "(Name of Municipality) Stormwater Management Ordinance" (Ordinance).

Section 102. Statement of Findings

The governing body of the Municipality finds that:

A. Inadequate management of stormwater runoff resulting from impervious surfaces and development activities throughout a watershed increases runoff volumes, flows, and velocities; contributes to accelerated erosion and sedimentation; overtaxes the carrying capacity of surface waters and storm sewers; greatly increases the cost of public and private facilities to carry and control stormwater; undermines floodplain management and flood control efforts in downstream communities; reduces groundwater recharge; threatens public health and safety; and increases point and nonpoint source pollution of water resources.

B. A comprehensive program of stormwater management, including reasonable regulation of development and activities causing accelerated runoff and increased pollution, is fundamental to the public health, safety, and welfare of people of the Commonwealth, their resources, and the environment.

C. Stormwater is an important water resource that provides groundwater recharge for water supplies and supports the base flow of surface waters.

D. Impacts from stormwater runoff can be minimized by using project designs that maintain the natural hydrologic regime and sustain high water quality, infiltration, stream baseflow, and aquatic ecosystems. The most cost-effective and environmentally advantageous way to manage stormwater runoff is through nonstructural project design that minimizes impervious surfaces and sprawl, avoids sensitive areas (i.e., stream buffers, floodplains, steep slopes), and considers topography and soils to maintain the natural hydrologic regime.

E. Public education on the control of pollution from stormwater is an essential component in successfully addressing stormwater.

F. Federal and state law requires certain municipalities to implement a stormwater management program and obtain National Pollutant Discharge Elimination System (NPDES) permit coverage to authorize the discharge of pollutants from small municipal separate storm sewer systems (MS4s) to control stormwater pollution to the maximum extent practicable.

G. Federal and state law requires, with certain exceptions, any person proposing an earth disturbance activity that will involve at least one (1) acre of earth disturbance, or an earth disturbance on any portion, part, or during any stage of, a larger common plan of development or sale that involves at least one (1) acre of earth disturbance, to obtain an NPDES permit for stormwater discharges associated with construction activities prior to commencing the earth disturbance activity. State law requires a person proposing a timber harvesting or road maintenance activity involving at least 25 acres of earth disturbance to obtain an Erosion and Sediment Control (E&S) permit prior to commencing the earth disturbance activity. State law requires a person proposing oil and gas activities involving at least five acres of earth disturbance to obtain an E&S permit prior to commencing the earth disturbance activity. To obtain an NPDES permit or E&S permit, a person must satisfy the requirements of 25 Pa. Code Chapter 102 and prepare an E&S Plan and a Post-Construction Stormwater Management (PCSM) Plan, when applicable.

H. The Pennsylvania Department of Environmental Protection (DEP) has established requirements, practices, and standards to control pollution during earth disturbance activities at 25 Pa. Code § 102.4 and the Erosion and Sediment Pollution Control Program Manual (E&S Manual), as amended. DEP has established requirements, practices, and standards to control stormwater after earth disturbance activities at 25 Pa. Code 102.8 and the Pennsylvania Stormwater BMP Manual (to be replaced by the Pennsylvania Post-Construction Stormwater Management Manual) (PCSM Manual)). The E&S Manual and PCSM Manual may be relied upon to satisfy the provisions of this Ordinance or alternative standards may be used that provide equal or better protection to waters of the Commonwealth.

I. Nonstormwater discharges to municipal separate storm sewer systems can contribute to pollution of waters of the Commonwealth by the Municipality.

J. The use of green infrastructure and natural landscape stormwater control measures (SCMs) can help to mitigate stormwater-related causes of surface water impairments by using systems and practices which use or mimic natural processes to infiltrate and evapotranspire stormwater, capture and use stormwater, and reduce the duration of erosive flow. Green infrastructure and natural landscape SCMs contribute to the restoration and mitigation of negative impacts due to urbanization.

Section 103. Purpose

The purpose of this Ordinance is to promote health, safety, and welfare within the Municipality and its watershed by minimizing the harms and maximizing the benefits described in Section 102 of this Ordinance, through provisions designed to:

A. Meet water quality requirements under state law, including regulations at 25 Pa. Code Chapter 93, state permit requirements, as applicable, and the Act of October 4, 1978 (P.L. 864, No. 167), *as amended,* known as the Stormwater Management Act or Act 167, to protect, maintain, reclaim, and restore the existing and designated uses of the waters of this Commonwealth.

B. Preserve the integrity of stream channels and maintain and protect the physical, biological and chemical qualities of the receiving stream.

C. Manage any increase in stormwater runoff volume.

D. Minimize impervious areas.

E. Minimize soil compaction.

F. Minimize land clearing and grading.

G. Manage any increase in the rate of stormwater runoff.

H. Maximize the protection of existing drainage features and vegetation.

I. Utilize natural landscape and other SCMs that reduce or minimize changes in stormwater runoff.

J. Prevent scour and erosion of stream banks and streambeds.

K. Provide procedures and performance standards for stormwater design, planning, inspection, and maintenance.

L. Provide proper operation, inspection, and maintenance of all SCMs that are implemented within the municipality.

M. Maintain groundwater recharge and shallow interflow to prevent degradation of surface and groundwater quality and to otherwise protect water resources.

N. Promote Alternative Project designs and layouts that minimize the impacts on surface and groundwater.

O. Promote non-structural best management practices (BMPs).

P. Manage accelerated stormwater runoff and erosion and sedimentation problems and stormwater runoff impacts at their source by regulating activities that cause these problems.

Q. Utilize and preserve existing natural drainage systems as much as possible.

R. Focus on infiltration of stormwater to maintain base flow, to prevent degradation of surface and groundwater quality, and to otherwise protect water resources.

S. Meet legal water quality requirements under state law, including regulations at 25 PA Code Chapter 93 to protect maintain, reclaim, and restore the existing designated uses of the Waters of the Commonwealth.

T. Address the quality and quantity of stormwater discharges from the development site.

U. Provide standards to meet certain NPDES MS4 permit requirements.

V. Implement an illicit discharge detection and elimination program that addresses non-stormwater discharges into the Municipality's separate storm sewer system (MS4).

W. Preserve the flood-carrying capacity of streams.

X. Prevent accelerated scour, erosion and sedimentation of stream channels.

Y. Provide performance standards and design criteria based on watershed-wide stormwater management planning.

Z. Provide proper operation and maintenance of all permanent stormwater management facilities and BMPs that are implemented within the Municipality.

AA. Implement the requirements of Total Maximum Daily Loads (TMDLs) where applicable to waters within or impacted by the Municipality.

Section 104. Statutory Authority

The Municipality is authorized to regulate land use activities that affect runoff by the Act of July 31, 1968 (P.L. 805, No. 247), *as amended,* known as the Pennsylvania Municipalities Planning Code; the Act of October 4, 1978 (P.L. 864, No. 167), *as amended,* known as the Stormwater Management Act or Act 167; Borough Code 8 Pa. C.S.A Section 101 et seq.; First Class Township Code, 53, Section 55101 et seq.; Second Class Township Code, 53 P.S> Sections 65101 et seq.; and the Third Class City Code, P.S. Sections 35101 et seq.

Section 105. Applicability

All regulated activities and all activities that may affect stormwater runoff, including land development and earth disturbance activities, are subject to regulation under this Ordinance.

This Ordinance contains the stormwater management performance standards and design criteria that are necessary from a watershed-wide perspective. Local stormwater management design criteria (e.g., inlet spacing, inlet type, collection system design and details, outlet structure design, etc.) shall continue to be regulated by the applicable municipal ordinances and applicable state regulations.

Section 106. Repealer

Any other ordinance provision(s) or regulation of the Municipality inconsistent with any of the provisions of this Ordinance are hereby repealed to the extent of the inconsistency only.

Section 107. Severability

In the event that a court of competent jurisdiction declares any section or provision of this Ordinance invalid, such decision may not affect the validity of any of the remaining provisions of this Ordinance.

Section 108. Compatibility with Other Requirements

A. Approvals issued and actions taken under this Ordinance do not relieve the applicant of the responsibility to secure required permits or approvals for activities regulated by any other code, law, regulation or ordinance.

B. To the extent that this Ordinance imposes more rigorous or stringent requirements for stormwater management, the specific requirements contained in this Ordinance shall be followed.

C. Nothing in this Ordinance shall be construed to affect any of the Municipality's requirements regarding stormwater matters that do not conflict with the provisions of this Ordinance, such as local stormwater management design criteria (e.g., inlet spacing, inlet type, collection system design and details, outlet structure design, etc.). Conflicting provisions in other municipal ordinances or regulations shall be construed to retain. The requirements of this Ordinance shall supersede any conflicting requirements in other municipal ordinance or regulations.

Section 109. Erroneous Permit

Any permit or authorization issued or approved based on false, misleading or erroneous information provided by an applicant is void without the necessity of any proceedings for revocation. Any work undertaken or use established pursuant to such permit or other authorization is unlawful. No action may be taken by a board, agency or employee of the municipality purporting to validate such a violation.

Section 110. Waivers

A. If the Municipality determines that any requirement under this Ordinance cannot be achieved for a particular regulated activity, the Municipality may, after an evaluation of alternatives submitted by the applicant for approval, approve measures other than those in this Ordinance, subject to Section 110, paragraphs B and C.

B. Waivers or modifications of the requirements of this Ordinance may be approved by the Municipality if enforcement of the Ordinance will exact undue hardship because of peculiar conditions pertaining to the land in question, provided that the modifications will not be contrary to the public interest and that the purpose of the Ordinance is preserved. Cost or financial burden may not be considered a hardship. Waivers or modification may only be considered if an alternative standard is proposed by an applicant and the applicant demonstrates to the satisfaction of the Municipal Engineer that the alternative will provide equal or better achievement of the purpose of the Ordinance provided that they meet the minimum requirements of, and do not conflict with, state, local, or federal laws, including the Clean Streams Law. A request for modifications must be in writing and accompany the E&S Plan and/or PCSM Plan submission. The request must provide the facts on which the request is based, the provisions of the Ordinance involved, the proposed waiver or modification, the proposed alternative standard, and a demonstration that the proposed alternative will be equally as protective of surface waters.

C. No waiver or modification of any regulated stormwater activity involving earth disturbance greater than

or equal to one acre may be granted by the Municipality unless that action is approved in advance by DEP or the Delaware County Conservation District.

Section 111. Financial Guarantee

A. For PCSM Plans that involve subdivision and land development, or involve redevelopment, the applicant must provide a financial guarantee to the Municipality for the timely installation and proper construction of all SCMs as required by the approved PCSM Plan and this Ordinance in accordance with the provisions of Sections 509, 510, and 511 of the Pennsylvania Municipalities Planning Code and the provisions of the Municipality's Subdivision and Land Development Ordinance (SALDO).

B. The guarantee must be equal to or greater than the full construction cost of the required SCMs and conveyance except the applicant may not be required to provide financial security for the costs of any improvements for which financial security is required by and provided to the Pennsylvania Department of Transportation in connection with the issuance of a highway occupancy permit pursuant to Section 420 of the Act of June 1, 1945 (P.L. 1242, No. 428), known as the "State Highway Law."

C. The financial guarantee for SCMs may not be released until 1) the SCM is accepted in writing for long-term maintenance by the entity identified in the operation and maintenance (O&M) Plan; 2) DEP or the District approves the Chapter 102 Notice of Termination (NOT) for the project; and 3) the SCM is inspected and approved by the Municipality.

ARTICLE II – DEFINITIONS

Section 201. Interpretation

For the purposes of this Ordinance, certain terms and words used herein shall be interpreted as follows:

A. Words used in the present tense include the future tense; the singular number includes the plural, and the plural number includes the singular; words of masculine gender include feminine gender; and words of feminine gender include masculine gender.

B. The word “includes” or “including” shall not limit the term to the specific example, but is intended to extend its meaning to all other instances of like kind and character.

C. The word “person” includes an individual, firm, association, organization, partnership, trust, company, corporation, unit of government, or any other similar entity.

D. The words “shall” and “must” are mandatory; the words “may” and “should” are permissive.

E. The words “used” or “occupied” include the words “intended, designed, maintained, or arranged to be used, occupied, or maintained.”

Section 202. Definitions

Agricultural Activities – The work of producing crops and raising livestock including tillage, plowing, disking, harrowing, pasturing, nursery and sod operations, excluding greenhouse structures, and installation of conservation measures. Construction of new buildings or impervious area is not considered an agricultural activity.

Agricultural Plowing or Tilling Activity – (i) Earth disturbance activity involving the preparation and maintenance of soil for the production of agricultural crops. (ii) The term includes no-till cropping methods, the practice of planting crops with minimal mechanical tillage.

Animal Heavy Use Area – (i) Barnyard, feedlot, loafing area, exercise lot, or other similar area on an agricultural operation where due to the concentration of animals it is not possible to establish and maintain vegetative cover of a density capable of minimizing accelerated erosion and sedimentation by usual planting methods. (ii) The term does not include entrances, pathways and walkways between areas where animals are housed or kept in concentration.

Antidegradation Best Available Combination of Technologies (ABACT) – Environmentally sound and cost effective treatment, land disposal, pollution prevention and stormwater reuse BMPs and SCMs that individually or collectively manage the difference in the net change in stormwater volume, rate, and quality for storm events up to and including the 2-year/24-hour storm when compared to the stormwater rate, volume and quality prior to the earth disturbance activities to maintain and protect the existing quality of the receiving surface waters of this Commonwealth.

Alteration – As applied to land, a change in topography as a result of the moving of soil and rock from one location or position to another; also the changing of surface conditions by causing the surface to be more or less impervious; land disturbance.

Applicant – A landowner, developer, or other person who has filed an application to the Municipality for approval to engage in any regulated activity at a project site in the Municipality.

As-built Drawings – Engineering or site drawings maintained by the contractor as he constructs the project and upon which he documents the actual locations of the building components and changes to the original

contract documents. These documents, or a copy of same, are turned over to the municipal Engineer at the completion of the project.

Bankfull – The channel at the top-of-bank or point from where water begins to overflow onto a floodplain.

Baseflow – Portion of stream discharge derived from groundwater; the sustained discharge that does not result from direct runoff or from water diversions, reservoir releases, piped discharges, or other human activities.

Bioretention – A stormwater retention area that utilizes woody and herbaceous plants and soils to remove pollutants before infiltration occurs.

Best Management Practices (BMPs) – Activities, facilities, measures, planning or procedures used to minimize accelerated erosion and sedimentation and manage stormwater to protect, maintain, reclaim, and restore the quality of waters and the existing and designated uses of waters within this Commonwealth before, during, and after earth disturbance activities.

Buffer – See Riparian Buffer

Channel – An open drainage feature through which stormwater flows. Channels include, but shall not be limited to, natural and man-made drainageways, swales, streams, ditches, canals, and pipes flowing partly full.

Channel Erosion – The widening, deepening, or headward cutting of channels and waterways caused by stormwater runoff or bankfull flows.

Cistern – An underground reservoir or tank for storing rainwater.

Controlled Release – A release of stormwater that approximates the expected average rate of interflow after a 2-year/24-hour storm event for a Pennsylvania forested non-karst watershed. See Managed Release Concept (MRC).

County Conservation District (District) – A conservation district, as defined in Section 3(c) of the Act of December 19, 1984 (P.L. 1125, No. 221), known as the Conservation District Law, which has the authority under a delegation agreement executed with the Department to administer and enforce all or a portion of the erosion, sediment, and stormwater management program in this Commonwealth. The District for the purpose of this Ordinance is the Delaware County Conservation District.

Continuous Simulation Analysis – A stormwater management design approach that uses a hydrologic computer model capable of processing long-term precipitation and climate records to determine runoff.

Conveyance – A feature used for transporting or transmitting stormwater from one place to another, including streams, channels, swales, pipes, conduits, culverts, storm sewers, gutters, and similar features.

Critical Stages – The installation of underground treatment SCMs, structurally engineered SCMs, or other SCMs or components thereof as deemed appropriate by DEP or a District and that require the oversight of a licensed professional or designee. Recommended critical stages are identified in DEP's PCSM Manual.

Culvert – A structure with its appurtenant works, which carries water under or through an embankment or fill.

Dam – A man-made barrier, together with its appurtenant works constructed for the purpose of impounding or storing water or another fluid or semi-fluid. A dam may include a refuse bank, fill, or structure for highway, railroad, or other purposes which impounds or may impound water or another fluid or semi-fluid.

Department or DEP – The Pennsylvania Department of Environmental Protection.

Designee – The agent of the Delaware County Planning Department], Delaware County Conservation District, and/or agent of the Governing Body involved with the administration, review, or enforcement of any provisions of this Ordinance by contract or memorandum of understanding.

Design Professional (Qualified) – A Pennsylvania Registered Professional Engineer, Registered Landscape Architect, Registered Professional Land Surveyor trained to develop SWM site plan, or any person licensed by the Pennsylvania Department of State or qualified by law to perform the work required by the Ordinance.

Design Storm – A hypothetical discrete rainstorm statistically-based rainstorm characterized by a specific duration, temporal center peaked distribution, rainfall intensity, return frequency, and total depth of rainfall.

Detention – Temporarily collecting and holding back stormwater for later release.

Detention Basin – An impoundment designed to collect and retard stormwater runoff by temporarily storing the runoff and releasing it at a predetermined rate. Detention basins are designed to drain completely soon after a rainfall event and become dry until the next rainfall event.

Developer – A person, or company, or organization who seeks to undertake any regulated earth disturbance activities at a project site in the Municipality.

Development Site – The specific tract or parcel of land where any regulated activity set forth in Section 105 is planned, conducted, or maintained.

Diameter at Breast Height (DBH) – The outside bark diameter at breast height which is defined as four and one half (4.5) feet (1.37m) above the forest floor on the uphill side of the tree.

Diffused Drainage Discharge – Drainage discharge that is not confined to a single point location or channel, including sheet flow or shallow concentrated flow.

Discharge – 1. (verb) To release water from a project, site, aquifer, drainage basin, or other point of interest; 2. (noun) The rate and volume of flow of water such as in a stream, generally expressed in cubic feet per second (see Peak Discharge).

Discharge Point (DP) – A location that helps define the outlets of drainage areas within a project site. DPs aid in the accounting of stormwater entering, flowing through, and discharging from a project site for all flow regimes (sheet flow, shallow concentrated flow, and channel flow), regardless of whether the drainage area outlets to a surface water or areas other than surface waters.

Disturbed Area – An unstabilized land area where an earth disturbance activity is occurring or has occurred.

Ditch – A man-made waterway constructed for irrigation or stormwater conveyance purposes.

Divert – To direct flows that would exceed the capacity of water quality or volume management SCM to a peak rate control SCM and/or to surface waters.

Downslope Property Line – That portion of the property line of the lot, tract, or parcels of land being developed, located such that overland or pipe flow from the project site would be directed towards it by gravity.

Drainage Conveyance Facility – A stormwater management facility designed to transport stormwater runoff that includes channels, swales, pipes, conduits, culverts, and storm sewers.

Drainage Easement – A right granted by a landowner to a grantee allowing the use of private land for

stormwater management purposes.

Drainage Permit – A permit issued by the Municipality after the stormwater management site plan has been approved.

Drainageway – Any natural or artificial watercourse, trench, ditch, pipe, swale, channel, or similar depression into which surface water flows.

E&S Manual – The most recent edition of the Erosion and Sediment Pollution Control Program Manual published by DEP.

Earth Disturbance Activity – A construction or other human activity which disturbs the surface of the land, including land clearing and grubbing, grading, excavations, embankments, land development, agricultural plowing or tilling, operation of animal heavy use areas, timber harvesting activities, road maintenance activities, oil and gas activities, well drilling, mineral extraction, and the moving, depositing, stockpiling, or storing of soil, rock or earth materials.

Emergency Spillway – A conveyance area that is used to pass peak discharge greater than the maximum design storm controlled by the stormwater facility.

Encroachment – A structure or activity that changes, expands, or diminishes the course, current, or cross-section of a watercourse, floodway, or body of water.

Erosion – The natural process by which the surface of the land is worn away by water, wind, or chemical action.

Erosion and Sediment Control Permit (E&S Permit) – A permit required for earth disturbance activities where the earth disturbance is associated with timber harvesting, road maintenance activities, or oil and gas activities.

E&S Plan – A site-specific plan consisting of both drawings and a narrative that identifies BMPs to minimize accelerated erosion and sedimentation before, during and after earth disturbance activities.

E&S Manual – The most recent edition of the Erosion and Sediment Pollution Control Manual published by DEP, as amended.

Evapotranspiration (ET) – The combined processes of evaporation from the water or soil surface and transpiration of water by plants.

Existing Condition – The dominant land cover during the 5-year period immediately preceding a proposed regulated activity.

Event Mean Concentration (EMC) – The median pollutant concentration in runoff from a land cover based on available literature.

Exceptional Value Waters (EV) – Surface waters of high quality which satisfy 25 Pa. Code § 93.4b(b) (relating to antidegradation).

FEMA – Federal Emergency Management Agency.

Financial Hardship – A situation where the greatest possible profit cannot be fully realized from development/redevelopment on a given parcel of land due to added costs or burdens associated with the design, construction, and/or maintenance of stormwater structures, facilities, buffers and/or setbacks.

Flood – A temporary condition of partial or complete inundation of land areas from the overflow of streams, rivers, and other waters of this Commonwealth.

Floodplain – The lands adjoining a river or stream that have been or may be expected to be inundated by flood waters in a 100-year frequency flood.

Floodway – The channel of the watercourse and those portions of the adjoining floodplains that are reasonably required to carry and discharge the 100-year frequency flood (also called the base flood or one percent annual chance flood). Unless otherwise specified, the boundary of the floodway is as indicated on maps and flood insurance studies provided by FEMA. In an area where no FEMA maps or studies have defined the boundary of the 100-year frequency floodway, it is assumed, absent evidence to the contrary, that the floodway extends from the stream to 50 feet from the top of the bank of the stream.

Fluvial Geomorphology – The study of landforms associated with river channels and the processes that form them.

Forest Management/Timber Operations – Planning and activities necessary for the management of forestland. These include conducting a timber inventory, preparation of forest management plans, silvicultural treatment, cutting budgets, logging road design and construction, timber harvesting, site preparation, and reforestation.

Freeboard – A vertical distance between the elevation of the design high-water and the top of a dam, levee, tank, basin, swale, or diversion berm. The space is required as a safety margin in a pond or basin.

Grade – 1. (noun) A slope, usually of a road, channel, or natural ground, specified in percent and shown on plans as specified herein. 2. (verb) To finish the surface of a roadbed, the top of an embankment, or the bottom of an excavation.

Grassed Waterway – A natural or man-made waterway, usually broad and shallow, covered with erosion-resistant grasses used to convey surface water.

Green Infrastructure – Systems and practices that use or mimic natural processes to infiltrate, evapotranspire, or reuse stormwater on the site where it is generated.

Groundwater – Water beneath the earth's surface that supplies wells and springs and is often between saturated soil and rock.

Groundwater Recharge – Replenishment of existing natural underground water supplies.

Hazardous Materials/Substances – Any material, including any substance, waste, or combination thereof, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause, or significantly contribute to, a substantial present or potential hazard to human health, safety, property, or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

High Quality Waters (HQ) – Surface waters having quality which exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water by satisfying 25 Pa. Code § 93.4b(a).

High Tunnel – A structure which meets the following:

(1) Is used for the production, processing, keeping, storing, sale or shelter of an agricultural commodity as defined in Section 2 of the act of December 19, 1974 (P.L. 973, No. 319), known as the "Pennsylvania Farmland and Forest Land Assessment Act of 1974," or for the storage of agricultural equipment or supplies.

(2) Is constructed consistent with all of the following:

(i) Has a metal, wood or plastic frame.
(ii) When covered, has a plastic, woven textile or other flexible covering.
(iii) Has a floor made of soil, crushed stone, matting, pavers or a floating concrete slab.

Hotspots – Areas where land use or activities generate highly contaminated runoff with concentrations of pollutants in excess of those typically found in stormwater.

Hydrograph – A graph representing the discharge of water versus time for a selected point in the drainage system.

Hydrologic Regime – The hydrologic cycle or balance that sustains quality and quantity of stormwater, baseflow, storage, and groundwater supplies under natural conditions.

Hydrologic Soil Group – A classification of soils by the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), into four runoff potential groups. The groups range from A soils, which are very permeable and produce little runoff, to D soils, which are not very permeable and produce much more runoff.

Illicit Connection – means any physical connection to a municipal separate storm sewer system that conveys illicit discharges into the system and/or is not authorized or permitted by the permittee.

Impaired Waters – Surface waters that fail to attain one or more of its designated uses under 25 Pa. Code Chapter 93 and as listed in Categories 4 and 5 of Pennsylvania's Integrated Water Quality Monitoring and Assessment Report.

Impervious Surface – Any land cover that prevents or impedes infiltration of stormwater into the soil. These areas include but are not limited to streets, sidewalks, pavements, additional indoor living spaces, patios [decks, swimming pools etc. see Note below], garages, storage sheds, and similar structures, driveway areas, roofs, tennis or other paved courts. For the purposes of determining compliance with this Ordinance, compacted soils or stone surfaces used for vehicle parking and movement shall be considered impervious. Uncompacted gravel areas with no vehicular traffic shall be considered pervious per review by the Municipal Engineer. Surfaces that were designed to allow infiltration (i.e. pavers and areas of porous pavement) are not to be considered impervious surface if designed to function as a BMP per review by the Municipal Engineer. Additionally, for the purposes of determining compliance with this Ordinance, the total horizontal projection area of all ground-mounted and free-standing solar collectors, including solar photovoltaic cells, panels, and arrays, shall be considered pervious so long as the Municipal Engineer determines that the area underneath the solar photovoltaic cells, panels, and arrays is maintained as a vegetated pervious surface.

NOTE TO EDITOR: Municipality may, at its option, include or delete decks or swimming pools in first sentence of Impervious Surface definition. The Municipality may also want to review the definitions of Impervious Surface in other sections of the Municipality's Code (Subdivision and Land Development, Zoning, etc.) for consistency and update if appropriate.

Impoundment – A retention or detention basin designed to retain stormwater runoff and release it at a controlled rate.

Infill – Development that occurs on smaller parcels that remain undeveloped but are within or in very close proximity to urban or densely developed areas. Infill development usually relies on existing infrastructure and does not require an extension of water, sewer, or other public utilities.

Infiltration – (i) The portion of rainfall or surface runoff that moves downward into the subsurface soil and rock. (ii) The entrance of surface water into the soil, usually at the soil/air interface.

Infiltration Structures – A structure designed to direct runoff into the underground water (e.g., French drains, seepage pits, or seepage trenches).

Inflow – The flow entering the stormwater management facility and/or BMP.

Inlets or Catch Basins – Structures included in storm drain collection systems where water is directed into a pipe network or SCM.

Intermittent Stream – A stream that flows only part of the time. Flow generally occurs for several weeks or months in response to seasonal precipitation or groundwater discharge.

Invert – The lowest surface, the floor or bottom of a culvert, drain, sewer, channel, basin, BMP, or orifice.

Karst – Description of a landscape found on limestone or dolomite rock that is characterized by any of the following: sinkholes, caves and underground drainage, dissolving of the rock, rock pinnacles, uneven bedrock surface, rolling terrain, swallets (where stream flow is lost into a hole), caves and underground drainage, large springs, and surface depressions that will not hold water.

Land Development (Development) – Inclusive of any or all of the following meanings:

(i) the improvement of one lot or two or more contiguous lots, tracts, or parcels of land for any purpose involving (a) a group of two or more buildings or (b) the division or allocation of land or space between or among two or more existing or prospective occupants by means of, or for the purpose of streets, common areas, leaseholds, condominiums, building groups, or other features;

(ii) any subdivision of land;

(iii) development in accordance with Section 503(1.1) of the Pennsylvania Municipalities Planning Code.

Licensed Professional – Professional engineers, landscape architects, geologists and land surveyors licensed to practice in the Commonwealth of Pennsylvania.

Limiting Zone – A soil horizon or condition in the soil profile or underlying strata that includes one of the following:

(i) A seasonal high water table, whether perched or regional, determined by direct observation of the water table or indicated by soil mottling.

(ii) A rock with open joints, fracture or solution channels, or masses of loose rock fragments, including gravel, with insufficient fine soil to fill the voids between the fragments.

(iii) A rock formation, other stratum, or soil condition that is so slowly permeable that it effectively limits downward passage of water.

Lot – A designated parcel, tract, or area of land established by a plat or otherwise as permitted by law and to be used, developed, or built upon as a unit.

Low Impact Development (LID) – Site design approaches and small-scale stormwater management practices that promote the use of natural systems for infiltration, evapotranspiration, and reuse of rainwater. LID can be applied to new development, urban retrofits, and revitalization projects. LID utilizes design techniques that infiltrate, filter, evaporate, and store runoff close to its source. Rather than rely on costly large-scale conveyance and treatment systems, LID addresses stormwater through a variety of small, cost-effective landscape features located on-site. LID includes natural stormwater features and natural stormwater processes as identified in DEP's PCSM Manual.

Main Stem (Main Channel) – Any stream segment or other runoff conveyance used as a reach in watershed-specific hydrologic models.

Managed Release Concept (MRC) – A PCSM strategy involving the capture, filtration, treatment, and controlled release of runoff from an SCM that may be used when there are environmental limitations on a project site and where natural landscape processes, ET and infiltration are implemented on a project site to the maximum extent practicable.

Manning Equation (Manning Formula) – A method for calculation of velocity of flow (e.g., feet per second) and flow rate (e.g., cubic feet per second) in open channels based upon channel shape, roughness, depth of flow, and slope. "Open channels" may include closed conduits so long as the flow is not under pressure.

Maximum Design Storm – The maximum (largest) design storm that is controlled by the stormwater facility.

Median Outflow Concentration (MOC) – A statistically derived concentration of a pollutant that is expected to exist in the outflow of a PCSM SCM based on available literature.

Municipal Engineer – A professional engineer licensed as such in the Commonwealth of Pennsylvania, duly appointed as the Engineer for a Municipality, planning agency, or joint planning commission.

Municipal Separate Storm Sewer System (MS4) – All separate storm sewers that are defined as "large" or "medium" or "small" municipal separate storm sewer systems pursuant to 40 CFR §§ 122.26(b)(4), (b)(7), and (b)(16), respectively, or designated under 40 CFR § 122.26(a)(1)(v).

Municipality – (Municipality Name), Delaware County, Pennsylvania.

National Pollutant Discharge Elimination System (NPDES) – The National system for the issuance of permits under Section 402 of the Federal Clean Water Act (33 U.S.C.A. § 1342) including a state or interstate program which has been approved in whole or in part by the EPA, including the regulations codified in Chapter 92a (relating to National Pollutant Discharge Elimination System permitting, monitoring and compliance), and as specified in 25 Pa. Code Chapter 102.

Natural Resources Conservation Service (NRCS) – A federal agency that is part of the U.S. Department of Agriculture which, among other things, provides technical assistance to county conservation districts, assists farmers in developing conservation plans, provides soil survey information, and assists local governments in planning and installation of erosion and flood control projects. The NRCS was formerly known as the Soil Conservation Service.

Natural Condition – Per-development condition.

Natural Hydrologic Regime – See Hydrologic Regime

Natural Recharge Area – Undisturbed surface area or depression where stormwater collects and a portion of which infiltrates and replenishes the underground and groundwater.

Natural Stormwater Features – Landscape features included in a PCSM design that will receive runoff from proposed land disturbance that are designated and potentially enhanced to manage increased runoff.

Natural Stormwater Processes – The functional value landscapes provide in the management of runoff. Landscapes with a functional value for the management of runoff include, but are not limited to, forests, orchards, fields, meadows, thickets, gullies, valleys, rangelands, shrublands, riparian areas, or historic areas where flow contacts soil and vegetation for a large portion of the flow path through the landscape. To provide runoff management, in most cases, these areas are not mowed more than once a year and are not tilled or heavily grazed.

Nonpoint Source Pollution – Pollution that enters a waterbody or conveyance from diffuse origins in the

watershed and does not result from discernible, confined, or discrete conveyances.

Non-Stormwater Discharge – Any discharge to waters of the Commonwealth that is not composed entirely of stormwater.

Nonstructural Best Management Practice (BMPs) – Methods of controlling stormwater runoff quantity and quality, such as innovative site planning, impervious area and grading reduction, protection of natural depression areas, temporary ponding on site, and other techniques.

NPDES Permit for Stormwater Discharges Associated With Construction Activities (NPDES Permit) – A permit required for the discharge or potential discharge of stormwater into waters of this Commonwealth from construction activities, including clearing and grubbing, grading and excavation activities involving one acre (0.4 hectare) or more of earth disturbance activity or an earth disturbance activity on any portion, part, or during any stage of, a larger common plan of development or sale that involves one acre (0.4 hectare) or more of earth disturbance activity over the life of the project.

NRCS – Natural Resource Conservation Service (previously SCS).

Off-Site Construction Support Activities (Off-Site Support Activities) – Activities providing support for construction and earth disturbance activities, including concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas (spoil), borrow areas, stockpiling of topsoil, transfer of topsoil to other locations, and turnaround areas.

Open Channel – A conveyance channel that is not enclosed.

Operation and Maintenance (O&M) Plan – A plan that identifies procedures for the long-term operation and maintenance of a BMP, SCM or stormwater management system or program, including repairs, to ensure continued function as intended and designed.

Outfall – A point source as defined by 40 CFR § 122.2 at the point where a municipal separate storm sewer discharges to surface waters and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels or other conveyances which connect segments of the same stream or other surface waters and are used to convey surface waters.

Outflow – The flow exiting the stormwater management facility and/or BMP.

Outlet – Points of water disposal to a stream, river, lake, tidewater, or artificial drain.

Parent Tract – The parcel of land from which a land development or subdivision originates, determined from the date of municipal adoption of this Ordinance.

Parking Lot Storage – Involves the use of parking areas as temporary impoundments with controlled release rates during rainstorms.

Person - Any individual, public or private corporation, partnership, association, municipality or political subdivision of this Commonwealth, institution, authority, firm, trust, estate, receiver, guardian, personal representative, successor, joint venture, joint stock company, fiduciary; department, agency or instrumentality of State, Federal or local government, or an agent or employee thereof; or any other legal entity.

Peak Flow or Discharge – The maximum rate of flow or discharge at a location of storm water discharge during or immediately following a storm event, usually expressed in reference to a specific return period storm or “design storm.”

Pennsylvania Post-Construction Stormwater Management (PCSM) Manual – The most recent edition of

the Pennsylvania Stormwater Best Management Practices Manual (BMP Manual) or its replacement, the Pennsylvania Post-Construction Stormwater Management Manual, published by DEP, as amended.

Permanent Stabilization – Long-term protection of soil and water resources from accelerated erosion.

Pervious Area – Any material or structure on or above the ground that permits water to infiltrate into the underlying soil.

Permittee – A person who has received approval from the Municipality to engage in a regulated activity at a project site in the Municipality.

Pet - A domesticated animal (other than a disability assistance animal) kept for amusement or companionship. *[OPTIONAL- Municipality to include only if Section 803 Pet Waste is included.]*

Plat – The map or plan of a subdivision or land development, whether preliminary or final.

Planning Commission – The Planning Commission of [*Municipal Name*].

Point Source – A discernible, confined, and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, Concentrated Aquatic Animal Production Facility (CAAP), Concentrated Animal Feeding Operation (CAFO), landfill leachate collection system, or vessel or other floating craft from which pollutants are or may be discharged.

Pollutant – Any contaminant or other alteration of the physical, chemical, biological, or radiological integrity of surface water which causes or has the potential to cause pollution as defined in Section 1 of the act of June 22, 1937 (P.L. 1987)*, as amended*, known as the Pennsylvania Clean Streams Law.

Post-construction – Period after construction during which disturbed areas are stabilized, stormwater controls are in place and functioning, and all proposed improvements in the approved land development plan are completed. Anonymous with Post-Development.

Post-Construction Stormwater Management (PCSM) Plan – A site-specific plan consisting of both drawings and a narrative that identifies SCMs to manage changes in stormwater runoff volume, rate and water quality after earth disturbance activities have ended and the project site is permanently stabilized.

Post-Development – The conditions that reasonably may be expected or anticipated to exist after completion of the land development activity on a specific site or tract of land. Post-development refers to the phase of a new development or redevelopment project after completion and does not refer to the construction phase of a project.

Pre-construction – Prior to commencing construction activities.

Pre-development Condition – Condition prior to the proposed development activities.

Pretreatment – Techniques employed in stormwater BMPs to provide storage or filtering to trap coarse materials and other pollutants before they enter the system, but not necessarily designed to meet the water quality volume requirements of Section 306.

Prescriptive Easement – An easement created by adverse, open, notorious, continuous, and uninterrupted use of land for a period of twenty-one years. An example would be runoff flowing across a downstream neighbor's property either as sheet flow or through a watercourse.

Project Site – The entire area of activity, development, lease or sale including (i) the area of an earth disturbance activity; (ii) the area planned for an earth disturbance activity; and (iii) other areas which are not subject to an earth disturbance activity.

Project Site Boundary – (i) A delineation of the Project Site; and (ii) the extent of lands included in a permit application, or that are used to satisfy the requirements of the permit. The Project Site Boundary must enclose all earth disturbance, SCMs, and conveyances to SCMs that manage runoff from all earth disturbance, regardless of whether the SCMs are or are not on property owned or under the direct control of an applicant.

Qualified Professional – Any person licensed by the Pennsylvania Department of State or otherwise qualified by law to perform the work required by this Ordinance.

Rational Formula – A rainfall-runoff relation used to estimate peak flow.

Reach – Any stream segment or other runoff conveyance used in the watershed-specific hydrologic models.

Recharge – Replenishment of groundwater reservoirs by infiltration through permeable soils.

Reconstruction – Demolition and subsequent rebuilding of an impervious surface. Also see Redevelopment.

Record Drawings – Drawings that wholly and accurately depict as-built conditions of a project site following completion of an earth disturbance activity including but not limited to land covers, structures, grades, and SCMs and components thereof.

Redevelopment – Earth disturbance activities on land that has previously been developed. Maintenance activities such as top-layer grinding and re-paving are not considered to be redevelopment. Interior remodeling projects and tenant improvements are also not considered to be redevelopment.

Regulated Activities – Any earth disturbances activities or any activities that involve the alteration or development of land in a manner that may affect stormwater runoff, including redevelopment.

Regulated Earth Disturbance Activity – Activity involving earth disturbance subject to regulation under the Clean Streams Law and 25 Pa. Code Chapters 92a and 102.

Regulated Impervious Surface – Proposed impervious surface as part of a current proposed activity and all existing impervious surfaces installed after [*MUNICIPALITY to insert date Stormwater Ordinance was adopted that first regulated impervious surface*] as part of a previous activity.

Release Rate – The percentage of existing conditions peak rate of runoff from a site or subarea to which the proposed conditions peak rate of runoff must be reduced to protect downstream areas.

Repaving – Resurfacing of the impervious surface that does not involve reconstruction of an existing paved (impervious) surface.

Replacement Paving – Reconstruction of and full replacement of an existing paved (impervious) surface.

Retention or **To Retain** – The prevention of direct discharge of stormwater runoff into receiving waters or water bodies by temporary or permanent containment in a pond or depression; examples include systems which discharge by percolation to groundwater, and/or evaporation processes and which generally have residence times of less than three (3) days.

Retention Basin – A structure in which stormwater is stored and not released during the storm event. Retention basins are designed for infiltration purposes and do not have an outlet.

Return Period (Return Frequency) – A common metric for the probability that a rainfall or runoff volume will be equaled or exceeded in any one year. The return period that such a storm will occur in any given year is equal to the reciprocal of the probability (e.g., there is a 50% chance that a 2-year storm event will occur in any given year, but only a 10% chance that a 10-year storm event will occur).

Riparian – Pertaining to anything connected with or immediately adjacent to the banks of a stream or other body of water.

Riparian Buffer – A BMP or SCM that is an area of permanent vegetation along surface waters.

Riser – A vertical pipe extending from the bottom of a pond that is used to control the discharge rate from the pond for a specified design storm.

Road Maintenance Activities – (i) Earth disturbance activities within the existing road cross-section or railroad right-of-way including the following: shaping or restabilizing unpaved roads; shoulder grading; slope stabilization; cutting of existing cut slopes; inlet and endwall cleaning; reshaping and cleaning drainage ditches and swales; pipe cleaning; pipe replacement; support activities incidental to resurfacing activities such as minor vertical adjustment to meet grade of resurfaced area; ballast cleaning; laying additional ballast; replacing ballast, ties and rails; and other similar activities. (ii) The existing road cross-section consists of the original graded area between the existing toes of fill slopes and tops of cut slopes on either side of the road and any associated drainage features.

Roof Drains – A drainage conduit or pipe that collects water runoff from a roof and leads it away from the structure.

Rooftop Detention – The temporary ponding and gradual release of stormwater falling directly onto flat roof surfaces using controlled-flow roof drains in building designs.

Runoff – That portion of rainfall or snowmelt that flows over the land surface or in the upper soil layer towards a surface water or conveyance.

SALDO – Subdivision and land development ordinance.

Sediment – Soils or other materials transported by surface water as a product of erosion.

Sediment Pollution – The placement, discharge, or any other introduction of sediment into the waters of the Commonwealth.

Sedimentation – The process by which mineral or organic matter is accumulated or deposited by the movement of water or air.

Seepage Pit/Seepage Trench – An area of excavated earth filled with loose stone or similar coarse material into which surface water is directed for infiltration into the underground water.

Separate Storm Sewer System – A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) primarily used for collecting and conveying stormwater runoff.

Shallow Concentrated Flow – Stormwater runoff flowing in shallow, defined ruts prior to entering a defined channel or waterway.

Sheet Flow – A flow process associated with broad, shallow water movement on sloping ground surfaces that is not channelized or concentrated.

Site Restoration Project – Activities regulated under 25 Pa. Code § 102.8(n).

Soil Cover Complex Method – A method of runoff computation developed by NRCS that is based on relating soil type and land use/cover to a runoff parameter called curve number (CN).

Source Water Protection Areas (SWPA) – The zone through which contaminants, if present, are likely to

migrate and reach a drinking water well or surface water intake.

Special Protection Subwatersheds – Watersheds that have been designated by PADEP as EV or HQ waters.

Spillway – A conveyance that is used to pass the peak discharge of the maximum design storm that is controlled by the stormwater facility.

State Water Quality Standards – The combination of water uses to be protected and the water quality criteria necessary to protect those uses under 25 Pa. Code Chapter 93.

Storage Indication Method – A reservoir routing procedure based on solution of the continuity equation (inflow minus outflow equals the change in storage) with outflow defined as a function of storage volume and depth.

Storm Frequency – The number of times that a given storm "event" occurs or is exceeded on the average in a stated period of years (see Return Period).

Storm of Record – A historic rainfall distribution record of an event used for SCM design using continuous simulation.

Stormwater – Drainage runoff from the surface of the land resulting from precipitation, snow, or ice melt.

Stormwater Control Measure (SCM) – Any natural feature or manmade structure designed or utilized to reduce or manage the volume, pollutant load, or the peak rate of stormwater runoff and achieve the objectives of the PCSM Manual. SCMs are BMPs that are used to treat impervious surfaces and/or post-construction stormwater.

Stormwater Management – Planning, designing, constructing, operating, maintaining, financing, and regulating constructed and natural systems that collect, store, control, treat and/or convey runoff.

Stormwater Management District – Those subareas of a watershed in which some type of detention is required to meet the plan requirements and the goals of Act 167.

Stormwater Management Facility – Any structure, natural or man-made, that, due to its condition, design, or construction, conveys, stores, or otherwise affects stormwater runoff quality, rate, or quantity, including Best Management Practices and Stormwater Control Measures. Typical stormwater management facilities include, but are not limited to, detention and retention basins, open channels, storm sewers, pipes, and infiltration structures.

Stormwater Management Plan – The watershed plan for managing stormwater runoff for a watershed, adopted by Delaware and Chester Counties as required by the Act of October 4, 1978, P.L. 864 (Act 167), as amended, and known as the "Storm Water Management Act." See also Watershed Stormwater Management Plan.

Stormwater Management (SWM) Site Plan – See Post Construction Stormwater Management (PCSM) Plan.

Stream – A natural watercourse.

Stream Buffer – The land area adjacent to each side of a stream essential to maintaining water quality (see also Riparian Buffer).

Stream Enclosure – A bridge, culvert, or other structure in excess of one hundred (100) feet in length upstream to downstream which encloses a regulated water of the Commonwealth.

Subarea (Subwatershed) – The smallest drainage unit of a watershed for which stormwater management criteria have been established in the stormwater management plan.

Subdivision – As defined in the Pennsylvania Municipalities Planning Code, Act of July 31, 1968, P.L. 805, No. 247*, as amended*.

Surface Waters – Perennial and intermittent streams, rivers, lakes, reservoirs, ponds, wetlands, springs, natural seeps and estuaries, excluding water at facilities approved for wastewater treatment such as wastewater treatment impoundments, cooling water ponds and constructed wetlands used as part of a wastewater treatment process.

Swale – A low-lying stretch of land that gathers or carries surface water runoff.

SWM Site Plan – See Stormwater Management Site Plan.

Timber Harvesting Activities – Earth disturbance activities including the construction of skid trails, logging roads, landing areas and other similar logging or silvicultural practices.

Time-of-concentration (Tc) – The time required for surface runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. This time is the combined total of overland flow time and flow time in pipes or channels, if any.

Top-of-bank – Highest point of elevation in a stream channel cross-section at which a rising water level just begins to flow out of the channel and over the floodplain.

Undetained Area – An area of a project site in which stormwater will not drain to an SCM for treatment.

USDA – United States Department of Agriculture.

Undeveloped Condition – Natural condition (see also Pre-development Condition).

Vernal Pond – Seasonal depressional wetlands that are covered by shallow water for variable periods from winter to spring but may be completely dry for most of the summer and fall.

Watercourse – A channel or conveyance of surface water having a defined bed and banks, whether natural or artificial, with perennial or intermittent flow.

Waters of the Commonwealth – Rivers, streams, creeks, rivulets, impoundments, ditches, watercourses, storm sewers, lakes, dammed water, wetlands, ponds, springs and other bodies or channels of conveyance of surface and underground water, or parts thereof, whether natural or artificial, within or on the boundaries of this Commonwealth.

Watershed – Region or area drained by a river, watercourse or other structure, whether natural or artificial.

Watershed Stormwater Management Plan – A watershed plan for managing stormwater runoff for a watershed, adopted by Delaware and Chester Counties as required by the Act of October 4, 1978, P.L. 864 (Act 167), as amended, and known as the “Storm Water Management Act” (e.g., Chester Creek, Ridley Creek, Crum Creek, Darby-Cobbs Creeks). See also Stormwater Management Plan.

Wellhead – 1. A structure built over a well, 2. The source of water for a well.

Wellhead Protection Area – The surface and subsurface area surrounding a water supply well, well field, or spring supplying a public water system through which contaminants are reasonably likely to move toward and reach the water source.

Wet Basin – Pond for urban runoff management that is designed to detain urban runoff and always contains water.

Wetlands – Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs and similar areas.

Woods – A natural groundcover with more than one (1) viable tree of a DBH of six (6) inches or greater per fifteen hundred (1,500) square feet which existed within three (3) years of application; a cover condition for which SCS curve numbers have been assigned or to which equivalent Rational Method runoff coefficients have been assigned.

ARTICLE III – GENERAL STORMWATER REQUIREMENTS

Section 301. Permit Requirements

A person may not proceed to conduct earth disturbance activities for development purposes until the Municipality has issued a building permit or other final approval. The Municipality may not issue a building permit or final approval to a person whose earth disturbance activities require an NPDES or E&S permit until such permit has been issued by DEP or the District.

Applicants proposing regulated activities in the Municipality which do not fall under the exemption criteria shown in Section 306 shall submit a stormwater management site plan consistent with this Ordinance and the applicable watershed stormwater management plan to the Municipality for review. The stormwater management criteria of this Ordinance shall apply to the total proposed development even if development is to take place in stages.

No regulated activity within the Municipality shall commence until the Municipality issues approval of a SWM plan, which demonstrates compliance with the requirements of this ordinance.

The following permit requirements may apply to certain regulated earth disturbance activities and must be met prior to commencement of regulated earth disturbance activities, as applicable:

A. All regulated earth disturbance activities subject to permit requirements by PADEP under regulations at Title 25 Pennsylvania Code Chapter 102.

B. Work within natural drainageways subject to permit by PADEP under Title 25 Pennsylvania Code Chapter 105.

C. Any stormwater management facility that would be located in or adjacent to surface waters of the Commonwealth, including wetlands, subject to permit by PADEP under Title 25 Pennsylvania Code Chapter 105.

D. Any stormwater management facility that would be located on or discharging to a state highway right-of-way, or require access to or from a state highway shall be subject to approval by PennDOT.

E. Culverts, bridges, storm sewers, or any other facilities which must pass or convey flows from the tributary area and any facility which may constitute a dam subject to permit by PADEP under Title 25 Pennsylvania Code Chapter 105.

Section 302. General E&S Requirements

A. Persons conducting earth disturbance activities must implement and maintain E&S BMPs to minimize the potential for accelerated erosion and sedimentation. Various E&S BMPs and design standards that may be utilized to meet this Ordinance and Chapter 102 of DEP's regulations are identified in DEP's E&S Manual, as amended.

B. A written E&S Plan is required for any earth disturbance activity that disturbs 5,000 square feet or more of land.

C. When an earth disturbance activity associated with development will disturb 5,000 square feet or more of land [*MUNICIPALITY may make this value smaller but may not make it larger]*, the written E&S Plan must be submitted to the Municipality and/or the County Conservation District for review and approval. If the municipality elects to have the Delaware County Conservation District conduct the review, said review shall be in accordance with a Memorandum of Understanding (MOU) between the Municipality and the Delaware County Conservation District. Said MOU is to be initiated by the Municipality. An E&S Plan that is approved by the Municipality or Delaware County Conservation Distirct must be retained on-site throughout the duration of the regulated activity.

D. If an NPDES permit or E&S permit is required for an earth disturbance activity, the applicant must submit a copy of the Notice of Intent (NOI) for general permit coverage or application for an individual permit, including the E&S Plan, to the Municipality upon the initial submission of the NOI or application to DEP or the Conservation District, and when resubmissions are made to DEP or the Conservation District in response to comments, as applicable.

E. If an NPDES permit or E&S permit is required for an earth disturbance activity and a person obtains general permit coverage or an individual permit from DEP or the Conservation District, the person conducting earth disturbance activity must submit the final, approved E&S Plan to the Municipality within [Municipality to enter the number of

Business or Calendar Days] days of the receipt of the general permit coverage or permit and prior to the commencement of earth disturbance activities.

F. E&S Plans prepared to satisfy the requirements of this Ordinance must be substantially the same as E&S Plans submitted to DEP or the District to obtain an NPDES or E&S permit, when applicable.

G. A copy of the erosion and sediment control plan and any required permit, as required by PADEP regulations, shall be available on the project site at all times.

H. Additional erosion and sediment control design standards and criteria are recommended to be applied where infiltration BMPs are proposed. At a minimum, they shall include the following:

1. Areas proposed for infiltration BMPs shall be protected from sedimentation and compaction during the construction phase to maintain maximum infiltration capacity.

2. Infiltration BMPs shall not be constructed nor receive runoff until the entire drainage area contributory to the infiltration BMP has achieved final stabilization.

Section 303. E&S Plan Preparer Qualifications

A written E&S Plan must be prepared by a person trained and experienced in E&S control methods and techniques applicable to the size and scope of the project being designed. The preparer of an E&S Plan must submit a summary of their qualifications and experience when requested by the Municipality.

Section 304. General PCSM Requirements

A. A written PCSM Plan is required for any earth disturbance activity that requires an NPDES permit or E&S permit and, for earth disturbance activities that do not require an NPDES permit or E&S permit and do not meet the exemption requirements in Section 306.

B. If a written PCSM Plan is required by Section 304, paragraph A, the written PCSM Plan must be submitted to the Municipality for review and approval. A PCSM Plan that is approved by the Municipality (and PADEP where applicable) must be retained on-site throughout the duration of the regulated activity.

C. Persons conducting earth disturbance activities must design, implement, operate, and maintain PCSM SCMs following earth disturbance activities to meet the requirements of this Ordinance and Chapter 102 of DEP's regulations. Various PCSM SCMs and design standards that may be utilized to meet this Ordinance and Chapter 102 are identified in DEP's PCSM Manual, as amended.

D. [Insert *MUNICIPALITY name*] will consider the addition of impervious surfaces to a lot, tract, or parcel over time on a cumulative basis starting with any impervious surface added after January 2006. If an impervious surface was constructed without SCMs to manage stormwater, and additional impervious surface is proposed that would cause the site to exceed the threshold established in Section 306 as related to exemptions, the person conducting earth disturbance must prepare and implement a written PCSM Plan.

E. If an NPDES permit or E&S permit is required for an earth disturbance activity, the applicant must submit a copy of the Notice of Intent (NOI) for general permit coverage or application for an individual permit, including the PCSM Plan, to the Municipality upon the initial submission of the NOI or application to DEP or the District, and when resubmissions are made to DEP or the District in response to comments, as applicable.

F. If an NPDES permit or E&S permit is required for an earth disturbance activity and a person obtains general permit coverage or an individual permit from DEP or the District, the person conducting earth disturbance activity must submit the final, approved PCSM Plan to the Municipality within (Enter No. of Business or Calendar Days) days of the receipt of the general permit coverage or permit.

Section 305. PCSM Plan Preparer Qualifications

A. The PCSM Plan must be prepared by a person trained and experienced in PCSM design methods and techniques applicable to the size and scope of the project being designed. The preparer of a PCSM Plan must submit a summary of their qualifications and experience when requested by the Municipality.

B. With the exception of site restoration projects and projects where site-specific designs are not required, and unless exempt under Section 5 of Act 367, the preparation of PCSM Plans requires that a licensed professional engineer be in responsible charge with respect to activities involving the practice of engineering. Such activities include SCM design and stormwater analysis.

C. Licensed, certified, and/or experienced professionals in the fields of soils science, geology, hydrology or hydrogeology, geomorphology, wetland science, aquatic ecology, forestry, terrestrial ecology, landscape design or architecture, and botany must be utilized in the preparation of PCSM Plans when expertise in these fields is necessary, as determined by the PCSM Plan preparer or Municipality, and as prescribed by law.

Section 306. Exemptions

A. The Municipality may deny or revoke any exemption pursuant to this Section at any time for any project that the Municipality believes may pose a threat to public health and safety or the environment.

B. Under no circumstance may the applicant be exempt from implementing such measures as necessary to meet State Water Quality Standards and protect health, safety, and property.

C. The following activities are exempt from some or all stormwater control activities as outlined in Table 306.1 below. All other standards established by the Municipality in other codes or ordinances must be followed, and all other provisions of this Ordinance apply.

1. Earth disturbance activities that disturb less than the maximum square footage or acreage identified for exempt items in Table 306.1 below.

2. The addition of new regulated impervious surfaces having total areas less than the maximum square footage identified as exempt in Table 306.1 below.

D. Exemptions for specific Activities

1. Use of Land for gardening for home consumption.

2. Agricultural plowing and tilling activities and animal heavy use areas when these activities are performed according to the requirements of 25 Pa. Code Chapter 102.

3. Road maintenance activities and timber harvesting activities involving less than 25 acres of earth disturbance when these activities are performed according to the requirements of 25 Pa. Code Chapter 102.

4. Maintenance and repairs to existing SCMs that are done in accordance with an approved long-term O&M Plan.

5. Projects that qualify as site restoration projects are exempt from Section 503 and Section 504 of this Ordinance.

6. High tunnels are exempt from the provisions of this Ordinance if the following criteria are met:

   a. The high tunnel or its flooring does not result in an impervious surface exceeding 25% of all structures located on the landowner's total contiguous land area; and

   b. The high tunnel meets one of the following:

      - The high tunnel is located at least 100 feet from any perennial stream or watercourse, public road, or neighboring property line.

      - The high tunnel is located at least 35 feet from any perennial stream or watercourse, public road or neighboring property line and located on land with a slope not greater than 7%.

      - The high tunnel is supported with a buffer or diversion system that does not directly drain into a stream or other watercourse by managing stormwater runoff in a manner consistent with the requirements of Act 167.

7. Repaving without reconstruction.

8. Direct discharges of stormwater to tidal areas or no detention areas, as identified in an Act 167 Plan or other ordinance, are exempt from the peak rate requirements as further qualified in Section 504.

9. Emergency Exemption – Emergency maintenance work performed for the protection of public health, safety, and welfare. A written description of the scope and extent of any emergency work performed shall be submitted to the [*insert Municipality name*] within two (2) calendar days of the commencement of the activity. If the [*insert Municipality name*] finds that the work is not an emergency, then the work shall cease immediately, until a stormwater site-plan in accordance with this ordinance is submitted and approved by the municipality

Table 306.1

Stormwater Management Requirement Exemptions

Ordinance Article or Section	Type of Project	Regulated Impervious Surface			Earth Disturbance		
		0-499 sq. ft.	500-999 sq. ft.	1,000+ sq. ft.	0-4,999 sq. ft. disturbance	5,000 sq. ft. - < 1 acre	≥ 1 acre
Article V PCSM Plan Requirements	Development Redevelopment	Exempt	Not Exempt Simplified Approach	Not Exempt	Exempt	Modified[1]	Not Exempt
Section 307 Nonstructural Project Design	Development Redevelopment	Exempt	Not Exempt Simplified Approach	Not Exempt	Exempt	Not Exempt	Not Exempt
Section 504 D Infiltration Volume Requirements	Development Redevelopment	Exempt	Not Exempt Simplified Approach	Not Exempt	Exempt	Exempt	Not Exempt
Section 504 D Water Quality Requirements	Development Redevelopment	Exempt	Not Exempt Simplified Approach	Not Exempt	Modified[2]	Modified[2]	Not Exempt
Section 504 E Stream Bank Erosion Requirements	Development Redevelopment	Exempt	Not Exempt Simplified Approach	Not Exempt	Exempt	Exempt	Not Exempt
Section 504 G Stormwater Peak Rate Control and Management Districts	Development Redevelopment	Exempt	Exempt	Not Exempt	Exempt	Not Exempt	Not Exempt
Article IV Erosion and Sediment Pollution Control Requirements	Must comply with Title 25, Chapter 102 of the PA Code and other applicable state and municipal codes, including the Clean Streams Law.						Not Exempt

Legend:

- **"Regulated Impervious Surface" in Table 306.1 includes new, additional, or replacement impervious surface/cover as part of development or redevelopment.**
- Exempt - Exempt from required section provision only – SWM site plan submission may still be required if other section provisions are applicable.
- Modified[1] - Modified SWM site plan need only consist of items in Sections 502 G, N, L1, L7, L9, L10, L20 and all supporting calculations, assumptions, and criteria used in the design of the stormwater management facilities, and related supportive material needed to determine compliance with Sections 307 and 504G. Modified SWM site plan is required that includes all elements of Section 307, as applicable.
- Modified[2] - Modified SWM site plan need only consist of items and related material needed to determine compliance with Section 605 as applicable.
- Simplified Approach – **Must comply with provisions of Appendix B of the Ordinance.**

E. General Exemptions

Table 306.1 summarizes the exemptions from certain provisions of this Ordinance. Exemptions are for the items noted in Table 306.1 only, and shall not relieve the Applicant from other applicable sections of this Ordinance.

Any regulated activity that is exempt from some provisions of the Ordinance is exempt only from those provisions. If development is to take place in phases, the developer is responsible for implementing the requirements of the Ordinance as the impervious cover/earth disturbance threshold is met. The date of the municipal Ordinance adoption shall be the starting point from which to consider tracts as "parent tracts" in which future subdivisions and respective impervious area and earth disturbance computations shall be cumulatively considered. Exemption shall not relieve the applicant from implementing such measures as are necessary to protect health, safety, and property. For example:

If a property owner proposes a **150 square foot shed** after adoption of the municipal stormwater management Ordinance, that property owner would be **exempted from water quality and quantity requirements of the Ordinance as noted in Table 306.1 of the Ordinance**. If, at a later date, the property owner proposes to construct a 499 square foot room addition, the applicant would be required to comply with the requirements for the **Simplified Method for the full 649 square feet of impervious cover created.** If an additional 700 square foot swimming pool/patio is proposed later, the property owner would be required to implement the full stormwater quantity and quality control submission requirements of this Ordinance for the **total 1,349 square feet of additional impervious surface added to the original property**.

Section 307. Nonstructural Project Design Process (Sequencing to Minimize Stormwater Impacts)

The design of all regulated activities shall include the following to minimize stormwater impacts to reduce the surface discharge of stormwater, reduce the creation of unnecessary impervious surfaces, prevent the degradation of waters of the Commonwealth, and maintain as much as possible the natural hydrologic regime of the site.

A. The Applicant shall apply Low Impact Development (LID) methods such as those listed in the Pennsylvania PCSM Manual provided that use of these method do not conflict with other local codes.

B. The Applicant shall demonstrate that the design process follows the sequence noted below. The goal of the sequence is to minimize the increases in stormwater runoff and impacts to water quality resulting from the proposed regulated activity:

1. The following items in this subsection shall be addressed prior to development of other stormwater management site plan design elements:

   a. Prepare an Existing Resource and Site Analysis Map (ERSAM) showing environmentally sensitive areas including, but not limited to, steep slopes, ponds, lakes, streams, wetlands, hydric soils, vernal pools, stream buffers, and hydrologic soil groups. Land development, any existing recharge areas, and other requirements outlined in the municipal SALDO shall also be included.

   b. Establish a stream buffer according to Section 605.

   c. Prepare a draft project layout avoiding sensitive areas identified in Section 307.B.1.a.

   d. Identify site-specific existing conditions drainage areas, discharge points, recharge areas, and hydrologic soil groups A and B (areas conducive to infiltration).

   e. Evaluate nonstructural stormwater management alternatives:

i. Minimize earth disturbance.

ii. Minimize impervious surfaces.

iii. Break up large impervious surfaces and with interspersed pervious surfaces.

f. Determine the management district the site falls in (Ordinance Appendix A), and conduct an existing conditions runoff analysis.

2. The following items in this subsection may be addressed in any order provided that all items in Section 307.B.1 have been completed.

x

a. Satisfy the infiltration objective (Section 504 D) and provide for stormwater pretreatment prior to infiltration.

b. Provide for water quality protection in accordance with Section 504 D.

c. Provide stream bank erosion protection in accordance with Section 504. E.

d. Prepare final project design to maintain existing conditions drainage areas and discharge points, to minimize earth disturbance and impervious surfaces, and, to the maximum extent possible, to ensure that the remaining site development has no surface or point discharge.

e. Conduct a proposed conditions runoff analysis based on the final design that meets the management district requirements (Section 504 G).

f. Manage any remaining runoff prior to discharge through detention, bioretention, direct discharge, or other structural control.

ARTICLE IV – E&S PLAN AND IMPLEMENTATION REQUIREMENTS

Section 401. General

A. If both a written E&S Plan and a written PCSM Plan must be submitted to the Municipality in accordance with Article III, and an NPDES permit or E&S permit is not required for the earth disturbance activity, the plans may be combined into a single plan submission.

B. Off-site support activities that are located contiguous to the project site or within one-quarter mile of the project site must be addressed in the E&S Plan for the project site.

Section 402. E&S Plan Contents

A written E&S Plan that is submitted to the [Insert name of Municipality] or Delaware County Conservation District for review and approval for an earth disturbance activity must contain the following information:

A. Required E&S Plan information specified in the current version of the PADEP Erosion and Sediment Pollution Control Program Manual.

B. An erosion potential analysis for discharges during construction in accordance with Section 505, if applicable.

C. Other information if required by the Municipality. [Municipality may insert specific information required here]

Section 403. Protection of Site Infiltration Properties During Earth Disturbance

A. Where a PCSM Plan will be implemented to manage post-construction stormwater in whole or part through on-site infiltration, the permittee must protect areas proposed for infiltration SCMs from sedimentation and compaction during earth disturbance activities to maintain the infiltration capacity of soils.

B. Site access must be limited to designated access roads that are identified on the approved E&S Plan. As part of the permanent stabilization process, all post-construction pervious surfaces associated with access roads and other locations on-site that have been subjected to soil compaction must be restored using methods identified in DEP's PCSM Manual or other approved methods.

C. Conversion of E&S BMPs to infiltration SCMs may be completed when the drainage area to be treated by infiltration SCMs is permanently stabilized.

1. The permittee must remove accumulated sediment and soils from E&S BMPs to the design infiltration depth during conversion to infiltration SCMs. Excavation to remove sediment must be performed to a depth where the underlying soils are dry.

2. The permittee must perform construction confirmation testing for infiltration capacity in accordance with Section 602.

Section 404. Discharges to Special Protection and Impaired Waters

For stormwater discharges to surface waters with designated or existing uses of HQ or EV under 25 Pa. Code Chapter 93 and for stormwater discharges to surface waters impaired for sediment and/or nutrient-related causes, the applicant must design and implement non-discharge alternatives or ABACT BMPs when an NPDES permit or E&S permit is required for earth disturbance activities.

Section 405. E&S Plan Submission

If E&S Plan review is by the Delaware County Conservation District, plan submission requirements shall be as specified by the Conservation District. In this case, [insert number of hard copies and/or electronic copies] of the final approved E&S Plan (narrative and plan drawings) shall be provided to the Municipality.

If E&S review and approval is by [insert municipal name], the initial E&S Plan (Narrative and Drawings) submission shall be [municipality to identify if electronic or paper copies are to be submitted and how many copies] for review.

Subsequent submissions shall be in the same format and include the same number of copies. Once approved by the municipality the following copies of the final E&S Plan (narrative and drawings) shall be submitted:

A. One sealed and signed electronic copy to the Delaware County Conservation District.

B. One sealed and signed electronic copy to the Delaware County Planning Commission.

In addition, a financial guarantee, per the requirements of Section 111, must be provided to the Municipality prior to approval of the E&S Plan by the Municipality.

Section 406. Municipal E&S Plan Review Process

A. When the municipality reviews the E&S Plan, the Municipality will notify the applicant in writing whether the E&S Plan is approved or disapproved within the time limits established in the Municipality's SALDO for applications for approval of a plat. If the E&S Plan does not involve subdivision and land development, the Municipality will render a decision on the E&S Plan within 45 days [Municipality to modify this section as desired].

B. If the Municipality disapproves the E&S Plan, the Municipality will state the reasons for disapproval in writing. The Municipality also may approve the E&S Plan with conditions and provide those conditions in writing.

C. The Municipality reserves the right to return without comment any E&S Plan that is not complete.

Section 407. Modification of E&S Plans

If an applicant or permittee proposes changes to the E&S Plan either prior to or following approval by the Municipality or the Delaware County Conservation District, the applicant or permittee must submit modified E&S Plan and applicable review fees to the review agency for review and approval prior to implementing the proposed changes. If required by DEP or the District, the modified E&S Plan must be submitted to DEP or the District for review and approval prior to implementing the proposed changes.

Section 408. Resubmission of Disapproved E&S Plans

A disapproved or returned E&S Plan may be resubmitted with additional review fees, if applicable, to the Municipality or the Delaware County Conservation District.

ARTICLE V – PCSM PLAN AND IMPLEMENTATION REQUIREMENTS

Section 501. General

A. If both a written E&S Plan and a written PCSM Plan must be submitted to the Municipality in accordance with Article III, and an NPDES permit or E&S permit is not required for the earth disturbance activity, the plans may be combined into a single plan submission.

B. Off-site support activities that will result in changes to post-construction land cover and are located contiguous to the project site or within one-quarter mile of the project site must be addressed in the PCSM Plan for the project site.

C. PCSM design must be done in a manner that assures long-term performance and minimizes long-term O&M costs to the permittee, landowner, and Municipality. Siting, construction, operation, inspection, maintenance, and repair costs must be considered during the selection of appropriate SCMs as well as the capabilities of the entity identified in the O&M Plan as responsible to inspect, operate, perform routine maintenance, and perform repairs or replacement of the SCM.

D. The applicant must adhere to the Municipality's SALDO and other applicable local ordinances in preparing a PCSM Plan. Where the Municipality lacks a SALDO, the applicant must adhere to the county's SALDO in preparing a PCSM Plan, as applicable.

E. The Applicant is required to design the site to minimize surface discharge of stormwater and the creation of impervious surfaces in order to maintain, as much as possible, the natural hydrologic regime.

F. The PCSM plan must be designed consistent with the sequencing provisions of Section 402 to ensure maintenance of the natural hydrologic regime, to promote infiltration, and to protect groundwater and surface water quality and quantity. The SWM site plan designer must proceed sequentially in accordance with Article III of this Ordinance.

G. Stormwater drainage systems shall be designed in order to preserve natural flow conditions to the maximum extent practicable.

H. Alteration of existing drainage discharges onto adjacent property shall only be proposed in accordance with PADEP guidance document "Chapter 102 Off-Site Discharges of Stormwater to Non-Surface Waters – Frequently Asked Questions (FAQ)" dated January 2, 2019, or latest guidance document from PADEP. Drainage discharges to adjacent properties shall not be altered in any manner without written permission from, and a maintenance access agreement with, the affected property owner(s). Such discharge shall be subject to any applicable discharge criteria specified in this Ordinance and must meet the requirements of the applicable Act 167 Plan.

I. Areas of existing diffused drainage discharge, whether proposed to be concentrated or maintained as diffused drainage areas, shall be subject to any applicable discharge criteria in the general direction of existing discharge, except as otherwise provided by this Ordinance. If diffused drainage discharge is proposed to be concentrated and discharged onto adjacent property, the Applicant must document that adequate downstream conveyance facilities exist to safely transport the concentrated discharge or otherwise prove that no erosion, sedimentation, flooding, or other impacts will result from the concentrated discharge.

J. Where a development site is traversed by a stream or drainage swale, drainage easements of [__feet] shall be provided on either side of, and conform to the line of such streams.

K. Minimization of impervious surfaces and infiltration of runoff through infiltration seepage beds, infiltration trenches, etc., is encouraged where soil conditions permit in order to reduce the size or eliminate the need for detention facilities or other structural SCMs.

L. All stormwater runoff from new development or redevelopment shall be pretreated for water quality prior to discharge to surface or groundwater. Rooftop runoff may go directly to an infiltration SCM or be evapotranspirated.

M. All regulated activities within the Municipality shall be designed, implemented, operated, and maintained to meet the purposes of this Ordinance.

N. SCMs shall be designed, implemented, and maintained to meet state water quality requirements and any other more stringent requirements as determined by the Municipality. Applicants shall utilize the Pennsylvania PCSM manual as amended, or other sources acceptable to the Municipal Engineer, for testing and design standards for SCMs/BMPs, and where there is a conflict with the provisions of this Ordinance, the most restrictive applies.

O. Post-construction water quality protection shall be addressed as required by Section 504 D.

P. Operations and maintenance of permanent stormwater BMPs shall be addressed as required by Article VII.

Q. All SCMs used to meet the requirements of this Ordinance shall conform to the state water quality requirements and any more stringent requirements as set forth by the Municipality.

R. Techniques described in Appendix E (Low Impact Development) of this Ordinance shall be considered because they reduce the costs of complying with the requirements of this Ordinance and the state water quality requirements.

S. In selecting the appropriate SCMs or combinations thereof, the Applicant shall consider the following:

1. Total contributing drainage area.
2. Permeability and infiltration rate of the site's soils.
3. Slope and depth to bedrock.
4. Seasonal high-water table.
5. Proximity to building foundations and wellheads.
6. Erodibility of soils.
7. Land availability and configuration of the topography.
8. Peak discharge and required volume control.
9. Stream bank erosion.
10. Efficiency of the SCMs to mitigate potential water quality problems.
11. The volume of runoff that will be effectively treated.
12. The nature of the pollutant(s) being removed.
13. Maintenance requirements.
14. Creation/protection of aquatic and wildlife habitat.
15. Recreational value.
16. Enhancement of aesthetic and property values.

T. The design of all stormwater management facilities shall incorporate sound engineering principles and practices in a manner that does not aggravate existing stormwater problems. The Municipality reserves the right to disapprove any design that would result in construction in or continuation of a stormwater problem area.

U. The applicant may meet the stormwater management criteria through off-site stormwater management measures as long as the proposed measures are in the same subwatershed as shown in Ordinance Appendix A.

V. Stormwater Hotspots – Stormwater runoff from hotspots shall be pretreated prior to surface or groundwater infiltration to prevent pollutant contamination of these waters. Industrial sites referenced in 40 CFR 125 are examples of hotspots.

Below is a list of examples of hotspots:

- Vehicle salvage yards and recycling facilities
- Vehicle fueling stations
- Vehicle service and maintenance facilities
- Vehicle and equipment cleaning facilities
- Fleet storage areas (bus, truck, etc.)
- Industrial sites based on Standard Industrial Classification Codes
- Marinas (service and maintenance areas)
- Outdoor liquid container storage
- Outdoor loading/unloading facilities

- Public works storage areas
- Facilities that generate or store hazardous materials
- Commercial container nursery
- Contaminated sites/brownfields
- Other land uses and activities as designated by an appropriate review authority

The following land uses and activities are not normally considered hotspots:

- Residential streets and rural highways
- Residential development
- Institutional development
- Office developments
- Nonindustrial rooftops
- Pervious areas, except golf courses and nurseries (which may need an integrated pest management (IPM) plan)

While streets and highways (average daily traffic volume (ADT) greater than thirty thousand (30,000)) are not considered stormwater hotspots, it is important to ensure that highway stormwater management facilities are designed to adequately protect receiving streams and/or groundwater.

The Environmental Protection Agency's (EPA) NPDES stormwater program requires some industrial sites to prepare and implement a stormwater pollution prevention plan.

W. The standards outlined in Section 802 must be applied for protection of adjacent and downgradient properties from off-site conveyance.

For any location where a new concentrated discharge of stormwater from any frequency rainfall event, up to and including the 100-year storm and the volume of runoff up to and including the 2-year storm onto or through adjacent property(ies) or a downgradient property or properties, the following are required:

1. A drainage easement (or other legal agreement/approval) must be obtained for conveyance of discharges onto or through adjacent properties per Section 802 of this ordinance. the PADEP guidance document "Chapter 102 Off-Site Discharges of Stormwater to Non-Surface Wasters – Frequently Asked Questions (FAQ)" dated January 2, 2019, or latest guidance document from PADEP.
2. The conveyance must be designed to avoid erosion, flooding, or other damage to the properties through which it is being conveyed. Also see Section 505.

Section 502. PCSM Plan Contents

A written PCSM Plan that is submitted to the Municipality for review and approval for an earth disturbance activity must contain the following information unless specifically exempted in Section 306:

A. The name of the project site; applicant name, mailing address, phone number, and email address; landowner name, mailing address, phone number and email address (if different from the applicant); the applicable tax parcel ID number(s); the location address of the project site, if available; the expected project time schedule, and the date of submission.

B. The existing topographic features of the project site and the immediate surrounding area, including areas of natural vegetation to be preserved, overland drainage paths, and upstream areas draining through the site.

C. The types, depth, slope, locations and limitations of the soils and geologic formations, including an identification of Hydrologic Soil Group (HSG) classifications and known karst features on the site.

D. The characteristics of the project site, including the past, present and proposed land uses and the proposed alteration to the project site.

E. An identification of the net change in volume, water quality and rate of stormwater from pre-construction hydrology to post-construction hydrology for the entire project site and each drainage area.

F. An identification of the location of surface waters of this Commonwealth, which may receive runoff within or from the project site and their classification under Chapter 93 (relating to water quality standards).

G. A written description of the type of PCSM SCMs including construction details and material specifications for permanent stormwater SCMs including permanent stabilization specifications and locations.

H. Results from SCM-specific infiltration testing and soil characterization for all infiltration based SCMs. Procedures for SCM specific infiltrating testing are detailed in DEP's PCSM Manual as updated.

I. A sequence of PCSM SCM implementation or installation in relation to earth disturbance activities of the project site and a schedule of inspections for critical stages of PCSM SCM installation.

J. Supporting calculations, including a stormwater analysis (see Section 504), an erosion potential analysis (see Section 505), and a stream stability analysis (see Section 506), as applicable.

K. Drawings that show site features including the project site boundary, the limit of disturbance, and existing and proposed structures, roads, utilities, wells, on lot sewage systems, and impervious surfaces; and provide plan and profile views of PCSM SCMs, SCM components and stormwater conveyance structures including drainage structures, pipes, open channels, and swales.

L. The drawings shall also identify:

1. The Date of Submission

2. The location of the project relative to highways, municipal boundaries, or other identifiable landmarks.

3. Existing contours at intervals of two (2) feet . In areas of slopes greater than [ ] percent, 5-footy contour intervals may be used.

4. Existing streams, lakes, ponds, or other waters of the Commonwealth within the project area.

5. Other physical features including flood hazard boundaries, stream buffers, existing drainage courses, and the total extent of the upslope area draining to the site.

6. The location of existing and proposed utilities, sanitary sewers, and water lines within fifty (50) feet of the property lines.

7. All stormwater management facilities must be located on the plan and described in detail.

8. An overlay showing soil names and boundaries.

9. Limits of earth disturbance including the type and amount of impervious area that would be added.

10. Proposed structures, roads, paved areas and buildings.

11. Final contours at intervals of two (2) feet. In areas of steep slopes (greater than [ ] percent), 5-foot contour intervals may be used.

12. A graphic and written scale of one (1) inch equals no more than fifty (50) feet; for tracts of twenty (20) aces or more, the scale shall be one (1) inch equals no more than one hundred (100) feet.

13. A North Arrow

14. A total tract boundary and size with distances marked to the nearest foot and bearings to the nearest degree.

15. Existing and proposed land uses.

16. A key map showing all existing man-made features beyond the property boundary that would be affected by the project.

17. Overland drainage patterns and swales.

18. A 15-foot wide access easement around all stormwater management facilities that provide ingress to

and egress from a public right-of-way.

19. A note on the plan indicating the location and responsibility for maintenance of stormwater management facilities that would be located off site. All off-site facilities shall meet the performance standards and design criteria specified in this Ordinance.

20. A statement, signed by the Applicant, acknowledging that any revision to the approved PCSM plan must be approved by the Municipality, and that a revised erosion and sediment control plan must be submitted to the Conservation District for a determination of adequacy. For projects where the municipality provides E&S review, a revised E&S Plan shall be submitted to the municipality for determination of adequacy.

M. A long-term O&M Plan, which provides for inspection of PCSM SCMs, and includes the repair, replacement, and routine maintenance of the PCSM SCMs to ensure proper long-term function and operation. The plan must 1) include schedules for inspections and routine maintenance; 2) provide for completion of a written report documenting each inspection and all SCM repair and maintenance activities; and 3) describe access to the PCSM SCMs. The O&M Plan must stipulate that all documentation must be retained by the entity responsible and be made available for inspection upon request. The O&M procedures identified in DEP's PCSM Manual must be used unless alternative procedures are approved by the Municipality.

N. An Erosion and Sediment Control Plan, including all reviews and letters of adequacy from the Conservation District.

O. Procedures that ensure proper measures for recycling or disposal of materials associated with or from the PCSM SCMs are in accordance with DEP laws, regulations and requirements.

P. An identification of naturally occurring geologic formations or soil conditions that may have the potential to cause pollution after earth disturbance activities are completed and PCSM SCMs are operational and development of a management plan to avoid or minimize potential pollution and its impacts, including but not limited to sinkholes and other karst features.

Q. An identification of potential thermal impacts from post-construction stormwater to surface waters of this Commonwealth including SCMs to avoid, minimize or mitigate potential pollution from thermal impacts.

R. A riparian forest buffer management plan when a riparian forest buffer will be newly established to satisfy the requirements of 25 Pa. Code Chapter 102.

S. Permanent drainage, access, and maintenance easements (see Section 801) for all PCSM SCMs used to satisfy the requirements of this Ordinance and as needed to implement the long-term O&M Plan identified in paragraph L above. The easements must be identified on PCSM Plan Drawings and the applicant must submit executed copies of the easements and easement agreement, as recorded, to the Municipality. In lieu of submission with the PCSM Plan, upon approval by the Municipality the permittee may submit copies of the easements with the record drawings described in Section 514.

T. Justification for any proposed alternative standard proposed. All alternative standards must be approved by the Municipality in accordance with this Ordinance.

U. The following signature block signed and sealed by the qualified Licensed Professional responsible for the preparation of the PCSM Plan:

"I (Licensed Professional Name), on this date (date of signature), hereby certify that the PCSM Plan meets all design standards and criteria of the [municipality name] Stormwater Management Ordinance [*Note: Licensed Professional stamp to be included here*]

V. The following signature block for the Municipality:

"I, (Municipal Official Name), on this date (Signature date), has reviewed and hereby certifies that the PCSM Plan meets all design standards and criteria of the Municipal Ordinance No. (Number Assigned to Ordinance)."

W. An erosion and sedimentation control plan, including all reviews and letters of adequacy from the Conservation District for sites were the Conservation District provides review of the E&S Plan. For sites where the municipality provides

E&S Review, a complete E&S Plan shall be submitted consistent with the requirements in Section 402.

X. A PCSM/Stormwater Management Site Plan application and completed fee schedule form and associated fee (See Appendix C-1).

Y. Supplemental information to be submitted to the Municipality:

- Expected project schedule
- Development stages or project phases, if so proposed.
- A description of the effect of the project (in terms of runoff volumes and peak flows) on adjacent properties and on any existing municipal stormwater collection system that may receive runoff from the project site.
- A Declaration of Adequacy and Highway Occupancy Permit from the Pennsylvania Department of Transportation (PennDOT) District office when utilization of a PennDOT storm drainage system is proposed.

Z. Other information if required by the Municipality.

Section 503. Pre-Development Site Characterization

A pre-development site characterization must be completed for the project site if the site is not exempt or permitted to use the simplified approach as identified in Section 306. The pre-development site characterization must address the following, at a minimum:

A. Pre-development soil characterization that includes infiltration testing must be completed by the applicant to evaluate the project site's capabilities to infiltrate and/or manage stormwater. Recommended guidance on the number of locations and test methodology for soil characterization and infiltration testing are contained in DEP's PCSM Manual, as updated. The results of soil characterization and infiltration testing must be submitted to the Municipality with the PCSM Plan.

B. Areas of known or suspected soil contamination must be identified and delineated on a map through soil sampling, as applicable.

C. Existing natural landscape features, drainage paths, and surface waters, including wetlands, must be identified by the applicant and delineated on a map, as applicable.

Section 504. Stormwater Analysis

The standards in this section apply to projects that are not exempt or projects that are not permitted to use the simplified approach as identified in Section 306. Standards for the Simplified Approach are provided in Appendix B of this ordinance.

A. A person proposing earth disturbance activities must complete a stormwater analysis that is consistent with the standards contained in 25 Pa. Code § 102.8(g) unless the project qualifies as a site restoration project per 25 Pa. Code 102.8(n), as determined by DEP or the District, The stormwater analysis will determine the volume, rate, and pollutant loads that must be managed by PCSM SCMs.

B. If a PCSM Plan is prepared for the purpose of obtaining an NPDES permit or E&S permit, the stormwater analysis completed for the PCSM Plan that is submitted to the Municipality must be consistent with the stormwater analysis that is submitted to DEP or the District.

C. To determine the volume of runoff for the stormwater analysis the applicant must use either 1) the 90% upper confidence interval precipitation data published by the National Oceanic and Atmospheric Administration (NOAA) for the city or region that is closest to the project site; 2) published studies of regional precipitation that have been adjusted to account for changes in precipitation patterns, temperature and other parameters in a manner consistent with methods contained in DEP's PCSM Manual, as updated; or 3) published studies of regional precipitation that have not been adjusted for climate change but are increased by the applicant using a factor of safety of at

least 20%.

D. Volume and Water Quality Management.

1. The applicant must analyze stormwater volume and water quality and demonstrate one of the following:

   a. The net change in stormwater volume and water quality compared to pre-construction conditions up to the 2-year/24-hour storm event will be managed. If the applicant elects to demonstrate management of the net change in volume and water quality, the applicant must use the Design Storm Analysis Approach, the Continuous Simulation Analysis Approach and/or the Water Balance Analysis Approach as described in DEP's PCSM Manual or other DEP-approved alternatives.

   b. An alternative design standard will be met that is either more protective of the standards in paragraphs D.1.a, or will maintain and protect existing water quality and existing and designated uses and has been approved by DEP.

2. SCMs as described in Article VI must be utilized to manage the net change in volume and water quality or achieve an alternative standard, as applicable.

3. For the analysis of volume and water quality, pre-construction non-forested pervious areas must be considered meadow or its equivalent except for repair, reconstruction or restoration of roadways or rail lines, or construction, repair, reconstruction or restoration of utility infrastructure when the site will be returned to existing condition, or in karst topography when PCSM design will be done in accordance with the latest version of the DEP's PCSM Manual.

E. Streambank Protection

Preservation of stream geomorphology is an important aspect of sustainable flood protection and water quality preservation. Comprehensive stormwater management cannot be attained without considering the impact of stormwater on the fluvial geomorphology of a watercourse and the associated increase in streambank erosion.

The streambank protection standard across all watersheds in Delaware County is control of the peak runoff from the post-development 2-year 24-hour storm event to the pre-development 1-year 24-hour storm peak runoff magnitude.

Sites discharging directly to the Delaware River and adjacent tidal areas are exempt from this standard. Sites discharging through an off-site conveyance path to the Delaware River are not exempt from this standard. Also see Section 504 F for Tidal Considerations.

F. Tidal Considerations

Tidal conditions are to be assessed through application of an appropriate tailwater condition as part of the engineering analysis and design performed for sites located in tidal areas. The minimum tailwater to be applied shall be the average of the NOAA Mean Higher High Water (MHHW) level at the Marcus Hook and Philadelphia NOAA Tides and Currents Data Stations. This value is currently 3.95 feet NAVD88.

G. Peak Rate Management.

The applicant must analyze stormwater peak runoff rates and demonstrate that one of the following release rates standards presented below are met. For this analysis the applicant must use the Design Storm Analysis Approach or the Storm of Record Approach as outlined in PADEPs PCSM Manual or other PADEP approved alternatives.

1. **100% Release Rate Standard:** The net change in peak rates compared to pre-construction conditions for the 2-, 10-, 50-, and 100-year/24-hour storm events will be managed. The 100% release rate standard is applicable to the following Delaware County Watersheds: Brandywine Creek, Gulph Mill Creek, Marcus Hook Creek, and Naamans Creek.

   In addition, Mill Creek includes a Provisional Infiltration Standard per the Lower Merion Drainage Area Act 167 Plan. Provisional Infiltration is defined as managing the increase in runoff volume from a 5-year 24-

hour storm using infiltration SCMs. If an applicant is able to meet the provisional infiltration standard the 100% release rate standard does not need to be met.

2. **Variable Release Rate Standard**: Variable release rate standards were developed for most of the major watersheds draining through Delaware County Including Chester Creek, Crum Creek, Darby/Cobbs Creeks, and Ridley Creek. Variable release rate district maps and the release rate standards for each of these watersheds are provided in Appendix A of this ordinance. The variable release rate standards are presented as either "Percent Reduction" or "Design Storm" based.

   The Percent Reduction approach establishes post-development peak runoff as a percentage of the pre-development runoff peak rate. For any development scenario within a given district (group of sub watershed areas), the post-development peak runoff rate cannot exceed a given percentage of the pre-development peak runoff rate. The percentage is defined as the release rate.

   The Design Storm approach limits post-development peak runoff rates based on design storm peak runoff rate considerations. For development scenarios within a given district (group or sub watershed areas), the post development peak runoff rate cannot exceed the pre-development runoff for the same or a more frequent design storm.

3. **Conditional No Detention Standard**: This standard applies to sites with direct discharges to the Delaware River and adjacent tidal areas for the following conditions:

   a. Sites that are directly adjacent to the Delaware River and tidal areas and site runoff is directly tributary to these areas do not need to post development peak runoff attenuation.

   b. For sites discharging through an off-site conveyance path to the Delaware River and adjacent tidal areas no peak rate reduction is required for the 5- to 100-yr 24-hour storm event if adequate conveyance capacity exists along the flow path from the site to the Delaware River. Adequate conveyance capacity is defined as conveyance through open channels or piped conveyance storm drainage elements having flow capacity sufficient to carry the 10-year 5-minute duration design storm runoff rate without flooding or impacts to adjacent properties. Note that the streambank protection standard outlined in Section 503 E above will still apply. Also see Section 503 F above for tidal considerations.

4. SCMs as described in Article VI must be utilized to manage the net change in peak rates as described in this section.

H. Impervious Surfaces.

The following provisions apply to the consideration of impervious surfaces when performing a stormwater analysis:

1. The PCSM Plan must consider all proposed impervious surfaces over the larger common plan of development or sale. For development taking place in phases, the entire development plan must be used in determining the area of impervious surfaces and must conform with this Ordinance.

2. When the existing project site contains impervious surfaces, 20% of the existing impervious surface area to be disturbed must be considered meadow or better, except for repair, reconstruction or restoration of roadways or rail lines, or construction, repair, reconstruction, or restoration of utility infrastructure when the site will be returned to existing condition for the purpose of analyzing volume and water quality management.

3. When the existing site contains impervious surface area and the existing site conditions have public health, safety or environmental limitations, the applicant may demonstrate to the Municipality that it is not practicable to satisfy the requirement in paragraph G.2, but the stormwater volume reduction and water quality treatment will be maximized to the extent practicable to maintain and protect existing water quality and existing and designated uses.

4. For multi-lot development projects where the lots are intended to be sold prior to, during, or following construction, the applicant must conduct the stormwater analysis by using the maximum area of impervious surface allowed on the lots under the municipal or county SALDO, if applicable, or add a factor of safety of at least 10% to the impervious area planned for the lots.

5. For proposed parking areas, the applicant must minimize impervious surfaces by designing such areas to accommodate only the number and type of vehicles that will regularly and at least once a week park on the property at the same time as demonstrated in a parking analysis, or otherwise proving to the satisfaction of the Municipality that the impervious surface area is necessary to meet the intent of the development. Parking provided above what is regularly needed (at least once a week) should be accommodated on pervious parking surface, a multi-story parking structure, or by developing a shared parking plan.

Section 505. Erosion Potential Analysis

A. For earth disturbance activities not exempt, or permitted to use the Simplified Method as outlined in Section 306, and that require an NPDES permit or E&S permit from DEP or the District that includes an overland discharge of stormwater, an erosion potential analysis is required to demonstrate that stormwater discharges from the project site during and following construction will not cause accelerated erosion up to the 10-year/24-hour storm event for the entire flow path to the surface water when stormwater flows are concentrated, such as outflows from BMPs and SCMs, and will be directed to areas on the project site and/or off-site that are not surface waters or conveyances that discharge directly to surface waters. A discharge point (DP) must be identified on E&S Plans and/or PCSM Plans at the outflow of the BMP or SCM to denote a location where an analysis has been performed. Non-surface waters include swales, ditches, channels, open areas, fields, forests, and riparian buffers.

B. An erosion potential analysis is not required when a new channel will be designed and constructed to convey stormwater runoff in accordance with DEP's E&S Manual.

Section 506. Stream Stability Analysis

For earth disturbance activities requiring an NPDES permit or E&S permit from DEP or the District, a stream stability analysis is required when an applicant proposes a post-construction increase, compared to pre-construction conditions, in stormwater peak rate (up to the 100-year/24-hour storm event) and/or volume (up to the 2-year/24-hour storm event) to a surface water with a drainage area of 0.5 square mile (mi^2) or less, to demonstrate that the discharge will not cause or contribute to an impairment of the surface water due to stream bed scour and/or stream bank erosion, unless the increase is managed through an SCM. The stream stability analysis may be completed by following procedures in DEP's PCSM Manual.

Section 507. Off-Site Stormwater Management

A. If an applicant demonstrates one or more of the following, off-site stormwater management may be proposed to offset changes in stormwater runoff from development on a project site:

1. There are limited opportunities available on-site to implement PCSM SCMs to satisfy this Ordinance.

2. Opportunities for establishing PCSM SCMs within the project site boundary have been considered but the implementation of off-site stormwater management would exceed the environmental benefits of on-site stormwater management.

3. There are restrictions or safety considerations that prevent the applicant from achieving regulatory requirements through on-site PCSM SCMs.

4. Implementing PCSM SCMs on-site is not feasible due to historic preservation or threatened and endangered species considerations.

B. The criteria established in DEP's PCSM Manual must be met for off-site stormwater management or otherwise the applicant must demonstrate how an alternative criterion is equally protective of surface waters.

C. The applicant must identify who will be responsible for long-term O&M in the PCSM Plan. If the applicant will retain this responsibility, the applicant must demonstrate that it has the legal right to access the SCM for inspection and maintenance. If a different entity other than the applicant will be responsible for O&M, the applicant must provide written proof that the other entity has accepted legal responsibility.

D. An easement must be recorded in accordance with Article VIII of this Ordinance that will allow access and inspection by the Municipality, DEP, and the District.

Section 508. Temporary and Permanent Stabilization

A. Temporary stabilization.

1. Upon temporary cessation of an earth disturbance activity or any stage or phase of an activity where a cessation of earth disturbance activities will exceed four days, the site must be immediately seeded, mulched, or otherwise protected from accelerated erosion and sedimentation pending future earth disturbance activities.

2. For an earth disturbance activity or any stage or phase of an activity to be considered temporarily stabilized, the disturbed areas must be covered with one of the following: (i) a minimum uniform coverage of mulch and seed, with a density capable of resisting accelerated erosion and sedimentation; or (ii) an acceptable BMP which temporarily minimizes accelerated erosion and sedimentation.

B. Permanent stabilization.

1. Upon final completion of an earth disturbance activity, or any stage or phase of an earth disturbance activity, the site must immediately have topsoil restored, replaced, or amended, seeded, mulched or otherwise permanently stabilized and protected from accelerated erosion and sedimentation. Acceptable soil restoration practices are identified in DEP's PCSM Manual, as updated.

2. E&S BMPs must be implemented and maintained until the permanent stabilization is completed. Once permanent stabilization has been established and approved by the Municipality, the temporary E&S BMPs must be removed and, if an NPDES permit or E&S permit was obtained for the project, an NOT must be submitted to DEP or the District. Any areas disturbed in the act of removing temporary E&S BMPs must be permanently stabilized.

3. For an earth disturbance activity, or any stage or phase of an earth disturbance activity, to be considered permanently stabilized, the disturbed areas must be covered with one of the following: (i) a minimum uniform 70% perennial vegetative cover, with a density capable of resisting accelerated erosion and sedimentation; or (ii) an acceptable BMP which permanently minimizes accelerated erosion and sedimentation.

Section 509. PCSM Plan Submission

The Municipality shall require receipt of a complete PCSM plan, as specified in this Ordinance.

A. Proof of application or documentation of required permit(s) or approvals for the programs listed below shall be part of the plan, as applicable:

1. NPDES Permit for Stormwater Discharges from Construction Activities

2. PADEP permits as needed

   a. PADEP Joint Permit Application

   b. Chapter 105 (Dam Safety and Waterway Management)

   c. Chapter 106 (Floodplain Management)

3. PennDOT Highway Occupancy Permit

4. Any other permit under applicable state or federal regulations

B. The plan shall be coordinated with the state and federal permit process and the municipal SALDO review process.

C. For projects that require SALDO approval, the PCSM plan shall be submitted by the Applicant as part of the preliminary plan submission where applicable for the regulated activity.

D. For regulated activities that do not require SALDO approval, see Section 501.

E. Unless the Municipality or County Conservation District notify the applicant that the electronic submission of a PCSM Plan is acceptable, the PCSM Plan must be submitted as follows:

1. Five (5) copies of the PCSM plan shall be submitted by the applicant for review in accordance with established criteria and procedures:

   a. Two (2) copies to the Municipality accompanied by the requisite application and municipal review fee as specified in this ordinance or as part of a separate municipal schedule of fees.

   b. Two (2) copies to the County Conservation District.

   c. One (1) copy to the Municipal Engineer.

F. Any submissions to the agencies listed above that are found to be incomplete shall not be accepted for review and shall be returned to the Applicant with a notification in writing of the specific manner in which the submission is incomplete.

In addition, a financial guarantee, per the requirements of Section 111, must be provided to the Municipality prior to approval of the PCSM Plan.

Section 510. PCSM Plan Review Process

A. The Municipality will notify the applicant in writing whether the PCSM Plan is approved or disapproved within the time limits established in the Municipality's SALDO for applications for approval of a plat. If the PCSM Plan does not involve subdivision and land development, the Municipality will render a decision on the PCSM Plan within 45 days.

B. If the Municipality disapproves the PCSM Plan, the Municipality will state the reasons for disapproval in writing. The Municipality also may approve the PCSM Plan with conditions and provide those conditions in writing.

C. The Municipality reserves the right to return without comment any PCSM Plan that is not complete.

Section 511. Modification or Revision of PCSM Plans

If an applicant or permittee proposes changes to the PCSM Plan either prior to or following approval by the Municipality, the applicant or permittee must submit the modified PCSM Plan and applicable review fees to the Municipality for review and approval prior to implementing the proposed changes. If required by DEP or the District, the modified PCSM Plan must be submitted to DEP or the District for review and approval prior to implementing the proposed changes.

Section 512. Resubmission of Disapproved PCSM Plans

A disapproved or returned PCSM Plan may be resubmitted with additional review fees, if applicable, to the Municipality.

Section 513. Authorization to Construct and Term of Validity

The Municipality's approval of a PCSM Plan authorizes the regulated activities contained in the PCSM Plan for a maximum term of validity of five years following the date of approval. The Municipality may specify a term of validity shorter than five years in the approval for any specific PCSM Plan. Terms of validity may commence on the date the Municipality signs the approval for a~~n~~ PCSM Plan. If an approved PCSM Plan is not completed within the term of validity, the Municipality may consider the PCSM Plan disapproved and may revoke any and all permits. PCSM Plans that are considered disapproved by the Municipality may be resubmitted in accordance with Section 512 of this

Ordinance.

Section 514. Project Completion

A. If an NPDES permit or E&S permit was required for the project, the permittee must submit an NOT to DEP or the District within 15 days of the completion of all PCSM SCMs identified in the approved PCSM Plan and permanent stabilization of the project site. A copy of the complete NOT submission must be submitted to the Municipality at the time the NOT is submitted to DEP or the District. If DEP or the District determine there are deficiencies with the NOT, the permittee must submit a copy of responses to the deficiencies to the Municipality.

B. If an NPDES permit or E&S permit was not required for the project, the permittee must submit the following documentation to the Municipality within 15 days of completion of all PCSM SCMs identified in the approved PCSM Plan and permanent stabilization of the project site:

   1. A long-term O&M Plan that has been recorded with the County Recorder of Deeds, proof of recording, and identification of the individual(s) responsible for long-term O&M.

   2. Record drawings (or equivalent information) that have been recorded with the County Recorder of Deeds and depict as-built conditions including land covers, structures, utilities, SCMs and other features, with proof of recording. The record drawings must include a certification of completion signed by a licensed professional verifying that all permanent PCSM SCMs have been constructed according to the approved plans and specifications.

C. After receipt of the information in paragraphs A or B above, the Municipality may conduct a final inspection.

D. The Municipality must receive documentation that DEP or the District has approved the NOT or, for projects not requiring an NPDES permit or E&S permit, the O&M Plan and record drawings must be deemed acceptable by the Municipality prior to:

   1. Closing of the project by the Municipality.

   2. Dedication of PCSM SCMs to the Municipality or conveyance to a homeowner’s association or other person

ARTICLE VI – STORMWATER CONTROL MEASURE REQUIREMENTS

Section 601. General Requirements

A. Acceptable SCMs include those identified in DEP's PCSM Manual and their variations or alternatives approved by DEP (for earth disturbance activities requiring an NPDES permit or E&S permit) or the Municipality (all other activities).

B. If an NPDES permit or E&S permit is required for an earth disturbance activity, the written PCSM Plan must consider the PCSM Objectives, outlined in the current version of the PADEP PCSM Manual.

C. A person proposing earth disturbance activity must demonstrate that land disturbance will be minimized by:

1. Including on the PCSM Plan a limit of disturbance that protects natural landscapes and limits construction and access to those areas identified in an E&S Plan.

2. Limiting the compaction of soils by restricting contractor access to designated paths. The designated paths must be described and shown on an E&S Plan.

3. Limiting the stripping of topsoil, removal of vegetation, and movements of construction equipment. Restoration of soils compacted during construction is required for all areas assumed to be pervious in the post-construction condition for the stormwater analysis. Guidance on soil restoration can be found in the PCSM Manual.

Section 602. SCM Design

A. Table 1 presents design parameters for common SCMs. Other SCMs may be proposed. For all projects that do not meet the exemption criteria or simple approach criteria in Section 306, the design of SCMs in Table 1 must conform to standards listed Table 1 or equivalent design standards contained in the latest version of DEP's PCSM Manual unless the PCSM Plan preparer provides justification in the PCSM Plan that alternative design criteria will achieve equal or better volume, water quality, and/or peak rate management and protect and maintain surface water uses.

B. Infiltration-Based SCMs.

1. For SCMs that will utilize infiltration for volume management, infiltration testing must be conducted in the proposed area of the SCM to determine a saturated hydraulic conductivity rate (infiltration rate) to be used in the design of the SCM. The applicant must test at a frequency and utilize methods contained in DEP's PCSM Manual, as updated, unless justification is provided for an alternative frequency or method that is approved by the Municipality.

2. For subsurface infiltration SCMs, access must be provided to the infiltrating surface (the interface between the soil and the storage component) for maintenance and inspection.

3. Underdrains may be proposed and installed beneath infiltration-based SCMs; however, where the design infiltration rate is at least 0.4 inch/hour, the underdrain must terminate at a structure that does not have a connected outflow pipe.

4. For earth disturbance activities requiring an NPDES permit or E&S permit where infiltration-based SCMs are proposed and implemented, the permittee must conduct construction confirmation testing for infiltration capacity as specified below. [the municipality at their option may require construction confirmation testing for non-exempt projects that disturb less than 1 acre]

a. The permittee must protect any area on a project site that will be used for infiltration-based SCMs from compaction and must complete construction confirmation testing for infiltration capacity on any infiltration-based SCM. This testing must be overseen by a licensed professional or designee.

Table 1: SCM Design Criteria

Parameter	Bioinfiltration	Surface Infiltration Basin	Permeable Pavement	Infiltration Trench	Underground Infiltration Basin	Bioretention	Green Roof	Regenerative Step Pool Systems	Stormwater Capture and Use	Blue Roof	Engineered Stormwater Treatment Wetland	MRC Bioretention	MRC Storage Systems	Wet Basin	Naturalized Detention Basin	Underground Detention
Drainage Area	≤5 ac	≤10 ac	-	≤1 ac	2 ac[1]	≤5 ac	-	-	-	-	>3 ac[2]	≤5 ac	≤5 ac	>10 ac[2]	≤20 ac	≤20 ac
Maximum Ponding Time	96 hrs	48 hrs	72 hrs[3]	72 hrs[3]	72 hrs[3]	96 hrs	-	-	-	72 hrs	72 hrs	72 hrs	72 hrs[3]	72 hrs	72 hrs	72 hrs
Maximum Ponding/Storage Depth	2 ft	2 ft	-	1 ft / 6 ft	1 ft[4]	2 ft	-	3 ft (Min 18 in)	-	6 in	4 ft[5]	2 ft	6 in[8]	5 ft[5]	5 ft	1 ft[4]
Soil Media Depth	Min. 18 in	-	-	-	-	Min 18 in	Min 3 in[7]	Min 18 in	-	-	6 in -18 in	Min 2 ft	Min 2 ft[8]	4 in	Min 8 in[2]	-
Distance Above SHWT[9]	2 ft	2 ft	2 ft	2 ft	2 ft	2 ft	-	-	-	-	[6]	2 ft	2 ft	[6]	2 ft	[2]

[1] Limit drainage area to two acres of impervious wherever possible. Drainage area can be up to five acres with appropriate pretreatment.
[2] See PCSM Manual for more information.
[3] Drawdown to native soil surface (not surface ponding above engineered media).
[4] Hydraulic depth should not exceed pavement subgrade elevation when placed under paved surfaces and should not be closer than one foot from the top of permeable pavements/subgrade; see PCSM Manual for more information.
[5] Above permanent pool.
[6] Can intercept groundwater.
[7] Typically, lightweight growing material.
[8] For vegetated component.
[9] SHWT = Seasonal High Water Table.

DRAFT

b. Construction confirmation testing for infiltration capacity must be conducted following methods set forth in DEP's PCSM Manual, as updated, unless an alternative is approved by the Municipality. The testing must be performed after major earthwork is complete and prior to placing soil media or stone in an SCM.

c. Construction confirmation testing for infiltration capacity should confirm that the SCM can function as intended and result in no adverse effects to the SCM or downstream systems in a manner consistent with the methods contained in DEP's PCSM Manual, as updated. If these criteria are not met, the permittee must implement corrective measures to ensure SCM function prior to submission of the NOT.

C. Other SCM Standards.

1. Access must be provided to all SCMs from a public right-of-way to the storage surface, outlet structure, embankment, inflow components, and any other component that may need routine or periodic maintenance or repairs. Access must be designed to enable required maintenance.

2. SCMs must include pretreatment appropriate to the type of SCM and anticipated pollutant loading.

3. All SCMs providing volume management functions must be protected from hydraulic overloading and excessive pollutant loading. The applicant must design SCMs providing volume management in a manner that protects these SCMs from storm events that exceed their design capacities by diverting higher flows to peak rate management SCMs, unless the applicant can demonstrate that the SCMs can receive higher flows without the need for increased maintenance, repair, or replacement.

4. Manufactured devices used for water quality management in a PCSM Plan that is submitted to the Municipality must be certified by an independent third party to establish performance of the device under the range of flow and water quality conditions anticipated with the project. A licensed professional engineer must evaluate project site conditions and certify that those conditions are within the range of performance values for the manufactured device as determined by the certification program, and that project design objectives will be achieved.

5. Embankments over three feet in height included in an SCM design must be designed and constructed in accordance with the Natural Resource Conservation Service (NRCS) Pond Code 378, as modified by DEP's PCSM Manual, unless an alternative is approved by the Municipality.

6. The use of MRC SCMs is limited to sites where infiltration is demonstrated to be limited (< 0.25 inch/hour infiltration rate) or other environmental or geological limitations exist.

7. Naturalized Detention Basin SCMs may be designed to provide peak rate management and limited volume and water quality management. Dry detention basin SCMs only provide peak rate management.

8. The Protected Natural Stormwater Features SCMs identified in DEP's PCSM Manual, as updated, including riparian buffers, can be used to manage stormwater runoff from adjacent impervious areas up to a maximum of 12% of the SCM area or 30,000 square feet of impervious area, whichever is more limiting, if runoff is directed to the SCM as sheet flow or shallow concentrated flow.

9. The Preserved Natural Open Spaces SCM identified in DEP's PCSM Manual, as updated, including undisturbed vegetated or forested lands, may provide water quality management credit as specified in DEP's PCSM Manual, as updated.

10. Tree plantings may be used toward achieving volume and water quality management requirements. Each new deciduous tree over two inches in caliper and each new evergreen

over six feet tall can be considered as managing six cubic feet of stormwater volume.

11. The Municipality will not approve a PCSM Plan that does not propose the use of Protected Natural Stormwater Features, Preserved Natural Open Spaces, Natural Landscape SCMs, and/or low impact development (LID) practices to achieve the volume and peak rate management requirements of this Ordinance unless the Municipality determines that these practices are not practicable. If these SCMs are not included in the PCSM Plan to manage a minimum of 5% of the runoff during a 2-year/24-hour storm, a justification for not utilizing these SCMs and practices must be submitted with the PCSM Plan.

12. The permittee must retain the services of a licensed professional or designee (someone supervised by the licensed professional) to provide oversight at critical stages of implementation of the PCSM Plan and construction of SCMs. The critical stages must be identified in the PCSM Plan. The licensed professional or designee must be on-site and responsible for construction of SCMs throughout the entirety of critical stages.

Section 603. Stormwater Conveyance

A. The inflow capacity for all SCMs must be adequate to convey all storms that the SCM is designed to manage, either independently or by providing a stable overland flow path. The supporting calculations must include a demonstration that the largest storm event that an SCM is designed for can be conveyed to the SCM. Analysis must include both the minor collection system (e.g., pipes, gutters, swales that are sized for the smaller frequency storm events) and the major conveyance pathways for the larger flows that exceed the capacity of the minor collection system.

B. The applicant must design inflow components including conveyance pipes, inlets, channels, energy dissipators, level spreaders, gutters, and other components that direct flow to an SCM in a manner that considers anticipated changes in rainfall patterns that are likely to occur during the design life of the SCM. The applicant must use a factor of safety of at least 20% for design rainfall intensities or use methods to incorporate current and anticipated changes in rainfall patterns as specified in DEP's PCSM Manual, as updated.

C. Stormwater may not be directed to sanitary sewers. To promote overland flow and infiltration of stormwater, roof drains may not be connected to roadway gutters or storm sewers unless otherwise approved by the Municipality.

D. When there will be an increase in stormwater rate discharged from a project site to existing storm sewers, the applicant must evaluate the carrying capacity of the sewers up to the 10-year/24-hour storm event and submit the evaluation to the Municipality with the PCSM Plan. The applicant is responsible for replacing any section of sewer when an increase in flow rate from the project site, in conjunction with other sources of stormwater, is projected to result in surcharge of the sewer or results in pressure flow within the sewer.

Section 604. Existing SCMs

A. Other than activities conducted pursuant to an approved long-term O&M Plan, no person may modify, remove, fill, landscape, or alter any PCSM SCMs, facilities, areas, easements, or structures that were installed or established as a requirement of this Ordinance without the written approval of the Municipality.

B. Prior to the issuance of permits or approvals for earth disturbance activities that do not require an NPDES permit or E&S permit where the property contains an existing PCSM SCM, an applicant must provide documentation demonstrating that the proposed earth disturbance activity will not adversely impact the SCM. If new impervious surfaces will be constructed within the drainage area of an existing SCM, the applicant must demonstrate that the SCM is capable of treating the increase in stormwater runoff or propose modifications to the SCM to treat increased runoff.

C. Where an existing PCSM SCM will be modified or removed as part of an earth disturbance activity, the Municipality will not issue approvals until DEP or the District provides approval of the SCM modification or removal.

Section 605. Riparian Buffers

[This section is identified as optional in the 2028 PADEP MS4/Act 167 Model Ordinance. This information may be more

appropriate or similar language may already exist in the Municipal Zoning Ordinance.]

A. In order to protect and improve water quality, a Riparian Buffer Easement must be created and recorded as part of any subdivision or land development that encompasses a Riparian Buffer.

B. Except as required by Chapter 102, the Riparian Buffer Easement must be measured to be the greater of the limit of the 100-year floodplain or a minimum of 50 feet from the top of the streambank (on each side).

C. Minimum Management Requirements for Riparian Buffers.

1. Existing native vegetation must be protected and maintained within the Riparian Buffer Easement.

2. Whenever practicable invasive vegetation must be actively removed and the Riparian Buffer Easement must be planted with native trees, shrubs and other vegetation to create a diverse native plant community appropriate to the intended ecological context of the site.

D. The Riparian Buffer Easement must be recorded in the County Recorder of Deeds Office so that it runs with the land and limits the use of the property located therein. The easement must allow for the continued private ownership and count toward the minimum lot area as required by Zoning, unless otherwise specified in the Municipal Zoning Ordinance.

E. Any permitted use within the Riparian Buffer Easement must be conducted in a manner that will maintain the extent of the existing 100-year floodplain, improve or maintain the stream stability, and preserve and protect the ecological function of the floodplain.

F. The following conditions apply when public and/or private recreation trails are permitted within Riparian Buffers:

1. Trails must be for non-motorized use only.

2. Trails must be designed to have the least impact on native plant species and other sensitive environmental features.

G. Septic drainfields and sewage disposal systems are not permitted within the Riparian Buffer Easement and must comply with setback requirements established under 25 Pa. Code Chapter 73.

ARTICLE VII – OPERATION AND MAINTENANCE (O&M)

Section 701. General Requirements

A. The permittee must record the O&M Plan required by Section 502I as a restrictive deed covenant that runs with the land and submit the recorded O&M Plan and proof of recording to the Municipality.

B. The O&M of E&S BMPs during earth disturbance activities is the responsibility of the permittee. The permittee must repair or replace any E&S BMP within 24 hours of discovery by the permittee, Municipality, DEP or the District of a failure in the BMP to effectively control pollution unless otherwise extended by the Municipality, DEP or the District in writing.

C. The O&M of PCSM SCMs prior to approval of record drawings and certification of completion by the Municipality is the responsibility of the permittee. The permittee must repair or replace any PCSM SCM within 24 hours of discovery by the permittee, Municipality, DEP or the District of a failure in the SCM to effectively control pollution unless otherwise extended by the Municipality, DEP or the District in writing.

D. Following approval of an NOT by DEP or the District or approval of record drawings and certification of completion by the Municipality, long-term O&M of PCSM SCMs is the responsibility of the permittee unless a different person is identified in the NOT approved by DEP or the District and that entity has agreed in writing to long-term O&M of PCSM SCMs. If a different person has not agreed in writing to long-term O&M of PCSM SCMs, the permittee and landowner remain jointly responsible for long-term O&M.

E. The Municipality will make a determination on the acceptability of the applicant's O&M Plan and the person identified as responsible for long-term O&M prior to approval of the PCSM Plan. The Municipality reserves the right to require dedication of SCMs to the Municipality but is under no obligation to do so.

F. Facilities, areas, or structures used as PCSM SCMs must be enumerated as permanent real estate appurtenances and recorded as deed restrictions or conservation easements that run with the land.

G. A person conducting long-term O&M for manufactured devices used as a PCSM SCM must follow the O&M specifications of the manufacturer.

Section 702. O&M Agreements

A. Prior to final approval of the PCSM Plan, the applicant must sign and record an O&M Agreement with the Municipality covering all stormwater controls and SCMs that are to be privately owned (Refer to Appendix D). The O&M Agreement must stipulate who will own and maintain PCSM SCMs and must be approved by the Municipality. The maintenance agreement shall be substantially the same as the agreement in Appendix D of this ordinance and shall be transferred with transfer of ownership in perpetuity.

   1. The owner and/or applicant must convey easements to the Municipality in accordance with Section 801 of this Ordinance.

   2. The owner, successor, and assigns must maintain all facilities in accordance with the approved maintenance schedule in the O&M Agreement.

   3. An owner must notify the Municipality of any changes in assignment of O&M responsibilities or property ownership. Until such notification is received by the Municipality, the owner listed in Municipal records as responsible for O&M remains fully responsible to comply with this Ordinance. The Municipality must be notified in writing of any change of responsibility or ownership within ten (10) business days of the change.

   4. A written inspection report must be completed for each inspection of a PCSM SCM. The inspection report must be submitted to the Municipality within ten (10) business days of completion of the inspection.

B. The owner may contract with others to complete O&M of PCSM SCMs; however, ultimately the owner is responsible for meeting obligations under this Ordinance. If the owner fails to meet the obligations described in the O&M

Agreement, the Municipality may perform required work and bill the owner the full cost. Non-payment may result in a lien against the owner's property.

ARTICLE VIII – EASEMENTS

Section 801. General

Easements are required as outlined here if the site is not exempt or is not permitted to use the Simplified Approach as identified in Section 306.

A. Permanent access, drainage, and maintenance easements (consisting of a written easement agreement, legal description, and an exhibit depicting bearings and distances describing the easement) must be recorded with the County Recorder of Deeds and shown on PCSM Plan Drawings for all PCSM SCMs on land outside of a public right-of-way or publicly controlled property. The purpose of the easements is to protect SCMs that are intended to be utilized to meet the requirements of this Ordinance; allow for access, inspection, and maintenance; protect the drainage path; and memorialize legal responsibility for meeting long-term obligations for protecting and maintaining stormwater management in accordance with this Ordinance and applicable laws.

1. Easements are required for all SCMs including non-structural (e.g., buffers, landscape features, protected natural stormwater features) and structural SCMs used to satisfy stormwater management requirements.

2. Easement agreements must identify the entity responsible for maintenance and clearly state that the Municipality, District, and DEP are not responsible for maintenance but may undertake maintenance and construction activities consistent with the purpose of the easement. The easement must grant access to the Municipality, District, and DEP for the purpose of inspection of stormwater management and enforcement of stormwater management regulations and permit requirements.

3. The easement must extend from a legal public right-of-way along an access path traversable by the type and kind of maintenance equipment anticipated to be used to maintain the SCM and fully enclose the SCM.

4. Access must be a minimum of 10 feet wide measured from edge of SCMs or top of bank for infiltration systems and aboveground facilities.

5. For drainage conveyance or open channels, the easement must provide 10 feet clear access on both sides measured from the top of bank.

6. Where possible, easements must be centered on side and/or rear lot lines.

B. The following language must be included in recorded easements:

"*The stormwater control measure(s) and drainage features within this easement, whether manmade or natural, must be protected and maintained to function as designed. If the entity identified in this easement as responsible for maintenance fails to properly address deficiencies identified in writing by the Municipality, the District, DEP, or other government agency within 180 days of receiving written notice of the deficiency, the Municipality, the District, DEP, or other government agency may cause the maintenance to be performed. The full cost of the maintenance may be billed to the entity identified as responsible for maintenance.*"

C. Residential Lots.

1. If an easement for stormwater management or drainage is located on a residential lot, the applicant for stormwater approval under this Ordinance is required to inform the current owner or, in the case of a new subdivision the original purchaser of the lot, of the existence of an easement. Proof of this notification must be provided to the Municipality in the form of an easement agreement or other documentation signed by the owner. If the purchaser/owner of the lot will assume any maintenance responsibilities, the purchaser must be a party to and sign the easement agreement.

2. When a homeowners association will assume partial or full responsibility for the maintenance and protection of stormwater management on a private residential lot, both the individual residential lot owner and the party responsible for the formation and operation of the homeowners association must be a party to the easement

agreement. Fully executed agreements must be submitted to the Municipality upon recordation.

3. If any responsibility for maintenance is assigned to an individual residential lot owner, the following language in paragraphs 3.a and 3.b, below, must be included in the easement:

   a. "*This permanent access, drainage, and maintenance easement encloses a stormwater management feature, drainage feature, or natural feature that must be protected and maintained. Assuring maintenance is performed and the intended function of the stormwater management, drainage feature, or natural feature is maintained is the responsibility of the owner of the land that includes the easement, and that responsibility is transferred with the land. The land and features within the easement must be maintained in accordance with the approved PCSM Plan.*"

   b. "*No structure may be added, grading performed, or other activities may occur within the easement that may, in the opinion of the Municipality, District, or DEP, interfere with the purpose of the easement.*"

D. A statement in the easement agreement must include reference to the approved PCSM Plan and explain that the PCSM Plan provides details on the maintenance requirements for the easement area. If a PCSM Plan does not exist, full details of all required maintenance must be included in the easement agreement.

E. The following notes must be placed on the PCSM Plan:

   a. "No alteration within the easement that would adversely affect the function of stormwater management or conflict with any conditions associated with such easement is permitted."

   b. A note must be placed on the PCSM Plan identifying the party responsible for assuring the continued functionality and performing required maintenance of any easement.

F. Off-site stormwater management SCMs that are relied upon to meet the requirements of this Ordinance must be included on PCSM Plan Drawings and enclosed within an easement that will allow for inspection by the Municipality, the District, and DEP.

G. Where surface waters traverse a development site, drainage easements must be provided conforming to the line of such surface waters and must be shown on PCSM Plan Drawings.

Section 802. Discharges to Adjacent Property

A. Stormwater runoff onto adjacent property must not be created, increased, decreased, relocated, or otherwise altered without written notification to the adjacent property owner(s). Such stormwater flows are subject to the requirements of this Ordinance.

B. For new or increased stormwater runoff from a project site during or following earth disturbance activities that will flow through adjacent properties prior to reaching surface waters and are not covered by prescriptive rights, the applicant must provide the following documentation to the Municipality with the PCSM Plan:

   1. An erosion potential analysis in accordance with Section 505.

   2. Documentation that the applicant has the right to discharge stormwater to off-site properties under state law.

ARTICLE IX – FEES AND EXPENSES

Section 901. General

The Municipality may include all anticipated costs in the review fee charged to an applicant. The fees may include, but not be limited to, costs for the following:

A. Administrative/clerical processing.

B. Review of the E&S Plan and PCSM Plan by the Municipality and the municipal Engineer.

C. Attendance at meetings.

D. Inspections of earth disturbance activities during construction, following permanent stabilization of the project site, and of PCSM SCMs to ensure proper operation and maintenance by the responsible party. These inspections may be periodic during construction or as part of a final inspection.

E. Any additional work required to enforce any provision of this Ordinance, correct violations, and assure proper completion of stipulated remedial actions.

ARTICLE X – PROHIBITIONS

Section 1001. Prohibited Discharges and Connections

A. Any drain or conveyance, whether on the surface or subsurface, that allows any unauthorized non-stormwater discharge to enter a regulated small MS4 or to enter a water of this Commonwealth is prohibited.

B. Illicit Discharges.

1. No person may allow, or cause to allow, discharges into a regulated small MS4, or discharges into waters of this Commonwealth, which are not composed entirely of stormwater, except (1) as provided in paragraph C below and (2) discharges authorized under a state or federal permit.

2. Any person or entity that causes an unauthorized non-stormwater discharge or discharge into or from the MS4 that results in or contributes to a violation of the Municipality's MS4 NPDES permit is subject to the enforcement provisions of Article XI.

3. Any drain or conveyance connected from a commercial or industrial land use to a storm sewer, which has not been approved by the Municipality, is prohibited.

C. The following non-stormwater discharges are authorized unless they are determined to be significant contributors of pollution to an MS4 or to the waters of this Commonwealth:

1. Discharges or flows from emergency firefighting activities.

2. Discharges from potable water sources including water line flushing and fire hydrant flushing, if such discharges do not contain detectable concentrations of Total Residual Chlorine (TRC).

3. Non-contaminated irrigation water, water from lawn maintenance, landscape drainage and flows from riparian habitats and wetlands.

4. Diverted stream flows and springs.

5. Non-contaminated pumped ground water and water from foundation and footing drains and crawl space pumps.

6. Non-contaminated HVAC condensation and water from geothermal systems.

7. Residential (that is, not commercial) vehicle wash water where agents are not utilized.

8. Non-contaminated hydrostatic test water discharges, if such discharges do not contain detectable concentrations of TRC.

9. Routine external building washdown (which does not use detergents or other compounds).

10. Pavement washwaters where spills or leaks of toxic or hazardous materials have not occurred (unless all spill material has been removed) and were detergents are not used.

D. In the event that the Municipality or DEP determines that any of the discharges identified in paragraph C is a significant contributor of pollutants to an MS4 or to the waters of this Commonwealth, the Municipality or DEP will notify the responsible person(s) to cease the discharge.

E. In the event that the Municipality or DEP discovers an illicitly connected drain or conveyance to a storm sewer which was not previously approved, the illicit connection must be eliminated if unauthorized non-stormwater discharges could enter the storm sewer.

Section 1002. Roof Drains and Sump Pumps

Roof drains and sump pumps may not discharge to sidewalks, streets, curbs, or where freezing of such discharges may create a nuisance or public hazard. Roof drains and sump pumps shall not be connected to sanitary sewers. Wherever

possible roof drains and sump pumps must discharge to vegetated SCMs.

Section 1003. Notification of Pollution

If, because of an accident or other activity or incident, a toxic substance or another substance which would endanger downstream users of the waters of this Commonwealth, would otherwise result in pollution or create a danger of pollution of the waters, or would damage property, is discharged into these waters, including sewers, drains, ditches or other channels of conveyance into the waters, or is placed so that it might discharge, flow, be washed or fall into them, it is the responsibility of the person at the time in charge of the substance or owning or in possession of the premises, facility, vehicle or vessel from or on which the substance is discharged or placed to immediately notify the Municipality and DEP by telephone of the location and nature of the danger and, if reasonably possible to do so, to notify known downstream users of the waters.

ARTICLE XI – INSPECTION, ENFORCEMENT AND PENALTIES

Section 1101. Right of Entry

Upon presentation of proper credentials, the Municipality or its designated agent may enter at reasonable times upon any property within the Municipality when necessary to inspect the condition of the project site, E&S BMPs, and PCSM SCMs to evaluate compliance with this Ordinance.

Section 1102. Post-Construction Inspections of SCMs

A. The landowner or the party identified in an O&M agreement (including the Municipality for dedicated and owned facilities) must inspect SCMs implemented under this Ordinance at the frequency(ies) identified in the long-term O&M Plan to ensure the SCMs continue to function as intended.

B. Post-construction inspections must be conducted during or immediately following precipitation events unless the inspection will evaluate the dewatering time of the SCM or other parameters that can be inspected during dry weather. A written inspection report must be prepared to document each inspection.

C. The following information must be recorded on the inspection report, at a minimum:

1. SCM type;
2. Date and time of the inspection;
3. Individual(s) who completed the inspection;
4. Location of the SCM inspected (including Latitude and Longitude, Parcel ID number, and physical address);
5. Landowner's or responsible party's name and contact information;
6. Observations on performance; and
7. Observations on maintenance needs, if applicable.

D. Where an inspection reveals improper performance and/or needed repairs, the landowner or responsible party must submit completed inspection reports to the Municipality within 30 days following completion of the inspection. If repairs are needed, the report must also include a timeframe for completing the repairs. All inspection records must be maintained by the landowner for not less than five (5) years and must be made available to the Municipality within five (5) calendar days of receipt of written request from the Municipality.

E. The Municipality may elect to conduct post-construction inspections in addition to routine inspections that must be conducted by the landowner or other responsible party.

Section 1103. Enforcement

A. The Municipality may take enforcement action against a permittee, landowner, or other responsible party for any failure to satisfy the provisions of this Ordinance.

B. It is unlawful for a person to undertake any regulated activity except as provided in an approved E&S Plan and PCSM Plan, unless specifically exempted in Section 306.

C. The Municipal Engineer or other designee is hereby authorized and directed to enforce all the provisions of this Ordinance. The Municipal Governing Body may delegate enforcement duties to such other officers or agents as the Municipality deems qualified for that purpose.

D. It is the responsibility of the landowner of the real property on which any regulated activity is proposed to occur, is occurring, or has occurred to comply with the applicable terms and conditions of this Ordinance.

E. During any stage of the work of any regulated activity, if the Municipal Engineer or other designee determines that the E&S BMPs, PCSM SCMs, conveyances or other stormwater facilities are not being installed or maintained in

accordance with the approved E&S Plan and PCSM Plan, the Municipality may suspend or revoke any existing permits or other approvals until the deficiencies are corrected or until a revised plan is submitted and approved, as determined to be necessary by the Municipal Engineer or other designee.

F. In the event that the Municipal Engineer or other designee finds that a person has violated a provision of this Ordinance, or fails to conform to the requirements of any permit or approval issued by the Municipality, or any O&M Plan or O&M Agreement approved by the Municipality, the Municipality may order compliance by written notice of the violation to the permittee, landowner, or other responsible party. Such notice may, without limitation, require the following remedies:

1. Performance of monitoring, analyses, and reporting;

2. Elimination of prohibited connections or discharges;

3. Cessation of any violating discharges, practices, or operations;

4. Abatement or remediation of stormwater pollution or contamination hazards and the restoration of any affected property;

5. Payment of a fine to cover administrative and remediation costs and/or forfeiture of financial guarantee;

6. Implementation of E&S BMPs, PCSM SCMs, and/or conveyances; and

7. Operation, maintenance or repair of SCMs, conveyances or other stormwater facilities.

G. Such notice will set forth the nature of the violation(s), citing the specific sections of this Ordinance which have not been met, and establish a timeframe for correction of the violations(s). The notice will provide for a right of appeal to the Municipal Governing Body in accordance with Section 1106 of this Ordinance. Said notice will further advise that, if applicable, should the violator fail to take the required action within the established deadline, possible sanctions, clearly described, may be imposed, or the work may be done by the Municipality or designee, and the expense thereof will be charged to the violator.

H. Failure to comply within the time specified in such notice subjects such person to the penalty provisions of this Ordinance. All such penalties will be deemed cumulative and will not prevent the Municipality from pursuing any and all other remedies available in law or equity.

Section 1104. Suspension and Revocation

A. Any approval or permit issued by the Municipality pursuant to this Ordinance may be suspended or revoked for:

1. Non-compliance with or failure to implement any provision of the approved E&S Plan, PCSM Plan or O&M Plan or Agreement.

2. A violation of any provision of this Ordinance or any other applicable law, ordinance, rule, or regulation relating to the regulated activity.

3. The creation of any condition or the commission of any act during the regulated activity which constitutes or creates a hazard, nuisance, pollution, or endangers the life or property of others.

B. A suspended approval may be reinstated by the Municipality when:

1. The Municipality has inspected and approved the corrections to the violations that caused the suspension.

2. The Municipality is satisfied that the violation has been corrected.

C. An approval that has been revoked by the Municipality cannot be reinstated. The applicant may apply for a new approval under the provisions of this Ordinance.

Section 1105. Penalties

A. Anyone violating the provisions of this Ordinance will be guilty of a summary offense, and upon conviction, will be subject to a fine of not more than (Enter $ amount) for each violation, recoverable with costs. Each day that the violation continues will be a separate offense and penalties will be cumulative.

B. In addition, the Municipality may institute injunctive, mandamus, or any other appropriate action or proceeding at law or in equity for the enforcement of this Ordinance. Any court of competent jurisdiction will have the right to issue restraining orders, temporary or permanent injunctions, mandamus, or other appropriate forms of remedy or relief.

Section 1106. Appeals

A. Any person aggrieved by any action of the Municipality or its designee, relevant to the provisions of this Ordinance, may appeal to the Municipality within 30 days of that action.

B. Any person aggrieved by any decision of the Municipality, relevant to the provisions of this Ordinance, may appeal to the County Court of Common Pleas in the county where the activity has taken place within 30 days of the Municipality's decision.

_____(Ordinance Name)_____

_____(Ordinance Number)_____

ENACTED and **ORDAINED** at a regular meeting of the

_____

on this _____day of _____, 20_____.

This Ordinance shall take effect immediately.

_____ _____
(Name) (Title)

_____ _____
(Name) (Title)

_____ _____
(Name) (Title)

ATTEST:

_____
Secretary

ORDINANCE APPENDIX A

MANAGEMENT DISTRICT MAPS

CHESTER CREEK WATERSHED
ACT 167 STUDY
PLATE 5: RELEASE RATE MAP

June, 2002

West Whiteland

East Goshen

West Goshen

West Chester

Chester County

Delaware County

Edgmont

Westtown

Middletown

Thornbury

Thornbury

Chester Heights

Concord

Chadds Ford

Aston

Brookhaven

Upland

Chester City

Chester Twp.

Bethel

Upper Chichester

LEGEND

- County Boundary
- Stream
- Municipal Boundary

Release Rates

- 0.5
- 0.75
- 1
- # Subarea Boundaries

N

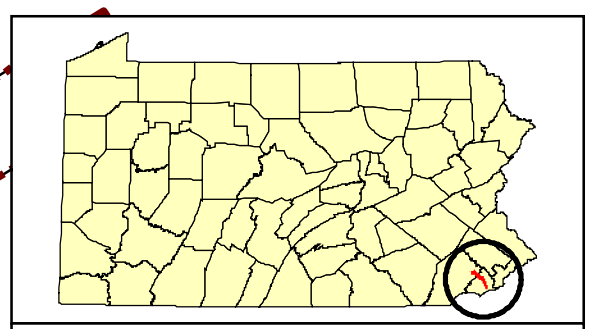
0.25 0 0.25 0.5 Miles

Note:

Map is for reference use only. The exact location of the stormwater management district boundaries as they apply to a given development site must be determined by mapping the boundaries using the two-foot topographic contours (or the most accurate data) required, provided as part of the drainage plan.

Sources: Gannett Fleming

CRUM CREEK
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN



TREDYFFRIN
EASTTOWN
MALVERN
WILLISTOWN
NEWTOWN
EDGMONT
UPPER PROVIDENCE
MARPLE
SPRINGFIELD
MEDIA
MORTON
SWARTHMORE
RUTLEDGE
NETHER PROVIDENCE
RIDLEY
RIDLEY PARK
EDDYSTONE
MONTGOMERY COUNTY
DELAWARE COUNTY
CHESTER COUNTY
DELAWARE COUNTY
PENNSYLVANIA
NEW JERSEY
Delaware River
Crum Creek
Springton Reservoir
Lewis Run
Reese Run
Preston Run
Hunter Run
Trout Run
Hotland Run
Dicks Run
Little Crum Creek

A
B
A
B
A

50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79

30 252 3 252 1 420 320 476 252 13 95 291

Management District Legend

District	Design Storm Proposed Conditions		Design Storm Existing Conditions
A	2-Year 5-Year 10-Year 25-Year 50-Year 100-Year	Reduce To	1-Year 5-Year 10-Year 25-Year 50-Year 100-Year
B	2-Year 5-Year 10-Year 25-Year 50-Year 100-Year	Reduce To	1-Year 2-Year 5-Year 10-Year 25-Year 100-Year

1.25 0.625 0 1.25

1 Inch = 1.25 Miles

APPENDIX A
MANAGEMENT DISTRICTS

Prepared For:
Delaware County Planning Department
Courthouse and Government Center Bldg
201 West Front Street
Media, PA 19063
610-891-5200

Legend

- WATERSHED BOUNDARY
- SURFACE WATER
- STREAMS
- SUBAREAS
- COUNTY BOUNDARIES
- MUNICIPAL BOUNDARIES

Roads

- INTERSTATE
- US HIGHWAY
- PA HIGHWAY
- OTHER ROADS

NOTE:
Portions of this map were generated from existing data sources as listed below. These data are shown on the map for spatial reference only. These data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of these data and has corrected the data in locations where discrepancies were obvious; however, it was not a part of this Act 167 Plan to correct all of the mapping data.

DATA SOURCES:
Watershed Boundary - PADEP
State Roads - PennDOT, 2004
Local Roads - PennDOT, 2001
Counties - PennDOT, 2002
Municipalities - PennDOT, 2001
Streams - PaDEP/ERRI, 2001
Lakes - Aqua America, 2001
Delaware River - USFWS (derived from NWI coverages)
Management Districts/ Subareas - Delineated by Borton-Lawson, 2006

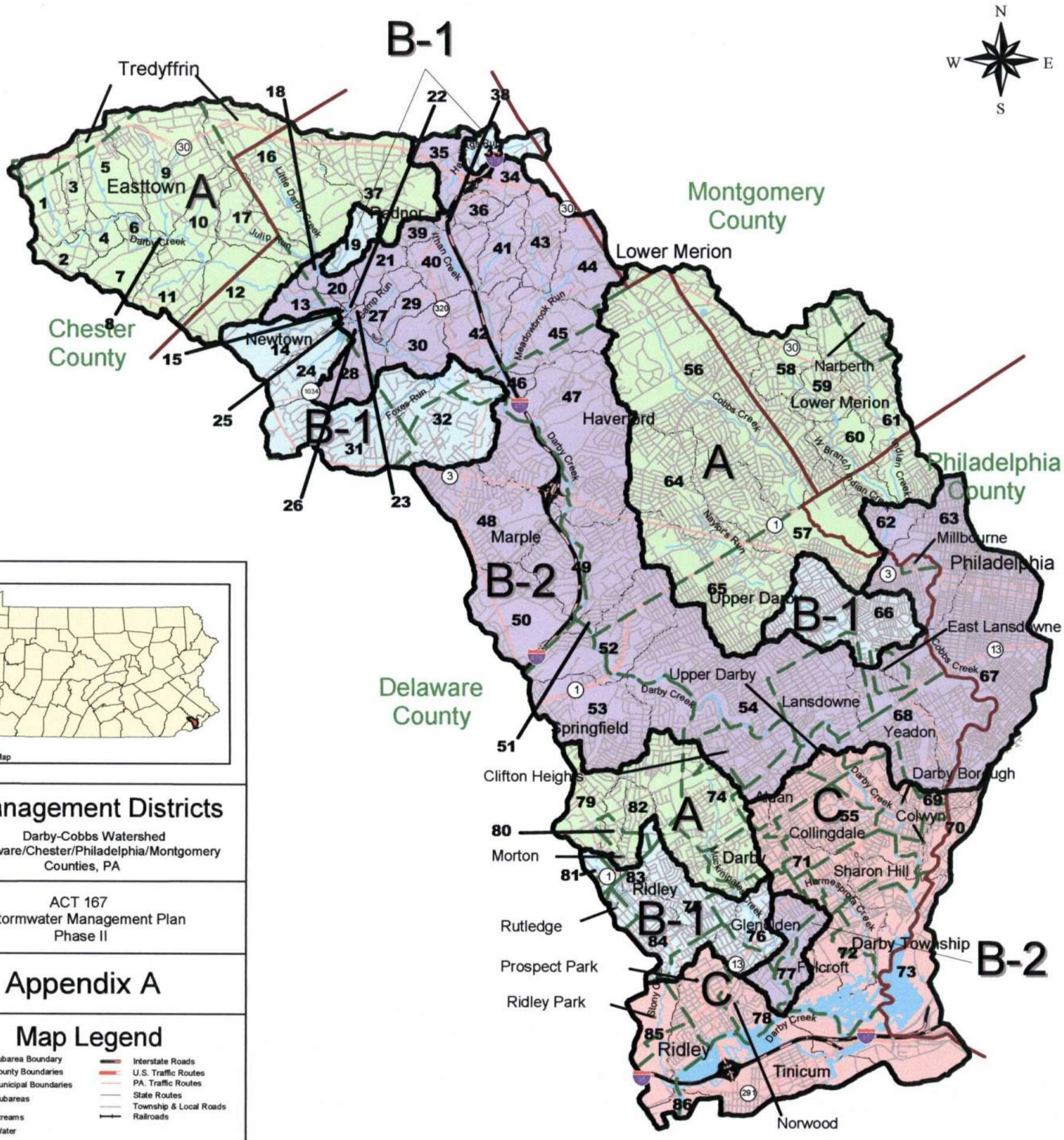
Borton Lawson ENGINEERING

Northeast Pennsylvania
613 Baltimore Drive
Wilkes-Barre, PA 18702
Tel: 570-821-1999

Lehigh Valley
3893 Adler Place
Bethlehem, PA 18017
Tel: 484-821-0470

PREPARED BY: WSB CHECKED BY: SJD
Date: 10/08/2008 PROJECT #: 2004-1553-00

FILE: \\Athens\dProjects\2004\1553\00\DATA\GIS\FINAL_REPORT_MAPS\ArcMap\AppendixA_Crum_Mgmt_Districts.mxd



Management Districts

Darby-Cobbs Watershed
Delaware/Chester/Philadelphia/Montgomery Counties, PA

ACT 167
Stormwater Management Plan
Phase II

Appendix A

Map Legend

- Subarea Boundary
- County Boundaries
- Municipal Boundaries
- Subareas
- Streams
- Water
- Interstate Roads
- U.S. Traffic Routes
- PA. Traffic Routes
- State Routes
- Township & Local Roads
- Railroads

Prepared For:
Delaware County Planning Department
Court House/Government Center
201 West Front Street
Media, PA 19063
610-891-5200

Note:

Portions of these maps were generated from existing data sources as listed below. This existing data was utilized for base mapping purposes and is shown on the maps for spatial reference only. This data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of this data and has corrected the data in locations where these discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the base data.

Data Sources:
DRGs - USGS
Subareas - BLE

Borton Lawson ENGINEERING

613 Baltimore Drive
Suite 300
Wilkes-Barre, PA 18702-7903
570-821-1999 Fax 570-821-1990

6814 Chrisphalt Drive
Suite 200
Bath, PA 18014
610-837-5916 Fax: 610-837-5918

World Wide Web : http://www.borton-lawson.com

Prepared By: CGF | Check By:
Project Number: 99613.01 | Date of Plot: December 2003

Management Districts Legend

	Design Storm Proposed Conditions	Reduce To	Design Storm Existing Conditions
A	2 - Year		1 - Year
	5 - Year		5 - Year
	10 - Year		10 - Year
	25 - Year		25 - Year
	100 - Year		100 - Year
B-1	2 - Year		1 - Year
	10 - Year		5 - Year
	25 - Year		10 - Year
	50 - Year		25 - Year
	100 - Year		100 - Year
B-2	2 - Year		1 - Year
	5 - Year		2 - Year
	25 - Year		5 - Year
	50 - Year		10 - Year
	100 - Year		100 - Year
C*	Provisional Discharge District (see notes below *)		

* If storms greater than the 2 - year storm cannot be conveyed to a stream or watercourse in a safe manner, then District A requirements shall apply. (See model ACT 167 Stormwater Management Ordinance, Article III Section 308 for details.)

In addition to the Management District Criteria above, the groundwater recharge (Secton 305), water quality (Section 306), and streambank erosion (Section 307) requirements shall also apply to all Management Districts within the Darby-Cobbs Watershed.

8000 0 8000 Feet

file: p:\99613\01\data\gis\arcinfo\wshed.apr\Appendix A - Management Districts D

Table I-2

RELEASE RATE PERCENTAGES FOR DELAWARE COUNTY SUBAREAS

Subarea	Release Rate Percentage	Subarea	Release Rate Percentage
3	85	35	100
4	100	36	100
5	100	37	100
6	100	38	100
7	100	39	100
8	80	40	85
9	100	41	100
11	100	42	100
12	100	43	100
14	100	44	100
16	95	45	100
17	100	47	100
18	100	48	100
19	100	49	100
20	100	50	100
21	100	51	100
22	100	52	100
23	70	53	100
24	80	54	100
25	95	55	100
26	100	56	100
27	100	57	100
28	60	58	100
29	100	59	100
30	100	60	100
31	60	62	100
32	100	63	100
33	100	64	100
34	100	65	100

N

Plate 1

DELAWARE COUNTY STORMWATER MANAGEMENT PLAN
RIDLEY CREEK WATERSHED

Subarea Map

NOVEMBER, 1982 REVISED NOVEMBER, 1987

0 2000 4000 6000 8000

LEGEND

- Watershed Boundary
- Subarea Boundaries
- County Boundary
- Municipal Boundaries
- State Park Boundary

NOTE: SUBAREAS 46 AND 61 HAVE NO REAL LAND AREA AND WERE NECESSARY ONLY FOR COMPUTATIONAL PURPOSES

Delaware County Planning Department
Toal Building, 2nd & Orange Sts, Media, Pa.
19063 215-891-5200

Walter B Satterthwaite Associates, Inc.
11 N Five Points Rd West Chester, Pa
19380 215-692-5770

Green International Inc.
504 Beaver St Sewickley, Pa.
15143 412-761-2770

CHESTER COUNTY

DELAWARE COUNTY

ORDINANCE APPENDIX B

SIMPLIFIED APPROACH TO STORMWATER MANAGEMENT FOR SMALL PROJECTS

This appendix provides simplified stormwater management procedures that are applicable for projects with between 500 square feet and 999 square feet of proposed impervious area.

SIMPLIFIED APPROACH TO STORMWATER MANAGEMENT FOR SMALL PROJECTS

Introduction

The following procedures have been developed to allow homeowners to comply with stormwater management criteria for new projects to meet the requirements of the Act 167 Stormwater Management Ordinance of the Municipality including sizing, designing, locating, and installing on-lot measures, referred to herein as "Best Management Practices" (BMPs). Pennsylvania Act 167 was authorized on October 4, 1978 (32 P.S., P.L. 864) and gave Pennsylvania municipalities the power to regulate activities that affect stormwater runoff and surface and groundwater quantity and quality.

Individual home construction projects on single-family lots which result in between 500 square feet and 999 square feet of impervious area (including the building footprint, driveway, sidewalks, and parking areas) are not required to submit formal drainage plans to the Municipality or County; however, they are still required to address water quality and infiltration goals as outlined in this Simplified Approach document. If the guidelines presented in this brochure are followed, the individual homeowner will not require professional services to comply with these water quality and infiltration goals.

Section B.1 describes requirements and a simplified method for designing a suitable BMP, and a description of what needs to be included on the simple sketch plan. Section B.2 presents definitions of key terms. Section B.3 presents options of BMPs that can be considered for on-lot stormwater management. An example of how to obtain the size and dimensions of a BMP is explained in Section B.4. Section B.5 describes the requirements to be met for the modified Operation, Maintenance, and Inspection Plan.

The Simplified Approach requires:

- The first 1" of rainfall runoff from new impervious surfaces to be captured (see definition in Section B.2).

The purpose of this is to help reduce stormwater runoff in the community, to maintain groundwater recharge, to prevent degradation of surface and groundwater quality, and to otherwise protect water resources and public safety.

What needs to be sent to the Municipality?

Even though a formal drainage plan is not required for individual lot owners, the Simplified Method worksheet found in Table B-4 and a simple sketch plan containing the features described in Step 5 of Section B.1 needs to be submitted to the Municipality, and if applicable, the contractor prior to construction. The Operation and Maintenance Agreement found in Section B.5 needs to be signed and submitted with the simple sketch plan to the Municipality for approval.

B.1 Determination of Simplified Approach Volume Requirements

All proposed impervious areas must be included in the determination of the amount of new impervious areas and the size of proposed BMPs needed to control stormwater. Proposed impervious areas on an individual residential lot include: roof area, pavement, sidewalks, driveways, patios, porches, permanent pools, or parking areas. Sidewalks, driveways, or patios that are constructed with gravel or pervious pavers that will not be converted to an impervious surface in the future need not be included in this calculation. Therefore, the amount of proposed impervious area can be reduced for proposed driveways, patios, and sidewalks through the use of gravel, pervious pavement, and turf pavers. All proposed impervious areas must be constructed so that runoff is conveyed to a BMP; no runoff can be directed to storm sewers, inlets, or other impervious areas (i.e., street).

In addition, the use of low impact development is recommended to further minimize the effect of the new construction on water, land, and air. Low impact development is a method of development that incorporates design techniques that include: minimizing the amount of land disturbance, reducing impervious cover, disconnecting gutters and directing runoff to vegetated areas to infiltrate, and redirecting the flow of runoff from impervious driveways to vegetated areas instead of to the street or gutter.

Below are the steps that must be undertaken to meet the Ordinance requirements. The results obtained for each step must be included in the Simplified Method Worksheet found in Table B-4:

STEP 1 – Determine the total area of all proposed impervious surfaces that will need to drain to one or more BMPs. Determine locations where BMPs need to be placed so that runoff from all of the proposed impervious surfaces can be captured. Select the BMPs to be used and determine the requirements of each from Section B.3. For instance, the back half of a garage may drain 200 square feet of roof to a rain barrel, and the front half of a garage may drain 200 square feet of roof and 540 square feet of driveway to a bioretention area. Then, obtain the required storage volume and surface area needed for each of the proposed BMPs from the appropriate heading below.

For Rain Barrels/Cisterns

STEP 2 –Select the proposed impervious area value in Column 1 of Table B-1 that is closest to, but not less than, the determined value.

STEP 3 – Determine the volume that needs to be provided in cubic feet and gallons to satisfy the volume requirements using Columns 2 and 3 in Table B-1.

Table B-1: Simplified Method - Calculating Rain Barrel/Cistern Storage Volume for 1" Rainfall[1]

Column 1	Column 2	Column 3	
Proposed Impervious Area (square feet)	**Volume of Rain Barrel/Cistern[2] (cubic feet)**	**Volume of Rain Barrel/Cistern (gallons)**	
I	V_{RBcf}	V_{RBgal}	
Sum of all Proposed Impervious Areas	$(1*(1/12)*I)/0.75=V_{RBcf}$	VRBcf * 7.48=VRBgal	
50	6	42	
100	11	83	
150	17	125	**Rain Barrel**
200	22	166	
250	28	208	
300	33	249	
350	39	291	
400	44	332	
450	50	374	
500	56	416	
550	61	457	**Cistern**
600	67	499	
650	72	540	
700	78	582	
750	83	623	
800	89	665	
850	94	706	
900	100	748	
950	106	790	
999	111	830	

[1]The typical volume of a rain barrel is between 50-200 gallons, so more than 1 rain barrel may be needed. Larger volumes may require a cistern.
[2]Assume that the rain barrel/cistern is 25% full

For Rain Gardens/Bioretention or Dry Well #1:

STEP 2 – Select the proposed impervious area value in Column 1 of Table B-2 that is closest to, but not less than, the determined value.

STEP 3 - Determine the volume that needs to be provided in cubic feet to satisfy the volume requirements using Column 2 in Table B-2.

STEP 4 – Using the value from Column 2 determined above, select the depth (D) of the proposed BMP, and then simply determine the surface area needed for that depth from Column 3 of Table B-2.

Note: The arrows under Column 3 in Table B-2 indicate which range of depths is appropriate for each BMP. To determine the depth based on the area, select an area that corresponds to the required volume that is closest to, but not more than the area to be used. To determine the area based on the depth, select a depth that is closest to, but not less than, the depth that is to be used.

Table B-2: Simplified Method - Calculating Rain Garden/Bioretention and Dry Well #1 Storage Volume and Surface Area for 1" Rainfall

Column 1	Column 2	Column 3							
Proposed Impervious Area (square feet)	**Volume of Rain Garden/Bioretention or Dry Well #1[1] (cubic feet)**	**Surface Area of Rain Garden/Bioretention or Dry Well #1** Acceptable Depths for Each BMP are indicated by the arrows below **(square feet)**							
		Area Required for a BMP with a Depth(D) of 0.5'	*Area Required for a BMP with a Depth(D) of 1.0'*	*Area Required for a BMP with a Depth(D) of 1.5'*	*Area Required for a BMP with a Depth(D) of 2.0'*	*Area Required for a BMP with a Depth(D) of 2.5'*	*Area Required for a BMP with a Depth(D) of 3.0'*	*Area Required for a BMP with a Depth(D) of 3.5'*	*Area Required for a BMP with a Depth(D) of 4.0'*
		Rain Garden /Bioretention (0.5'-1.0')		**Dry Well #1 (1.5'-4.0')**					
I	V	*A(sf)*							
Sum of all Proposed Impervious Areas	1*(1/12)*I= V	V/D=A							
50	4	8	4	3	2	2	1	1	1
100	8	17	8	6	4	3	3	2	2
150	13	25	13	8	6	5	4	4	3
200	17	33	17	11	8	7	6	5	4
250	21	42	21	14	10	8	7	6	5
300	25	50	25	17	13	10	8	7	6
350	29	58	29	19	15	12	10	8	7
400	33	67	33	22	17	13	11	10	8
450	38	75	38	25	19	15	13	11	9
500	42	83	42	28	21	17	14	12	10
550	46	92	46	31	23	18	15	13	11
600	50	100	50	33	25	20	17	14	13
650	54	108	54	36	27	22	18	15	14
700	58	117	58	39	29	23	19	17	15
750	63	125	63	42	31	25	21	18	16
800	67	133	67	44	33	27	22	19	17
850	71	142	71	47	35	28	24	20	18
900	75	150	75	50	38	30	25	21	19
950	79	158	79	53	40	32	26	23	20
999	83	167	83	56	42	33	28	24	21

[1]Assume that the rain garden/bioretention or the dry well #1 are 0% full

For Infiltration Trench or Dry Well #2:

STEP 2 – Select the proposed impervious area value in Column 1 of Table B-3 that is closest to, but not less than, the determined value.

STEP 3 - Determine the volume that needs to be provided in cubic feet to satisfy the volume requirements using Column 2 in Table B-3.

STEP 4 – Using the value from Column 2 determined above, select the depth (D) of the proposed BMP, and then simply determine the surface area needed from Column 3 of Table B-3.

Note: The arrows under Column 3 in Table B-3 indicate which range of depths is appropriate for each BMP. To determine the depth based on the area, select an area that corresponds to the required volume that is closest to, but not less than, the area to be used. To determine the area based on the depth, select a depth that is closest to, but not less than, the depth that is to be used.

STEP 5 - Sketch a simple site plan as shown in Figure B-1 that includes:

- Name and address of the owner of the property, and or name and address of the individual preparing the plan, along with the date of submission.

- Location of proposed structures, driveways, or other paved areas with approximate size in square feet.

- Location, orientation, and dimensions of all proposed BMPs. For all rain gardens/bioretention, infiltration trenches, and dry wells, the length, width, and depth must be included on the plan. For rain barrels or cisterns the volume must be included.

- Location of any existing or proposed on-site septic system and/or potable water wells showing rough proximity to infiltration facilities.

- Location of any existing waterbodies such as; streams, lakes, ponds, wetlands, or other waters of the Commonwealth within fifty (50) feet of the project site, and the distance to the project site and/or BMPs. The project or BMPs cannot be located less than fifty (50) feet away from a perennial or intermittent stream. If an existing buffer is legally prescribed (i.e., deed, convenant, easement, etc.) and it exceeds the requirements of this Ordinance, the existing buffer shall be maintained.

- Location of all existing structures including buildings, driveways, and roads within fifty (50) feet of the project site.

Fill in the simplified method worksheet found in Table B-4, then submit the worksheet and the simple site sketch to the Municipality. Additionally, the operation and maintenance agreement found in Section B.5 must be signed and submitted to the Municipality.

Table B-3: Simplified Method - Calculating Infiltration Trench and Dry Well #2 Storage Volume and Surface Area for 1" Rainfall

Column 1	Column 2	Column 3							
Total Proposed Impervious Area (square feet)	**Volume of Infiltration Trench or Dry Well #2[1] (cubic feet)**	**Surface Area of Infiltration Trench or Dry Well #2** Acceptable Depths for Each BMP are indicated by the arrows below **(square feet)**							
		Area Required for a BMP with a Depth(D) of 1.5'	*Area Required for a BMP with a Depth(D) of 2.0'*	*Area Required for a BMP with a Depth(D) of 2.5'*	*Area Required for a BMP with a Depth(D) of 3.0'*	*Area Required for a BMP with a Depth(D) of 3.5'*	*Area Required for a BMP with a Depth(D) of 4.0'*	*Area Required for a BMP with a Depth(D) of 4.5'*	*Area Required for a BMP with a Depth(D) of 5.0'*
		Dry Well #2 (1.5'-4.0')				**Infiltration Trench (2.0'-5.0')**			
I	V	*A(sf)*							
Sum of all Proposed Impervious Areas	(1*(1/12)*I)/Void Ratio (0.4)*=V	V/D=A							
50	10	7	5	4	3	3	3	2	2
100	21	14	10	8	7	6	5	5	4
150	31	21	16	13	10	9	8	7	6
200	42	28	21	17	14	12	10	9	8
250	52	35	26	21	17	15	13	12	10
300	63	42	31	25	21	18	16	14	13
350	73	49	36	29	24	21	18	16	15
400	83	56	42	33	28	24	21	19	17
450	94	63	47	38	31	27	23	21	19
500	104	69	52	42	35	30	26	23	21
550	115	76	57	46	38	33	29	25	23
600	125	83	63	50	42	36	31	28	25
650	135	90	68	54	45	39	34	30	27
700	146	97	73	58	49	42	36	32	29
750	156	104	78	63	52	45	39	35	31
800	167	111	83	67	56	48	42	37	33
850	177	118	89	71	59	51	44	39	35
900	188	125	94	75	63	54	47	42	38
950	198	132	99	79	66	57	49	44	40
999	208	139	104	83	69	59	52	46	42

[1]Assume a void ratio of 40%

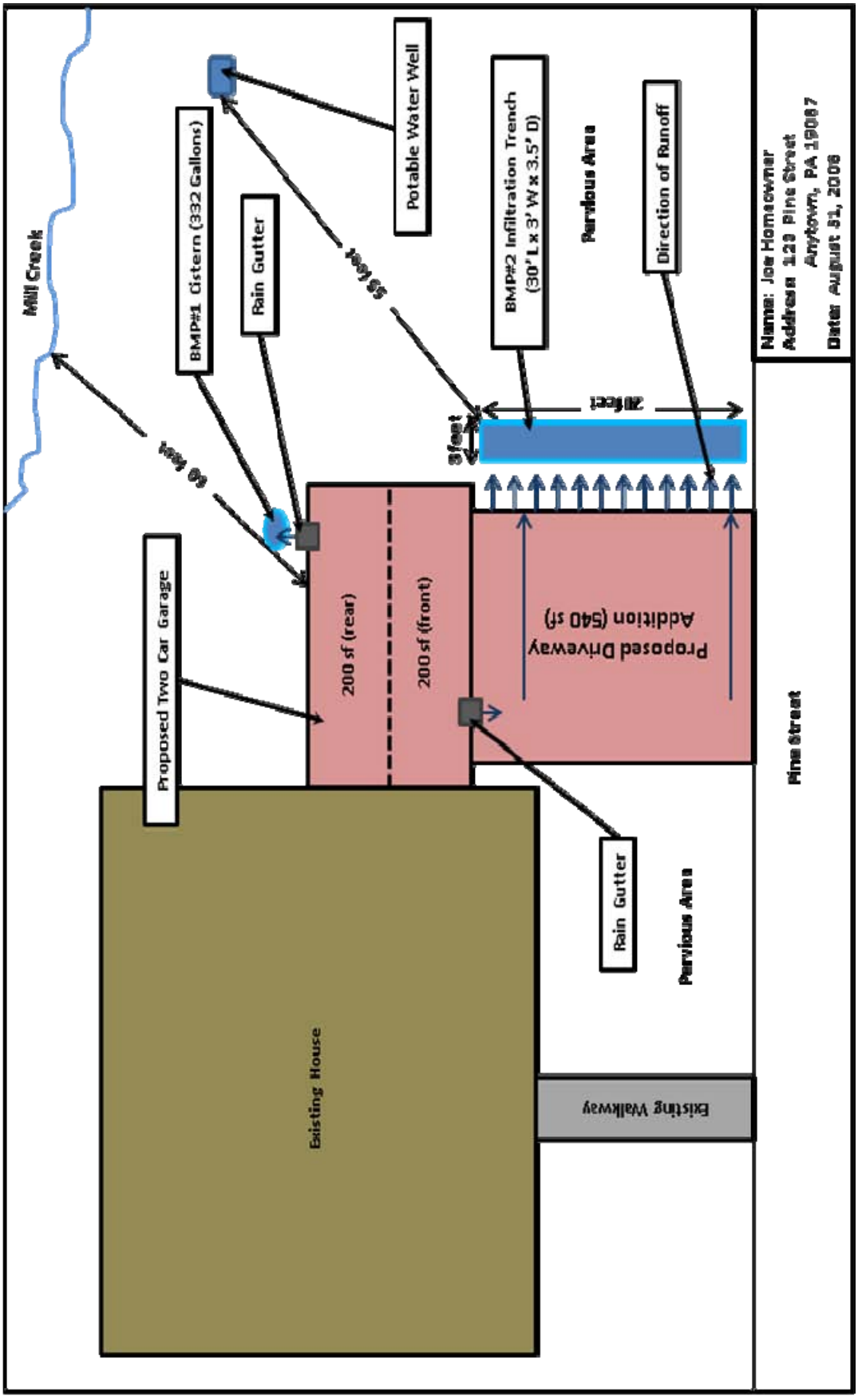


Figure B-1: Typical Dry Well Configuration filled with Stone Fill (Left) and Structural Prefabricated Chamber (Right)

Table B-4: Simplified Method Worksheet

Simplified Method Worksheet				
STEP 1				
Proposed Impervious Surface for BMP #1	**Proposed Impervious Surface for BMP #2**	**Proposed Impervious Surface for BMP #3**		
STEPS 2&3				
Rain Barrel or Cistern				
Proposed Impervious Surface from Column 1 in Table B-1	**Volume from Column 2 or 3 in Table B-1**			
Rain Garden/Bioretention or Dry Well #1				
Proposed Impervious Surface from Column 2 in Table B-2	**Volume of BMP from Column 2 in Table B-2**	**Area of BMP from Column 3 in Table B-2**	**Depth of BMP from Column 3 in Table B-2**	**Types of Material to Be Used**
Infiltration Trench or Dry Well #2				
Proposed Impervious Surface from Column 2 in Table B-3	**Volume of BMP from Column 2 in Table B-3**	**Area of BMP from Column 3 in Table B-3**	**Depth of BMP from Column 3 in Table B-3**	**Types of Material to Be Used**

Note: For additional BMPs, use additional sheets

B.2 Definitions

Best Management Practice (BMP) - Activities, facilities, designs, measures, or procedures used to manage stormwater impacts from land development, to protect and maintain water quality and groundwater recharge and to otherwise meet the purposes of the Municipal Stormwater Management Ordinance, including but not limited to infiltration trenches, dry wells, bioretention, rain gardens, permeable paving, rain barrels, and cisterns.

Capture - Collecting runoff to be stored for reuse or allowed to slowly infiltrate into the ground.

Geotextile - A fabric manufactured from synthetic fiber that is used to achieve specific objectives, including infiltration, separation between different types of media (i.e., between soil and stone), or filtration.

Hotspot - Areas where land use or activities generate highly contaminated runoff, with concentrations of pollutants that are higher than those that are typically found in stormwater (e.g., vehicle salvage yards and recycling facilities, vehicle fueling stations, fleet storage areas, vehicle equipment and cleaning facilities, and vehicle service and maintenance facilities).

Impervious Surface - A surface that prevents the infiltration of water into the ground. Impervious surfaces include, but are not limited to, streets, sidewalks, pavements, swimming pools, driveway areas or roofs.

Infiltration - Movement of surface water into the soil, where it is absorbed by plant roots, evaporated into the atmosphere, or percolated downward to recharge groundwater.

Low Impact Development - A land development and construction approach that uses various land planning, design practices, and technologies to simultaneously conserve and protect natural resource systems, and reduce infrastructure costs.

Pervious Surface - Any surface that is not impervious.

Runoff - Any part of precipitation that flows over the land surface.

Stormwater - Drainage runoff from the surface of the land resulting from precipitation or snow or ice melt.

Void Ratio - The ratio of the volume of void space to the volume of solid substance in any material.

B.3 Description of BMPs

The following is a description of several types of BMPs that could be implemented. The requirements of each BMP as described below are taken directly from the PA BMP Manual. Refer to the PA BMP Manual which can be found on the PA Department of Environmental Protection's website.

Rain Barrels/Cisterns

Rain barrels are large containers that collect drainage from roof leaders and temporarily store water to be released to lawns, gardens, and other landscaped areas after the rainfall has ended. Rain barrels are typically between 50 and 200 gallons in size. The stored water can also be used as a non-potable water supply. Cisterns are larger than rain barrels having volumes of 200 gallons or more, and can be placed on the surface or underground. Figures B-2 and B-3 show examples of rain barrels and cisterns, respectively, that could be used. Rain barrels and cisterns are manufactured in a variety of shapes and sizes. All of these facilities must make provisions for the following items:

- There must be a means to release the water stored between storm events in order for the necessary storage volume to be available for the next storm.
- Stormwater must be kept from entering other potable systems, and pipes and storage units must be clearly marked "Do Not Drink."
- An overflow outlet should be placed a few inches below the top with an overflow pipe to divert flow away from structures.
- Use screens to filter debris, and covers (lids) to prevent mosquitoes.
- Make sure cisterns are watertight and do not leak.
- Rain barrels are typically assumed to be 25% full to calculate volume since they are not always emptied before each storm.*

Figure B-2: Rain Barrels



*This 25% has already been taken into account in Table 3.

Figure B-3: Cisterns



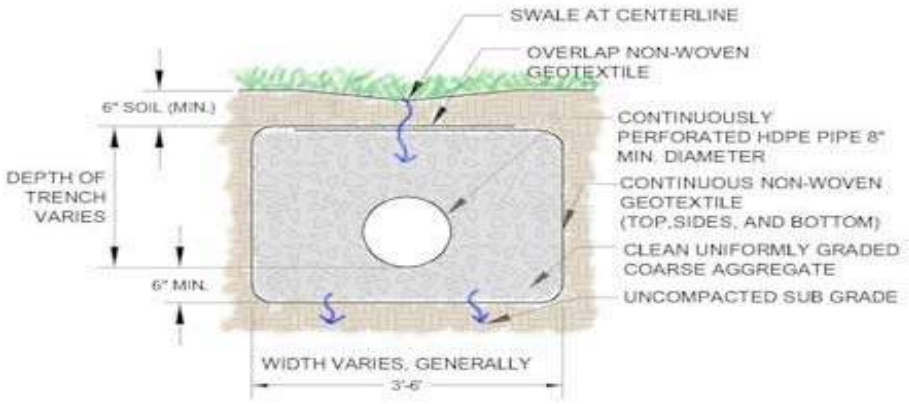
Source (for both pics): Pennsylvania Stormwater BMP Manual (2006)

Infiltration Trench

An infiltration trench is a long, narrow, rock-filled trench with or without a perforated pipe that receives stormwater runoff and has no outlet. Runoff is stored in the void space between the stones and in the pipe and infiltrates through the bottom and into the underlying soil matrix. Infiltration trenches perform well for removal of fine sediment and associated pollutants. Figure B-4 shows a typical infiltration trench configuration. Infiltration trenches shall incorporate or make provisions for the following elements:

- Perforated pipe is to be set level.
- The width is limited to between **3 and 8 feet**, and the depth ranges from **2 to 6 feet**.
- Trench should be wrapped in nonwoven geotextile (see definition in Section B.2) on the top, sides, and bottom.
- There should be a positive overflow that allows stormwater that cannot be stored or infiltrated to be discharged into a nearby vegetated area.
- Roof downspouts may be connected to infiltration trenches, but should contain a cleanout to collect sediment and debris before entering the infiltration area.
- Infiltration testing is recommended to ensure that the soil is capable of infiltrating stormwater. A description of how an infiltration test is performed is found in Appendix C of the PA BMP Manual.
- It is recommended that there be a 2-foot clearance above the regularly occurring seasonal high water table and a minimum depth to bedrock of 2 feet.
- The infiltration trench should be at least 50 feet from individual water supply wells, 100 feet from community or municipal water supply wells, and 50 feet from any septic system component. It should not be located near hotspots (see definition in Section B.2).
- The infiltration trench should be located so that it presents no threat to sub-surface structures such as building foundations and basements.
- Protect infiltration areas from compaction.
- The ratio of the collected area to the footprint of the facility should be as small as possible with a ratio of less than 5:1 preferred.

Figure B-4: Typical Infiltration Trench



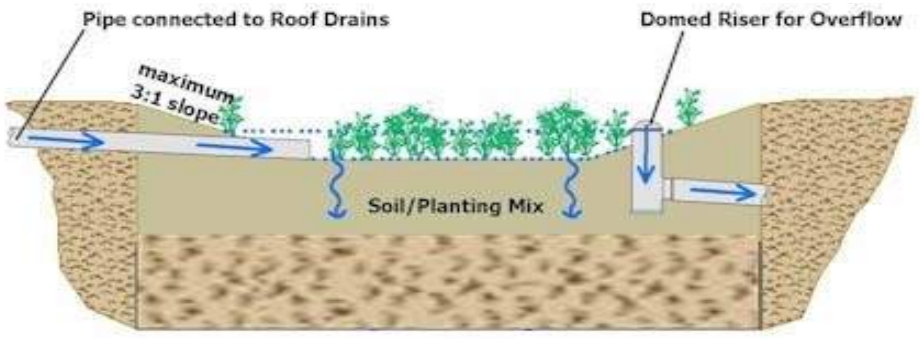
Source: Pennsylvania Stormwater BMP Manual (2006)

Rain Garden/Bioretention Area

A rain garden (bioretention area) is an excavated depression area on the surface of the land in which native vegetation is planted to filter and use stormwater runoff. Runoff ponds on top of the surface of the rain garden and then infiltrates into an enhanced soil below the surface where plants can use the water to grow. Bioretention also improves water quality, vegetation filters the water, and the root systems encourage or promote infiltration. Figure B-5 shows a typical rain garden. Key elements of a rain garden include:

- Ponding depths of **1 foot** or less (recommended).
- Native vegetation that can tolerate dry and wet weather.
- An overflow area where, if the bioretention area were to overflow, the water would flow over pervious area (i.e., grass, meadow), and would not cause harm to property, or;
- An overflow such as a domed riser to allow excess flow from large storms to travel to other substantial infiltration areas or pervious areas.
- Typical side slopes of 3:1 are recommended, with 2:1 being the maximum.
- The soil/planting mix depth should be between 1.5 feet and 6 feet deep.

Figure B-5: Typical Rain Garden/Bioretention Area



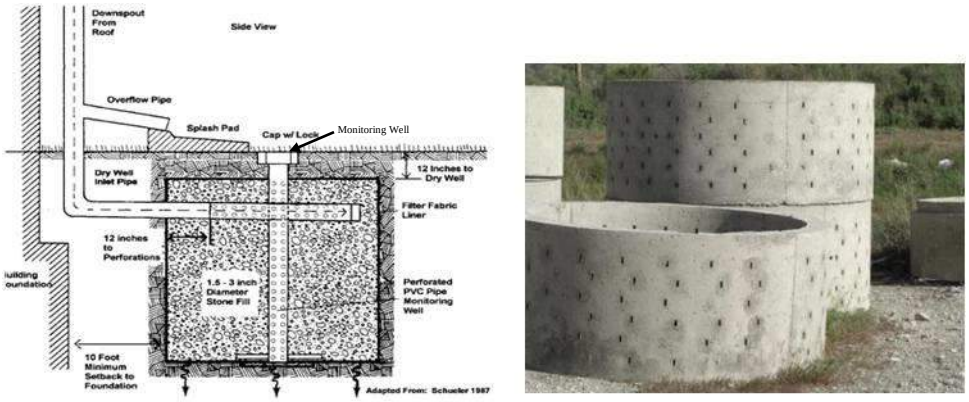
Source: Pennsylvania Stormwater BMP Manual (2006)

Dry Wells

A dry well, also referred to as a seepage pit is a subsurface storage facility that temporarily stores and infiltrates runoff from the roofs of buildings or other impervious surfaces. A dry well can be either a structural prefabricated chamber (Dry Well #1) or an excavated pit filled with stone fill (Dry Well #2). Dry wells discharge the stored runoff via infiltration into the surrounding or underlying soils. Figure B-6 shows a typical prefabricated dry well and a typical dry well configuration with stone fill. The following elements shall be incorporated into all dry well designs:

- These facilities should be located a minimum of ten (10) feet from the building foundation to avoid foundation seepage problems and are not recommended if their installation would create a risk for basement flooding.
- Construction of a dry well should be performed after surface soils in all other areas of the site are stabilized to avoid clogging.
- During construction, compaction of the subgrade soil in the bottom of the dry well should be avoided, and construction should be performed only with light machinery.
- Depth of a dry well should be between **1.5 feet and 4 feet**. Gravel fill should consist of stone of an average of one and one half to three (1.5 – 3.0) inches in diameter with the gravel fill wrapped in a nonwoven geotextile that separates the stone fill from the surrounding soil.
- At least 1 foot of soil needs to be placed over the top of the dry well.
- Dry wells should be inspected at least four (4) times annually as well as after large storm events.
- Dry wells should have overflow pipes to allow high volumes of runoff to connect to other on-site substantial infiltration areas or pervious areas.
- Every dry well needs to have at least one monitoring well.
- Infiltration testing is recommended to ensure that the underlying soil is capable of infiltrating the needed volume of stormwater.

Figure B-6: Typical Dry Well Configuration filled with Stone Fill (DRY WELL #2) (Left) and Structural Prefabricated Chamber (DRY WELL #1) (Right)



Source (for pic on left): https://seagrant.sunysb.edu/marina/pdfs/BMPsForMarinas.htm

B.4 Example

Simplified Approach Volume Determination:

Joe Homeowner wants to build a 400 square foot two car garage, and a 540 square foot (30' L x 18' W) impervious driveway that is graded so that the stormwater runoff drains to the grassy area along one edge of the driveway. (A duplicate of Table B-1 is provided below in Table B-5, a duplicate of Table B-3 is provided below in Table B-6 and outlines the steps of this example) a duplicate of Figure B-1 (Figure B-7) and a duplicate of Table B-4 are provided in Table B-7.

STEP 1 - Determine the total area of all proposed impervious surfaces to drain to each BMP:

Garage Roof (Front)	10 ft. x 20 ft.	=	200 sq. ft
Garage Roof (Rear)	10 ft. x 20 ft.	=	200 sq. ft.
Driveway (Front)	30 ft. x 18 ft.	=	540 sq. ft.

Total Proposed Impervious Surface			**940 sq. ft.**

Note: If the driveway used pervious pavement (i.e., paving blocks), then the total impervious area would only be 400 square feet, and no stormwater management practices would need to control runoff from the driveway.

Select a BMP or combination of BMPs from Section B.3 to be used to satisfy the volume requirement. Determine the length, width, depth and other requirements for the BMPs in Section B.3. A BMP needs to be placed to catch runoff from the back of the garage, and a BMP needs to be placed to capture runoff from the front of the garage and the driveway. Figure B-7 shows the direction the runoff flows and the locations where the BMPs are to be placed.

Joe Homeowner would like to use a rain barrel (BMP #1) to capture the runoff from the rear of the garage and an infiltration trench (BMP #2) to capture runoff from the front of the garage and the driveway.

STEP 2 and 3 for BMP #1 (Rain Barrel/Cistern)

STEP 2 - Select the proposed impervious area value for BMP #1, the rain barrel or cistern, in Column 1 that is closest to, but not less than 200 in Table B-5:

The value in Column 1 that is closest to but is not less than 200 is 200.

STEP 3 - Determine the volume that BMP #1 must be to satisfy the volume requirements using Columns 2 and 3 in Table B-5:

The volume in gallons of the rain barrel/cistern to be used as BMP #1, assuming the rain barrel/cistern is 25% full, is determined by finding the row in Column 3 that corresponds to the impervious area value determined in Step 1. Therefore, the volume of BMP #1, the rain barrel/cistern must be ≥ 166 gallons. A combination of rain barrels could be used in succession as shown in Figure B-2, or a cistern could be used.

Table B-5: Example – Calculating Storage Volume for Rain Barrel/Cistern

Column 1	Column 2	Column 3	
Proposed Impervious Area (square feet)	**Volume of Rain Barrel/Cistern[1] (cubic feet)**	**Volume of Rain Barrel/Cistern (gallons)**	
I	V_{RBcf}	V_{RBgal}	
Sum of all Proposed Impervious Areas	$(1*(1/12)*I)/0.75=V_{RBcf}$	$V_{RBcf} * 7.48=V_{RBgal}$	
50	6	42	
100	11	83	**Rain Barrel**
150	17	125	
2 200	22	**3** 166	
250	28	208	
300	33	249	
350	39	291	
400	44	332	
450	50	374	
500	56	416	
550	61	457	
600	67	499	**Cistern**
650	72	540	
700	78	582	
750	83	623	
800	89	665	
850	94	706	
900	100	748	
950	106	790	
999	111	830	

[1]Assume that the rain barrel/cistern is 25% full

STEPS 2 through 4 for BMP #2 (Infiltration Trench)

STEP 2 - Select the proposed impervious area value for BMP #2, the infiltration trench, using Column 1 in Table B-6:

Find the row in Column 1 that is closest to but not less than 740 (200 from the front of the garage + 540 from the driveway). Therefore, the value selected is 750.

STEP 3 - Determine the volume that BMP #2, the infiltration trench must be to satisfy the volume requirements using Column 2 in Table B-6:

The volume of the infiltration trench to be used as BMP #2, assuming a void ratio of 40%, is determined by finding the row in Column 2 that is in the same row as 750 square feet from Step 2. Therefore, the volume of BMP #2 must be 156 cubic feet.

STEP 4 - Utilizing the value from Column 2 determined above, and the surface area that the proposed BMP will occupy, identify the proposed depth and corresponding surface area needed using Column 3 in Table B-6:

Joe Homeowner would like to place the infiltration trench along the edge of the driveway that the runoff drains to, so it would have a length of 20 feet. The smallest width that can be used, as stated in the infiltration trench requirements in Section B.3, is 3 feet. Therefore, the area of the infiltration trench is:

$$20 * 3 = 60 \text{ square feet}$$

To find the minimum depth of the trench, move toward the right side of the table from 156 cubic feet in Column 2 to Column 3, and find the column with a value of as close to but not more than 60 square feet, which is 52 square feet. Then obtain the minimum depth of the facility by reading the depth from the column heading at the top of the table. Therefore, the depth of the trench would need to be 3 feet.

Selected BMPs: Rain barrel(s) ≥ 166 gallons and a 20’ L x 3’ W x 3’ D infiltration trench

STEP 5 – Make a sketch of the site plan as shown in Figure B-7, and fill in the simplified method worksheet found as shown in Table B-7.

Table B-6: Example – Calculating Storage Volume Surface Area and Depth for Infiltration Trench

Column 1	Column 2	Column 3							
Total Proposed Impervious Area (square feet)	**Volume of Infiltration Trench or Dry Well #2* (cubic feet)**	**Surface Area of Infiltration Trench or Dry Well #2** Acceptable Depths for Each BMP are indicated by the arrows below **(square feet)**							
		Area Required for a BMP with a Depth(D) of 1.5'	*Area Required for a BMP with a Depth(D) of 2.0'*	*Area Required for a BMP with a Depth(D) of 2.5'*	*Area Required for a BMP with a Depth(D) of 3.0'*	*Area Required for a BMP with a Depth(D) of 3.5'*	*Area Required for a BMP with a Depth(D) of 4.0'*	*Area Required for a BMP with a Depth(D) of 4.5'*	*Area Required for a BMP with a Depth(D) of 5.0'*
		Dry Well #2 (1.5'-4.0')				**Infiltration Trench (2.0'-5.0')**			
I	V	*A(sf)*							
Sum of all Proposed Impervious Areas	(1*(1/12)*I)/Void Ratio (0.4)*=V	V/D=A							
50	10	7	5	4	3	3	3	2	2
100	21	14	10	8	7	6	5	5	4
150	31	21	16	13	10	9	8	7	6
200	42	28	21	17	14	12	10	9	8
250	52	35	26	21	17	15	13	12	10
300	63	42	31	25	21	18	16	14	13
350	73	49	36	29	24	21	18	16	15
400	83	56	42	33	28	24	21	19	17
450	94	63	47	38	31	27	23	21	19
500	104	69	52	42	35	30	26	23	21
550	115	76	57	46	38	33	29	25	23
600	125	83	63	50	42	36	31	28	25
650	135	90	68	54	45	39	34	30	27
700	146	97	73	58	49	42	36	32	29
750	156	104	78	63	52	45	39	35	31
800	167	111	83	67	56	48	42	37	33
850	177	118	89	71	59	51	44	39	35
900	188	125	94	75	63	54	47	42	38
950	198	132	99	79	66	57	49	44	40
999	208	139	104	83	69	59	52	46	42

2 → **3** → **4**

*Assume a void ratio of 40%

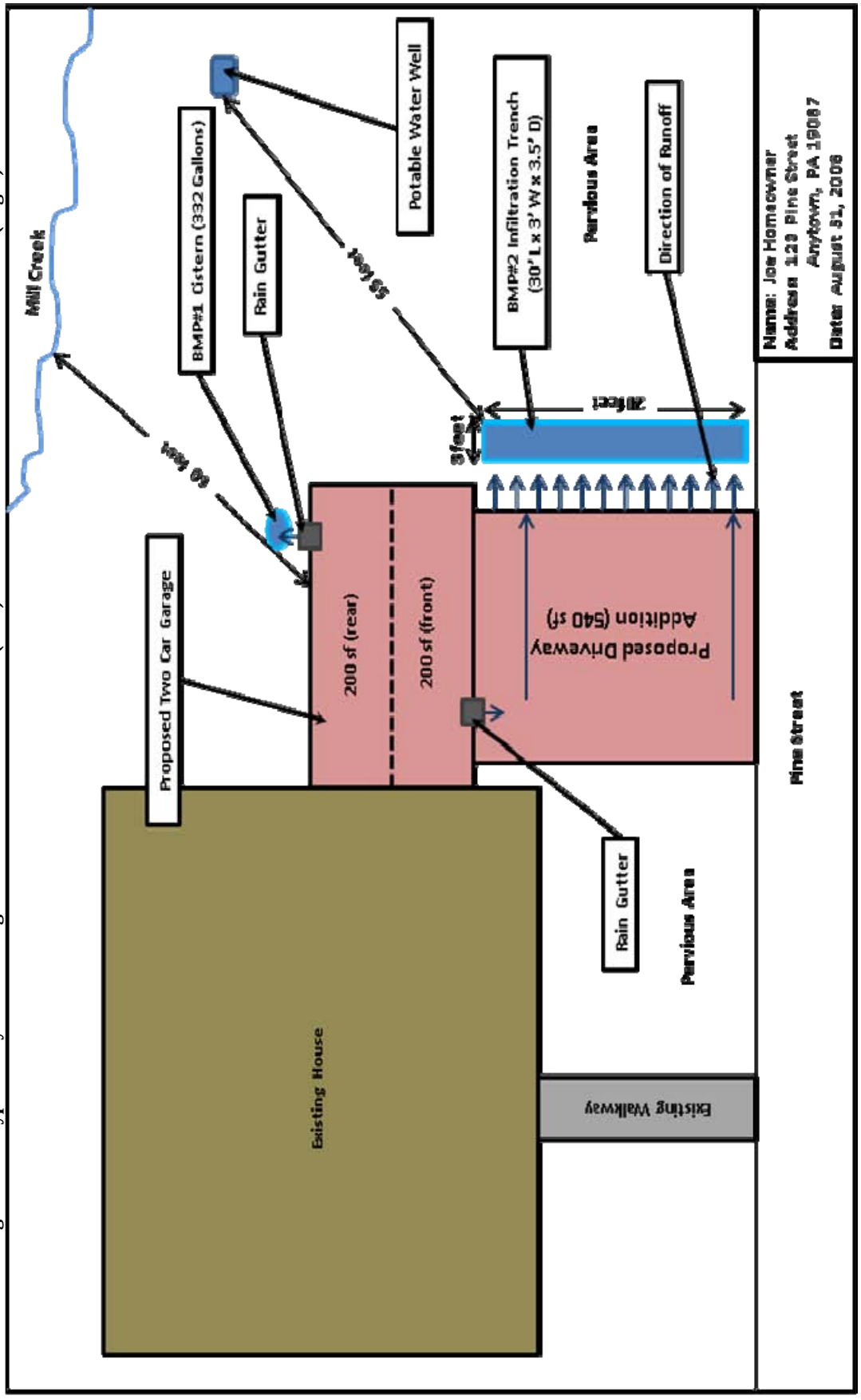


Figure B-7: Typical Dry Well Configuration filled with Stone Fill (Left) and Structural Prefabricated Chamber (Right)

Table B-7: Example – Simplified Method Worksheet with Results

Simplified Method Worksheet				
STEP 1				
Proposed Impervious Surface for BMP #1	**Proposed Impervious Surface for BMP #2**	**Proposed Impervious Surface for BMP #3**		
200	740			
STEPS 2&3				
Rain Barrel or Cistern				
Proposed Impervious Surface from Column 1 in Table B-5	**Volume from Column 2 or 3 in Table B-5**			
200	166 gallons			
Rain Garden/Bioretention or Dry Well #1				
Proposed Impervious Surface from Column 2 in Table B-2	**Volume of BMP from Column 2 in Table B-2**	**Area of BMP from Column 3 in Table B-2**	**Depth of BMP from Column 3 in Table B-2**	**Types of Material to Be Used**
Infiltration Trench or Dry Well #2				
Proposed Impervious Surface from Column 2 in Table B-6	**Volume of BMP from Column 2 in Table B-6**	**Area of BMP from Column 3 in Table B-6**	**Depth of BMP from Column 3 in Table B-6**	**Types of Material to Be Used**
740	156	52	3	Infiltration Trench, Uniformly Graded Aggregate, HDPE 8" pipe, geotextile material, grass planted on top
Note: For additional BMPs, use additional sheets				

B.5 Simplified Operation, Inspection, and Maintenance Plan

It is the property owner's responsibility to properly maintain BMPs. It is also the property owner's responsibility to inform any future buyers of the function, operation, and maintenance needed for any BMPs on the property prior to the purchase of the property. The following maintenance agreement outlines the maintenance required for each type of BMP, the responsibilities of the property owner, and the rights of the Municipality in regards to inspection and enforcement of the maintenance requirements. The Operation and Maintenance Agreement must be signed and submitted to the Municipality.

STORMWATER BEST MANAGEMENT PRACTICES
OPERATIONS, MAINTENANCE, AND INSPECTION AGREEMENT

THIS AGREEMENT, made and entered into this _____ day of _____, 200__, by and between _____, (hereinafter the "Landowner"), and _____, _____ (County, Township, or Borough) Pennsylvania, (hereinafter "Municipality");

WITNESSETH

WHEREAS, the Landowner is the owner of certain real property as recorded by deed in the land records of _____ County, Pennsylvania, Deed Book _____ at Page _____, (hereinafter "Property"); and,

WHEREAS, the Landowner _____

recognizes that the stormwater management best management practices or BMPs (hereinafter referred to as "the BMP" or "BMPs") must be maintained for the development called,

_____, located at _____

_____ (address of property where BMP is located); and,

WHEREAS, the Municipality and the Landowner, its administrators, executors, successors, heirs, or assigns, agree that the health, safety, and welfare of the residents of the Municipality and the protection and maintenance of water quality require that on-site stormwater Best Management Practices be constructed and maintained on the property; and,

WHEREAS, the Landowner is required to inform future buyers of the property about the function of, operation, and maintenance requirements of the BMP or BMPs prior to the purchase of the property by said future buyer, and upon purchase of the property the future buyer assumes all responsibilities as Landowner and must comply with all components of this agreement.

WHEREAS, for the purposes of this agreement, the following definition shall apply:

- BMP – "Best Management Practice;" activities, facilities, designs, measures, or procedures used to manage stormwater impacts from land development, to protect and maintain water quality and groundwater recharge, and to otherwise meet the purposes of the Municipal Stormwater Management Ordinance, including, but not limited to, infiltration trenches, dry wells, bioretention, rain gardens, permeable paving, rain barrels, and cisterns.

WHEREAS, it is required that the BMP or BMPs as shown on the simple sketch plan further referred to as the "Plan" and in accordance with the sizing calculations found on the simplified method worksheet further referred to as the "Calculation Worksheet" be constructed and maintained by the Landowner, its administrators, executors, successors, heirs, or assigns.

WHEREAS, the Municipality requires that stormwater management BMPs be constructed and adequately operated and maintained by the Landowner, its administrators, executors, successors, heirs, or assigns, in accordance with the following maintenance requirements.

- Vegetation along the surface of an infiltration trench should be maintained in good condition, and any bare spots should be revegetated as soon as possible.

- Vehicles shouldn't be parked or driven on an infiltration trench, and care should be taken to avoid excessive compaction by mowers.
- Any debris such as leaves blocking flow from reaching an infiltration trench or bioretention/rain garden should be routinely removed.
- While vegetation is being established, pruning and weeding may be required for a bioretention/rain garden.
- Mulch in a bioretention/rain garden needs to be re-spread when erosion is evident. Once every two to three years or after major storms the entire area may require mulch replacement.
- At least twice a year the landowner needs to inspect the bioretention/rain garden for sediment buildup and vegetative conditions.
- During periods of extended drought, the bioretention/rain garden requires watering.
- Trees and shrubs in a bioretention/rain garden need to be inspected at least twice per year by the landowner to evaluate their health. If they are in poor health, they need to be replaced.
- Dry wells need to be inspected by the landowner at least four times a year and after significant rainfalls, and debris/trash, sediment, and any other waste material need to be removed and disposed of at suitable disposal/recycling sites and in compliance with local, state, and federal waste regulations.
- For dry wells, gutters need to be regularly cleaned out, and proper connections must be maintained to facilitate the effectiveness of the dry well.
- The filter screen for the dry well that intercepts roof runoff must be replaced as necessary.
- Dry wells that are damaged need to be fixed or replaced within two weeks of being damaged.
- If an intermediate sump box exists in conjunction with a dry well, it must be cleaned out at least once per year.
- Rain barrels and cisterns need to be cleared of debris routinely at least every three months and after significant storms to allow stormwater from gutters to enter them.

- Gutters that directly convey rain water to dry wells, rain barrels, and cisterns need to be routinely cleared of trash and debris at least every three months and after significant storms.
- Rain barrels and cisterns must be kept covered.
- Rain barrels and cisterns should be routinely emptied so that they are only ¼ of the way full to allow for storage of additional rainwater.
- Overflow outlets from rain barrels and cisterns must be kept free and clear of debris.
- Rain barrels and cisterns that are damaged need to be fixed or replaced within two weeks of being damaged.

NOW, THEREFORE, in consideration of the foregoing promises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. The BMPs shall be constructed by the Landowner in accordance with specifications identified in the Plan and Calculation Worksheet.

2. The Landowner shall operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Municipality and in accordance with the specific maintenance requirements outlined in this agreement.

3. The Landowner hereby grants permission to the Municipality, its authorized agents, and employees to enter upon the property at reasonable times and upon presentation of proper identification, to inspect the BMP(s) whenever it deems necessary. Whenever possible, the Municipality shall notify the Landowner prior to entering the property.

4. In the event that the Landowner fails to operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Municipality, the Municipality or its representatives may enter upon the property and take whatever action is deemed necessary to maintain said BMP(s). This provision shall not be construed to allow the Municipality to erect any permanent structure on the land of the Landowner. It is expressly understood and agreed that the Municipality is under no obligation to maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the Municipality.

5. In the event that the Municipality, pursuant to this Agreement, performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner shall reimburse the Municipality for all expenses (direct and indirect) incurred within ten days of receipt of an invoice from the Municipality.

6. The intent and purpose of this Agreement is to ensure the proper maintenance of the on-site BMP(s) by the Landowner; provided, however, that this Agreement shall not be deemed to create or affect any additional liability of any party for damage alleged to result from or be caused by stormwater runoff.

7. The Landowner, its executors, administrators, assigns, heirs, and other successors in interests, shall release the Municipality's employees and designated representatives from all damages, accidents, casualties, occurrences, or claims which might arise or be asserted against said employees and representatives from the construction, presence, existence, or maintenance of the BMP(s) by the Landowner or Municipality. In the event that a claim is asserted against the Municipality, its designated representatives, or employees, the Municipality shall promptly notify the Landowner and the Landowner shall defend, at his own expense, any suit based on the claim. If any judgment or claims against the Municipality's employees or designated representatives shall be allowed, the Landowner shall pay all costs and expenses regarding said judgment or claim.

This Agreement shall be recorded at the Office of the Recorder of Deeds of _____ County, Pennsylvania, and shall constitute a covenant running with the Property and/or equitable servitude, and shall be binding on the Landowner, his administrators, executors, assigns, heirs, and any other successors in interests, in perpetuity.

ATTEST:

WITNESS the following signatures and seals:

(SEAL) For the Municipality:

_____

(SEAL) For the Landowner:

_____

ATTEST:

_____ (City, Borough, Township)

County of _____, Pennsylvania

I, _____, a Notary Public in and for the County and State aforesaid, whose commission expires on the _____ day of _____, 20__, do hereby certify that _____ whose name(s) is/are signed to the foregoing Agreement bearing date of the _____ day of _____, 20__, has acknowledged the same before me in my said County and State.

GIVEN UNDER MY HAND THIS _____ day of _____, 200_.

_____ _____

NOTARY PUBLIC **(SEAL)**

ORDINANCE APPENDIX C

STORMWATER MANAGEMENT DESIGN

CRITERIA

Table C-1
Runoff Curve Numbers

Table C-2
Rational Runoff Coefficients

Table C-3
Mannings Roughness Coefficients

TABLE C-1

RUNOFF CURVE NUMBERS

LAND USE DESCRIPTION	Hydrologic Condition	HYDROLOGIC SOIL GROUP A	B	C	D
Open Space					
Grass cover < 50%	Poor	68	79	86	89
Grass cover 50% to 75%	Fair	49	69	79	84
Grass cover > 75%	Good	39	61	74	80
Meadow		30	58	71	78
Agricultural					
Pasture, grassland, or range – Continuous forage for grazing	Poor	68	79	86	89
Pasture, grassland, or range – Continuous forage for grazing	Fair	49	69	79	84
Pasture, grassland, or range – Continuous forage for grazing	Good	39	61	74	80
Brush—brush-weed-grass mixture with brush the major element	Poor	48	67	77	83
Brush—brush-weed-grass mixture with brush the major element	Fair	35	56	70	77
Brush—brush-weed-grass mixture with brush the major element	Good	30	48	65	73
Fallow Bare soil	-------	77	86	91	94
Crop residue cover (CR)	Poor	76	85	90	93
	Good	74	83	88	90
Woods – grass combination (orchard or tree farm)	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77

Commercial	(85% impervious)	89	92	94	95
Industrial	(72% impervious)	81	88	91	93
Institutional	(50% impervious)	71	82	88	90

Residential districts by average lot size:

	% Impervious				
1/8 acre or less * (townhouses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Farmstead		59	74	82	86
Smooth surfaces (concrete, asphalt, gravel, or bare compacted soil)		98	98	98	98
Water		98	98	98	98
Mining/newly graded areas (pervious areas only)		77	86	91	94

* Includes multi-family housing unless justified lower density can be provided.

Note: Existing site conditions of bare earth or fallow ground shall be considered as meadow when choosing a CN value.

Source: NRCS (SCS) TR-55

TABLE C-2

RATIONAL RUNOFF COEFFICIENTS

		HYDROLOGIC SOIL GROUP			
LAND USE DESCRIPTION		A	B	C	D
Cultivated land : without conservation treatment		.49	.67	.81	.88
: with conservation treatment		.27	.43	.61	.67
Pasture or range land: poor condition		.38	.63	.78	.84
: good condition		---*	.25	.51	.65
Meadow: good condition		---*	---*	.44	.61
Woods: thin stand, poor cover, no mulch		---*	.34	.59	.70
: good cover		---*	---*	.45	.59
Open spaces, lawns, parks, golf courses, cemeteries					
Good condition: grass cover on 75% or more of the area		---*	.25	.51	.65
Fair condition: grass cover on 50% to 75% of the area		---*	.45	.63	.74
Commercial and business areas (85% impervious)		.84	.90	.93	.96
Industrial districts (72% impervious)		.67	.81	.88	.92
Residential:					
Average lot size	Average % impervious				
1/8 acre or less	65	.59	.76	.86	.90
1/4 acre	38	.25	.49	.67	.78
1/3 acre	30	---*	.49	.67	.78
1/2 acre	25	---*	.45	.65	.76
1 acre	20	---*	.41	.63	.74
Paved parking lots, roofs, driveways, etc.		.99	.99	.99	.99
Streets and roads:					
Paved with curbs and storm sewers		.99	.99	.99	.99
Gravel		.57	.76	.84	.88
Dirt		.49	.69	.80	.84

Notes: Values are based on SCS definitions and are average values**.**
Values indicated by ---* should be determined by the design engineer based on site characteristics.

Source : New Jersey Department of Environmental Protection, Technical Manual for Stream Encroachment, August 1984

TABLE C-3

MANNING'S ROUGHNESS COEFFICIENTS

Roughness Coefficients (Manning's "n") for Overland Flow

Surface Description	n		
Dense growth	0.4	-	0.5
Pasture	0.3	-	0.4
Lawns	0.2	-	0.3
Bluegrass sod	0.2	-	0.5
Short grass prairie	0.1	-	0.2
Sparse vegetation	0.05	-	0.13
Bare clay-loam soil (eroded)	0.01	-	0.03
Concrete/asphalt - very shallow depths (less than 1/4 inch)	0.10	-	0.15
- small depths (1/4 inch to several inches)	0.05	-	0.10

Roughness Coefficients (Manning's "n") for Channel Flow

Reach Description	n
Natural stream, clean, straight, no rifts or pools	0.03
Natural stream, clean, winding, some pools or shoals	0.04
Natural stream, winding, pools, shoals, stony with some weeds	0.05
Natural stream, sluggish deep pools and weeds	0.07
Natural stream or swale, very weedy or with timber underbrush	0.10
Concrete pipe, culvert, or channel	0.012
Corrugated metal pipe	0.012-0.027(1)
High density polyethylene (HDPE) pipe	
Corrugated	0.021-0.029(2)
Smooth lined	0.012-0.020(2)

(1) Depending upon type, coating, and diameter

(2) Values recommended by the American Concrete Pipe Association, check manufacturer's recommended value

Source: U.S. Army Corps of Engineers, HEC-1 Users Manual

ORDINANCE APPENDIX D

STORMWATER CONTROL MEASURE OPERATIONS AND MAINTENANCE AGREEMENT

OPERATION AND MAINTENANCE (O&M) AGREEMENT
STORMWATER CONTROL MEASURES (SCMs)

THIS AGREEMENT, made and entered into this _____ day of _____, 20_____, by and between _____ (hereinafter the "Landowner"), and [*enter municipality name*] , Delaware County, Pennsylvania (hereinafter "Municipality");

WITNESSETH

WHEREAS, the Landowner is the owner of certain real property as recorded by deed in the land records of Delaware County, Pennsylvania, Deed Book ___at page _____, hereinafter "Property") and

WHEREAS, the Landowner is proceeding to build and develop the Property; and

WHEREAS, the Operation and Maintenance (O&M) Plan approved by the Municipality (hereinafter referred to as the "O&M Plan") for the property identified herein, which is attached hereto as Appendix A and made part hereof, as approved by the Municipality, provides for management of stormwater within the confines of the Property through the use of post-construction stormwater management (PCSM) stormwater control measures (SCMs); and

WHEREAS, the Municipality, and the Landowner, his successors and assigns, agree that the health, safety, and welfare of the residents of the Municipality and the protection and maintenance of water quality require that on-site PCSM SCMs be constructed and maintained on the Property; and

WHEREAS, the Municipality requires, through the implementation of the PCSM Plan, that PCSM SCMs as required by said PCSM Plan and the Municipal Stormwater Management Ordinance be constructed and adequately operated and maintained by the Landowner, successors, and assigns.

NOW, THEREFORE, in consideration of the foregoing promises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. The Landowner or designee shall construct the SCMs in accordance with the plans and specifications identified in the PCSM Plan.

2. The Landowner or designee must operate and maintain the SCMs as shown on the PCSM Plan in good working order in accordance with the specific operation and maintenance requirements identified in the approved O&M Plan.

3. The Landowner hereby grants permission to the Municipality, its authorized agents and employees, to enter upon the property, at reasonable times and upon presentation of proper credentials, to inspect the SCMs whenever necessary. Whenever possible, the Municipality will notify the Landowner prior to entering the property.

4. In the event the Landowner fails to operate and maintain the SCMs per paragraph 2, the Municipality or its representatives may enter upon the Property and take whatever action is deemed necessary to maintain said SCMs. It is expressly understood and agreed that the Municipality is under no obligation to maintain or repair said facilities, and in no event may this Agreement be construed to impose any such obligation on the Municipality.

5. In the event the Municipality, pursuant to this Agreement, performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner must reimburse the Municipality for all expenses (direct and indirect) incurred within 10 days of receipt of an invoice from the Municipality.

6. The intent and purpose of this Agreement is to ensure the proper maintenance of the on-site SCMs by the Landowner; provided, however, that this Agreement may not be deemed to create any additional liability of any party for damage alleged to result from or be caused by stormwater runoff.

7. The Landowner, its executors, administrators, assigns, and other successors in interests, must release the Municipality from all damages, accidents, casualties, occurrences, or claims which might arise or be asserted against said employees and representatives from the construction, presence, existence, or maintenance of the SCM(s) by the Landowner or Municipality.

8. The Municipality intends to inspect the SCMs on a periodic basis to ensure their continued functioning.

9. The individual or entity responsible for long-term O&M of SCMs on the real property is identified as follows:

(Name)
(Address)
(Phone)

This Agreement must be recorded at the Office of the Recorder of Deeds Delaware County, Pennsylvania, and constitutes a covenant running with the Property and/or equitable servitude, and is binding on the Landowner, their administrators, executors, assigns, heirs, and any other successors in interests, in perpetuity.

ATTEST:

WITNESS the following signatures and seals:

(SEAL)

For the Municipality:

_____

For the Landowner:

_____

ATTEST:

_____ (City, Borough, Township)

County of Delaware, Pennsylvania.

I, _____ , a Notary Public in and for the county and state aforesaid, whose commission expires on the _____ day of _____ , 20 _____ has acknowledged the same before me in my said county and state.

GIVEN UNDER MY HAND THIS ___ day of _____ , 20 _____

_____ _____

NOTARY PUBLIC **(SEAL)**

ORDINANCE APPENDIX E

LOW IMPACT DEVELOPMENT (LID) TECHNIQUES

LOW IMPACT DEVELOPMENT (LID) PRACTICES

ALTERNATIVE APPROACH FOR MANAGING STORMWATER RUNOFF

Natural hydrologic conditions can be altered radically by poorly planned development practices such as introducing unnecessary impervious surfaces, destroying existing drainage swales, constructing unnecessary storm sewers, and changing local topography. A traditional drainage approach of development has been to remove runoff from a site as quickly as possible and capture it in a detention basin. This approach leads ultimately to the degradation of water quality as well as expenditure of additional resources for detaining and managing concentrated runoff at some downstream location.

The recommended alternative approach is to promote practices that will minimize proposed conditions runoff rates and volumes, which will minimize needs for artificial conveyance and storage facilities. To simulate pre-development hydrologic conditions, infiltration is often necessary to offset the loss of infiltration by creation of impervious surfaces. The ability of the ground to infiltrate depends upon the soil types and its conditions.

Preserving natural hydrologic conditions requires careful alternative site design considerations. Site design practices include preserving natural drainage features, minimizing impervious surface area, reducing the hydraulic connectivity of impervious surfaces, and protecting natural depression storage. A well-designed site will contain a mix of all of those features. The following describes various techniques to achieve the alternative approach:

- **Preserving Natural Drainage Features**. Protecting natural drainage features, particularly vegetated drainage swales and channels, is desirable because of their ability to infiltrate and attenuate flows and to filter pollutants. However, this objective is often not accomplished in land development. In fact, commonly held drainage philosophy encourages just the opposite pattern – streets and adjacent storm sewers are typically located in the natural headwater valleys and swales, thereby replacing natural drainage functions with a completely impervious system. As a result, runoff and pollutants generated from impervious surfaces flow directly into storm sewers with no opportunity for attenuation, infiltration, or filtration. Developments designed to fit site topography also minimize the amount of grading on site.

- **Protecting Natural Depression Storage Areas**. Depressional storage areas either have no surface outlet or drain very slowly following a storm event. They can be commonly seen as ponded areas in farm fields during the wet season or after large runoff events. Traditional development practices eliminate these depressions by filling or draining, thereby obliterating their ability to reduce surface runoff volumes and trap pollutants. The volume and release rate characteristics of depressions should be protected in the design of the development site. The depressions can be protected by simply avoiding the depression or by incorporating its storage as additional capacity in required detention facilities.

- **Avoiding Introduction of Impervious Areas**. Careful site planning should consider reducing impervious coverage to the maximum extent possible. Building footprints, sidewalks, driveways, and other features producing impervious surfaces should be evaluated to minimize impacts on runoff.

- **Reducing the Hydraulic Connectivity of Impervious Surfaces**. Impervious surfaces are significantly less of a problem if they are not directly connected to an impervious conveyance system (such as a storm sewer). Two basic ways to reduce hydraulic connectivity are routing of roof runoff over lawns and reducing the use of storm sewers. Site grading should promote increasing travel time of stormwater runoff and should help reduce concentration of runoff to a single point in the development.

- **Routing Roof Runoff Over Lawns**. Roof runoff can be easily routed over lawns in most site designs. The practice discourages direct connection of downspouts to storm sewers or parking lots. The practice also discourages sloping driveways and parking lots to the street. By routing roof drains and crowning the driveway to run off to the lawn, the lawn is essentially used as a filter strip.

- **Reducing the Use of Storm Sewers**. By reducing use of storm sewers for draining streets, parking lots, and back yards, the potential for accelerating runoff from the development can be greatly reduced. The practice requires greater use of swales and may not be practical for some development sites, especially if there are concerns for areas that do not drain in a "reasonable" time. The practice requires educating local citizens and public works officials who expect runoff to disappear shortly after a rainfall event.

- **Reducing Street Widths**. Street widths can be reduced by either eliminating on-street parking or by reducing roadway widths. Municipal planners and traffic designers should encourage narrower neighborhood streets which ultimately could lower maintenance.

- **Limiting Sidewalks to One Side of the Street**. A sidewalk on one side of the street may suffice in low-traffic neighborhoods. The lost sidewalk could be replaced with bicycle/recreational trails that follow back-of-lot lines. Where appropriate, backyard trails should be constructed using pervious materials.

- **Using Permeable Paving Materials**. These materials include permeable interlocking concrete paving blocks or porous bituminous concrete. Such materials should be considered as alternatives to conventional pavement surfaces, especially for low use surfaces such as driveways, overflow parking lots, and emergency access roads.

- **Reducing Building Setbacks**. Reducing building setbacks reduces impervious cover associated with driveway and entry walks and is most readily accomplished along low-traffic streets where traffic noise is not a problem.

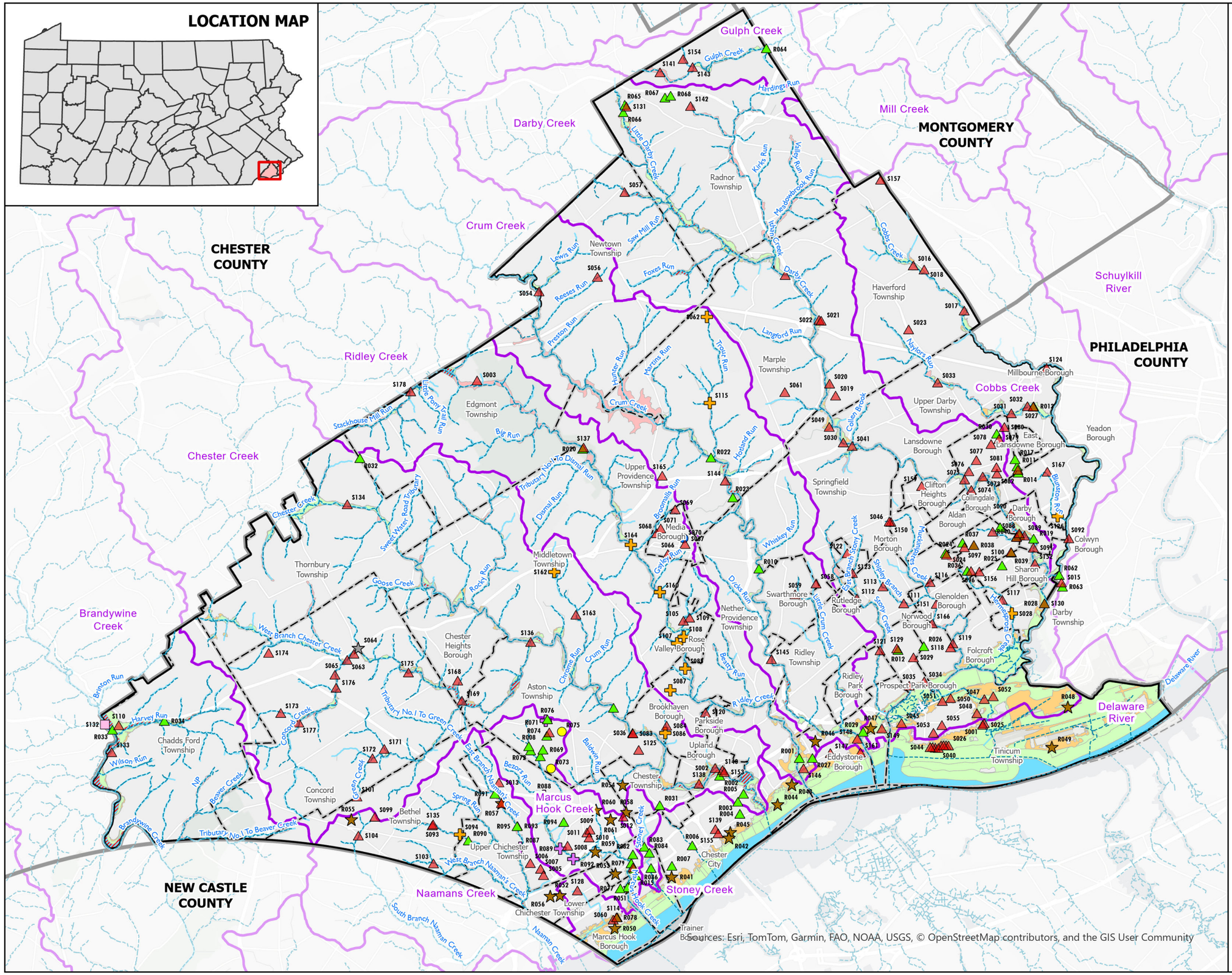
- **Constructing Cluster Developments**. Cluster developments can also reduce the amount of impervious area for a given number of lots. The biggest savings occurs with street length, which also will reduce costs of the development. Cluster development groups the

construction activity in less-sensitive areas without substantially affecting the gross density of development.

In summary, a careful consideration of the existing topography and implementation of a combination of the above mentioned techniques may avoid construction of costly stormwater control measures. Benefits include reduced potential for downstream flooding and water quality degradation of receiving streams/water bodies, enhancement of aesthetics, and reduction of development costs. Other benefits include more stable baseflows in receiving streams, improved infiltration, reduced flood flows, reduced pollutant loads, and reduced costs for conveyance and storage.

Appendix E – Problem Areas and Obstructions Maps

Appendix E.1 – Stormwater Problem Areas Map



Delaware County Act 167 Stormwater Management Plan

Stormwater Problem Areas (Overview)

Legend

Stormwater Problem Type

- Survey - Flooding Related
- Study - Flooding Related
- Survey - Accelerated Erosion/Sedimentation
- Study - Erosion
- Survey - Groundwater
- Study - Groundwater
- Survey - Water Pollution
- Study - Water Quality
- Survey - NA
- Streams - USGS
- Streams - Delaware County
- Municipal Boundaries
- County Boundaries
- Watersheds

FEMA Flood Zones (FIS data 11/2017)*

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone AO
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

*The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Delaware County Act 167 Stormwater Management Plan

Stormwater Problem Areas (Overview)

Map 1 of 4

Legend

Stormwater Problem Type

- Survey - Flooding Related
- Study - Flooding Related
- Survey - Accelerated Erosion/Sedimentation
- Study - Erosion
- Survey - Groundwater
- Study - Groundwater
- Survey - Water Pollution
- Study - Water Quality
- Survey - NA
- Streams - USGS
- Streams - Delaware County
- Municipal Boundaries
- County Boundaries
- Watersheds

FEMA Flood Zones (FIS data 11/2017)*

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone AO
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

*The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 0.5 1 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & MacKay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

Stormwater Problem Areas (Overview)

Map 2 of 4

Legend

Stormwater Problem Type

- Survey - Flooding Related
- Study - Flooding Related
- Survey - Accelerated Erosion/Sedimentation
- Study - Erosion
- Survey - Groundwater
- Study - Groundwater
- Survey - Water Pollution
- Study - Water Quality
- Survey - NA
- Streams - USGS
- Streams - Delaware County
- Municipal Boundaries
- County Boundaries
- Watersheds

FEMA Flood Zones (FIS data 11/2017)*

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone AO
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

*The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 0.5 1 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & MacKay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

Stormwater Problem Areas (Overview)

Map 3 of 4

Legend

Stormwater Problem Type

- Survey - Flooding Related
- Study - Flooding Related
- Survey - Accelerated Erosion/Sedimentation
- Study - Erosion
- Survey - Groundwater
- Study - Groundwater
- Survey - Water Pollution
- Study - Water Quality
- Survey - NA
- Streams - USGS
- Streams - Delaware County
- Municipal Boundaries
- County Boundaries
- Watersheds

FEMA Flood Zones (FIS data 11/2017)*

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone AO
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

*The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 0.5 1 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & MacKay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

Stormwater Problem Areas (Overview)

Map 4 of 4

Legend

Stormwater Problem Type

- Survey - Flooding Related
- Study - Flooding Related
- Survey - Accelerated Erosion/Sedimentation
- Study - Erosion
- Survey - Groundwater
- Study - Groundwater
- Survey - Water Pollution
- Study - Water Quality
- Survey - NA
- Streams - USGS
- Streams - Delaware County
- Municipal Boundaries
- County Boundaries
- Watersheds

FEMA Flood Zones (FIS data 11/2017)*

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone AO
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

*The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

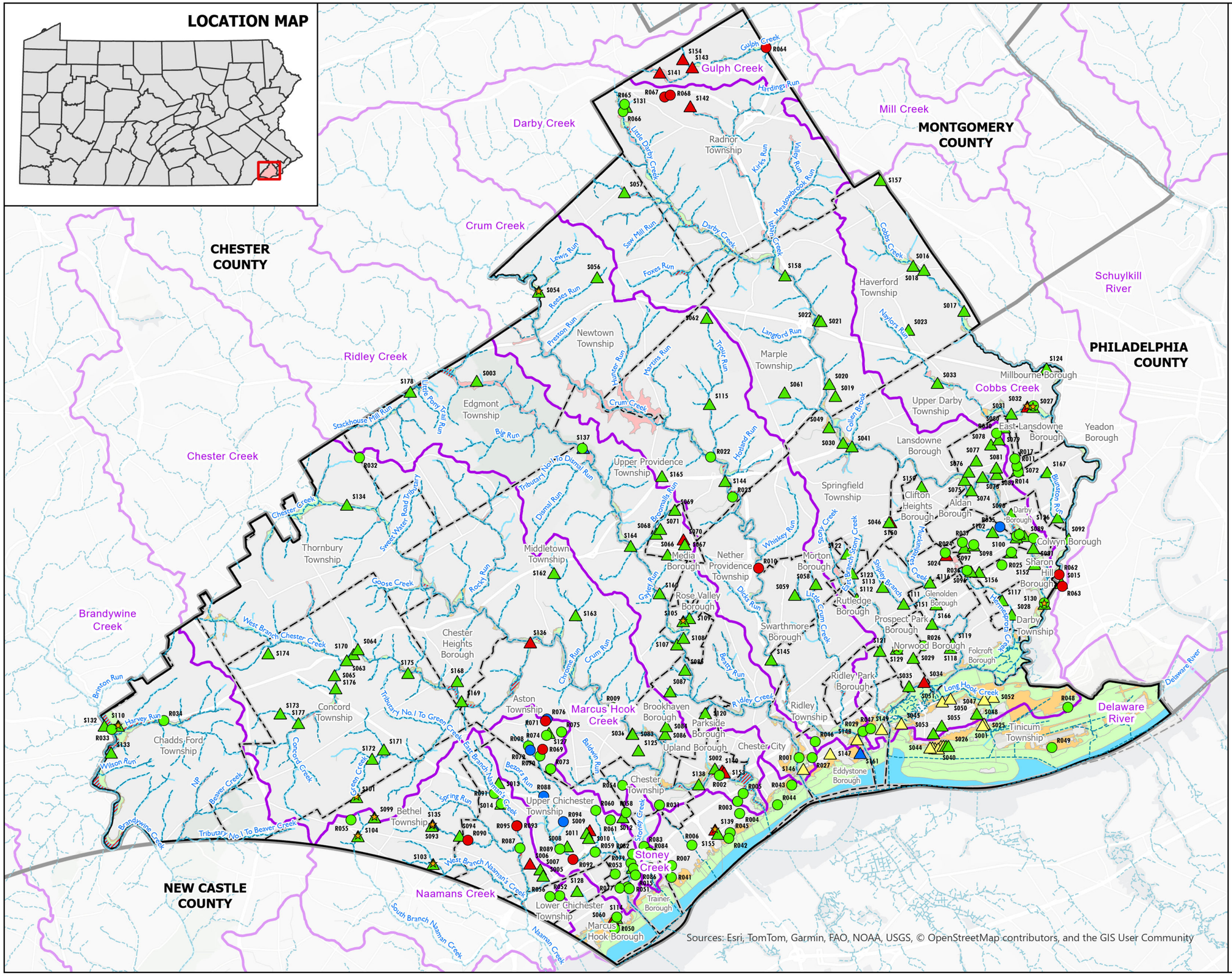
0 0.5 1 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix E.2 – Flooding Related Stormwater Problem Areas Map



Delaware County Act 167 Stormwater Management Plan

Stormwater Problem Areas - Flooding Related

Legend

- Stormwater Problem Area - Loss of Life or Vital Services

Stormwater Problem Area - Cause of Flooding

- Survey - Infrastructure Related
- Survey - Stream Obstruction Related
- Survey - Tidal Related
- Survey - Flooding Category Not Specified
- Study - Infrastructure Related
- Study - Stream Obstruction Related
- Study - Flooding Category Not Specified
- Streams - USGS
- Streams - Delaware County
- County Boundaries
- Municipal Boundaries
- Watersheds

FEMA Flood Zones (FIS data 11/2017)*

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone AO
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

*The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 0.5 1 2 Miles

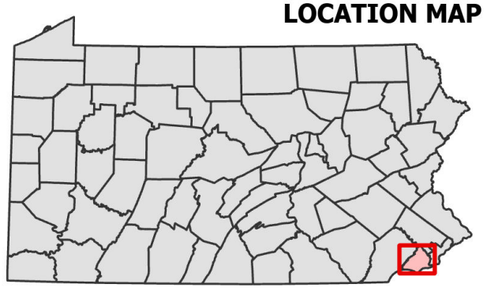
Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Appendix E.3 – Stormwater Problem Areas by Property Type Map

Delaware County Act 167 Stormwater Management Plan

Stormwater Problem Areas - Property Type



Legend

Stormwater Problem Area - Property Type

- Survey - Commercial
- Survey - Commercial/Other
- Survey - Industrial
- Survey - Open Space
- Survey - Open Space/Public/Right of Way
- Survey - Residential
- Survey - Residential/Other
- Survey - Right of Way
- Study - Public
- Study - Residential
- Study - Residential/Commerical
- Study - Right of Way
- Study - Open Space
- Study - Not Listed
- Streams - USGS
- Streams - Delaware County
- Municipal Boundaries
- County Boundaries
- Watersheds

FEMA Flood Zones (FIS data 11/2017)*

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone AO
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

*The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

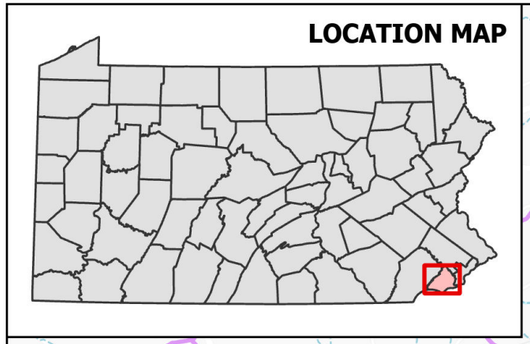
0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 2/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix E.4 – Surveyed Flooding Problem Areas: Number of Damaged Properties Map



Delaware County Act 167 Stormwater Management Plan

Surveyed Flooding Problem Areas - # of Damaged Properties*

Legend

Stormwater Problem Areas - # of Properties Damaged

- Survey: 1 to 5
- Survey: 5-10
- Survey: 10 - 20
- Survey: >20
- Survey: >50
- Streams - USGS
- Streams - Delaware County
- County Boundaries
- Municipal Boundaries
- Watersheds

FEMA Flood Zones (FIS data 11/2017)**

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone AO
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

*Map excludes surveyed Problem Areas which did not have damaged properties. Map also excludes Problem Areas from studies because number of damaged properties was not available.

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 2/4/2026

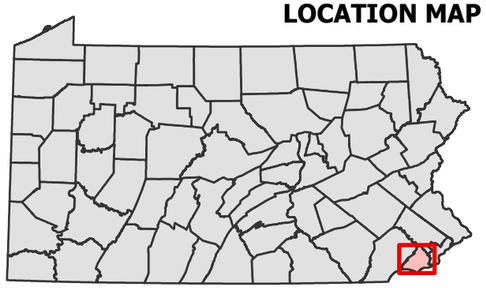
Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix E.5 – Stormwater Problem Area Solution Prioritization Map

Delaware County Act 167 Stormwater Management Plan

Stormwater Problem Areas - Solution Priority



Legend

Priority Level
- High Priority
- Not High Priority
- Streams - USGS
- Streams - Delaware County
- Municipal Boundaries
- County Boundaries
- Watersheds

FEMA Flood Zones (FIS data 11/2017)**
- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone AO
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

*Site visit prioritization is based on prioritizing sites which involved severe incidents (emergency rescues, loss of life), and sites with problems that impact public infrastructure, and multiple stakeholders.

The following types of problem areas were deprioritized for site visit:
-MS4 drainage systems
-Tidal Flooding
-Discrete issues resolvable with standard maintenance

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 0.5 1 2 Miles

Map prepared by Jacobs and NTM 5/20/2026

Jacobs | Newell Tereska & MacKay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix F – High Priority Problem Area Conceptual Solution Forms

ID#R008 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Marcus Hook Creek	**Source of Problem:**	Delaware County Department of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	
Municipality:	Aston Township	**Location:**	Clearview Ln & Moser St
Property Type:	Residential, Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Stormwater runoff floods the backyards of properties on Moser Street and Clearview Lane, and has occasionally entered several of the homes there. The roads have also experienced flooding during very large storm events.		
Field Visit Notes:	The stream daylights in a small section; evidence of streambank overtopping and flooding in the backyards; streambank erosion		

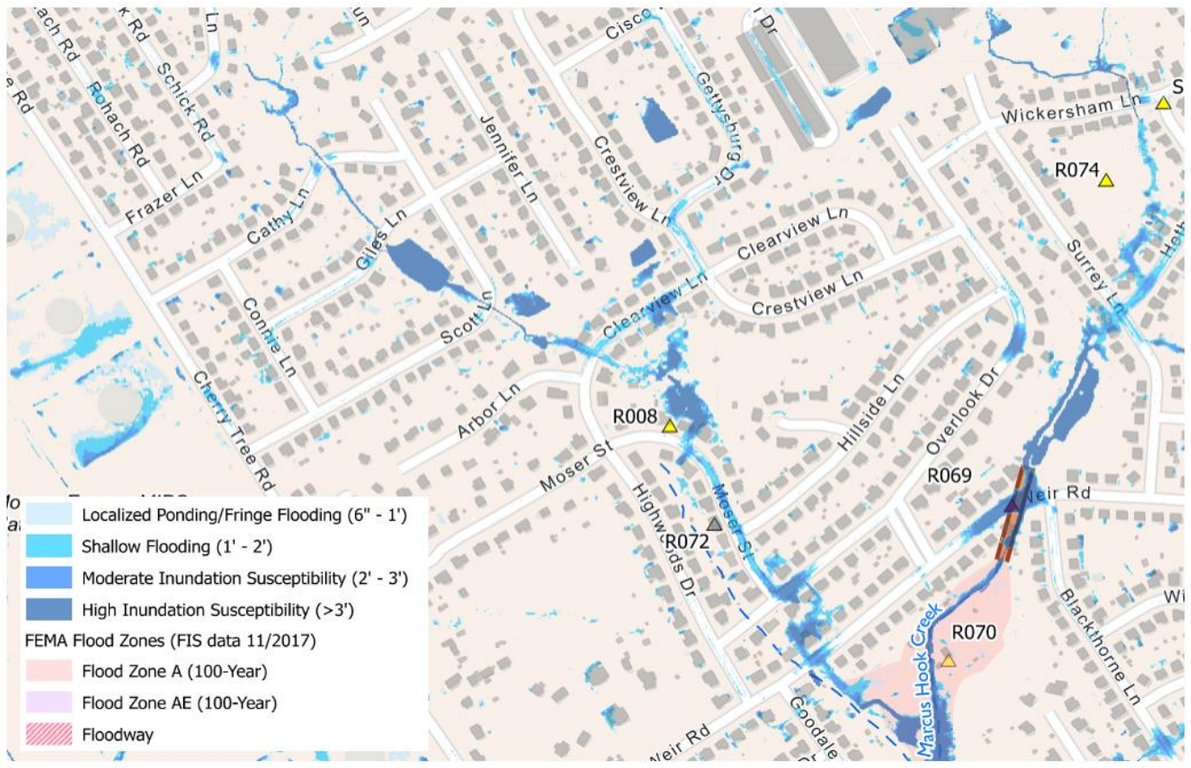


Daylighted channel with observed erosion

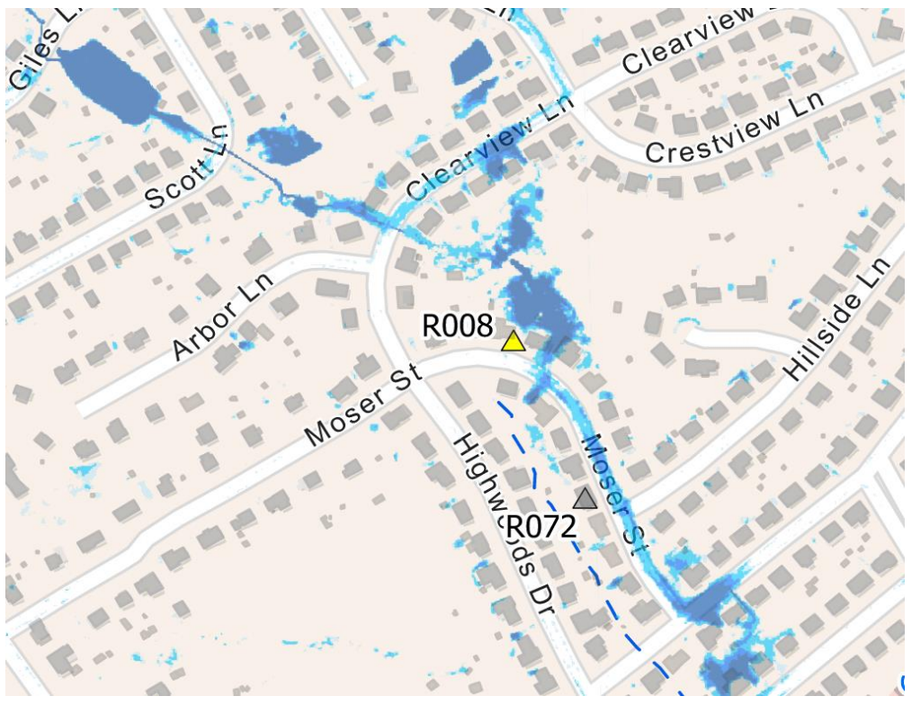


Confluence of two buried streams

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Potential retrofits of upstream municipal ponds/basins
- Improve drainage on Clearview Lane
- Improve/upsize the culvert passing under Moser Street (without making downstream flooding worse)
- Stabilize/repair stream channel
- Investigate opportunities for controlled retention / detention at confluence location (bioretention, wetlands, etc.) (private property)
- Develop more detailed model to evaluate hydraulic performance of existing upstream ponds/basins and simulate potential solutions

ID#R010 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Crum Creek	**Source of Problem:**	Delaware County Department of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	-
Municipality:	Nether Providence Township	**Location:**	Plush Mill Rd & Rogers Ln
Property Type:	Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Dam appears to be in disrepair; erosion apparent along pipeline right of way; critical facility affected (petroleum pipeline)		
Field Visit Notes:	Shallow portion of Crum Creek with relatively still water; signs of erosion along the banks of the creek		



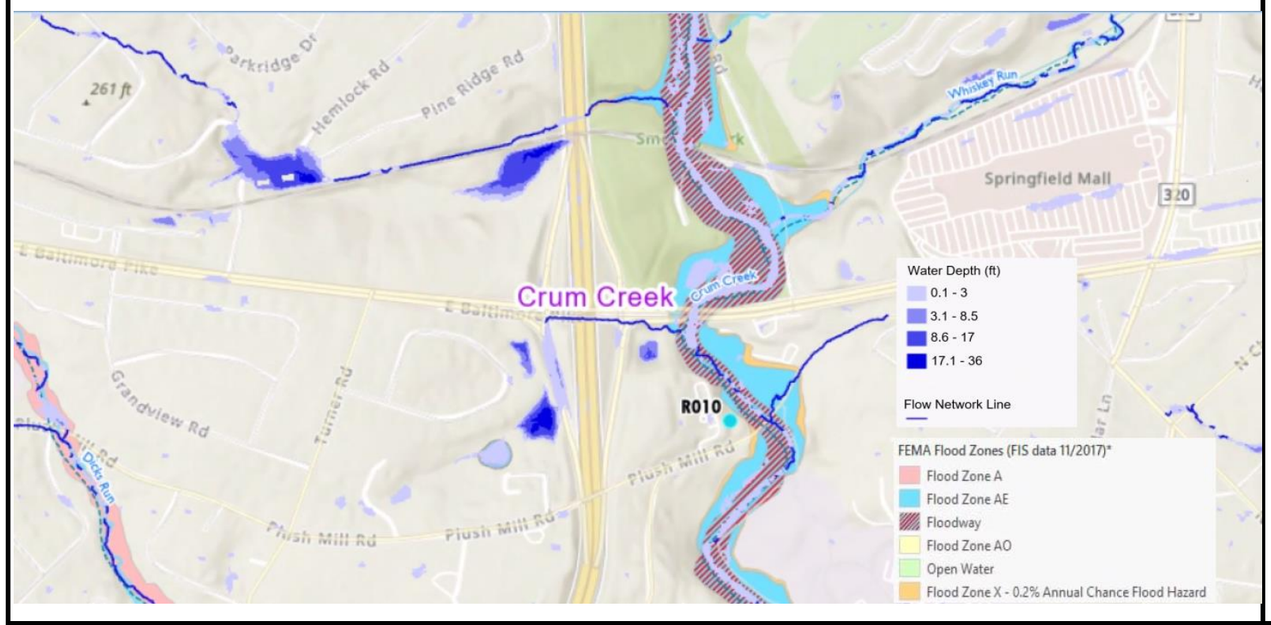
Erosion along banks of creek



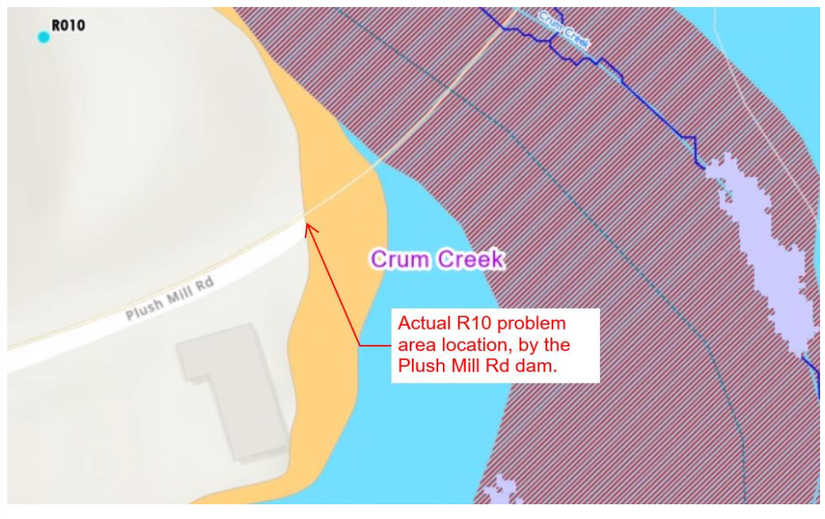
Erosion along banks of creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Opportunities for flood storage in immediately upstream park (Smedley Park)
- Streambank stabilization
- Evaluate elevating bridge/road
- Structural repairs on bridge may be needed

ID#R011 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	Blunston Run	**Problem Area Submission Date:**	9/5/2025
Municipality:	Upper Darby Township	**Location:**	Nyack Ave & S Union Ave, Lansdowne, PA 19050
Property Type:	Right of way		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Road closure 9 instances		
Field Visit Notes:	Entire southwest corner appears to have significant ponding recurring as indicated by sediment patterns. There are no inlets at the intersection despite it being a locally low point. Most runoff seems to come from the driveway to the Safeguard Self Storage and other runoff from Nyack Avenue.		

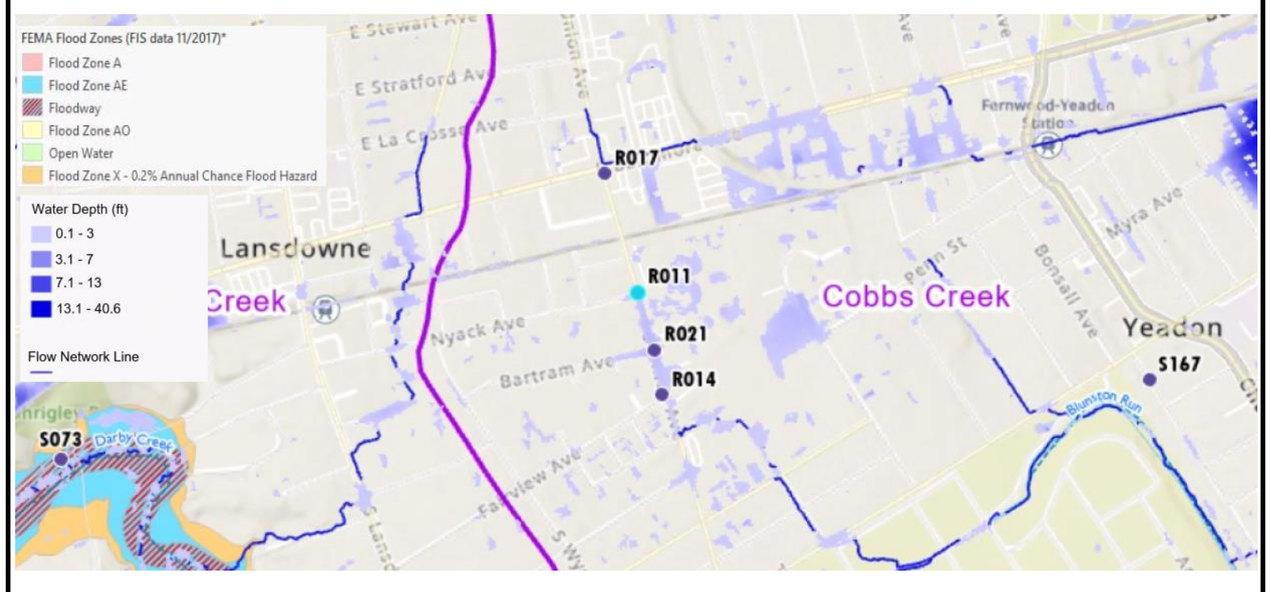


Southwest corner of Nyack Ave & S Union Ave with sediment deposits



View from intersection looking upgradient at Safeguard Self Storage driveway

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Consider adding inlets to this intersection.
- Some unused green space adjacent to storage driveway could convert to small basins to manage runoff from that property and reduce load at the intersection.

ID#R012 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Prospect Park Borough	**Location:**	11th Ave & Lincoln Ave, Prospect Park, PA 19076
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient drainage infrastructure.		
Problem Description:	Road closure 12 instances		
Field Visit Notes:	Minor signs of flooding along the curbs of 11th Ave which is fairly steep with no inlets along the curb. Additionally there is a small outlet pipe at the top of 11th Ave that appears to convey runoff from the townhouse complex. High velocities and lack of inlets along 11th Ave appear to be the main cause of flooding at this site.		

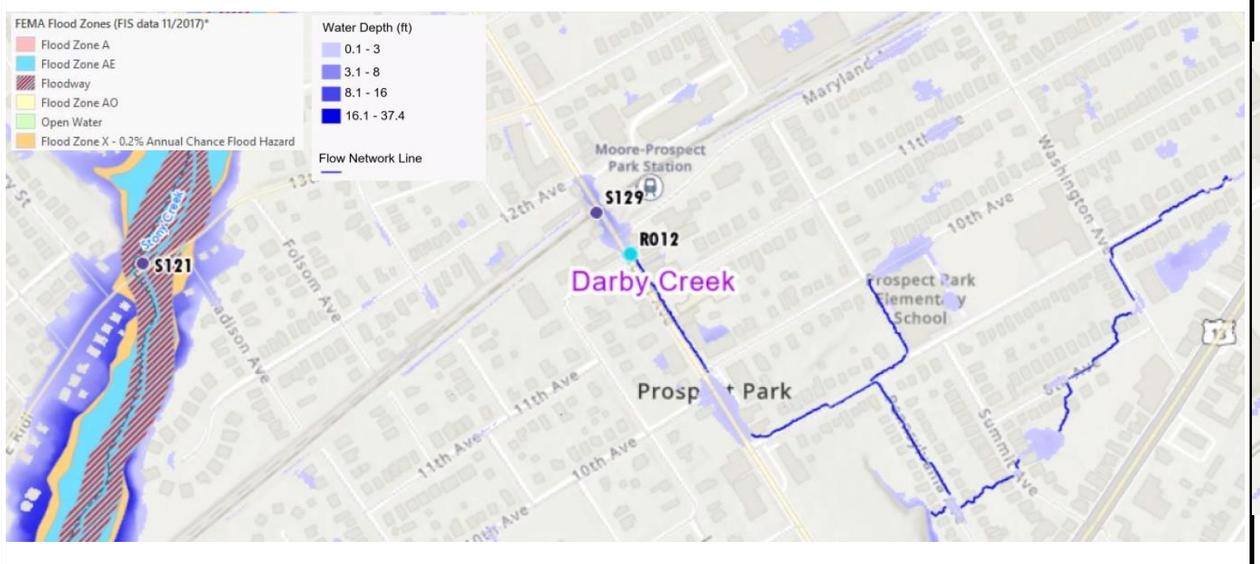


Sediment deposited along curb of 11th Ave

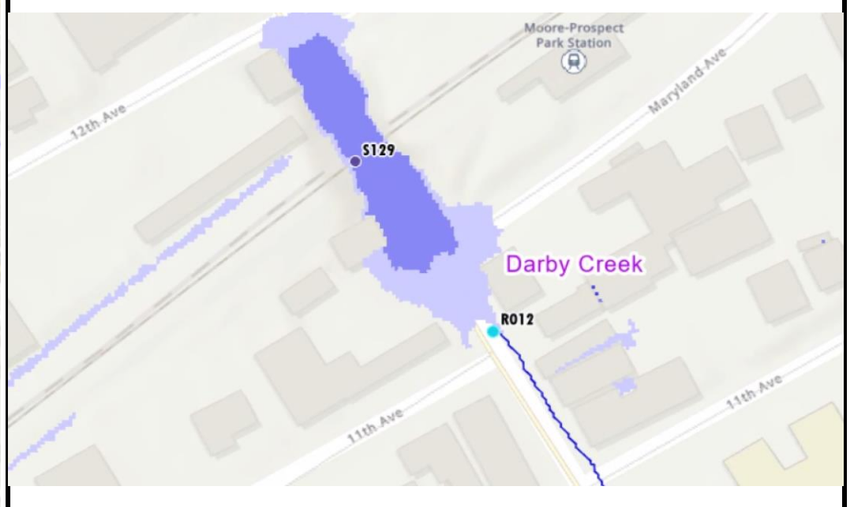


Top of 11th Ave only inlet present is outside of the right of way

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional inlets along 11th Ave.
- Pump station may be required to dewater this location.

ID#R013 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Upper Darby Township	**Location:**	6898 Marshall Rd, Upper Darby Township, PA 19082
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Road closure 3 instances		
Field Visit Notes:	Some signs of flooding on both sides of Marshall Rd in the form of sedimentation along the curb line. Flooding mostly due to aging drainage and roadway infrastructure in an area with little to no pervious coverage. Some trash/debris observed in inlets.		



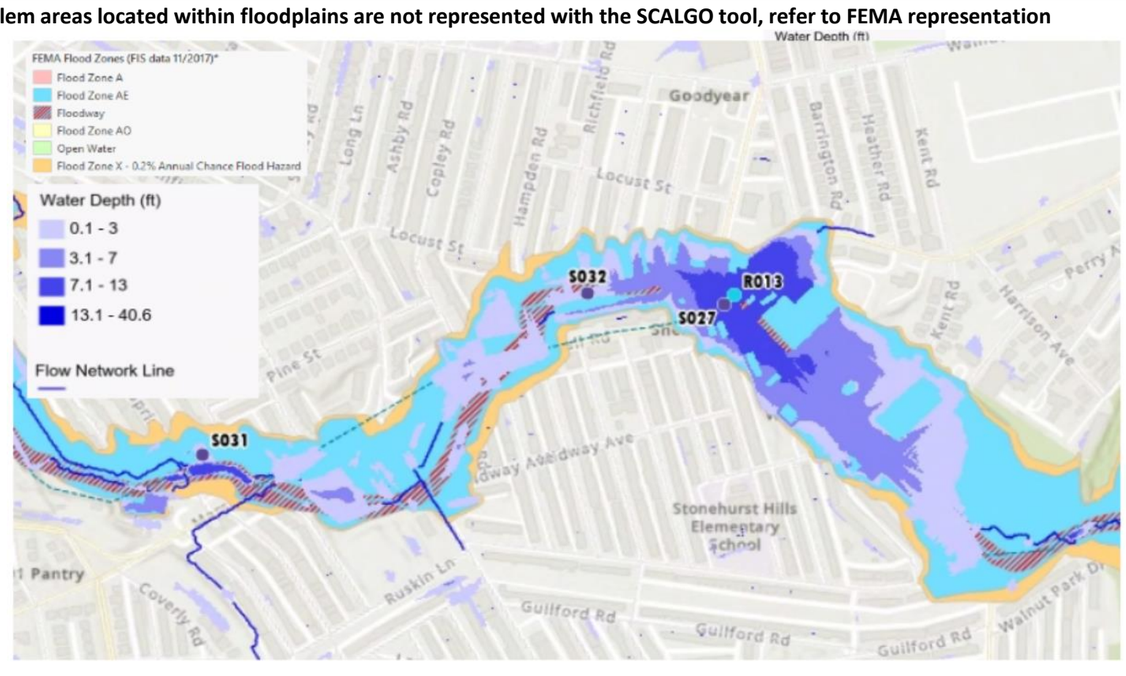
Sidewalk along Marshall Rd with sediment trapped between walkway and curb



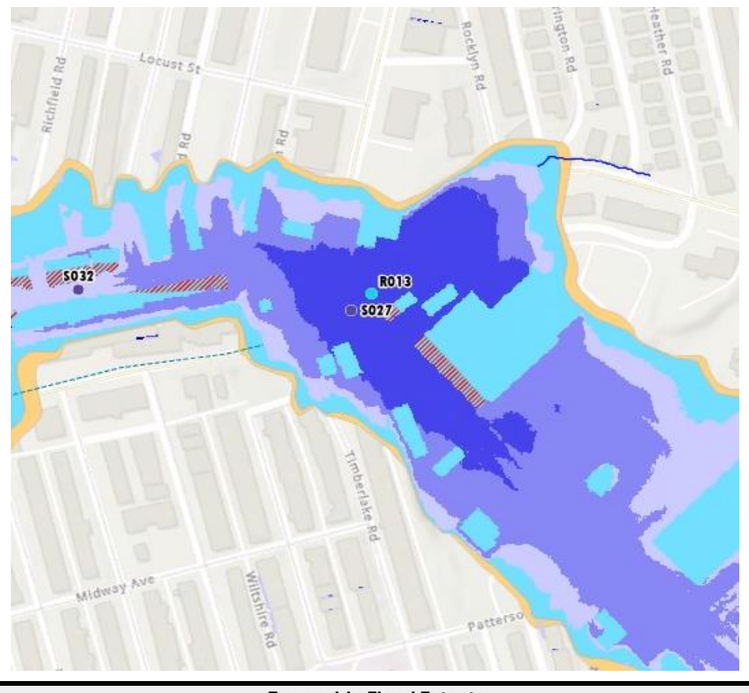
Aging inlet in roadway containing debris

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Routine maintenance to remove debris from existing aging inlets and pipes.
- Replace aging sidewalks or replace curbs to allow water to flow into inlets more efficiently.
- Consider flood control infrastructure as roadway is within the FEMA floodway.

ID#R014 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	Blunston Run	**Problem Area Submission Date:**	9/5/2025
Municipality:	Lansdowne Borough	**Location:**	Fairview Ave & S Union Ave, Lansdowne, PA 19050
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Road closure 3 instances		
Field Visit Notes:	Minor signs of flooding observed at intersection of Union and Fairview. Intersection is relatively flat with minimal drainage infrastructure. A couple inlets along Union Ave south of the intersection containing a lot of debris.		

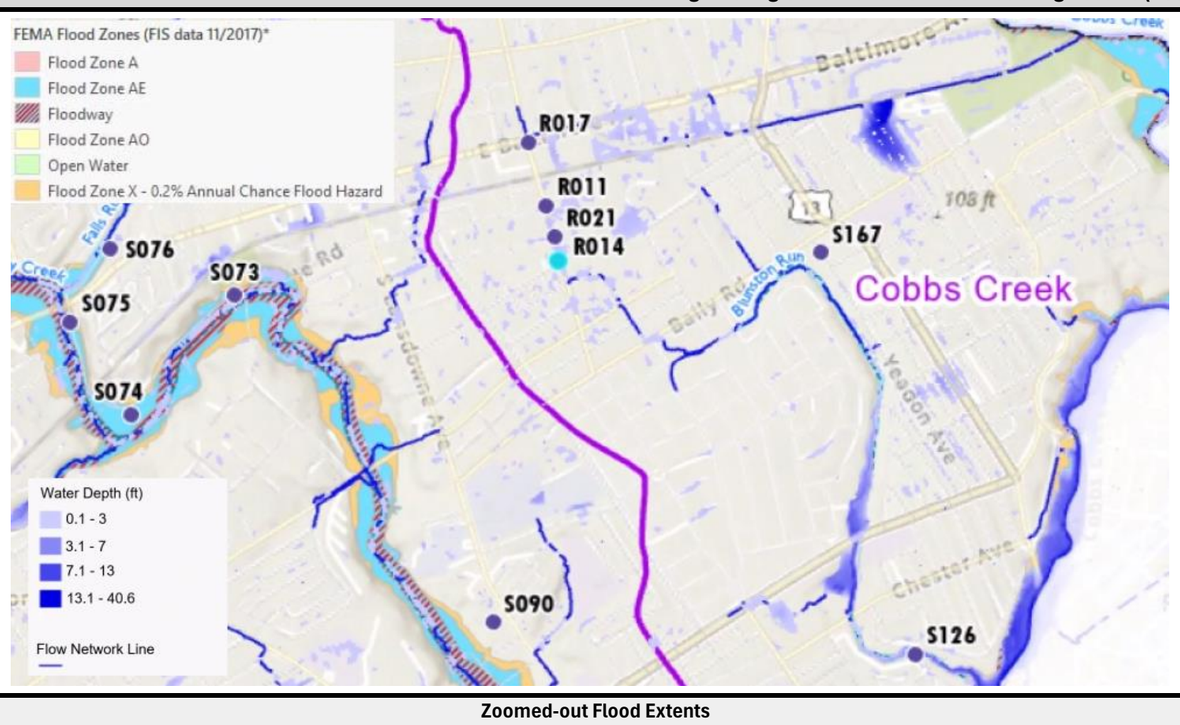


Sediment along roadway (left) inlet containging debris (right)

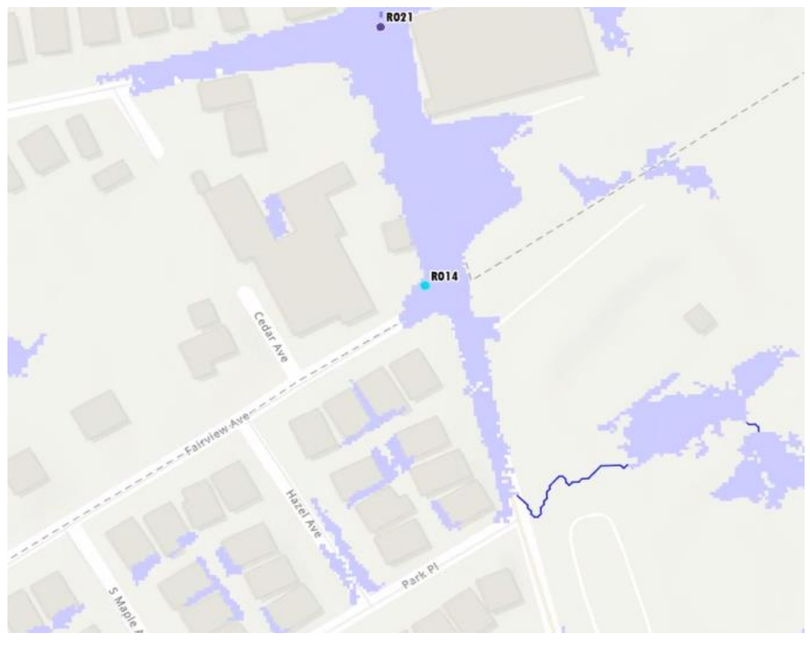


Existing SCM along west side of Union Ave

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install inlet(s) at intersection of Fairview Ave and Union Ave.
- Potentially re-grade intersection to allow for positive drainage.
- Small SCM along west side of Union Ave which collects drainage from Yeadon Community park could potentially be used for additional storage.

ID#R015 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Marcus Hook Creek	**Source of Problem:**	Delaware County Department of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	-
Municipality:	Trainer Borough	**Location:**	Main St & W 5th St
Property Type:	Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Road closure (3 instances)		
Field Visit Notes:	The intersection of Main and 5th Streets is a flat spot with no inlets. It is apparent that water ponds along Main Street especially at the base of 5th Street. The railroad crossing of Main Street was also investigated and it is apparent that that low spot does get significant ponded water as indicated by large amounts of sediment in the area. Inlets, with the exception of the city inlet under the crossing, appeared to have pipes that were not significantly blocked by debris. Parts of the roadway surface under the railroad crossing are cracked, likely from the prolonged presence of water.		



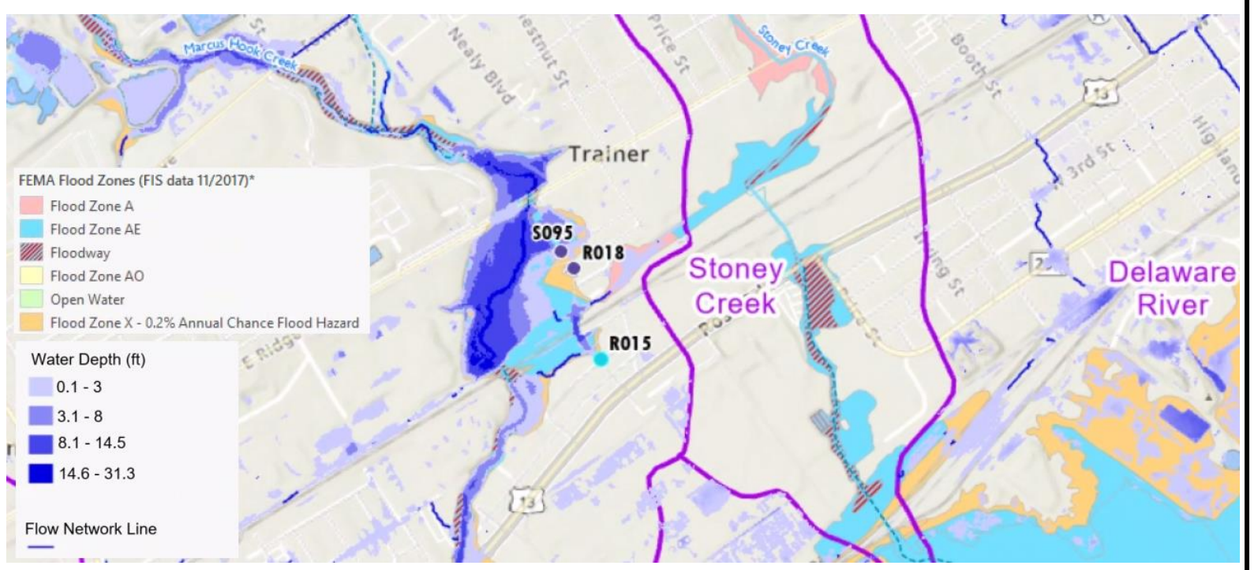
Main St & W 5th St



Cracking pavement and sediment in the area under the railroad crossing

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install inlets at the intersection of Main and 5th Streets.
- Increase the capacity of the drainage system at the crossing of Main Street and the railroad overpass.

ID#R016 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Collingdale Borough	**Location:**	Springfield Rd & S Macdade Blvd, Darby, PA 19023
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Road closures 4 instances		
Field Visit Notes:	Sources of flooding at this intersection appear to be Darby Creek overtopping the bridge during large events and overland flow coming from the Dunkin Donuts parking lot at the southwest corner of the intersection. The pavement at this intersection is in rough shape and some of the inlets contain a lot of trash/debris.		



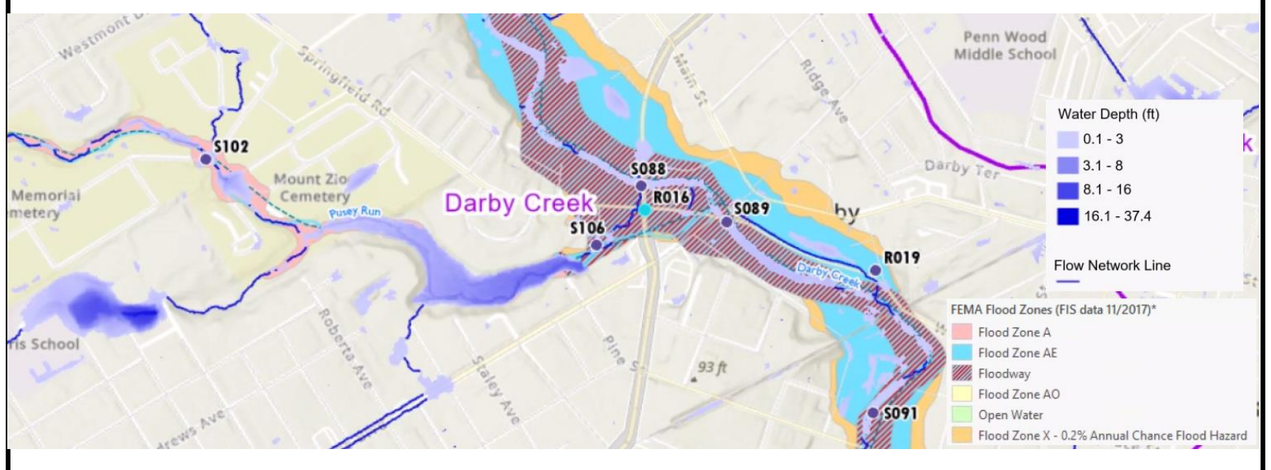
Overall view of intersection



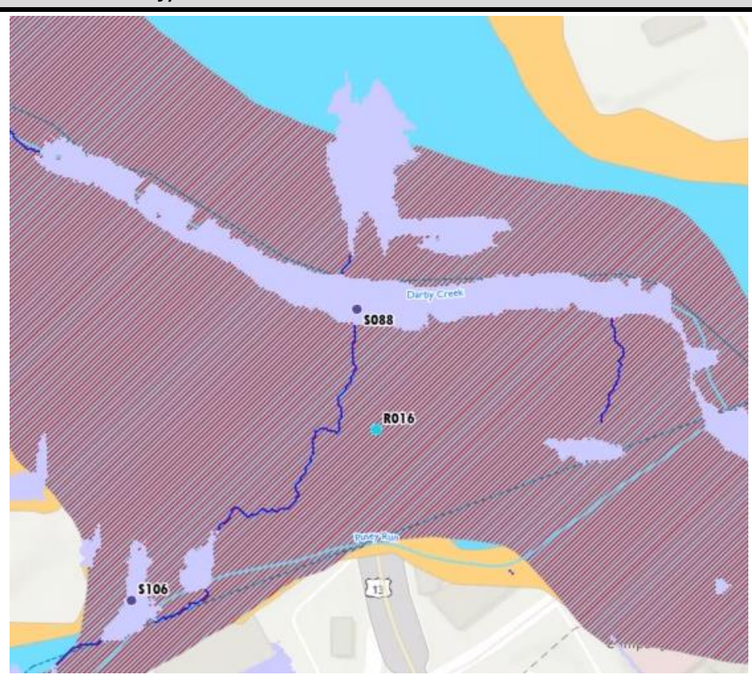
Trash filled inlet and sediment deposit along sidewalk in front of Dunkin Donuts

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- See point S088 for solutions to bridge site over Darby Creek.
- Clear debris from existing inlet at Southwest corner of intersection and ensure all inlets are functioning properly.
- Consider replacing sidewalk contributing to that inlet and re-grading to provide more uniform slope.

ID#R017 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	Blunston Run	**Problem Area Submission Date:**	9/5/2025
Municipality:	Upper Darby Township	**Location:**	119 East Baltimore Ave, Lansdowne, PA 19050
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Road closure 1 instance		
Field Visit Notes:	Aging drainage infrastructure appears to contribute to flooding of intersection. Curb inlet on North side of Baltimore Ave is partially blocked with debris. Inlet on south side of intersection is dislodged which could contribute to flooding issue.		

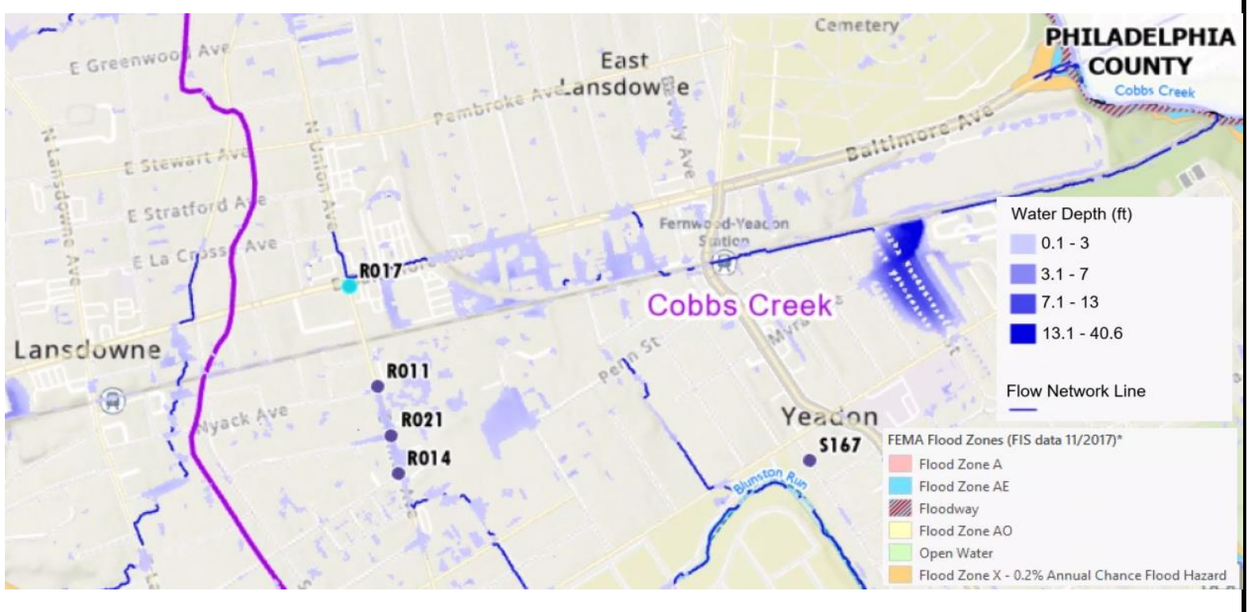


Old damaged curb inlet at intersection



Sediment deposit along curbline of Baltimore Ave

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Repair existing inlet on South East corner of Union Ave & E Baltimore Ave intersection.
- Replace damaged/eroded sections of sidewalks along that same corner which could be inhibiting flow and creating more sediment deposits.
- Additional Storm conveyance is appears to be needed in this area.

ID#R018 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Marcus Hook Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Trainer Borough	**Location:**	W 7th St & Main St, Marcus Hook, PA 19061
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient drainage infrastructure.		
Problem Description:	Road closure 5 instances		
Field Visit Notes:	Runoff from W 7th Street flows down and stops at Main Street intersection. Main Street is crowned while W 7th Street is not crowned. Damaged pavement and sediment deposition on W 7th Street suggest prolonged water exposure. No inlets or curb cuts.		



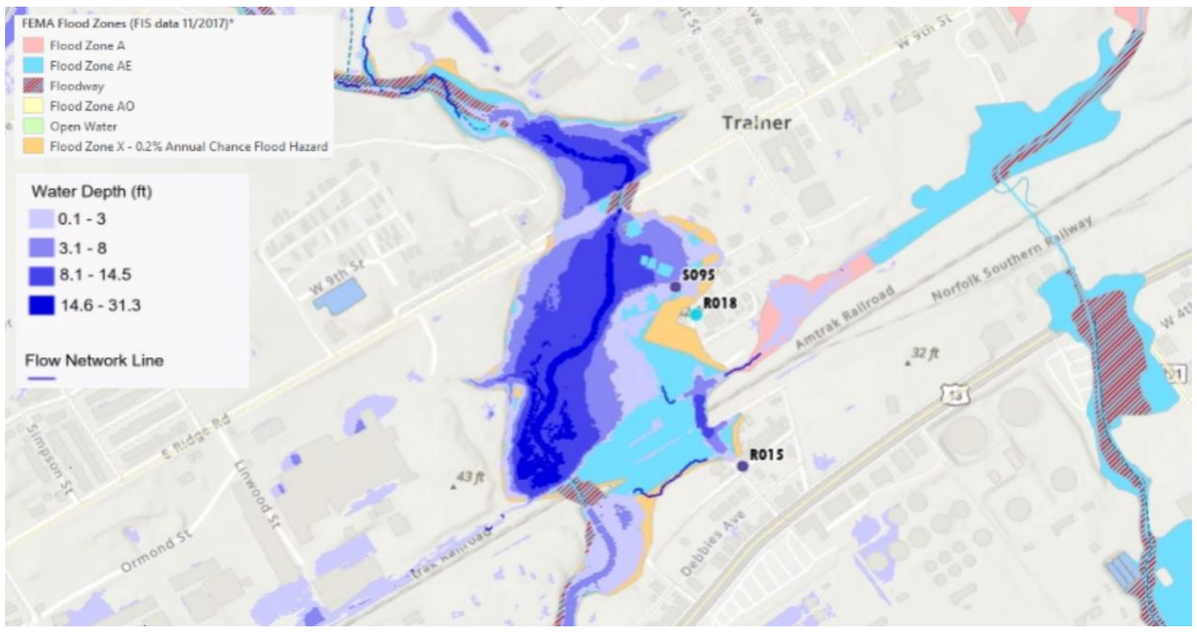
View of intersection looking down 7th St



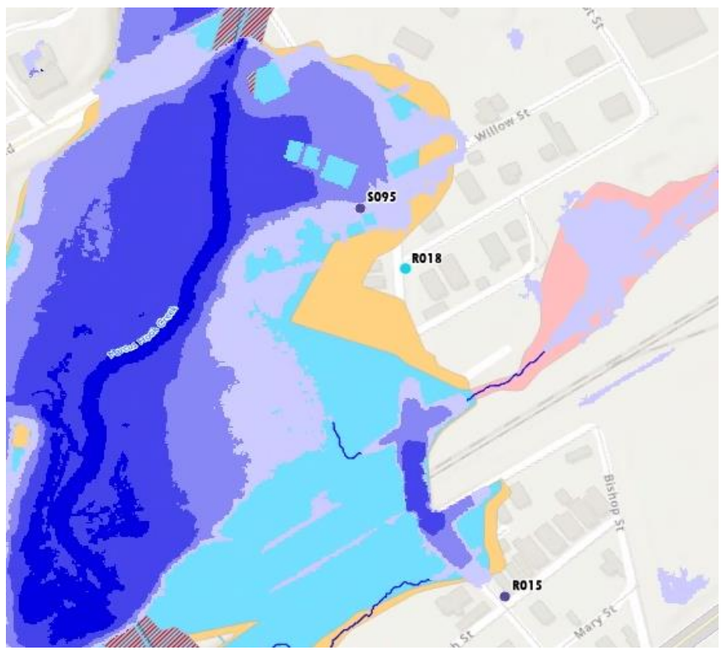
View of Main St from intersection (left) and damaged ADA ramp with sediment deposit (right)

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

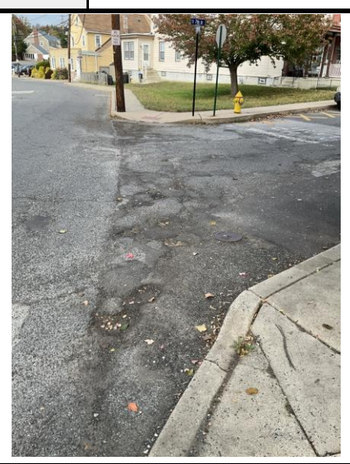
Potential Solutions

- Install additional inlets and/or curb cuts.
- Floodplain restoration and flood control is recommended to prevent floodwaters from encroaching on roadway and structures.

ID#R018 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Marcus Hook Creek	**Source of Problem:**	Delaware County Department of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	-
Municipality:	Trainer Borough	**Location:**	Main St & W 7th St
Property Type:	Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Road closure (5 instances)		
Field Visit Notes:	It is apparent that runoff from W 7th Street flows down and ponds at its intersection with Main Street. Main Street is crowned while W 7th street is not. Damaged pavement and sediment deposition on W 7th Street suggest prolonged water exposure. No inlets or curb cuts were observed at this location.		



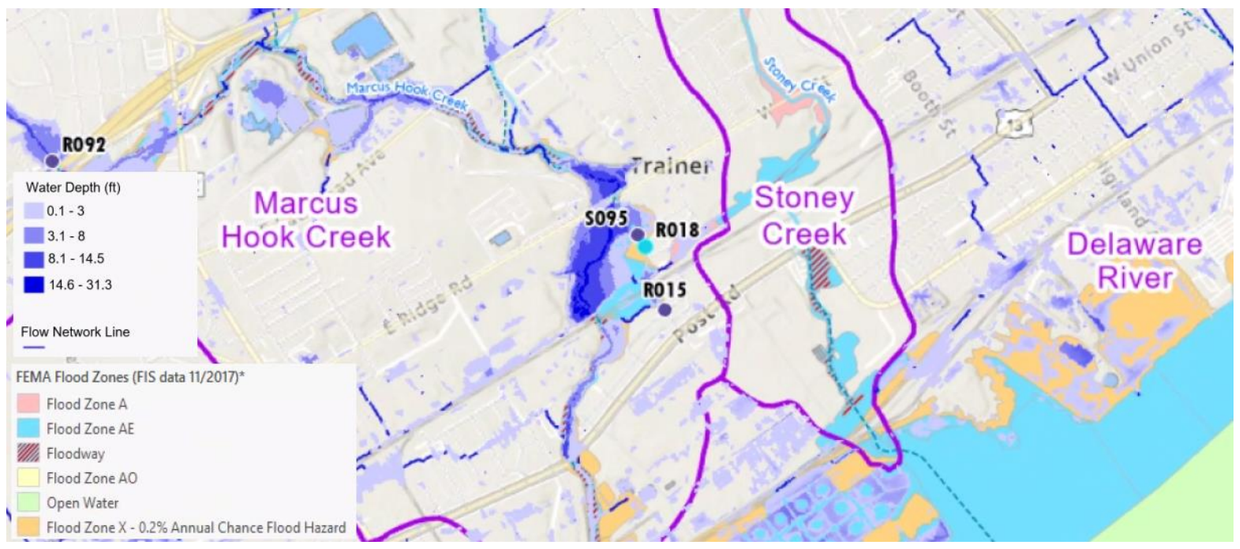
Damaged pavement and sediment deposition at the intersecion of Main St & W 7th St



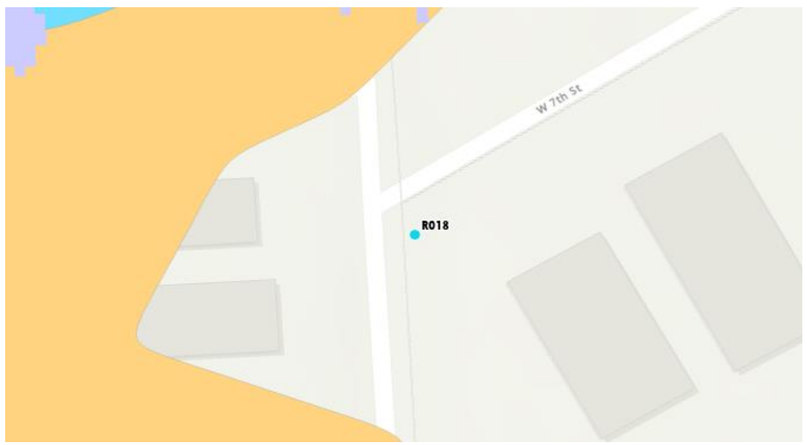
Pavement damage and sediment deposition along W 7th St

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

*** Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional inlets or curb cuts
- Potential for subsurface storage system in Main Street

ID#R025 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Darby Borough	**Location:**	Mill St & Walnut St, Darby, PA 19023
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient drainage infrastructure.		
Problem Description:	Road closure 1 instances		
Field Visit Notes:	Sidewalk corners and ramps have been recently reinstalled at this intersection most likely due to flood damage. There are no inlets at the intersection and the one inlet upgradient along Walnut St is not functional. Corner on the south side of the intersection appears to have some drainage improvements in the works as the gravel trench lines up with the natural path of the runoff through the grass. Grass area on west side of Walnut St does show signs of Darby Creek overtopping.		



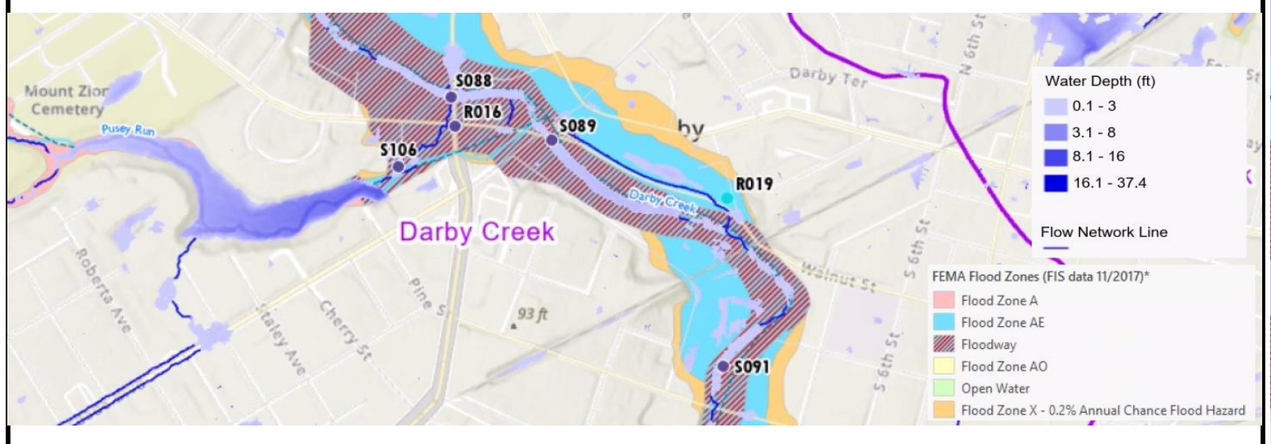
Newly constructed sidewalks and ADA ramps



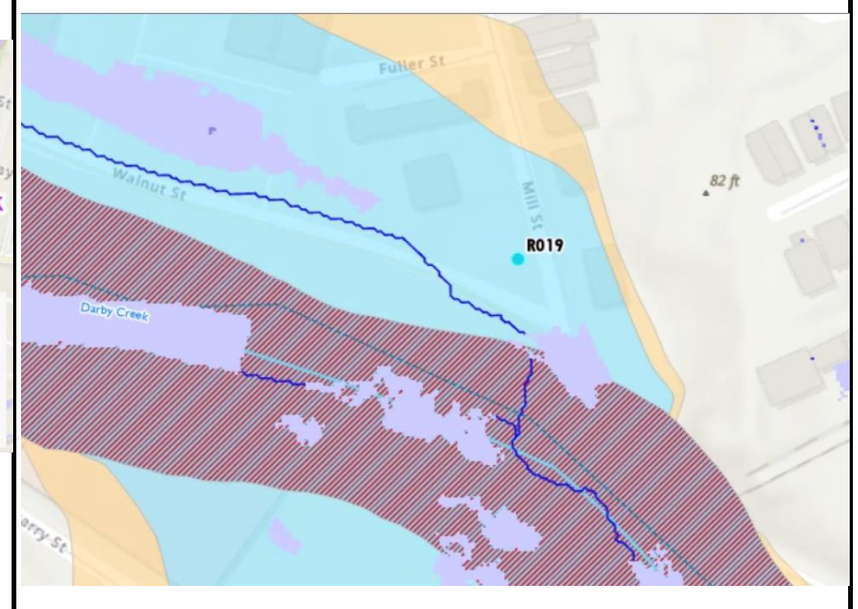
Erosion in grass area at corner on the southside of the intersection

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- It appears that final construction at this intersection is not yet completed so there may be some drainage improvements in the near future.
- This intersection could benefit from some additional drainage and the existing inlet on Walnut street should be cleared of debris to ensure it functions properly.
- Consider elevating Walnut Street above floodway elevation.

ID#R020 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Ridley Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Middletown Township	**Location:**	504 Barren Rd, Media, PA 19063
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Restricted capacity, Insufficient/aging drainage infrastructure		
Problem Description:	Road closure 1 instance		
Field Visit Notes:	60 foot length of bridge. Approximately 9.5 ft height from abutment to apex of span. Signs of flooding in the trailhead parking lot-sedimentation and erosion. Erosion and spalling on top of bridge and on the abutments below. 12in SLCPP coming from under Bishop Hollow Road. There is some erosion adjacent to the pipe coming from the road surface. Downstream of bridge there are some fallen tree obstructions. Upstream of bridge is a long dam, see info for point S137.		



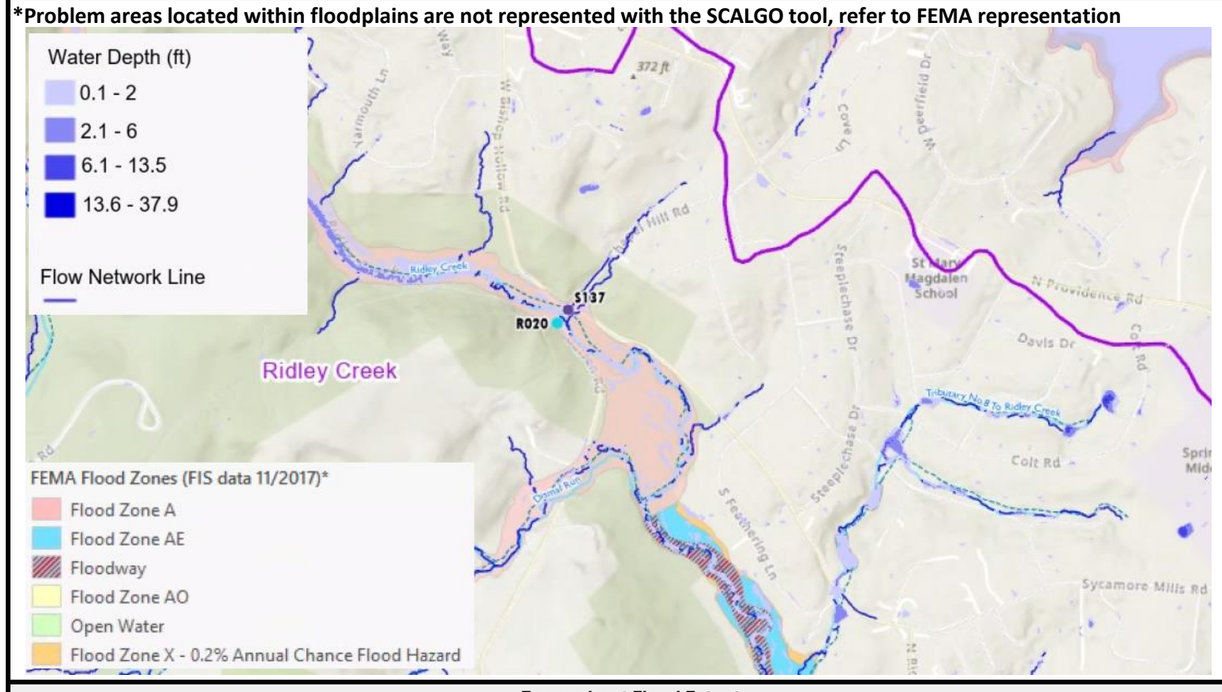
Ponding at trailhead parking lot where Barren Rd meets Sycamore Mills Rd



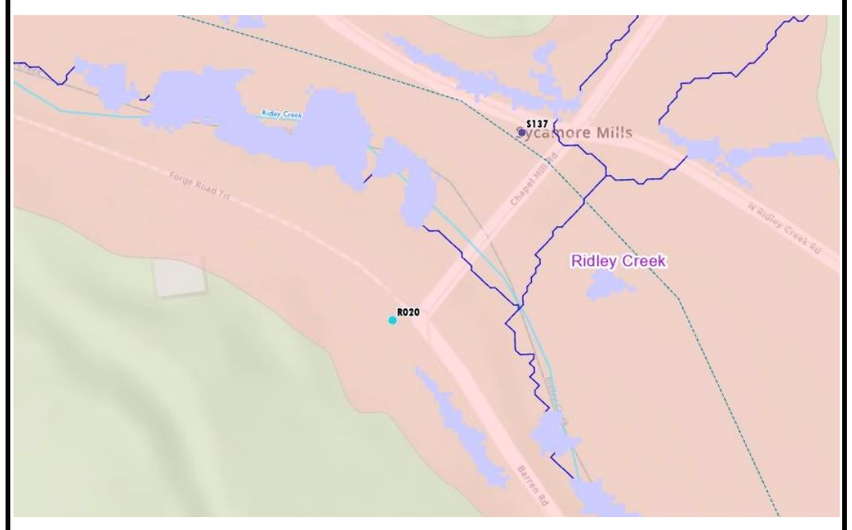
View of Ridley Creek at Chapel Hill Rd bridge

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Routine maintenance to remove obstructions in waterway.
- Additional drainage infrastructure upgradient along Barren Rd
- Stabilize streambanks.
- If necessary, elevate Barren Road and Chapel Hill Road Bridge.

ID#R021 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	Blunston Run	**Problem Area Submission Date:**	9/5/2025
Municipality:	Upper Darby Township	**Location:**	Bartrams Ave & S Union Ave, Lansdowne, PA 19050
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Road closure 1 instance		
Field Visit Notes:	Intersection is at a low point for the area with 4 inlets all of which are filled with debris. 2 of the inlets are older and shallow while the other 2 are newly installed and deeper. The nearby church property drains to this intersection and contains trench drains that are completely filled with vegetation and not functioning.		

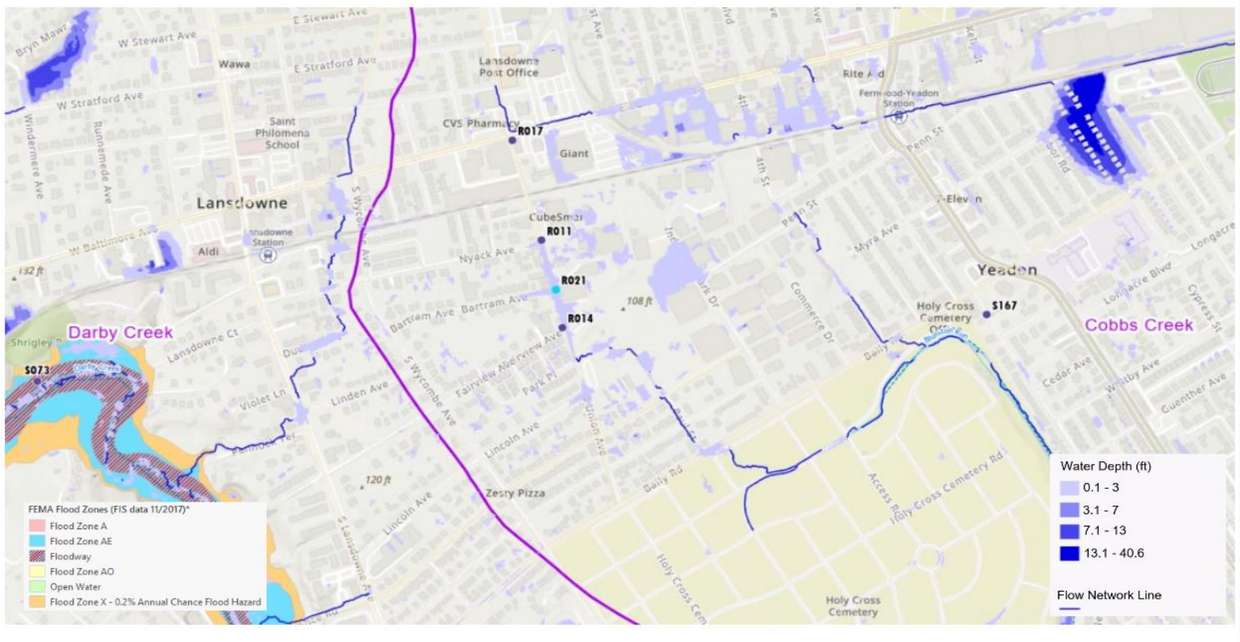


Sediment deposit along sidewalk at corner of intersection



Aging shallow inlet filled with debris

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Perform maintenance and clear obstructions/clean all inlets at the intersection as well as the trench drains servicing the church parking lot.
- Pump Station may be required to dewater the low point.

ID#R022 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Crum Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Marple Township	**Location:**	Bridge near 901 Crum Creek Rd, Springfield, PA 19064
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Restricted Capacity, Insufficient drainage infrastructure.		
Problem Description:	Road closure 3 instances		
Field Visit Notes:	Minor sedimentation in front of residence at 901 Crum Creek Rd. 3'x60' bridge culvert has downed tree on upstream end. Smaller 36" RCP culvert crossing under Crum Creek Rd is heavily obstructed with vegetation on downstream end which may be factor in flooding on site.		



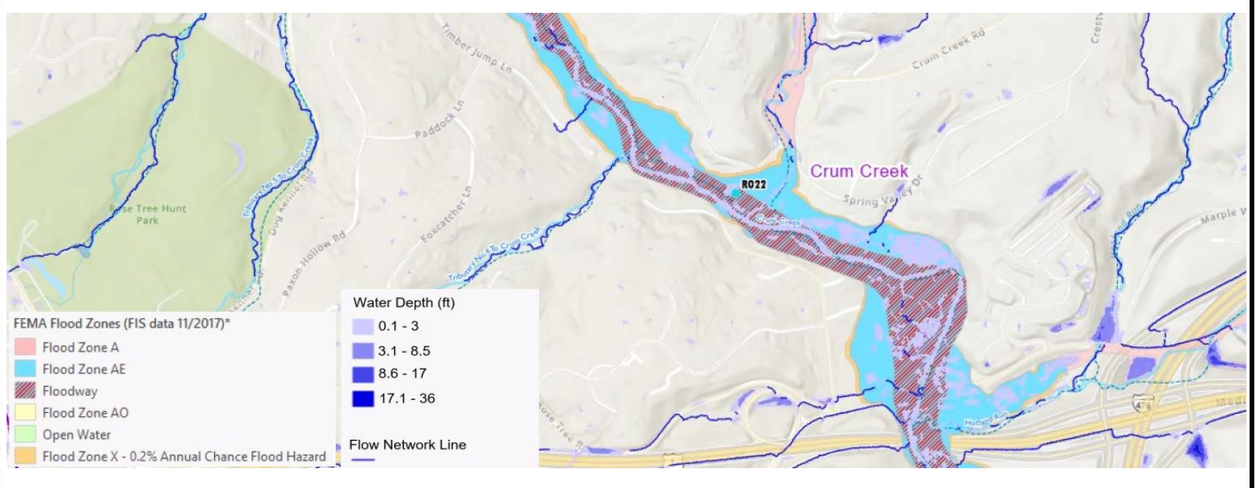
Downed tree on upstream side of bridge culvert (left) and onstructed 36" RCP culvert (right)



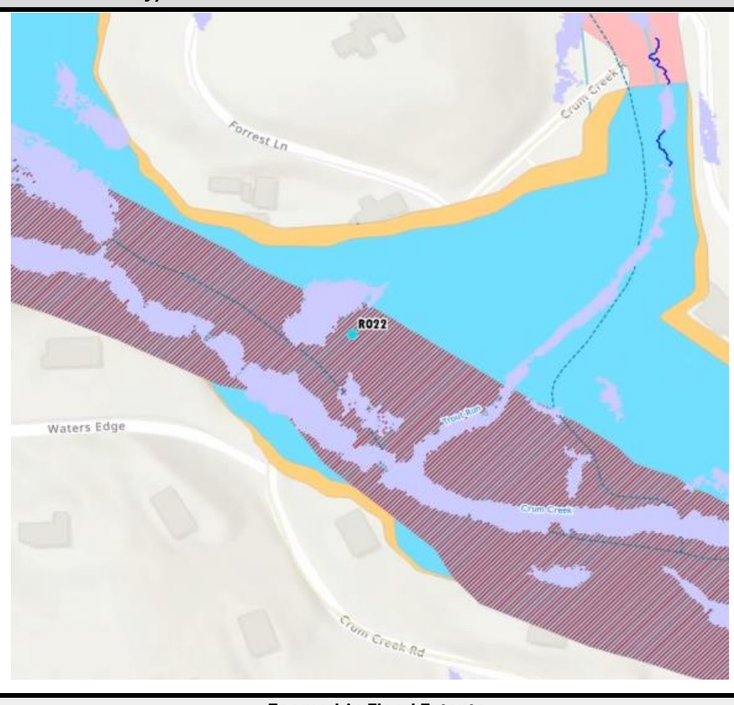
Sediment deposit along Crum Creek Rd adjacent to bridge

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Perform maintenance on Crum Creek Rd culvert to ensure it conveys water properly.
- Remove tree from upstream end of bridge.
- Install inlets along Crum Creek Road to lessen overland flow.

ID#R023 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Crum Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Upper Providence Township	**Location:**	Farnum Rd & Crum Creek Rd, Media, PA 19063
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Restricted Capacity, Insufficient/aging drainage infrastructure		
Problem Description:	Road closures 2 instances		
Field Visit Notes:	Unable to stop and inspect site fully due to unsafe pull-off conditions. Intersection is at a low point with one inlet which presumably discharges to Crum Creek (dimension unknown). Invasive bamboo was observed near the creek crossing of the road which could cause obstruction.		



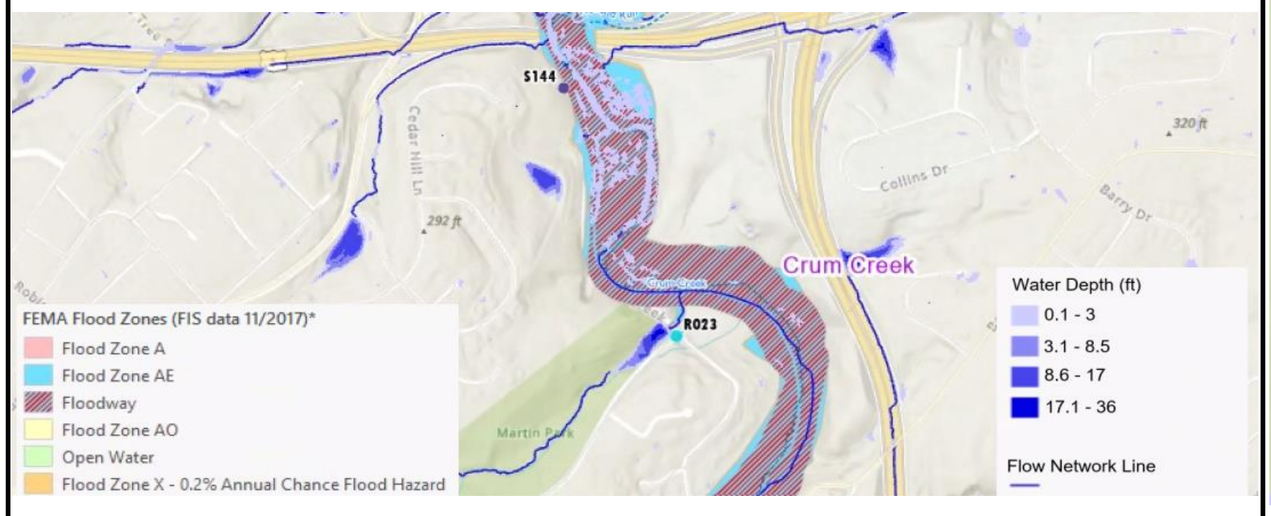
Farnum Rd & Crum Creek Rd intersection



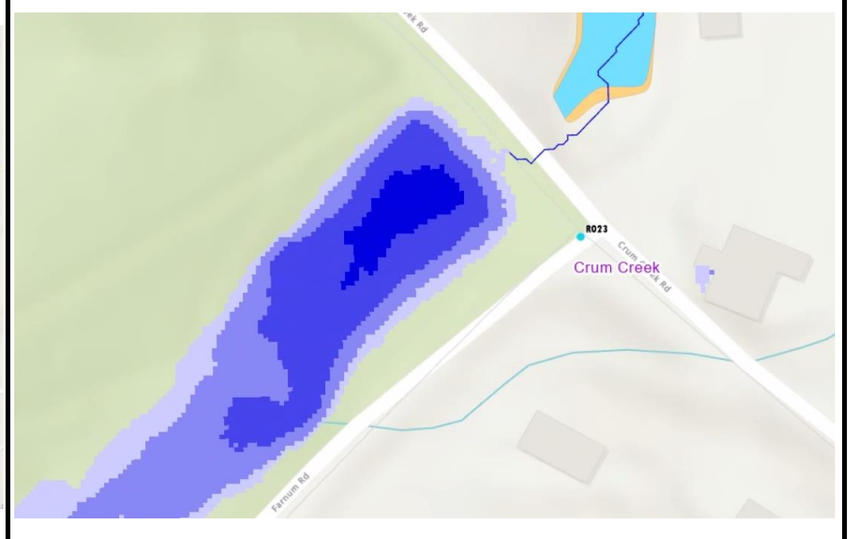
Lone inlet at intersection (left) and invasive bamboo patch (right)

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Remove invasive bamboo and any other obstructions to the culvert.
- Upsize culvert if necessary.
- If problems continue after removal of obstructions further investigation with traffic control may be necessary

ID#R025 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Sharon Hill Borough	**Location:**	Ridley Ave & Chester Pike, Sharon Hill, PA 19079
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient drainage infrastructure.		
Problem Description:	Road closure 1 instances		
Field Visit Notes:	Northeast and Southeast corners of Ridley Ave and Chester Pike intersection have sedimentation at the base of the curb ramps. Both spots appear to be relatively low points at the intersection which has no inlets.		



Northeast corner of intersection

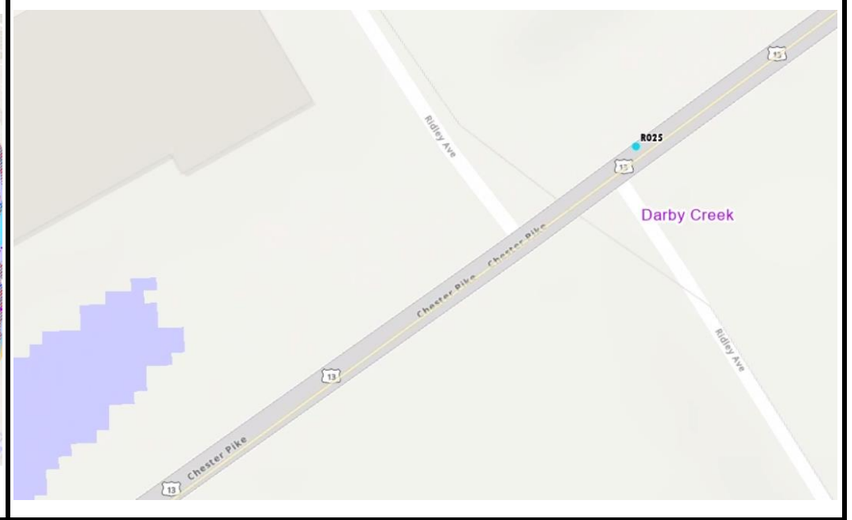


Southeast corner of intersection

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional inlets
- Re-grade pavement to provide positive drainage.
- Low point at this location may require pump station to be installed.

ID#R026 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Norwood Borough	**Location:**	W Amosland Rd & Chester Pike, Norwood, PA 19074
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Road closure 1 instances		
Field Visit Notes:	Signs of ponding at the South side of the intersection with inadequate grading/drainage. Inlet on this side has standing water indicating possible clog. Inlets on other side of intersection are larger but show some structural damage. Funeral home adjacent to site appears to be main source of unmanaged drainage.		

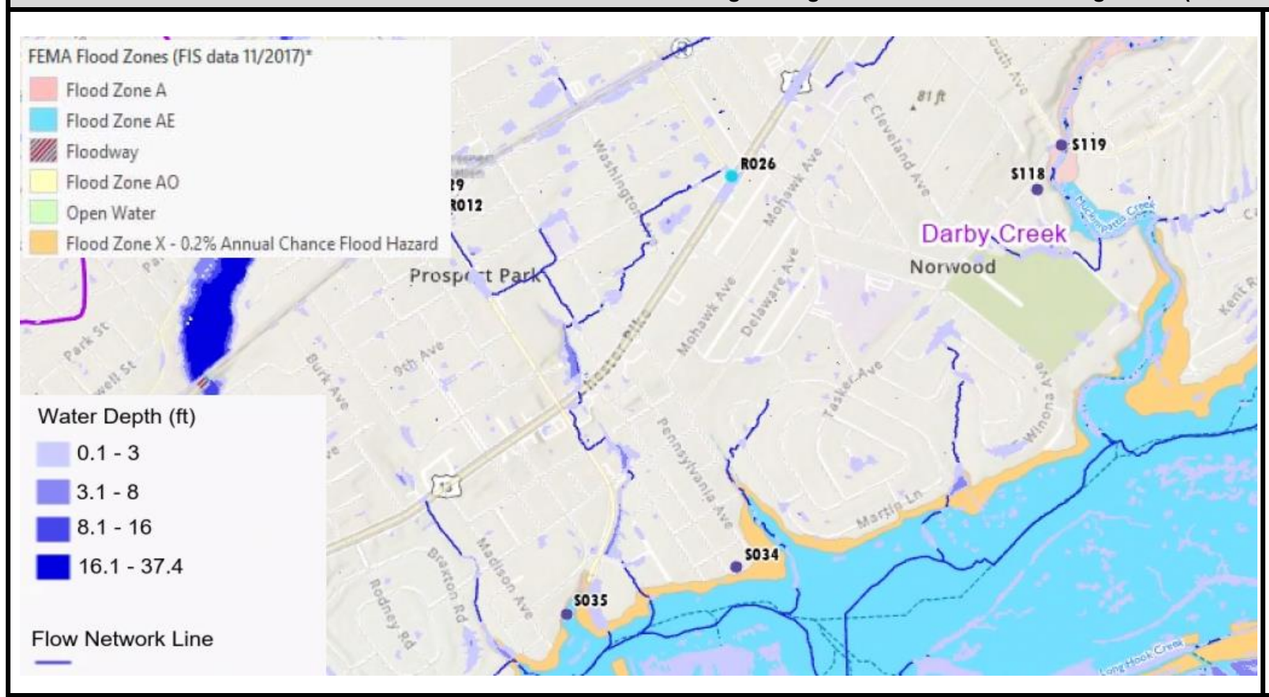


Sediment deposit along curb on south side of intersection

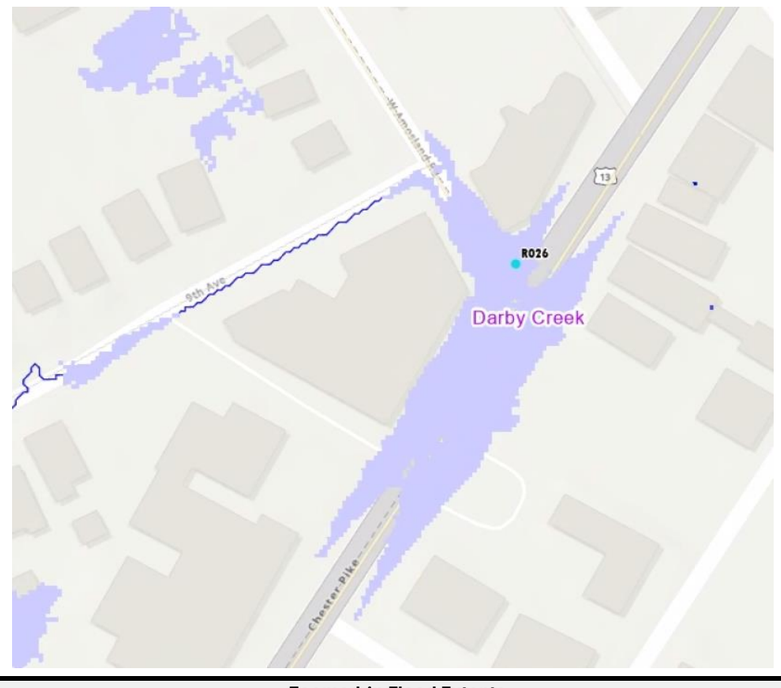


Small aging inlet with sediment and damaged pavement

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Consider clearing out inlet with standing water.
- Repairing deteriorating inlets
- Add inlet sumps
- Upsize stormwater pipes in area.
- Low point at this location may require pump station to dewater completely.
- A indepth investigation of existing stormwater conveyance networks is recommended.

ID#R027 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Ridley Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Eddystone Borough	**Location:**	702 Saville Ave, Eddystone, PA 19022
Property Type:	Rightofway		
Type of Problem(s):	Flooding (EMS Road Closures) - Roadway elevation, Restricted Capacity		
Problem Description:	Road closure (1 instance)		
Field Visit Notes:	Large number of inlets at this crossing. Railway adjacent is elevated with steep slopes. Inlets and their outlet pipes seem relatively shallow. Some evidence of ponding.		



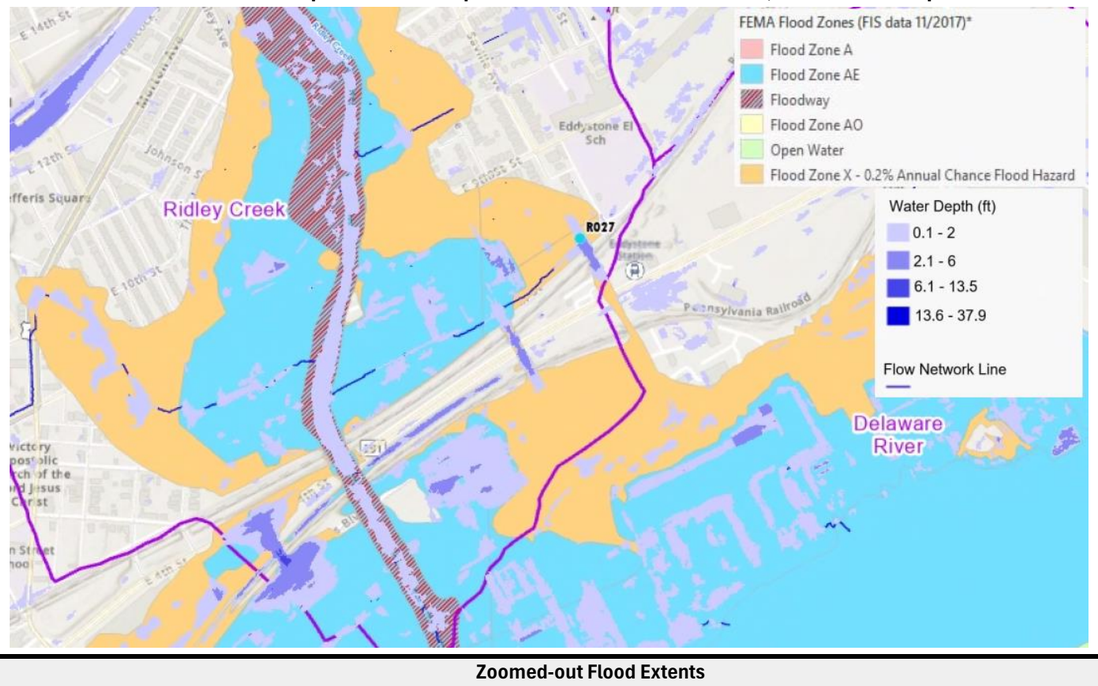
Shallow inlet along Saville Ave which is shallow and appears to have some debris restricting flow



View of Saville Ave at railroad underpass

Existing Condition Flood Analysis Image (SCALGO 100 year storm-7.61 in)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Increase the capacity of the drainage system at this intersection.
- If elevations are restricting the inlet depth/pipe sizes potentially install new SW basin(s) up gradient along each roadway approach to reduce peak rates.
- Flooding at this location related to widespread innundation from Delaware River and Ridley Creek. Regrading of Seville Ave is infeasble due to railroad elevations. Therefore, a large floodway management project recommended and may require flood control such as a levee wall or increased capacity of Ridley Creek at the creek crossing with 491 and the existing and historic railroad bridges.

ID#R029 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Ridley Township	**Location:**	Industrial Hwy and Sea Knight Ave: @BOEING BDS
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Road closure 1 instance		
Field Visit Notes:	Witness testimony Mike Levantry states the north side of this intersection does flood. Sediment deposits on road and in inlet at the base of the driveway into the Boeing complex. Not many inlets along this side of the road.		



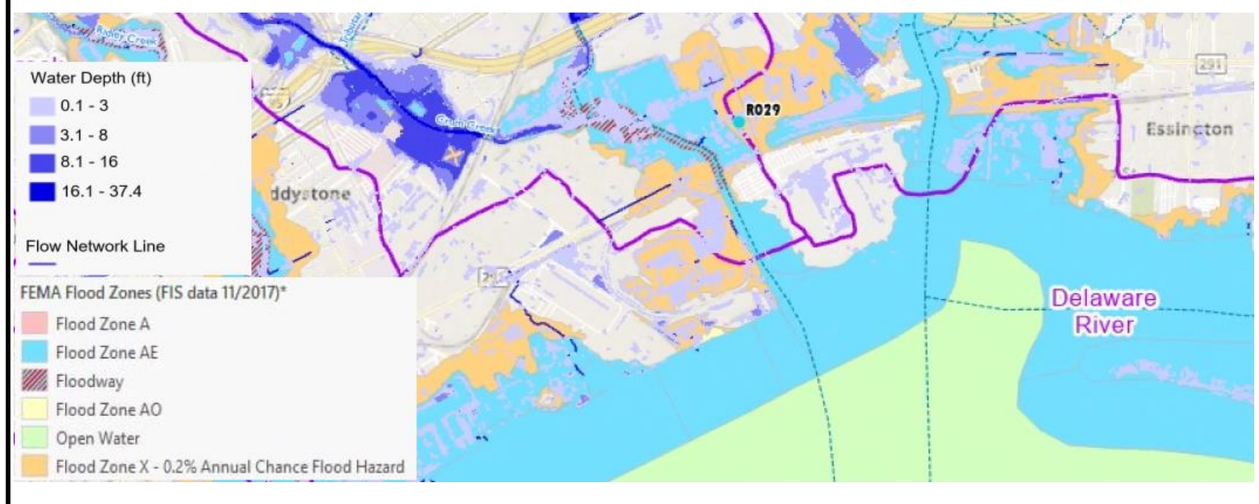
View of Industrial Hwy and Sea Knight Ave intersection



ADA ramp with sediment deposit

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional inlets at this intersection.
- Consider installing a pump station or elevating the affected structures.
- Large green space between roadway and boeing facility could be used for SW basin.
- Area is inundated by flooding from the Delaware River which is anticipated to experience SLR. Flood protection infrastructure is recommended.

ID#R030 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Lansdowne Borough	**Location:**	Green Ave & E Essex Ave, Lansdowne, PA 19050
Property Type:	Right of way		
Type of Problem(s):	Flooding - Restricted Capacity, Insufficient/aging drainage infrastructure		
Problem Description:	Road closure 1 instance		
Field Visit Notes:	There is an inlet at all 4 corners of the Green Ave and E Essex Ave intersection which are all very shallow and show signs of ponding nearby. Additionally in front of the school along Green Ave there are 2 inlets which lead to the intersection. The roadway and sidewalk in front of the school shows signs of prolonged ponding.		



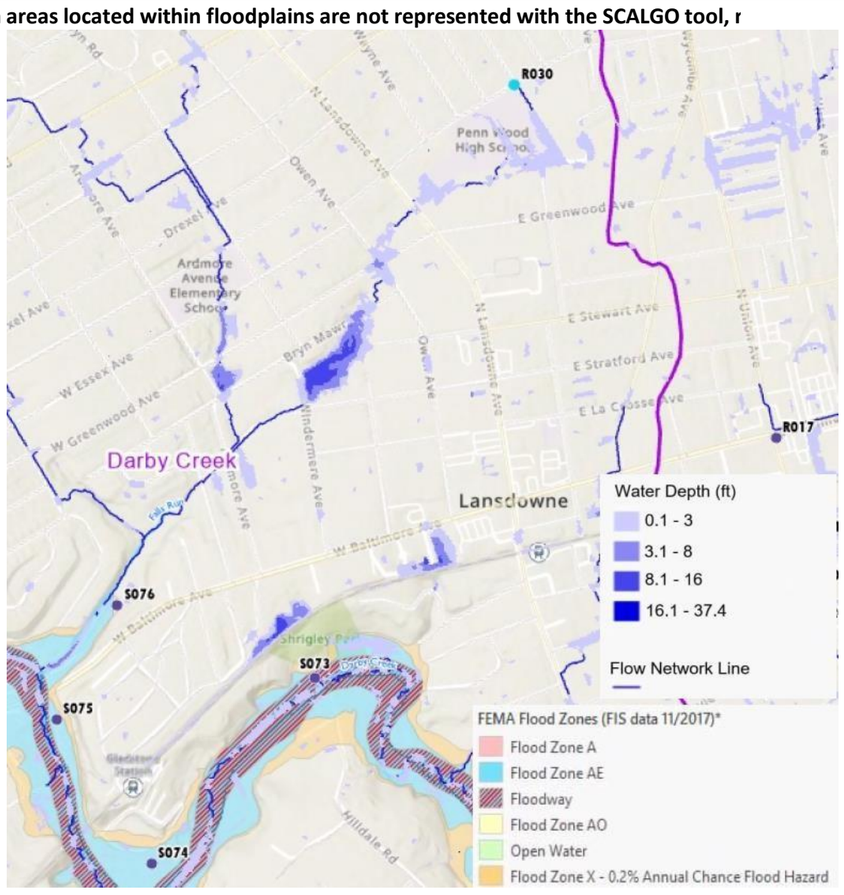
Damaged sidewalk in front of school along Green Ave



Damaged inlet which is shallow and filled with trash

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, r**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Improve drainage at intersection of E Essex Ave and Green Ave
- Evaluate potential opportunities for subsurface flood storage below playfields and/or parking lots at Penn Wood High School
- Potential for subsurface storage system in E Essex Ave and/or Green Ave

ID#R031 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	DELCO Dept of Emergency Services
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/5/2025
Municipality:	Chester Township	**Location:**	Concord Rd & Green St, Chester, PA 19013
Property Type:	Rightofway		
Type of Problem(s):	Flooding - insufficient/aging drainage infrastructure		
Problem Description:	Road closures 2 instances		
Field Visit Notes:	RR bridge appears to be low point. Unable to access bridge and surrounding inlets due to limited pedestrian access, traffic controls required.		

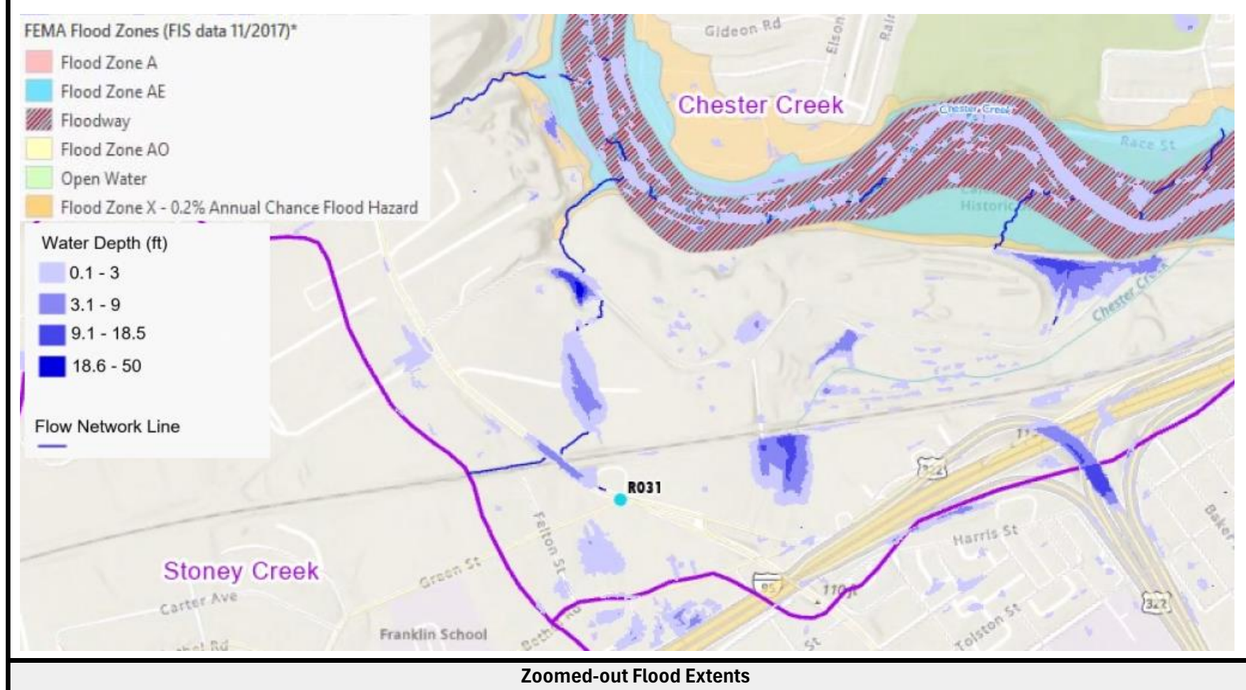


Concord Rd passing under railroad bridge

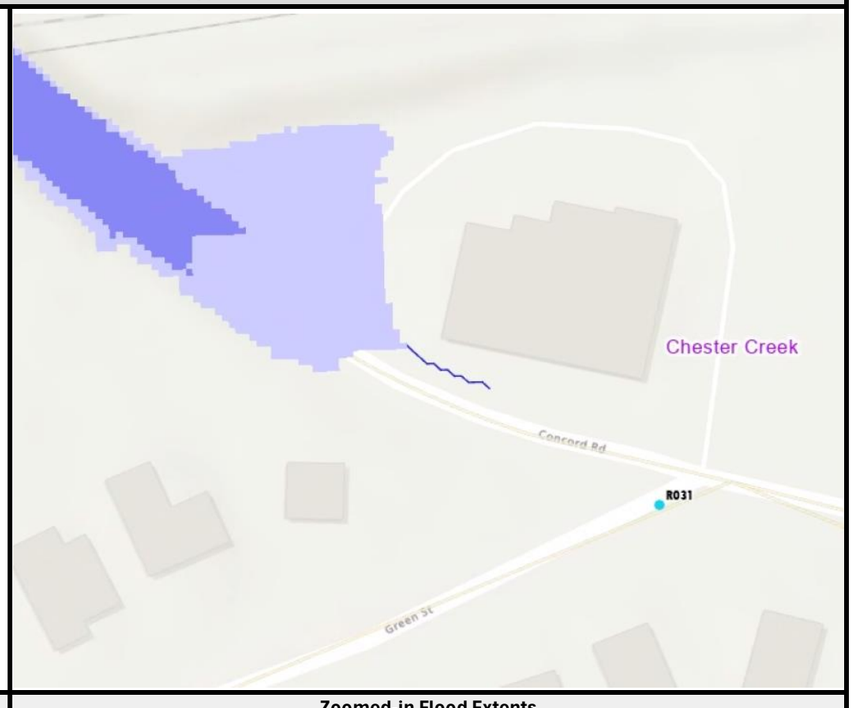


Inlet on Concord Rd appears to be in good shape

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Organize MPT to inspect intersection of Concord Road and the railroad.
- Roadway regrading potential is limited by the elevation ove the overhead roadway.
- Consider installing pumpstation to dewater low area.

ID#R062 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Philadelphia Water Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	-
Municipality:	City of Philadelphia	**Location:**	Eastwick Park
Property Type:	Open Space		
Type of Problem(s):	Flooding		
Problem Description:	Flooding of structures during high stream flow events; proposed site for tentatively selected Eastwick Park Levee		
Field Visit Notes:	Area is very flat with a broad floodplain, including many of the townhomes to the east. There is a large area of well-maintained recreational open space adjacent to creek (east side). Creek buffer on east side is relatively limited.		



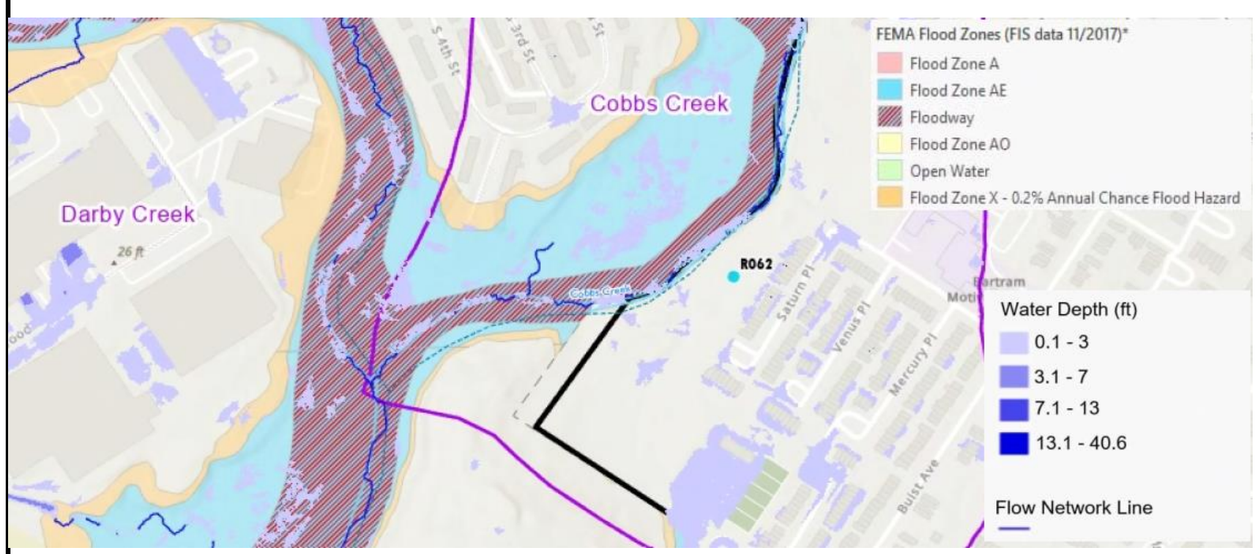
Cobbs Creek at Eastwick Park



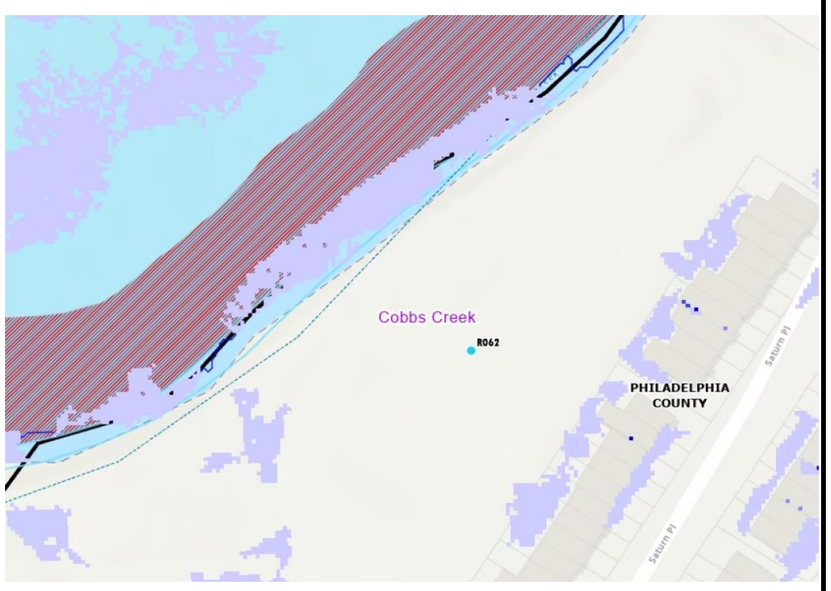
Open space immediately to the east of Cobbs Creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Opportunities to increase floodway on both sides of creek, as well as for increasing floodplain storage
- Increase buffer on east side of creek
- Evaluate opportunities for constructed wetlands, as well as flood storage in upstream parks
- Solutions need to be coordinated with other planned projects, including a proposed levee on the east side
- See the Potential Solution Analysis form for S092 for additional supporting analysis related to this problem location

ID#R087 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Naamans Creek	**Source of Problem:**	DELCO Planning Dept
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/11/2025
Municipality:	Upper Chichester Township	**Location:**	3419 Bethel Rd, Boothwyn, PA 19061
Property Type:	Rightofway		
Type of Problem(s):	Erosion - Insufficient Natural Channel Capacity		
Problem Description:	Roadway, curb, and walk damage		
Field Visit Notes:	Erosion present along streambank and a lot of debris deposited along top of bank from high velocity flooding during large events. Erosion and debris most likely due to shallow stream with grassy banks (no rock) and many outfalls upstream at bridge.		

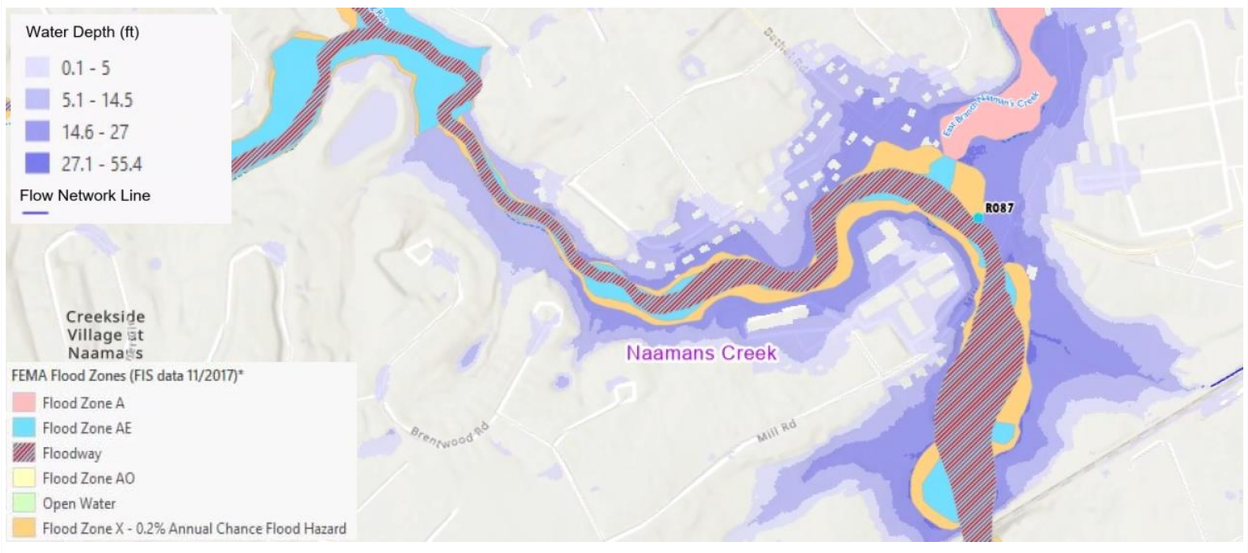


Large pile of debris deposited from high velocity flooding

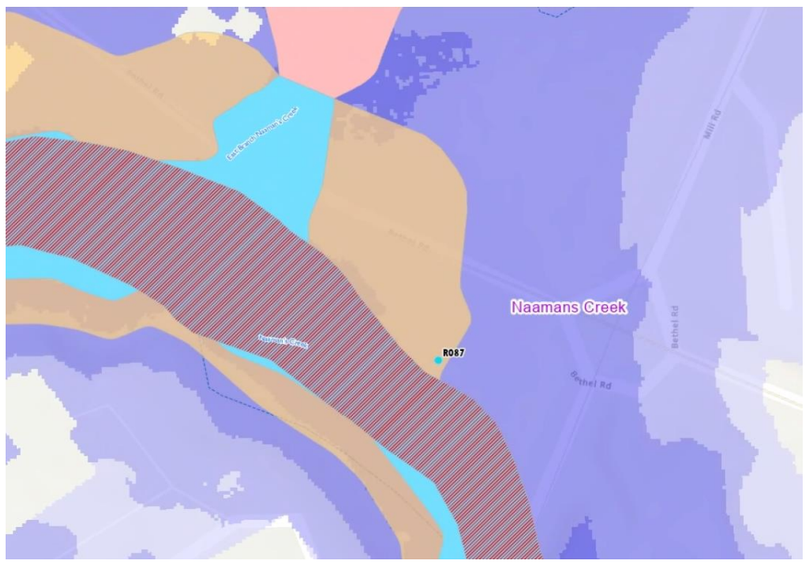


East Branch Naamans Creek with streambank erosion

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stabilize streambanks.
- Expand floodplain after confluence with East Branch Naaman's Creek.
- Large green space for potential SW basin upgradient along Bethel Road (east direction).
-Problem areas reported upstream include watershed scale stormwater management solutions that may provide improvements to flooding at this location.

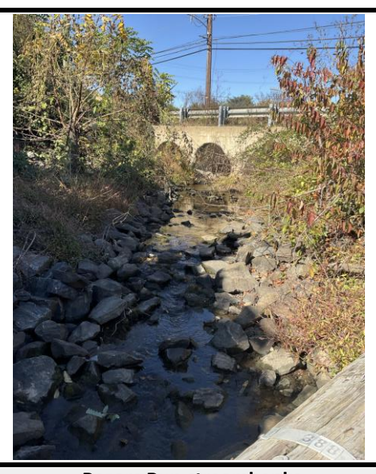
ID#R088 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Marcus Hook Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	Bezors Run	**Problem Area Submission Date:**	-
Municipality:	Upper Chichester Township	**Location:**	Bethel Ave & Cherry Tree Rd
Property Type:	Open Space, Right of Way		
Type of Problem(s):	Erosion		
Problem Description:	Roadway, curb, and walk damage at open space.		
Field Visit Notes:	Active work zone at time of visit. Cannot determine how erosion is occurring until construction is complete. New culverts and bridges.		

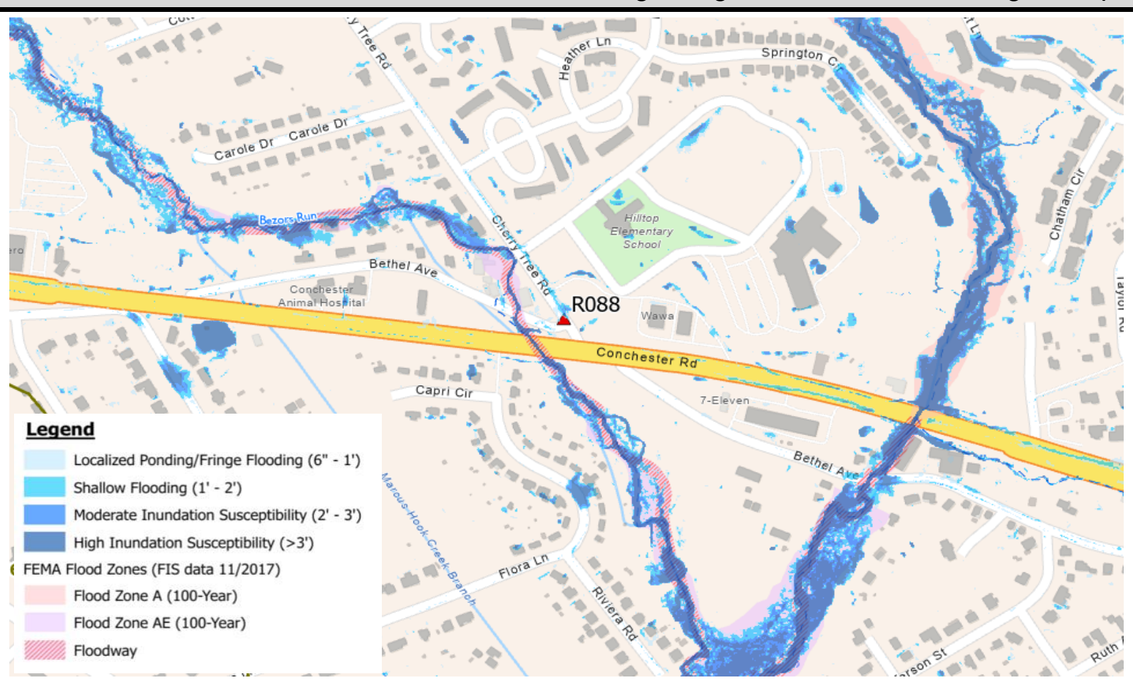


Construction along Bezors Run (Tributary to Marcus Hook Creek)

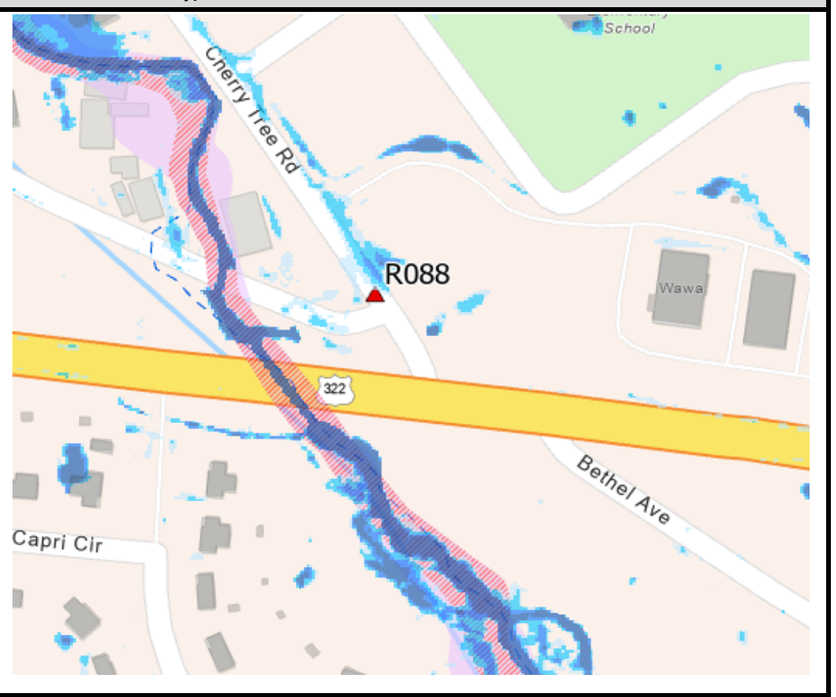


Bezors Run streambanks

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stream restoration and stabilization
- Enhance stream buffer
- Remove downstream fill and obstructions
- Evaluate upstream open space opportunities to capture stormwater, especially at Hilltop Elementary School
- This area should be reassessed following the completion of construction in the area

ID#R090 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Naamans Creek	**Source of Problem:**	DELCO Planning Dept
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/11/2025
Municipality:	Upper Chichester Township	**Location:**	Larkin Road at East Branch of Naamans Creek
Property Type:			
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Pennsylvania culvert does not convey 25 yr storm per PennDOT calculations (insufficient drainage infrastructure)		
Field Visit Notes:	10/15/25 culvert measured to have a smaller outflow than inflow, suggesting that during large storm events the road will inundate due to the narrowness. No evidence of flooding or overtopping of culvert observed. Minor erosion on stream banks.		



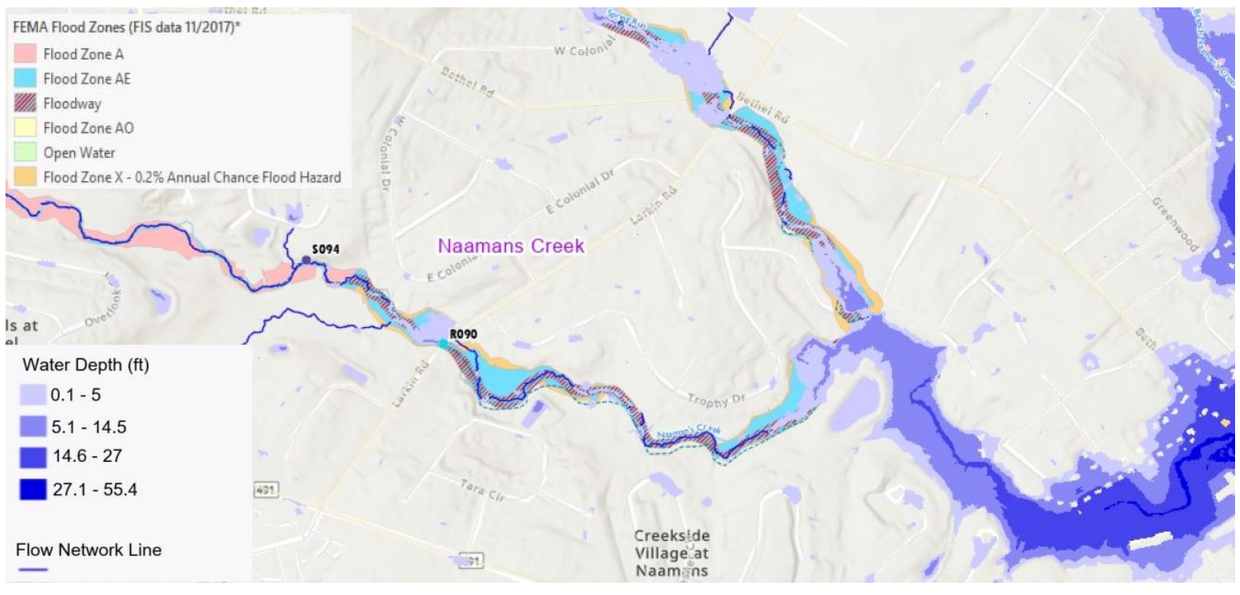
Large culvert under Larkin Road. Outflow pipe to left of photo with some minor erosion along streambank



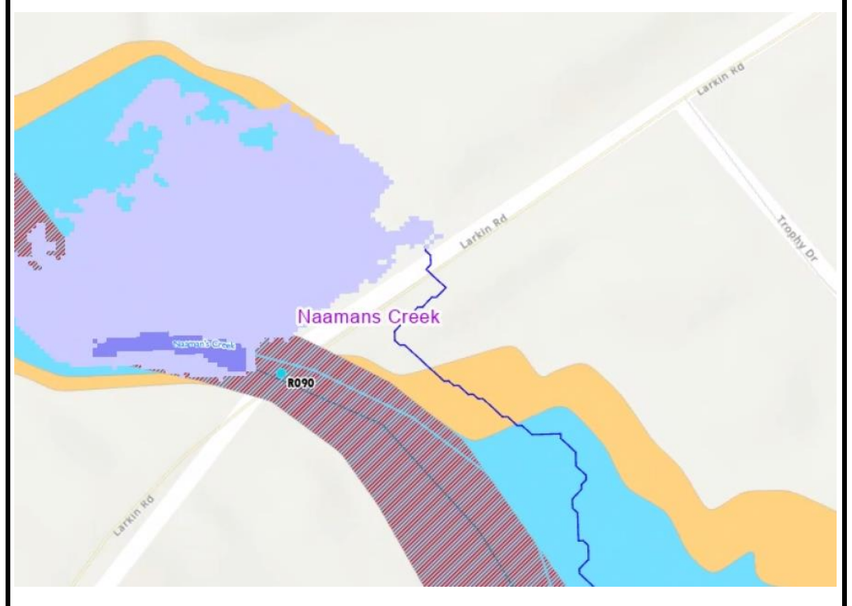
Outfall partially obstructed by vegetation

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

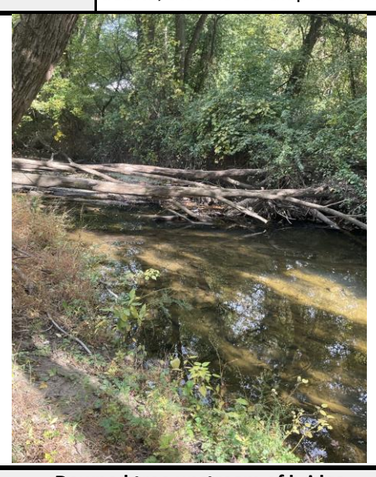
Potential Solutions

- Resize the culvert to increase flow rates.
- Stabilize streambanks.

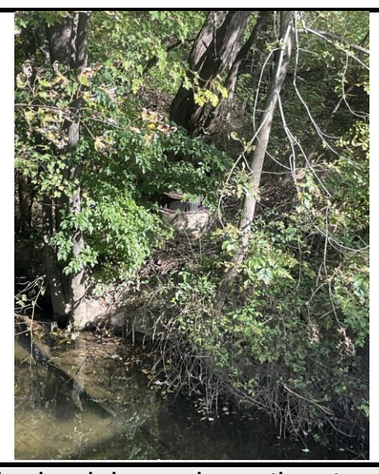
ID#R092 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Marcus Hook Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	-
Municipality:	Upper Chichester Township	**Location:**	Briarcliff Ave Bridge at Marcus Hook Creek
Property Type:	Residential, right of way		
Type of Problem(s):	Erosion		
Problem Description:	Limited details provided		
Field Visit Notes:	No major erosion observed on streambanks; some channeling near SE corner of bridge from roadway runoff; downed tree about 30' upstream of bridge inhibiting flow and catching debris; also noted displaced manhole cover (photo below) along northern streambank		



Downed tree upstream of bridge



Displaced manhole cover along northern streambank

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Repair and stabilize streambanks
- Remove obstructions in the waterway
- Stabilize bridge runoff channels

ID#R093 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Naamans Creek	**Source of Problem:**	DELCO Planning Dept
Minor Watershed:	N/A	**Problem Area Submission Date:**	9/11/2025
Municipality:	Upper Chichester Township	**Location:**	1629 Peach St, Boothwyn, PA 19061
Property Type:			
Type of Problem(s):	Flooding - Clogging/obstruction		
Problem Description:	Pedestrian bridge obstruction.		
Field Visit Notes:	10/15/25 pedestrian bridge has debris caught on it causing the area to potentially flood. 2 of the 4 stormwater outlets are functioning from the inlets. High velocity of runoff bypassing some inlet. Some erosion noted downstream of bridge.		

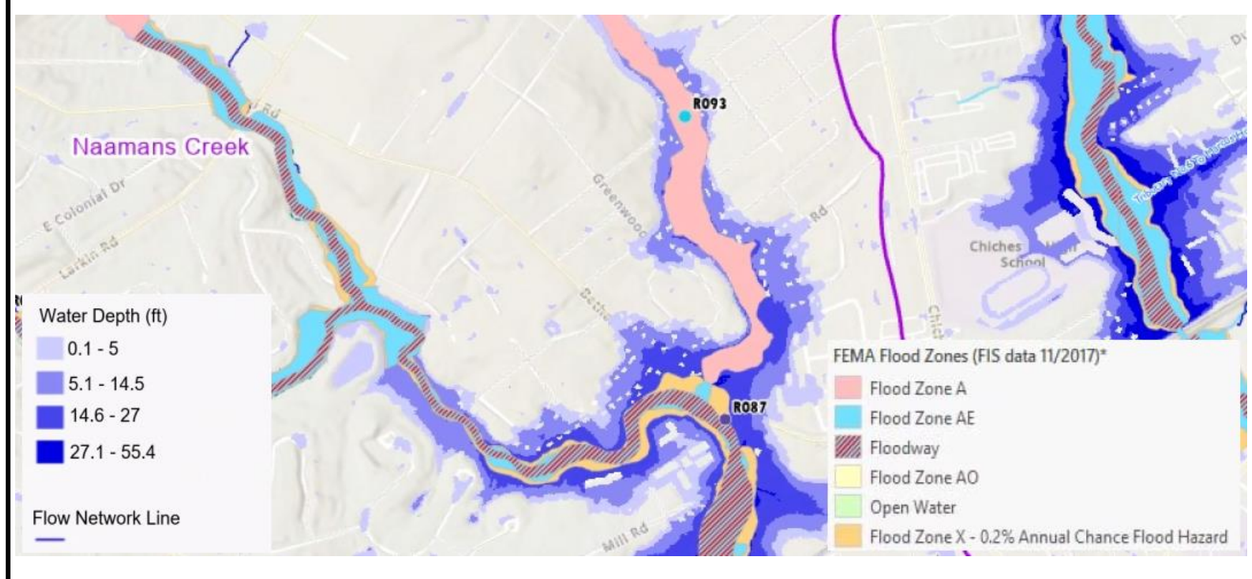


Pedestrian bridge at Gardendale Park

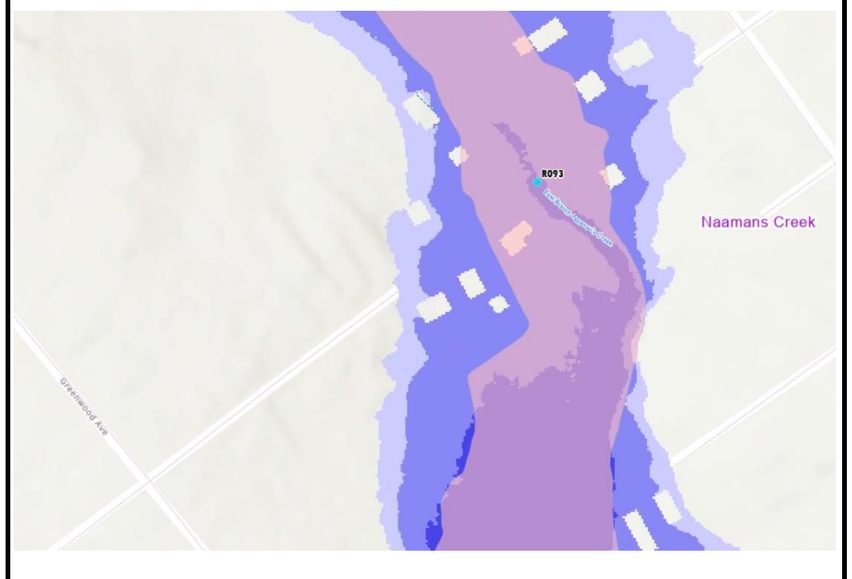


Concrete curb swale directing runoff to inlet at bottom of Peach St with sedimentation present

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Remove and raise bridge to pass 100 year storm or expand floodplain.
- Repair 2 inlets that are not functional.
- Assess inlet bypassing.
- Remove debris.
- Downstream flooding likely impacts flood conditions at this point.

ID#S014 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Naamans Creek	**Source of Problem:**	Upper Chichester Township/Southeastern PA SWA
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/24/2025
Municipality:	Upper Chichester Township	**Location:**	1569 Larkin Rd, Boothwyn, PA 19061
Property Type:	Residential,Open Space,Rightofway		
Type of Problem(s):	Flooding, Sedimentation, Restricted Capacity, Insufficient drainage infrastructure		
Problem Description:	Flooding and improper drainage along Larkin road		
Field Visit Notes:	Runoff from Belmont Drive and east side of Larkin Rd entering upstream side of 4'x5' double barrel culvert (left pipe broken). West side of Larkin Drive outfalls into stream on downstream side of double barrel culvert. Much more velocity on downstream end.		



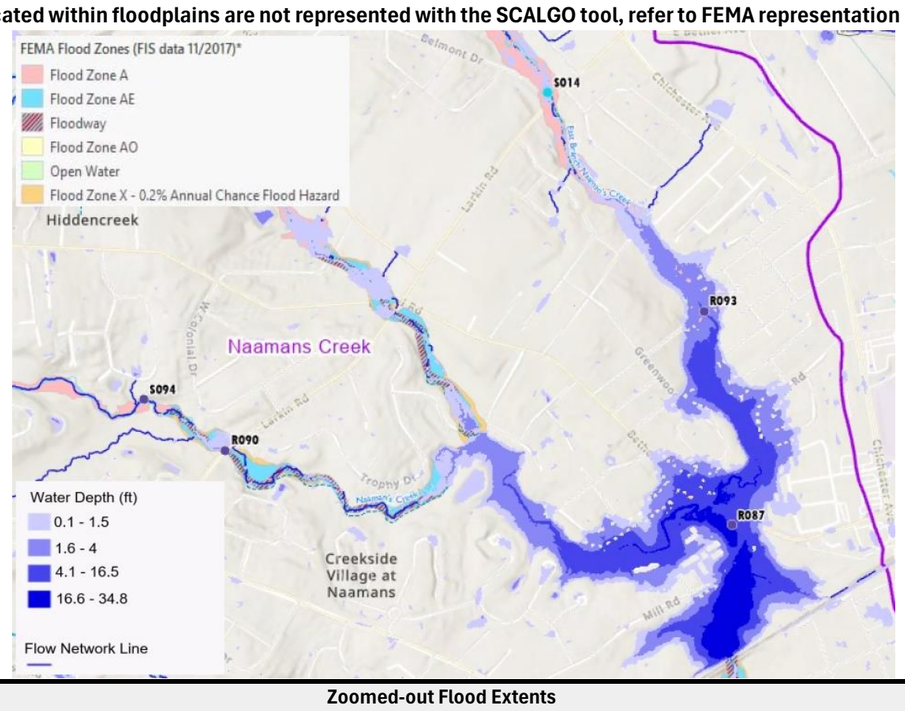
Upstream end of 4'x5' double barrel culvert



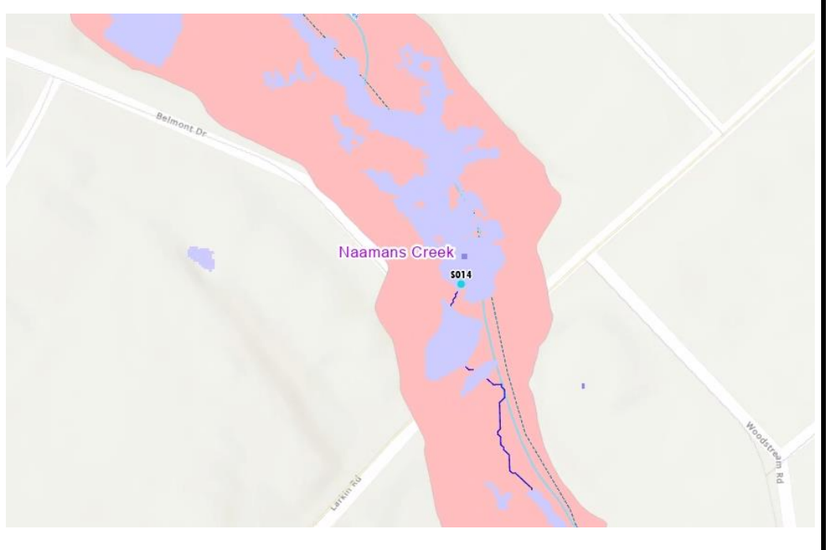
Downstream end of 4'x5' double barrel culvert

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Culvert at Larkin Road appears to be undersized.
- Increased capacity recommended for culvert recommended at this location.
- Watershed scale solutions recommended to help manage downstream flooding concerns.

ID#S017 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Haverford Township
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/29/2025
Municipality:	Haverford Township	**Location:**	Manoa Rd & Karakung Dr
Property Type:	Commercial, Open Space		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation		
Problem Description:	Problem causes include stormwater volume, stormwater velocity, and water obstruction. Limited details provided.		
Field Visit Notes:	Cobbs Creek runs under a bridge on Manoa Rd that looks relatively new, and has a relatively wide and deep opening. Evidence of erosion and flooding of the creek.		



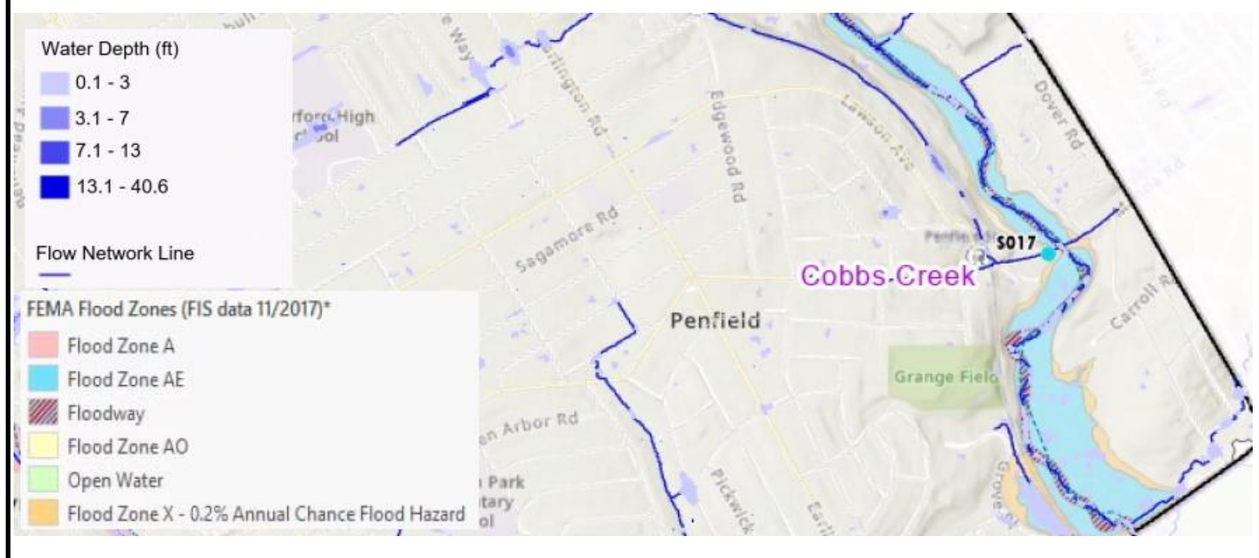
Evidence of flooding and erosion along creek



Bridge along Manoa Rd

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

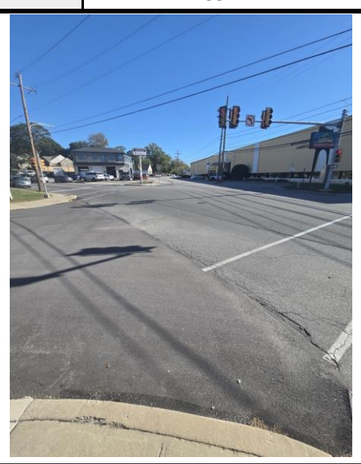
Potential Solutions

- Evaluate upstream open space areas and parks for opportunities to capture stormwater
- Stream restoration and stabilization

ID#S018 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Haverford Township
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/29/2025
Municipality:	Haverford Township	**Location:**	Haverford Rd & Karakung Dr
Property Type:	Commercial, Right of Way		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation		
Problem Description:	Limited details provided.		
Field Visit Notes:	Three relatively wide and streets intersect at a low point in front of a bowling alley. It is easy to see how flooding could occur at this location, especially in large storms or if the existing inlets are clogged. Could not access creek due to fencing and railroad tracks.		

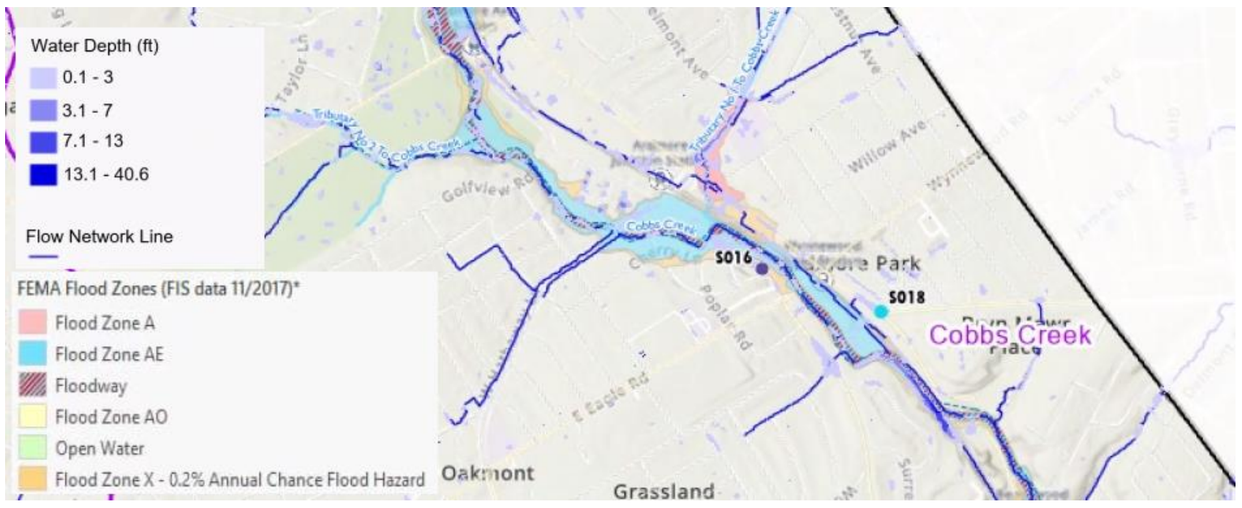


Intersection of Haverford Rd, Karakung Dr, and Winchester Rd

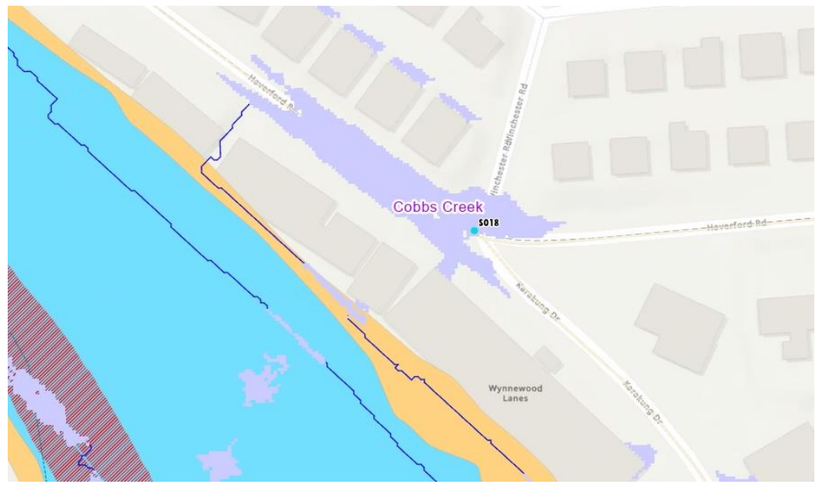


Railroad tracks preventing access to Cobbs Creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Appears to be a green area wide enough behind the train tracks that could possibly be used for floodplain expansion
- Potential for subsurface storage system in Haverford Road and/or Karakung Drive
- Evaluate upstream open space areas and parks for opportunities to capture stormwater

ID#S020 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Haverford Township
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/29/2025
Municipality:	Haverford Township	**Location:**	Merry Place Park
Property Type:	Residential, Open Space		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation		
Problem Description:	Limited details provided.		
Field Visit Notes:	In the park there was strong evidence of erosion along the bansk of Darby Creek. The park has limited tree coverage and short grass.		



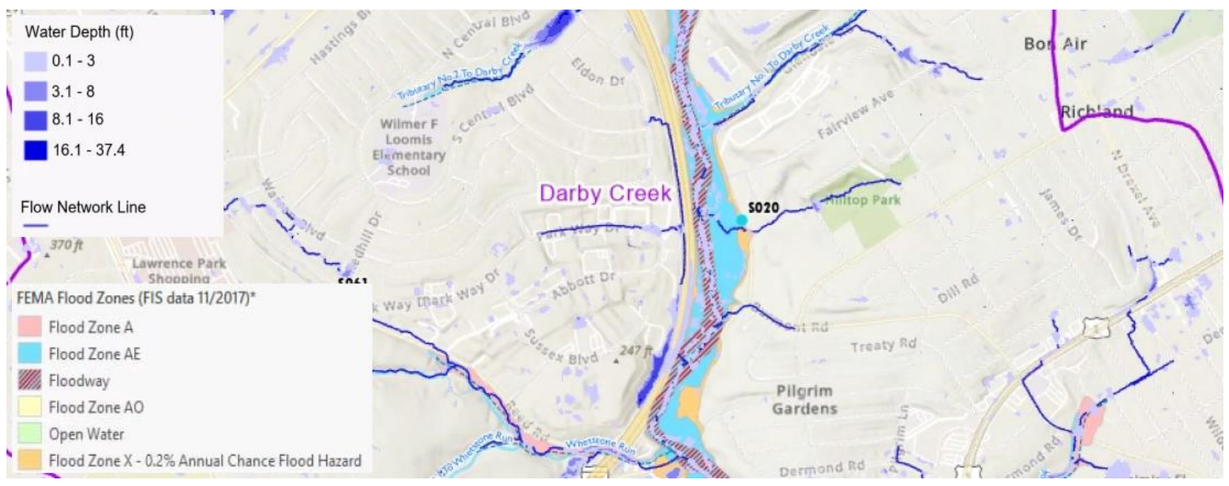
Erosion along Darby Creek streambank



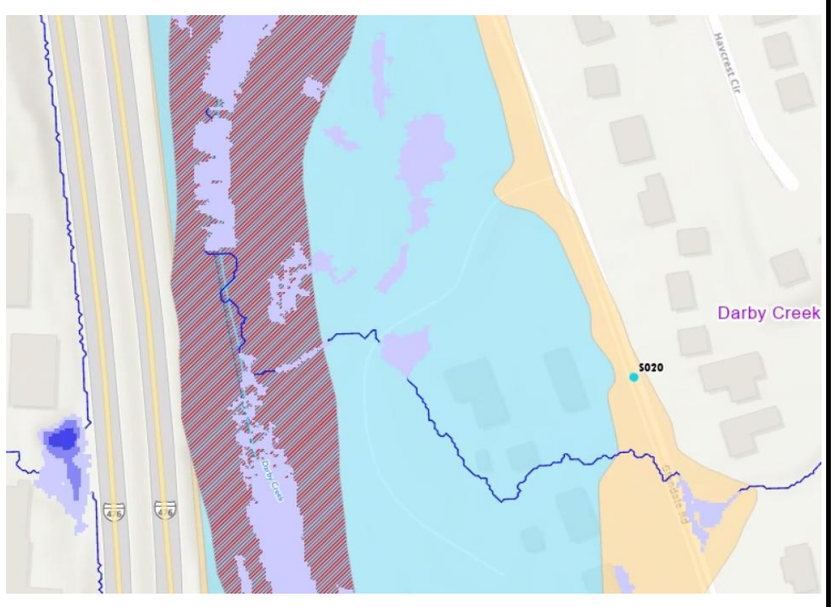
Pedestrian bridge at Merry Place Park

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- The open green space by the bridge could be repurposed for stormwater capture
- Various other potential stormwater capture opportunities throughout the park (permeable pavement, bioretention, etc.)
- Stream restoration and stabilization
- Evaluate upstream open space areas and parks for opportunities to capture stormwater

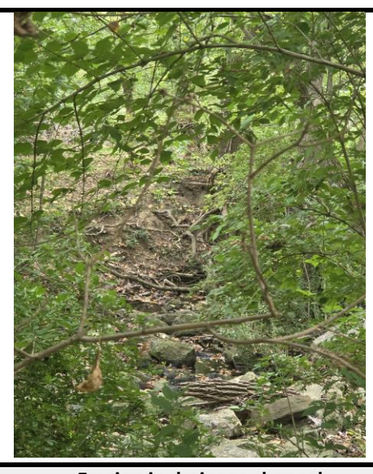
ID#S022 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Haverford Township
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/29/2025
Municipality:	Haverford Township	**Location:**	Darby Creek Rd & Joann Cir
Property Type:	Residential, Open Space		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation		
Problem Description:	Limited details provided.		
Field Visit Notes:	Pavement failure and curb damage noted at northeast corner of Darby Creek Rd and Joann Cir. Significant erosion in the drainage channel to Darby Creek both above and below the intersection. Damaged pipe in the creek.		



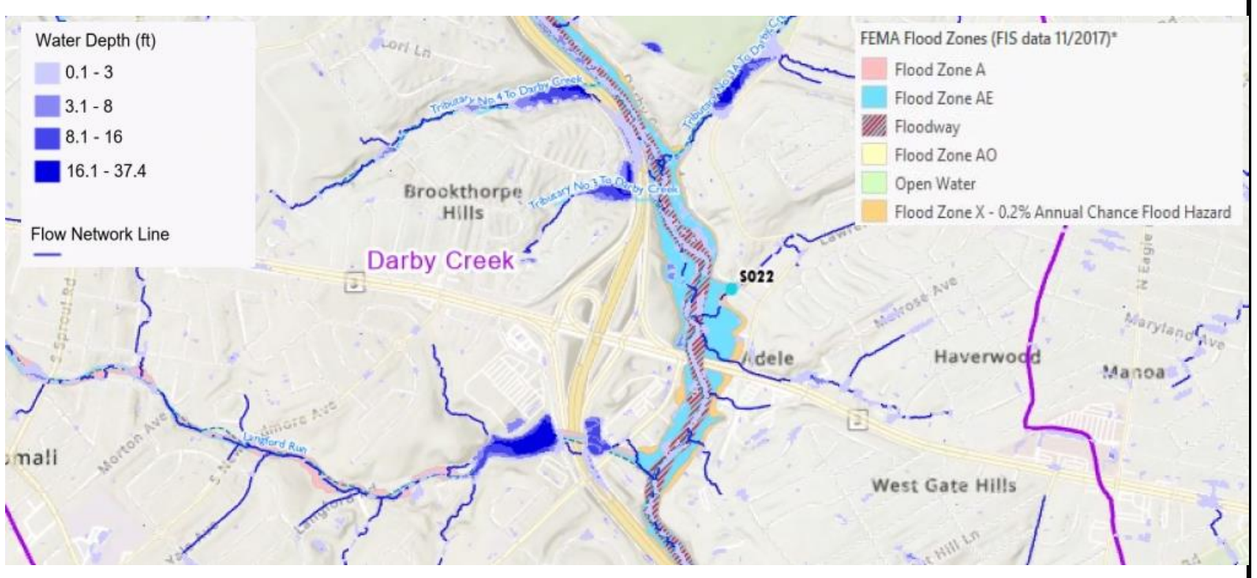
Pavement failure and damaged curb in Darby Creek Rd



Erosion in drainage channel

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Repair damaged infrastructure
- Evaluate upstream open space areas and parks for opportunities to capture stormwater
- Stream/channel restoration and stabilization

ID#S024 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	Hermesprota Creek	**Problem Area Submission Date:**	7/30/2025
Municipality:	Darby Township	**Location:**	W Oak Ln & N Academy Ave
Property Type:	Commercial, Industrial, Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Outfall at creek is set too low.		
Field Visit Notes:	Channel gets piped through Mt Lebanon Cemetery starting at the footbridge behind the Oaks Ballroom. Evidence of sedimentation in Mt Lebanon Cemetery and erosion in the daylighted channel in Har Zion Cemetery. Nearby roadway has signs saying it may flood. Back parking lot of Oaks Ballroom in poor condition. Catania Engineering later followed up with mapping and photos of outfall noted in survey information.		



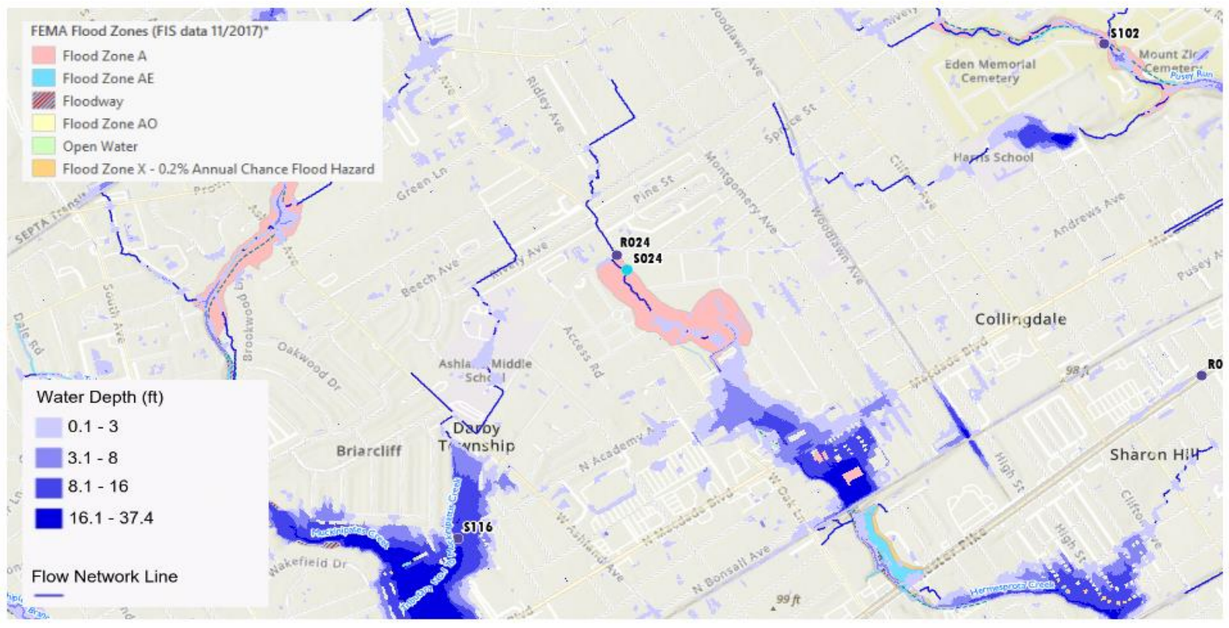
Signs of erosion and sedimentation in cemetery



Sedimentation at low spot in cemetery

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Drainage improvements needed
- Stream restoration and stabilization
- Potential for subsurface storage system in back parking lot
- Additional site investigations and analysis needed

ID#S028 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/30/2025
Municipality:	Darby Township	**Location:**	Forrester Avenue
Property Type:	Residential, Open Space		
Type of Problem(s):	Accelerated Erosion, Sedimentation		
Problem Description:	Erosion causing sinkholes.		
Field Visit Notes:	Large open space west of creek, north of Forrester Ave, with minimal buffer; CMP culvert at Forrester Ave bridge; some erosion and debris present in creek downstream of Forrester Ave		

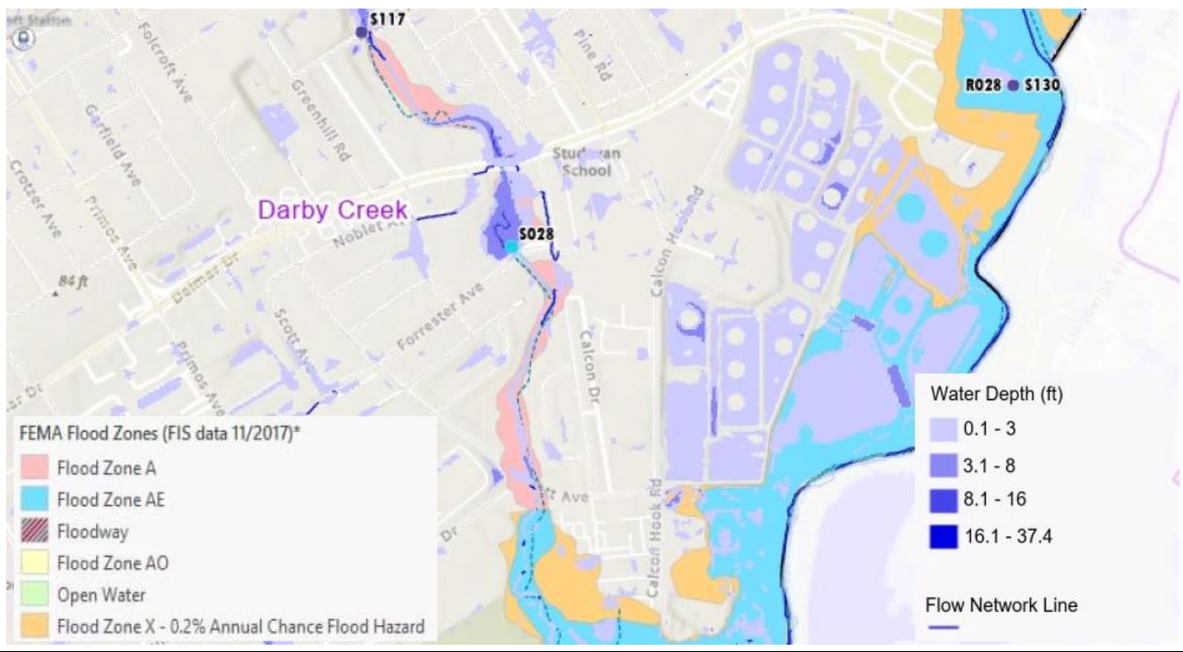


Erosion and debris observed in creek

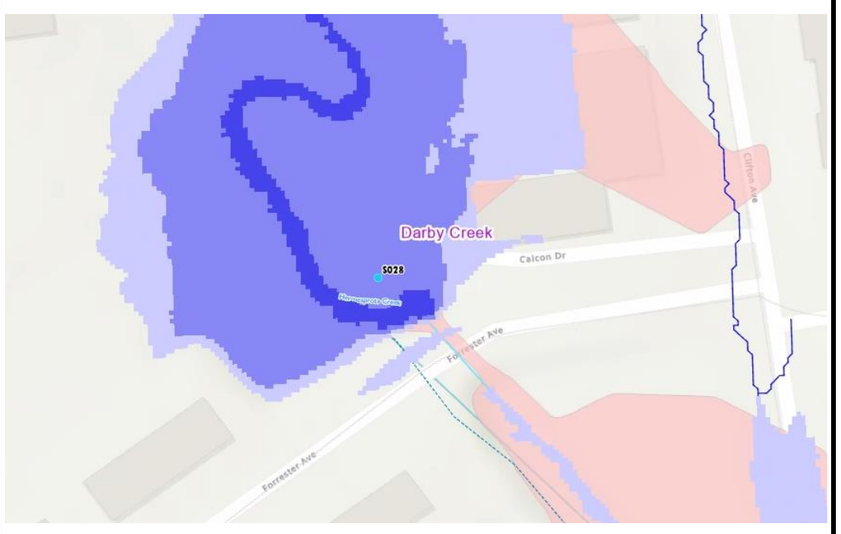


Open space west of creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stream restoration and stabilization
- Clean up and maintain channel
- Slip-line culvert
- Evaluate opportunities for enhanced flood storage in open space on west side of creek north of Forrester Ave (floodplain expansion and/or constructed wetlands)

ID#S030 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Pennoni
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/30/2025
Municipality:	Upper Darby Township	**Location:**	Idle Hour Tennis Club on Township Line Rd
Property Type:	Commercial		
Type of Problem(s):	Flooding		
Problem Description:	The property is a tennis club that has a history of flooding issues.		
Field Visit Notes:	Darby Creek is directly adjacent to the site, which is mostly comprised of tennis courts. There is evidence of erosion in the creek and flooding by the courts. Moss lines were observed on benches by the tennis courts.		



Evidence of erosion and sedimentation from previous flooding



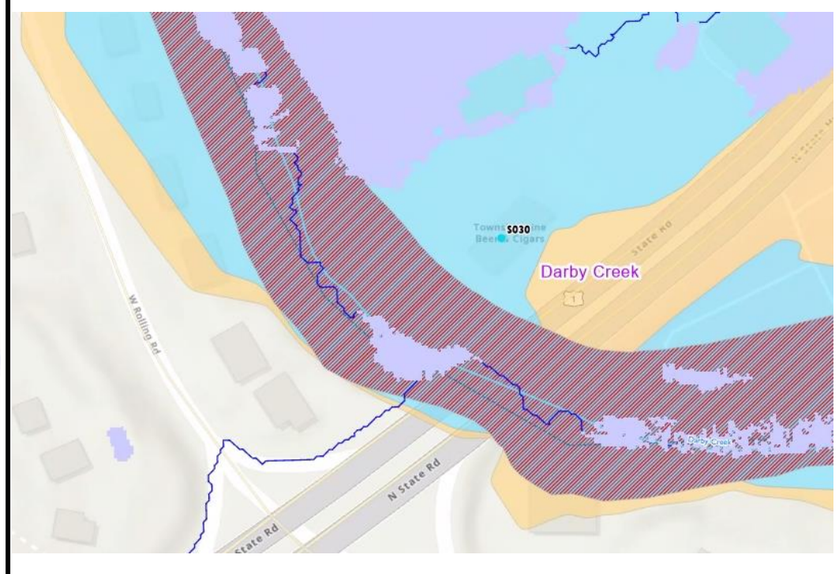
Darby Creek (left) is separated from the site by a berm

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Evaluate upstream open space areas and parks for opportunities to capture stormwater
- Potential opportunities for subsurface flood storage below courts
- Raise/stabilize berm between creek and site

ID#S031 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Naylors Run	**Problem Area Submission Date:**	7/30/2025
Municipality:	Upper Darby Township	**Location:**	100 Blocks of Normandy Rd and Springton Rd
Property Type:	Residential, Commercial, Public (Other)		
Type of Problem(s):	Flooding, Groundwater, Other		
Problem Description:	Flooding of properties when Naylors Run Creek culvert is flowing full from heavy rain events		
Field Visit Notes:	Naylors Run flows in a relatively constrained, open concrete channel next to a structure (small grocery store) for a short stretch before it is once again buried in a pipe. Sediment and debris were observed in the channel.		



Naylors Run at Springton Rd & Sherbrook Blvd



Bridge along Marshall Rd at Normandy Rd

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Evaluate upstream open space areas and parks for opportunities to capture stormwater (Beverly Hills Recreation Area, Naylor's Run Park, Upper Darby High School, etc.)
- Evaluate potential for daylighting creek and creating flood storage (constructed wetlands) in the lawn area east of Gilpin Rd and south of Marshall Rd; while this area is downstream from S031, it could help mitigate the flooding there, especially if new inlets and auxiliary storm pipes are added at Springton Rd and Marshall Rd to convey runoff into that lawn area
- Conduct additional detailed flooding study
- See the Potential Solution Analysis form for S027 for additional supporting analysis related to this problem location

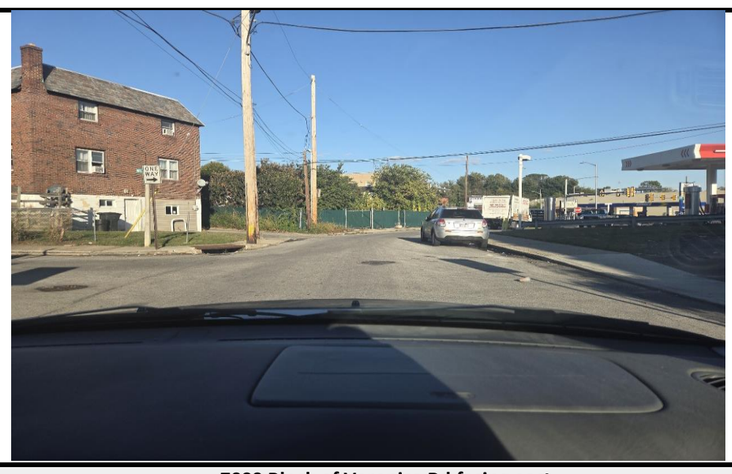
ID#S032 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Naylors Run	**Problem Area Submission Date:**	7/30/2025
Municipality:	Upper Darby Township	**Location:**	7000 Block of Veronica Rd
Property Type:	Residential, Commercial, Public (Other)		
Type of Problem(s):	Flooding, Groundwater		
Problem Description:	Naylors Run flows below Veronica Rd in a culvert (likely undersized); flooding reported in basements of residential properties		
Field Visit Notes:	All private properties, difficult to access.		

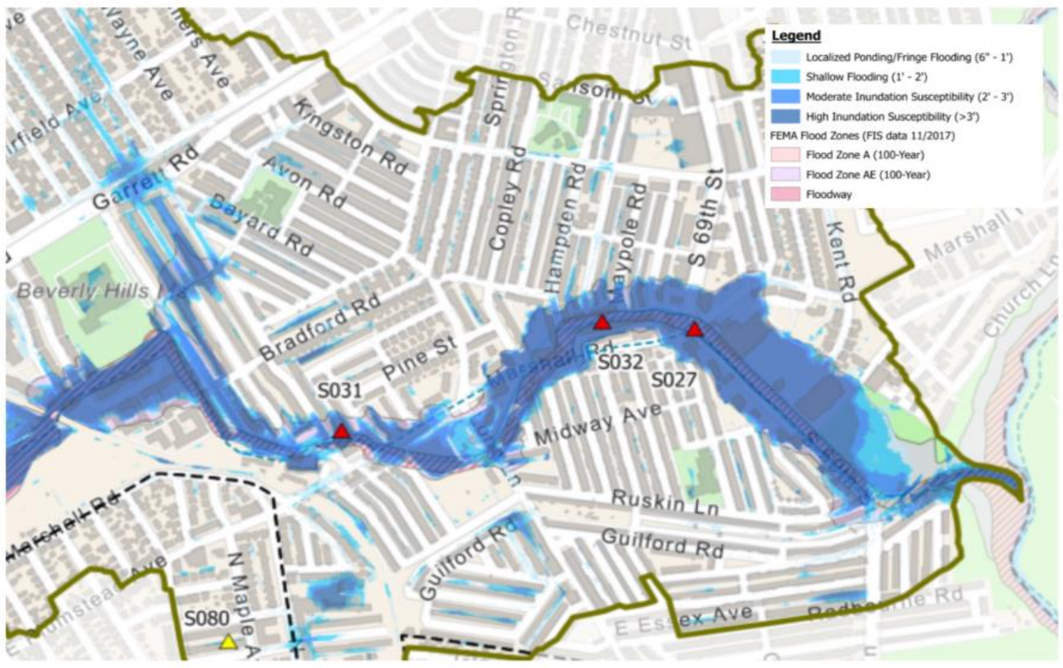


7000 Block of Veronica Rd facing east

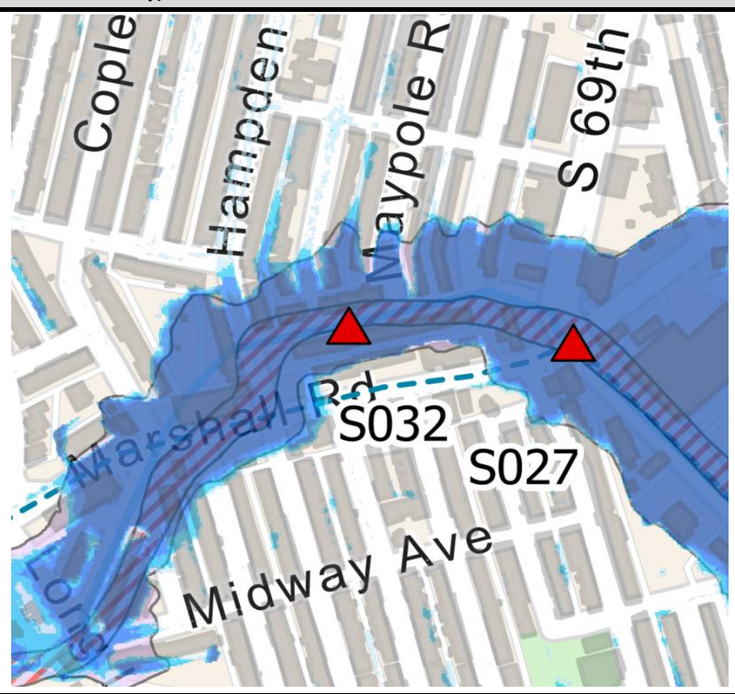


7000 Block of Veronica Rd facing east

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Evaluate upstream open space areas and parks for opportunities to capture stormwater
- Evaluate installing an auxiliary drainage system in conjunction with potential solution for S027, which is immediately downstream
- Conduct additional detailed flooding study
- See the Potential Solution Analysis form for S027 for additional supporting analysis related to this problem location

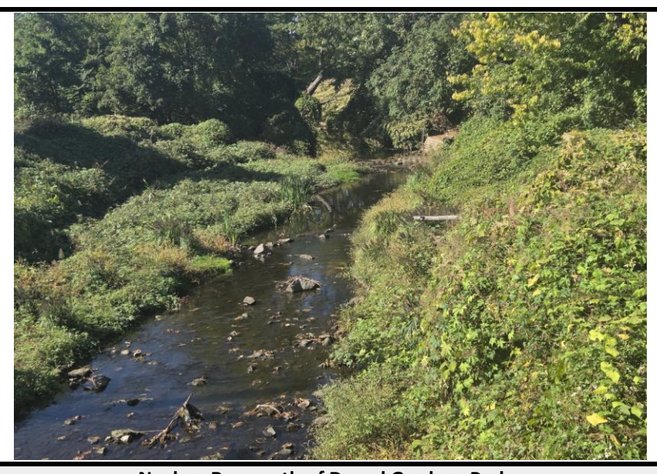
ID#S033 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Naylors Run	**Problem Area Submission Date:**	7/30/2025
Municipality:	Upper Darby Township	**Location:**	Drexel Gardens Park
Property Type:	Open Space, Other		
Type of Problem(s):	Flooding		
Problem Description:	Limited details provided.		
Field Visit Notes:	A homeowner noted that during certain storms, the creek floods the park, as well as some of the houses on Bond Ave. Construction was taking place in the park at time of the field visit (possibly stormwater related). Several stormwater-related projects have already been completed in or just outside of the park, including enhanced riparian buffer and two rain gardens adjacent to the cul-de-sac on Bond Ave. One of these rain gardens is on the north side and the other is on the south side, at the entrance to the park. Immediately to the north of the cul-de-sac is a seemingly unused, dead-end roadway in the corner of Har Jehuda Cemetery.		

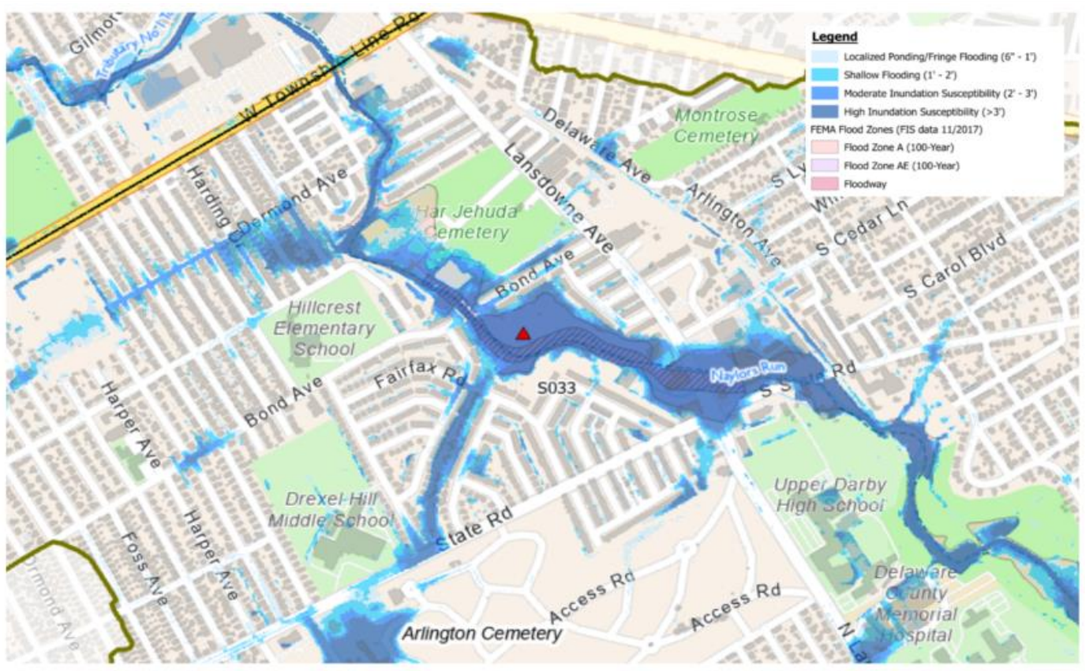


Cul-de-sac at the end of Bond Ave

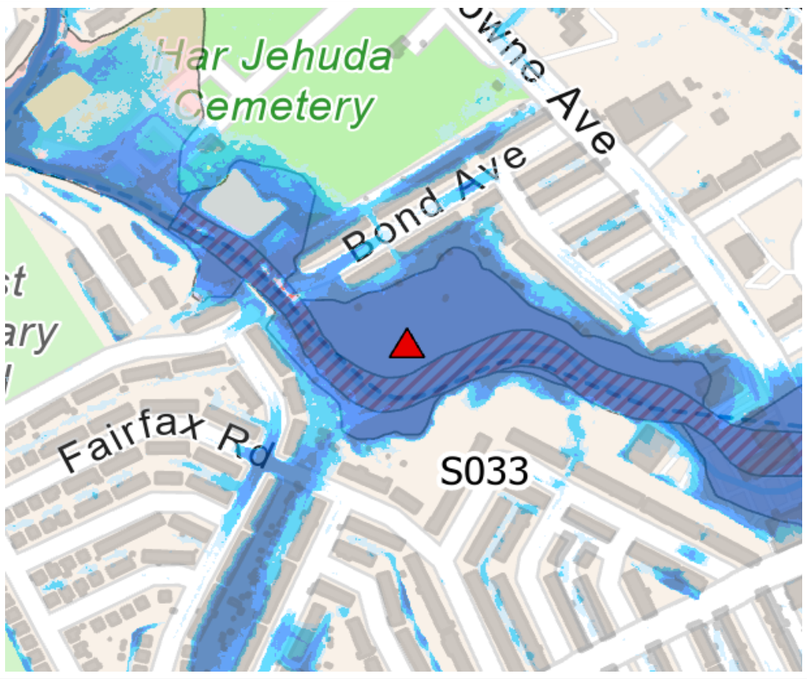


Naylors Run north of Drexel Gardens Park

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Expand the creek width north of Bond Ave into the unused roadway in the cemetery to create additional flood storage (per the homeowner discussion, adding flood storage north of Bond Ave should be prioritized)
- Potential for additional storage opportunities within Drexel Gardens Park (coordinated with other completed/planned improvements)
- Evaluate upstream open space areas and parks for opportunities to capture stormwater
- See the Potential Solution Analysis form for S027 for additional supporting analysis related to this problem location

ID#S034 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/30/2025
Municipality:	Prospect Park Borough	**Location:**	Summit Ave & 3rd Ave, Prospect Park, PA 19076
Property Type:	Residential, Open Space, Other public		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation		
Problem Description:	Deteriorated storm piping/ endwall		
Field Visit Notes:	Site is located near the intersection of Summit Ave and 3rd Ave in Prospect Park, about 3 blocks north of Darby Crescent Road / Darby Creek. Endwall was missing and the first section of concrete pipe was dislodged.		



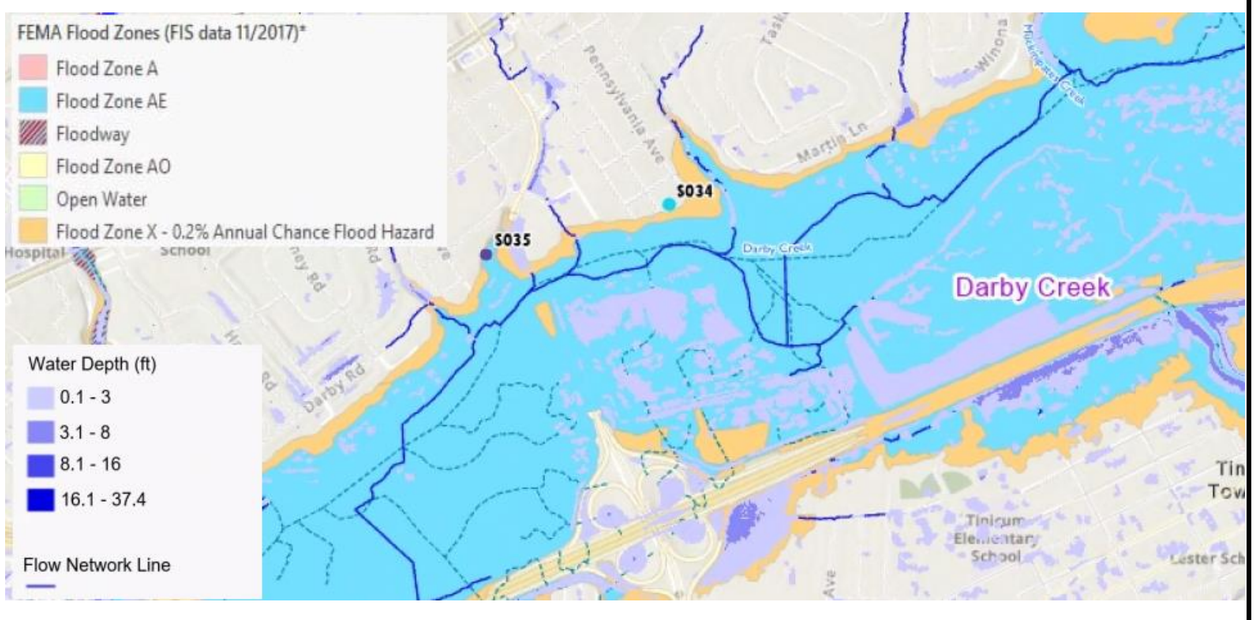
Outfall at problem site with missing endwall and damaged pipe



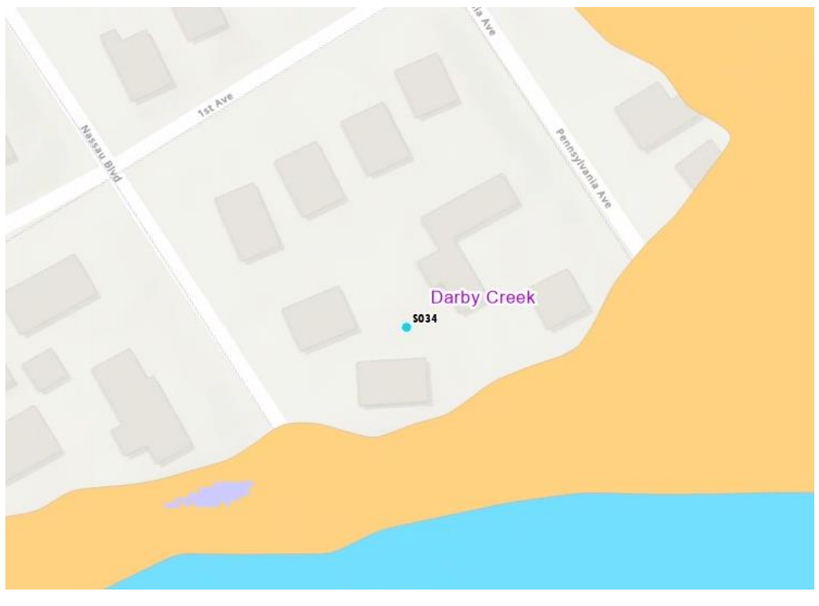
Proximity of major section of Darby Creek to nearby properties

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Pipe replacement
- Endwall replacement
- Streambank restoration.
- Install endwall and repair dislodged pipe.
- Tinicum Park is on the other end of Darby Creek with seemingly lots of unused green area and could possibly be used to expand the floodplain.

ID#S035 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/31/2025
Municipality:	Prospect Park Borough	**Location:**	100 Lincoln Ave, Prospect Park, PA 19076
Property Type:	Residential,Open Space		
Type of Problem(s):	Flooding, Accelerated Erosion - Tidal, Restricted Capacity		
Problem Description:	Streambank erosion - loss of property		
Field Visit Notes:	UNT to Darby floods and erosion. Flooding driven by Darby Creek.		



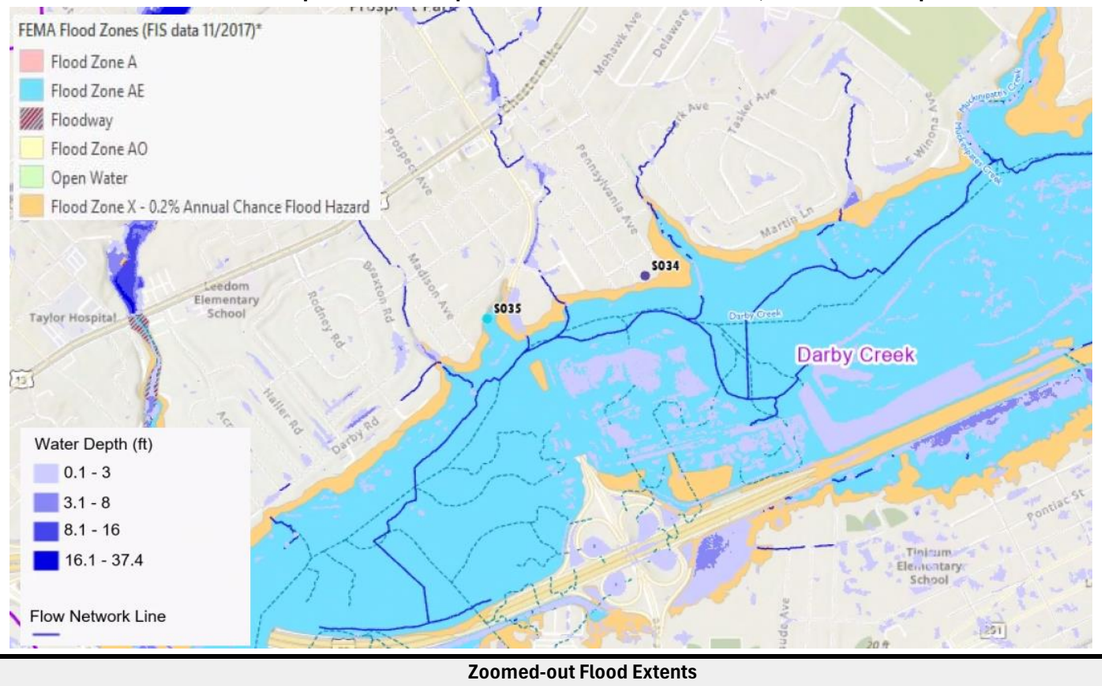
Main portion of Darby Creek directly adjacent to property



Darby Creek tributary with streambank erosion

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

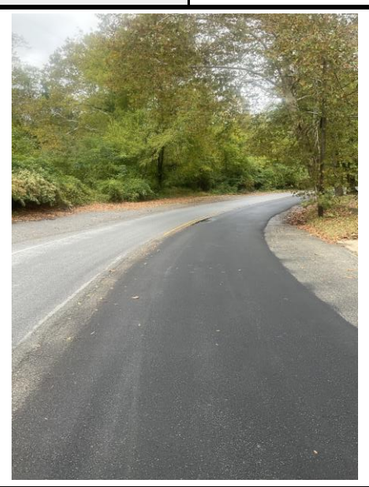
Potential Solutions

- Regrading
- Riparian buffer restoration
- Streambank restoration.
- Potentially space for a flood storage project at the softball fields at 301 Madison Ave (underground storage) or in Morton Homestead State Park (surface storage).
- Flood control infrastructure recommended to protect the Historic Homestead and other structures in this area.

ID#S036 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Brookhaven Borough Emergency Management Coordinator
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/31/2025
Municipality:	Brookhaven Borough	**Location:**	4951 Chester Creek Rd, Brookhaven, PA 19015
Property Type:	Residential		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Drainage of storm water is one issue, The Chester Creek coming over its banks is another. Bottom floor flooding to residential structures.		
Field Visit Notes:	Property flooding most likely due to lack of drainage. 1 inlet found with heavy debris and 1 outflow pipe to the creek which is partially filled at the outlet structure (see problem area S083 for outlet pipe). Road is graded towards curb line with flat longitudinal slope.		



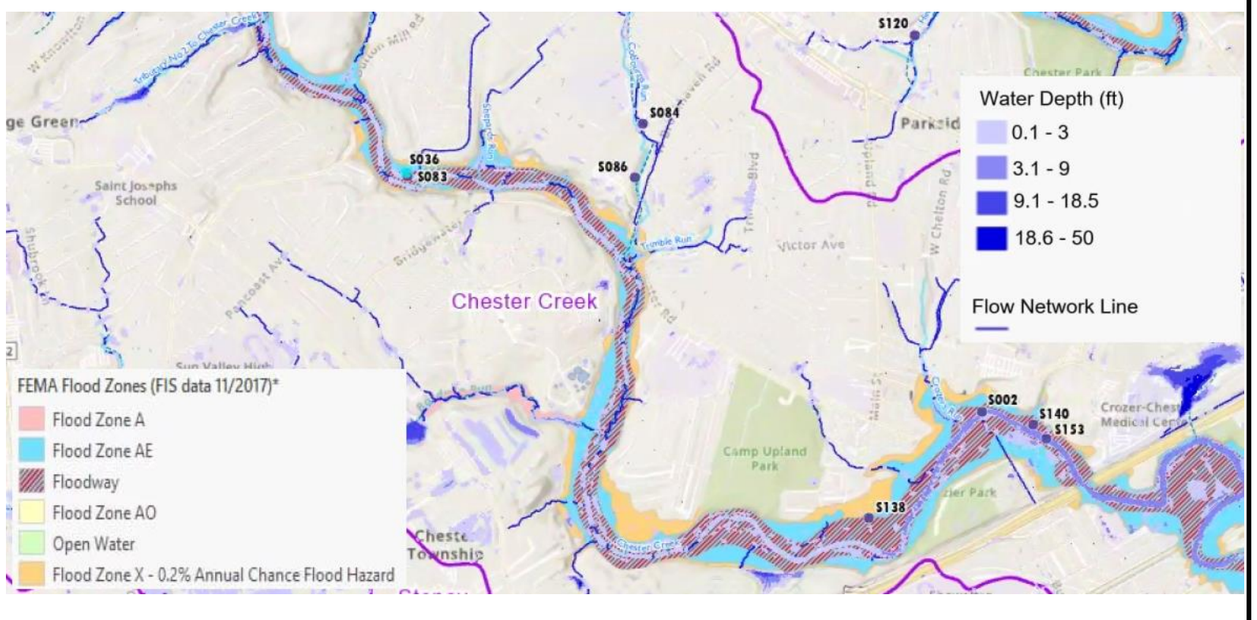
Chester Creek Rd with one single inlet which the roadway is sloped towards



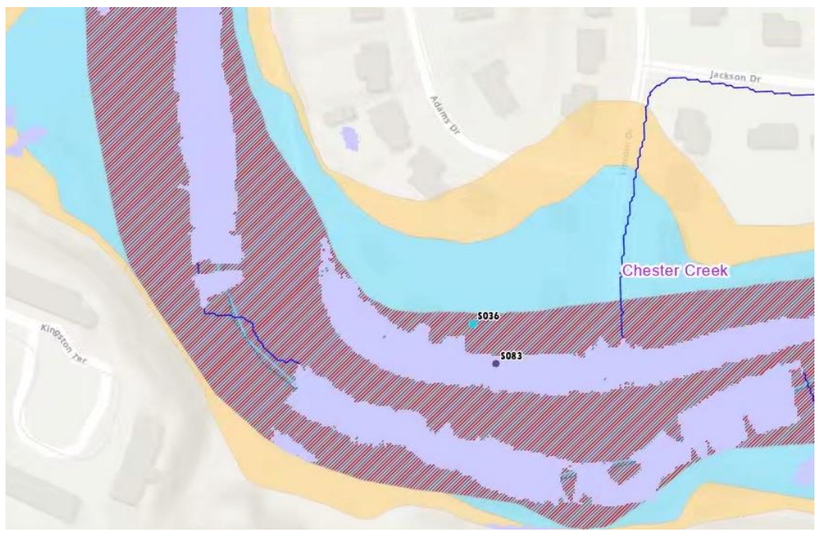
Zoomed in photo of inlet on Chester Creek Rd covered in leaves and little to no longitudinal slope

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional inlets.
- Remove debris from existing inlet and outfall pipe.
- Elevate or otherwise floodproof affected structures.
- Floodplain restoration recommended.

ID#S041 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Springfield Township
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/1/2025
Municipality:	Springfield Township	**Location:**	Springfield Swim Club on N Rolling Rd
Property Type:	Public (Other)		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation		
Problem Description:	Community pool gets flooded by Darby Creek following large rain events.		
Field Visit Notes:	Clear evidence of flooding, there were 2 instances where part of the creek was running on the roads leading to the parking lot. Some small areas of ponding observed in the parking lot. DCCD will provide contact information of their partners to get more information about the site.		



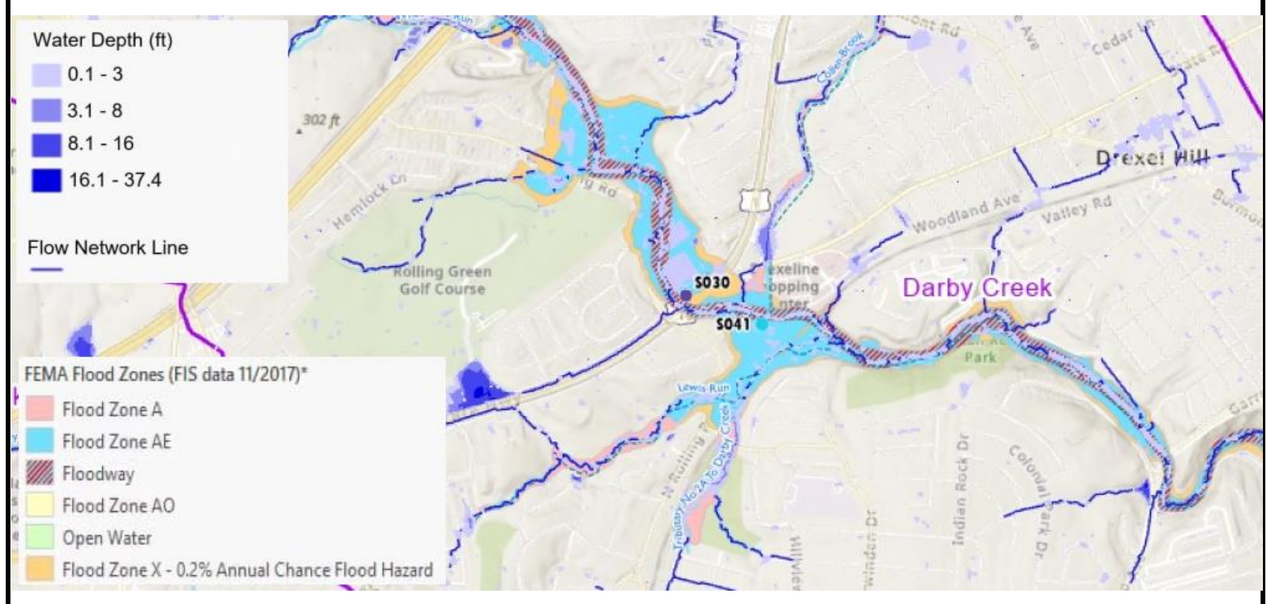
Darby Creek running on roads leading to parking lot



Darby Creek running on roads leading to parking lot

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- The site is located in a heavily wooded area well within the Darby Creek floodplain. A detailed review of the existing stormwater management/drainage plan is needed to ensure the existing runoff from the parking lot and other associated impervious cover is being managed and directed appropriately. The parking lot itself has localized depressions that should be regraded. It appears flow channels throughout the property form during/after rainfall events that are not in existence year around. Therefore selective inclusion of bioswales or raingardens along with some regrading may help formalize these flowpaths around the paved areas, to help initial flooding to occur in a safer manner.
-The parking lot itself is a good candidate for underground storage or infiltration, if coupled with a detention/slow release mechanism and formalized outfall, for managing smaller rainfall events.
-Selective upstream stormwater management is recommended to lessen floodplain impacts at this location.

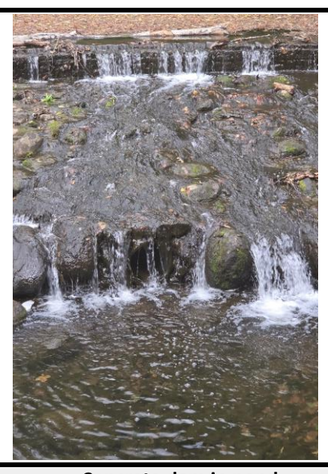
ID#S057 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Newtown Township
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/1/2025
Municipality:	Newtown Township	**Location:**	11 Paper Mill Rd
Property Type:	Residential, Open Space, Right of Way		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation		
Problem Description:	Limited details provided.		
Field Visit Notes:	There is a shallow pond on private property that appears to have enough storage in case of rain. There is a concrete dam that allows the water to cascade down.		



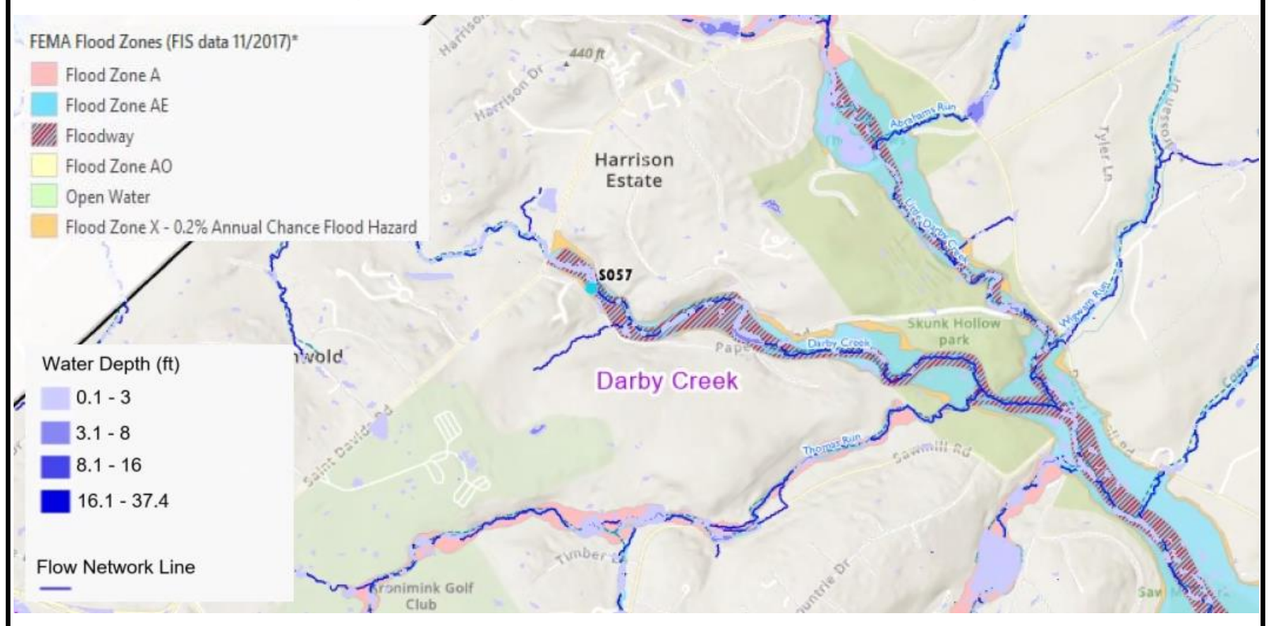
Private shallow pond



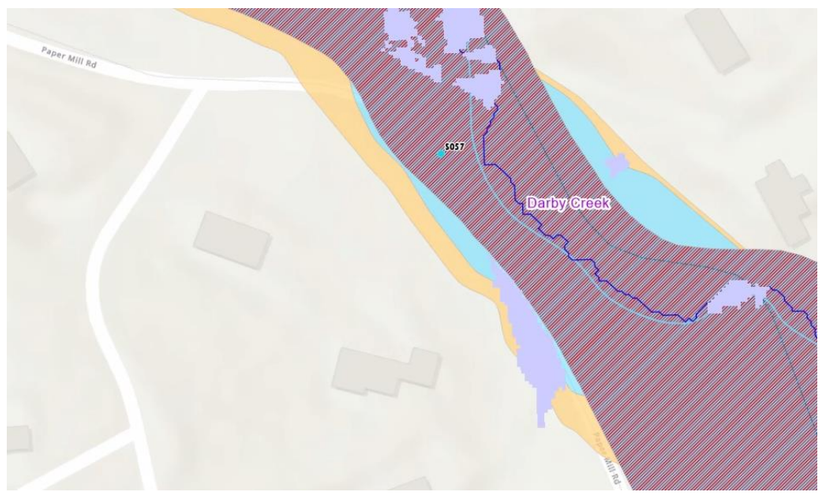
Concrete dam in pond

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- More investigation and discussion with property owner needed. Assessment of dam condition and sizing recommended. -
The shallow pond has potential for increased capacity via making it deeper and wider to store more stormwater. Possibility of automation for dam controls in case of larger events.
- Study for assessment of scenario with dam removed, although that could be contested.

ID#S061 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Pennoni
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/3/2025
Municipality:	Marple Township	**Location:**	Redhill Dr & S Pwky Blvd
Property Type:	Residential		
Type of Problem(s):	Flooding		
Problem Description:	Red Hill Drive is the low point for a large portion of the Lawrence Park section of Marple Township. During intense rain Redhill Drive floods.		
Field Visit Notes:	Wide streets in a residential neighborhood with seemingly enough inlets for drainage.		

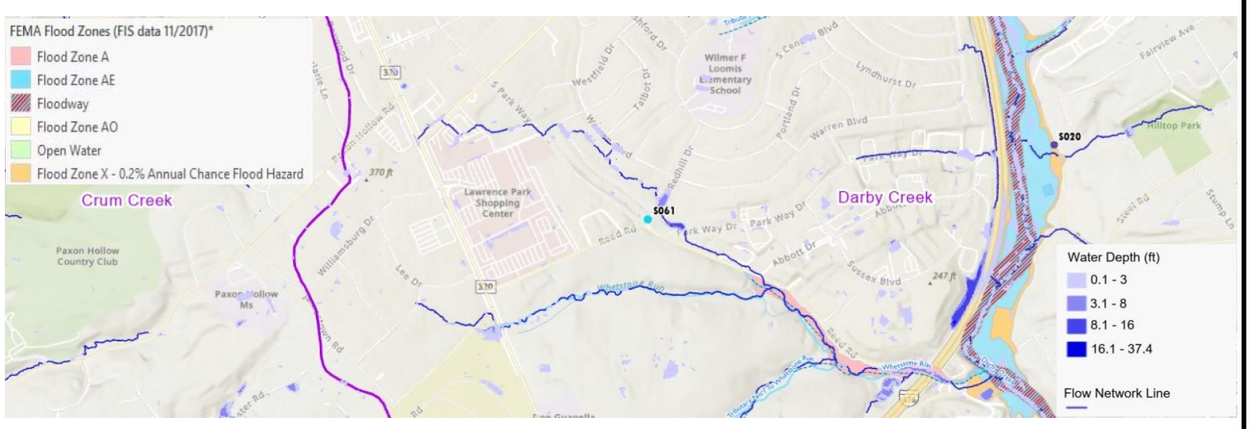


Wide streets along Redhill Dr

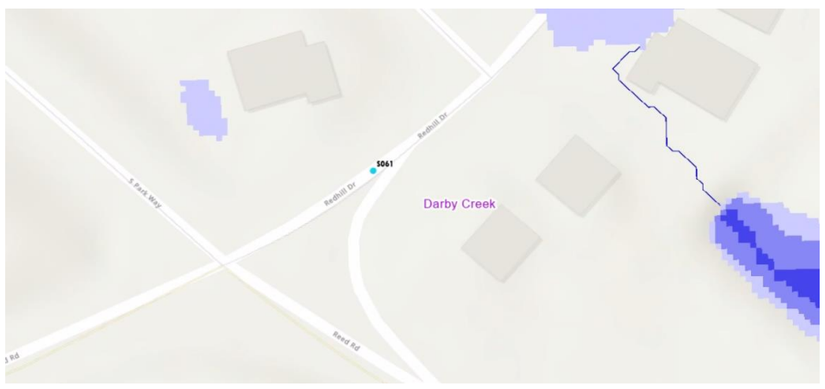


Inlets along Redhill Dr

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- The flow path from SCALGO indicates that water naturally collects and migrates along Red Hill Drive in this vicinity, particularly as an upstream flow path / natural extension to the Whetstone Run Creek which initiates in Delco Woods County Park. Recommend following up with municipality for more detail on flooding in roadway specifically. The following is suggested:
- Capitalize on the wide available street width to implement linear stormwater storage projects along Redhill Drive. Above ground solutions can include bioswale, stormwater planters, or stormwater bumpouts.
- Collaborate with DCPD to investigate Delco Woods County Park for nearby downstream storage/stormwater capture. Also see high priority problem are S073 additional analysis suggestions.
- Review the following parks for upstream stormwter practices to help mitigate flooding: New Ardmore Ave Park, Veterans Memorial Park, and Lawrence Park.

ID#S062 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Crum Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Not Applicable	**Problem Area Submission Date:**	8/3/2025
Municipality:	Marple Township	**Location:**	Broomall Commons Shopping Center
Property Type:	Commercial		
Type of Problem(s):	Accelerated Erosion		
Problem Description:	Tributary to Crum Creek eroded, adjacent to Broomall Commons Shopping Center.		
Field Visit Notes:	Could not access the site on 10/07. There was a tall fence and steep slope that prevented safe access. County to follow up with Pennoni to obtain pictures of the area. Site was accessed succesfully on 10/23/2025: Lots of trash and downed trees in channel; channel is lined with concrete starting at the outfall; grate on outfall is partially removed.		



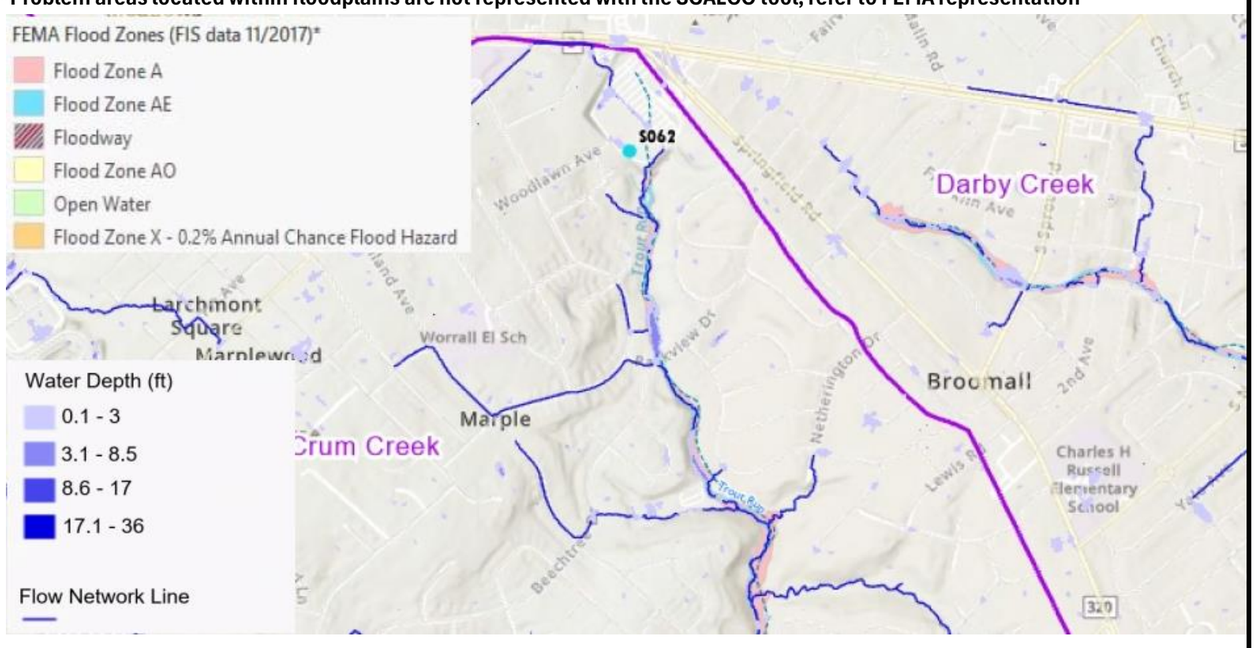
Downed trees along channel



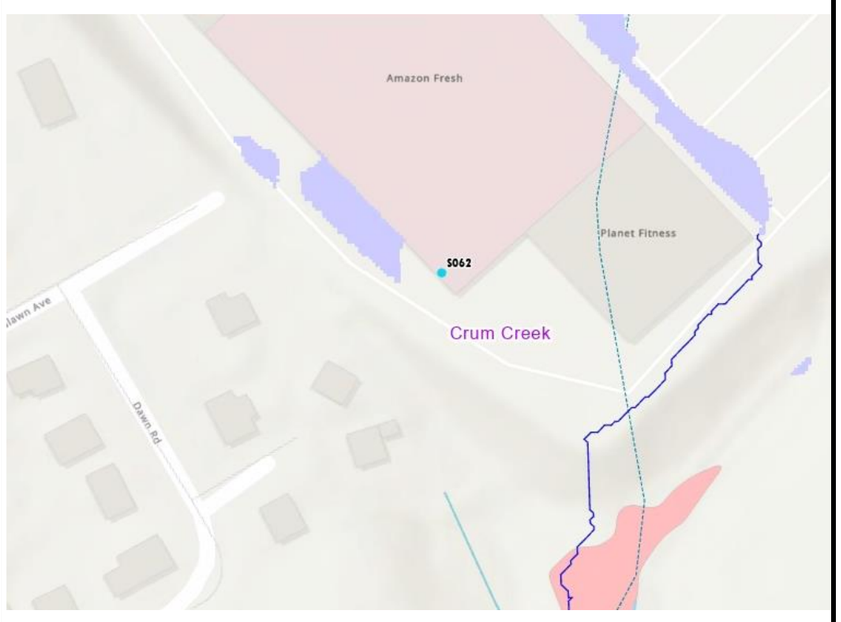
Outfall with partially removed grate

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

As evident from SCALGO, flow path from Trout Run initiates between the shopping center and stream. Field visit corroborates progressive erosion occurences. Recommend the following actions to promote streambank restoration:
- Removal of multiple obstructions (fallen trees) from concrete channel
- Stream restoration/stabilization (remove concrete and create more naturalized channel)
- Replacement of grate/screen on outfall
- Potential detention basin/wetland plantings

ID#S063 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Newlin Grist Mill
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/3/2025
Municipality:	Concord Township	**Location:**	West Branch Chester at Newlin Grist Mill Park
Property Type:	Open Space		
Type of Problem(s):	Flooding,Accelerated Erosion - Restricted Capacity		
Problem Description:	Damage to major trails, educational spaces, and recreational access		
Field Visit Notes:	Damage to banks during prior flooding has reduced overall stability.		



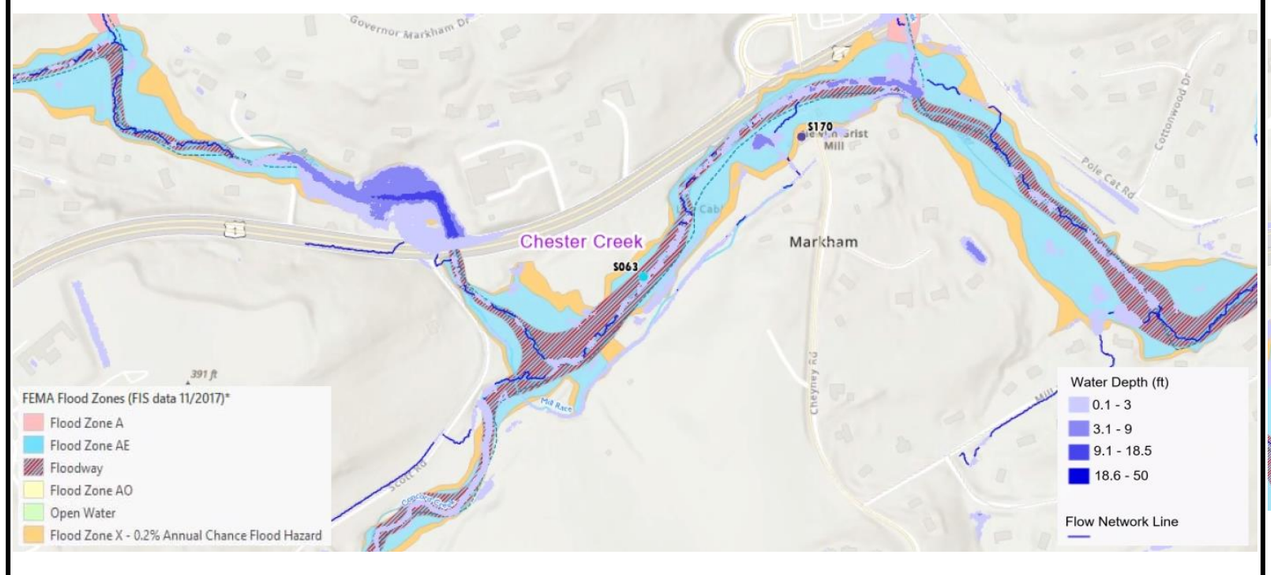
Streambank showing signs of erosion



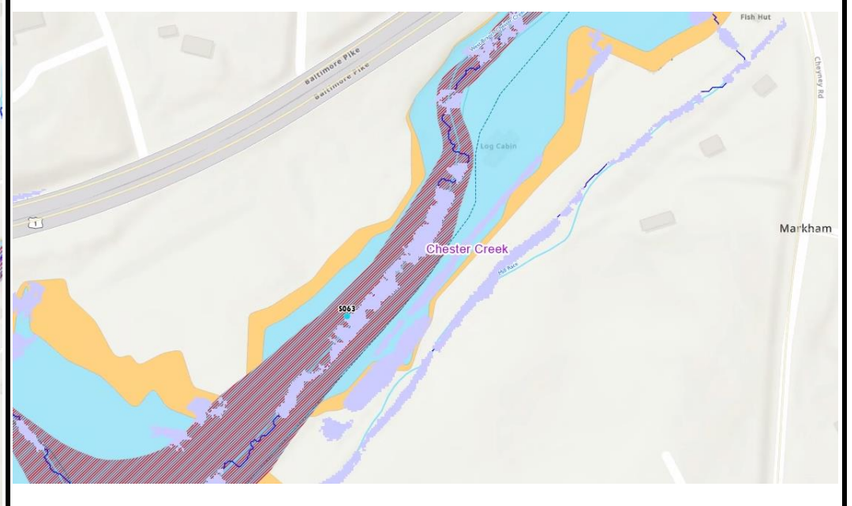
Portion of streambank with large rock bank

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stabilize streambanks and provide stream and floodplain restoration.
- Existing open space in this area be utilized manage downstream concerns.

ID#S065 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Newlin Grist Mill
Minor Watershed:	Concord Creek	**Problem Area Submission Date:**	8/3/2025
Municipality:	Concord Township	**Location:**	West Branch Chester at Newlin Grist Mill Park
Property Type:	Open Space		
Type of Problem(s):	Flooding, Accelerated Erosion - Restricted Capacity		
Problem Description:	Damage to major trails, educational spaces, and recreational access		
Field Visit Notes:	Some streambank erosion, obstruction in the waterways, downed trees.		



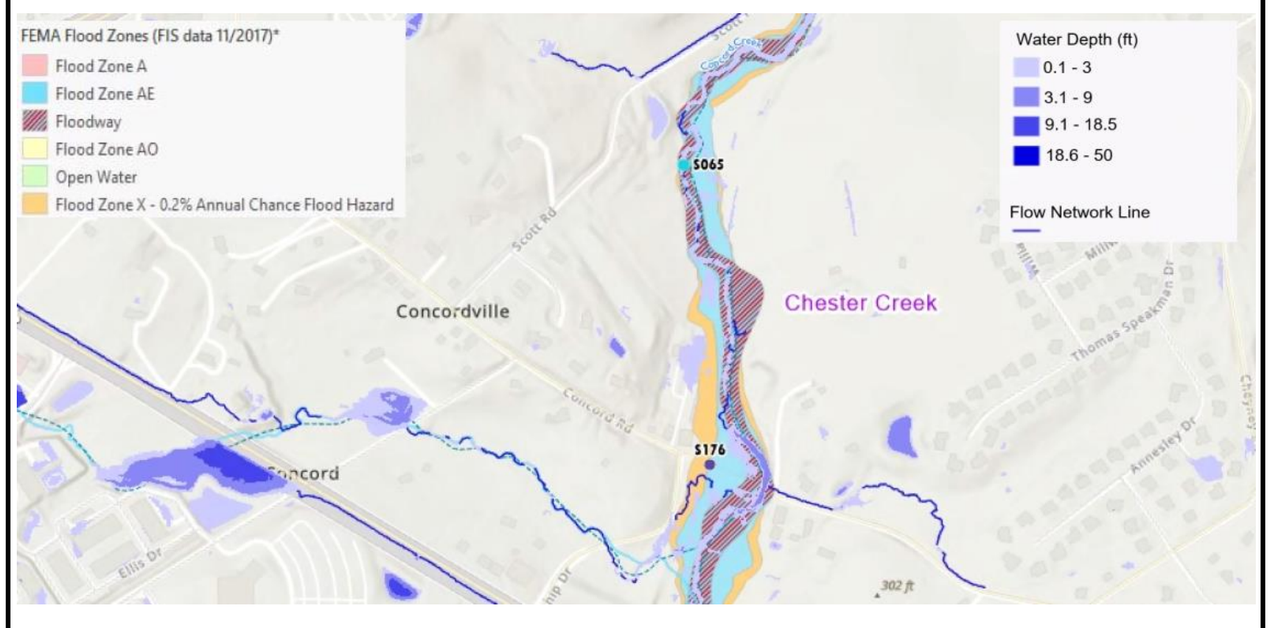
View of West Branch Chester Creek at Newlin Grist Mill Park with some minor erosion on streambank



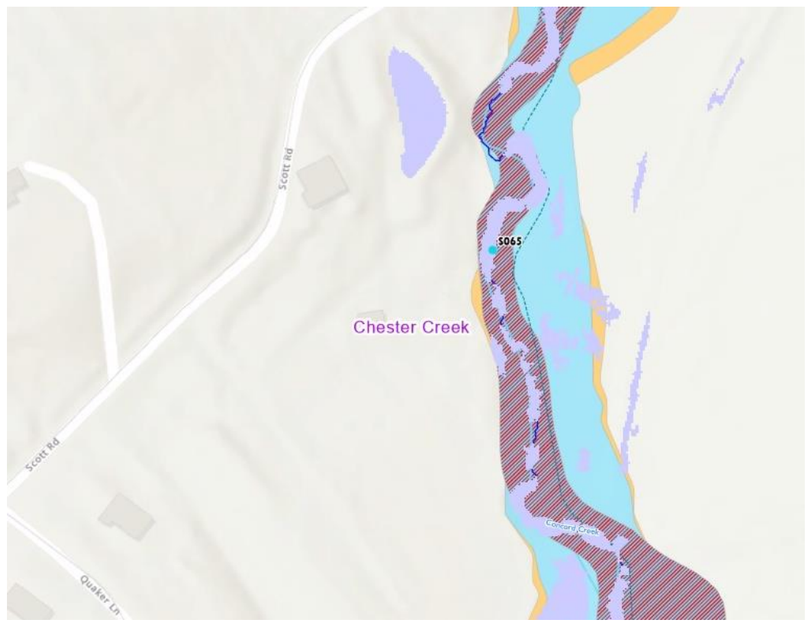
Old abandoned bridge over creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Address runoff off Concord Road and Station Road.
- Stabilize streambanks.
- Remove obstructions from waterway.
- Reduce upstream impervious.
- Reduce peak rates through stream restoration.

ID#S068 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Ridley Creek	**Source of Problem:**	Lighthouse Engineering, LLC
Minor Watershed:	Broomalls Run	**Problem Area Submission Date:**	8/3/2025
Municipality:	Media Borough	**Location:**	403 W 3rd St, Media, PA 19063
Property Type:	Other/public		
Type of Problem(s):	Flooding, Accelerated Erosion		
Problem Description:	Restricted capacity, insufficient drainage infrastructure		
Field Visit Notes:	Large drainage area from steep roadways collects at the inlet shown below. In this inlet a 36” terracotta pipe flows into a 12” HDPE. This could cause backflow displacing the grate and causing downstream erosion.		



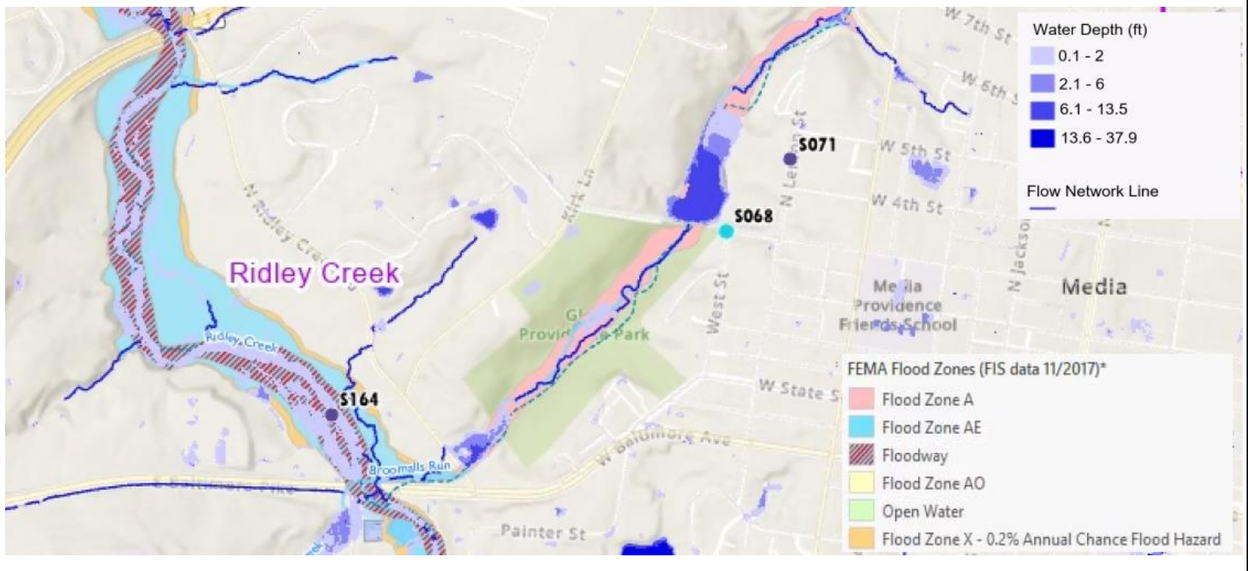
Inlet at end of W 3rd St with displaced grate and exposed liner downgradient



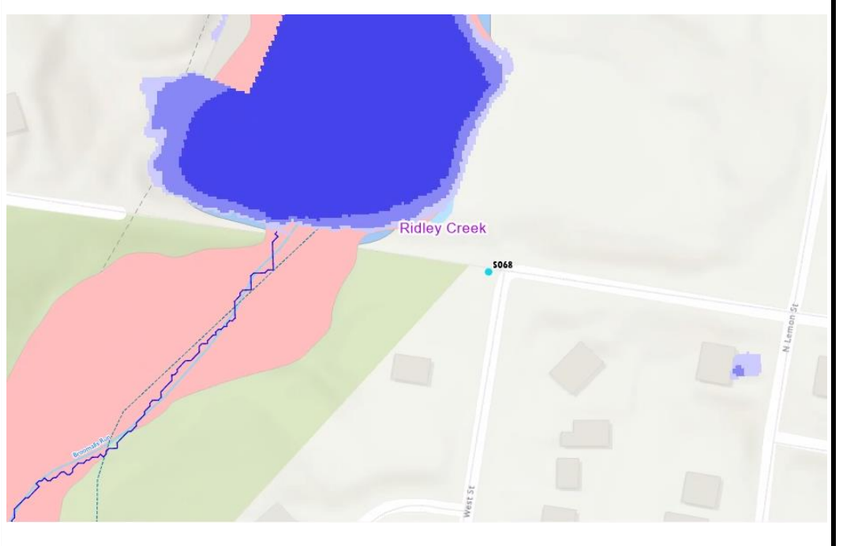
Severe flood damage in between inlet and outfall location at creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

The Borough is implementing the 2016 SWM Master Plan: https://www.lighthouse-engineers.com/ProjectMgmt/02-Media/02-Planning-Reports-Studies/07-Utilities-Plans-Mapping/Stormwater/24-SWM%20Master%20Plan.pdf Master Plan includes retentive grading in this area, infiltration and retention practices upstream of this site. and gray infrastructure improvements. Evaluate a drawdown schedule for the 3rd Street dam prior to storm events.

ID#S069 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Ridley Creek	**Source of Problem:**	Lighthouse Engineering, LLC
Minor Watershed:	Broomalls Run	**Problem Area Submission Date:**	8/3/2025
Municipality:	Media Borough	**Location:**	18 West Ridge Rd, Media, PA 19063
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Restricted Capacity, Insufficient drainage infrastructure		
Problem Description:	Heavy Flooding makes roads impassable.		
Field Visit Notes:	There is an outlet on West Ridge Road that expels water onto the road which flows down a steep intersection onto North Olive Street. Eventually hitting a low point where water collects and flows off site through a 36” CMP.		



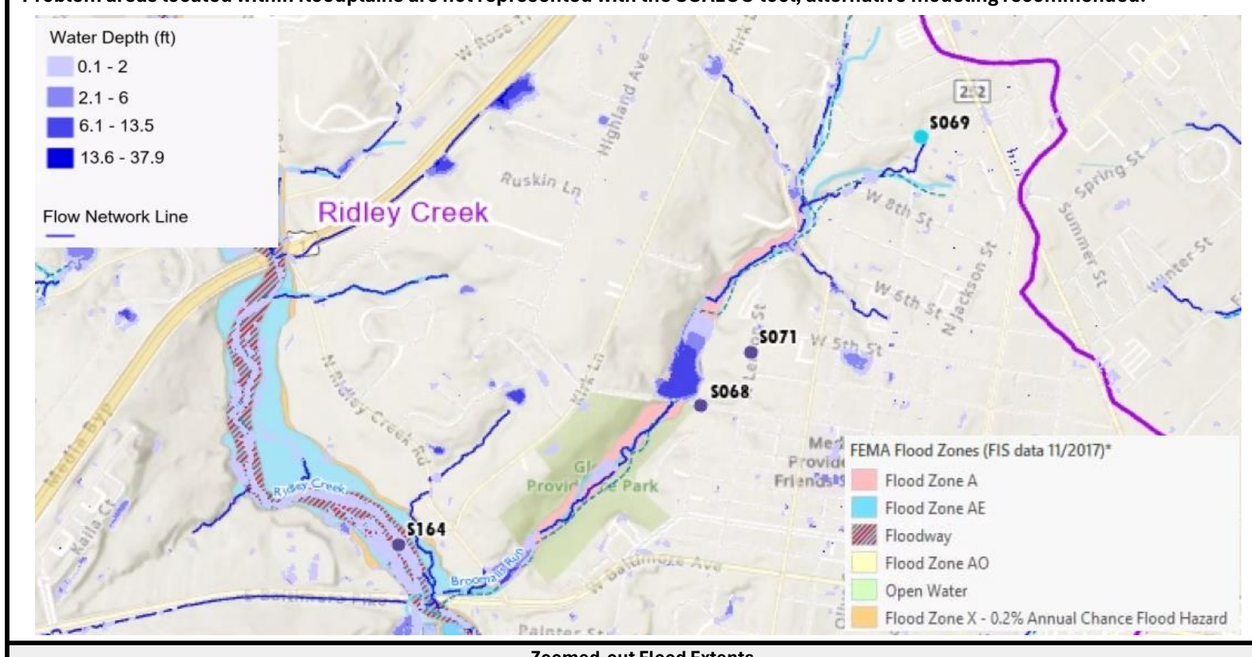
Low point on North Olive St with planters and curb inlets



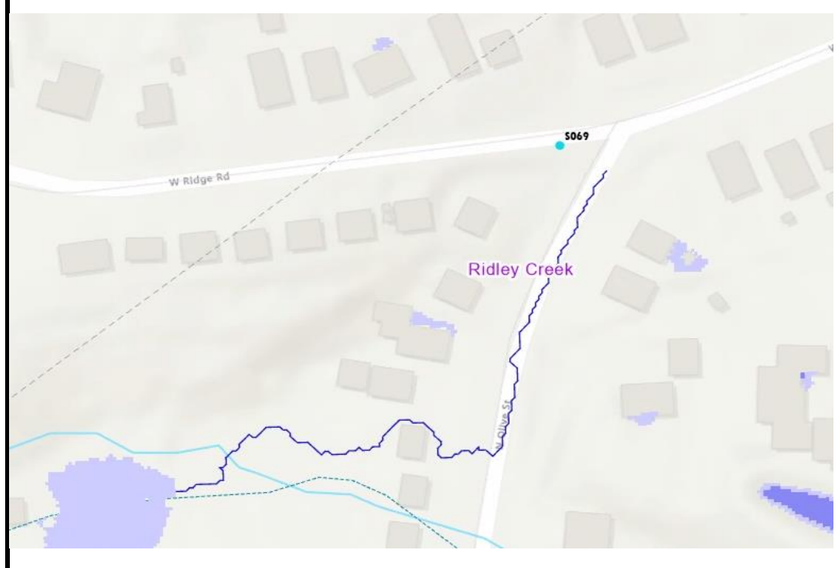
Outlet pipe along West Ridge Rd

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

Watershed gray and green infrastructure is proposed in this area. Details were outlined in the SWM Master Plan: https://www.lighthouse-engineers.com/ProjectMgmt/02-Media/02-Planning-Reports-Studies/07-Utilities-Plans-Mapping/Stormwater/24-SWM%20Master%20Plan.pdf

ID#S071 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Ridley Creek	**Source of Problem:**	Lighthouse Engineering, LLC
Minor Watershed:	Broomalls Run	**Problem Area Submission Date:**	8/3/2025
Municipality:	Media Borough	**Location:**	403 West 3rd St, Media, PA 19063
Property Type:	Open Space,Otherpublic		
Type of Problem(s):	Flooding, Accelerated Erosion - Insufficient drainage infrastructure		
Problem Description:	Broomall's Lake Swim Club recieves heavy Stormwater. Insufficient drainage infrastructure		
Field Visit Notes:	Observed standing water along edge of parking lot with debris. Parking lot sits in a bowl area, with rolled curbs and 2 spots in curb to release sheet flow. Poured concrete observed on one spot suggesting temporary control of erosion from sheet flow.		

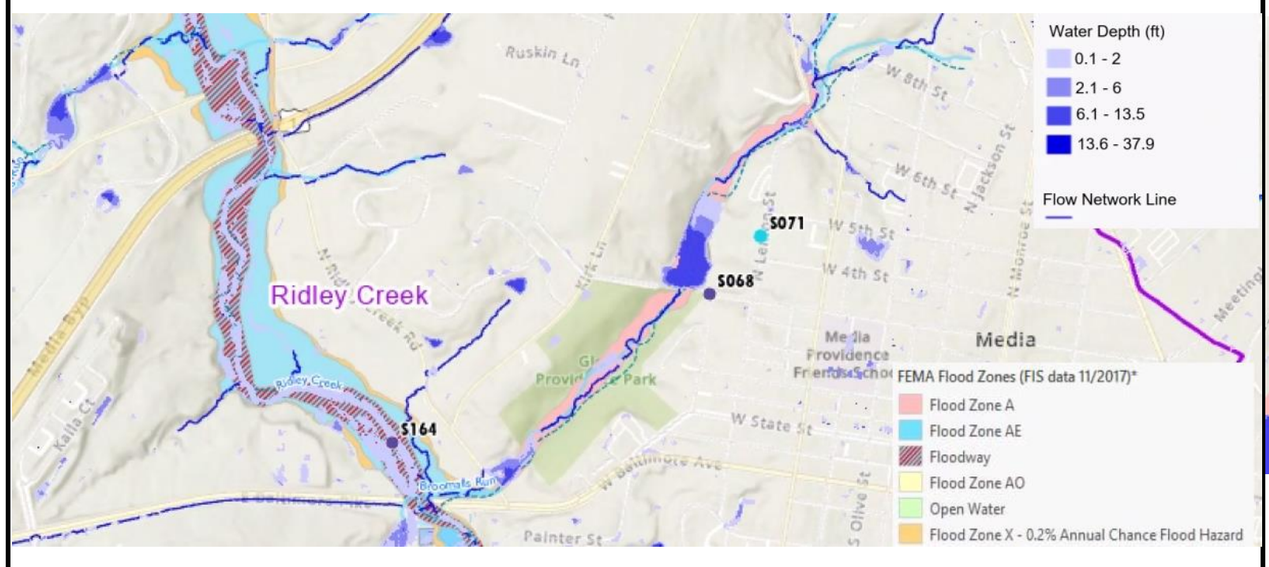


Area in parking lot with rolled curb and cut in center to release flow

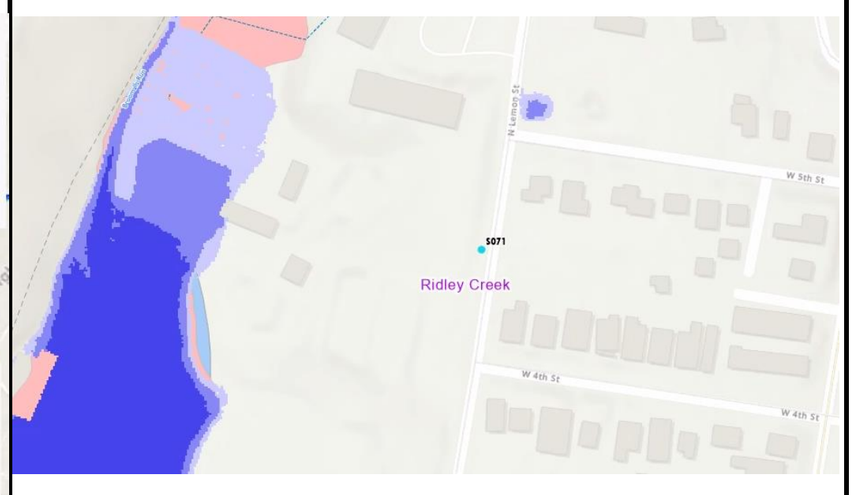


View of parking lot driveway looking upgradient

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional inlets.
- Construct a new SCM.
- https://www.lighthouse-engineers.com/ProjectMgmt/02-Media/02-Planning-Reports-Studies/07-Utilities-Plans-Mapping/Stormwater/24-SWM%20Master%20Plan.pdf

ID#S074 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Lighthouse Engineering, LLC
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/3/2025
Municipality:	Lansdowne Borough	**Location:**	Hoffman Park
Property Type:	Open Space, Right of Way		
Type of Problem(s):	Flooding, Accelerated Erosion		
Problem Description:	https://www.youtube.com/watch?v=IdEidV3RXzk		
Field Visit Notes:	From the video provided, it seemed like the park acted as an unintended floodable park. The creek is wide with shallow banks. The creek flow was relatively high.		



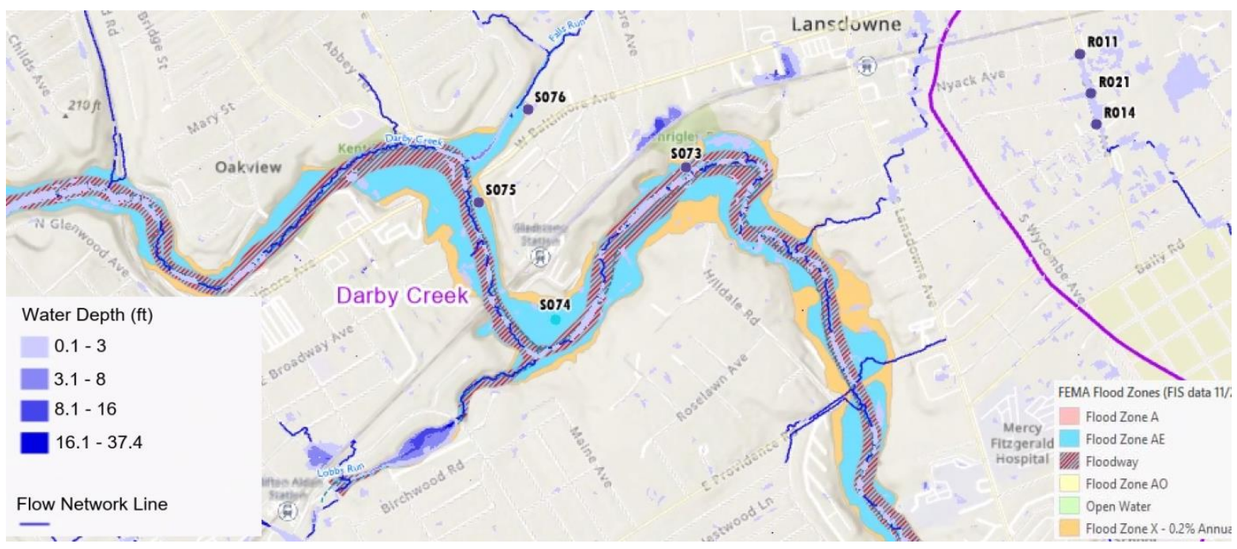
Darby Creek at Hoffman Park



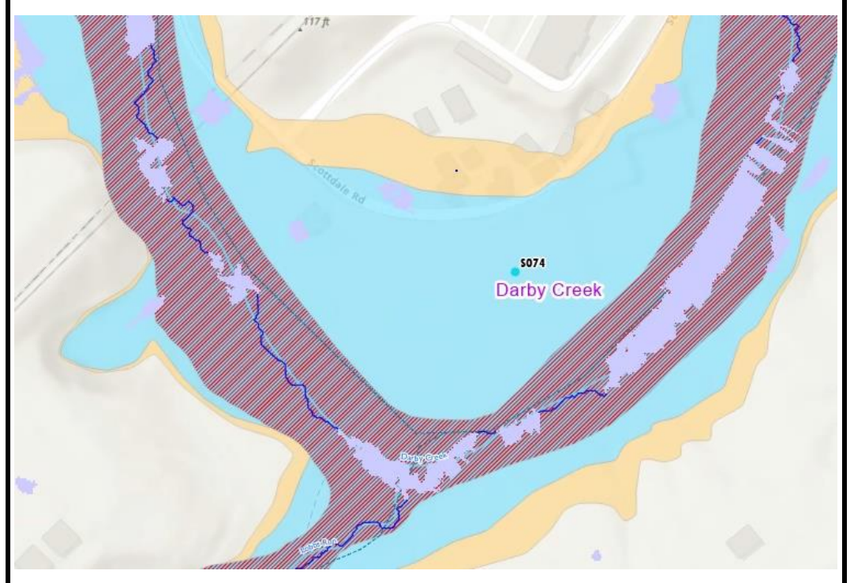
Green space in park

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Heavy Flooding of Darby Creek with possibility of subsurface opportunities under the tennis courts and green area of the park.
- Possibility of using upstream parks for localized stormwater management.
- See the Potential Solution Analysis form for S073 for additional supporting analysis related to this problem location

ID#S075 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Lighthouse Engineering, LLC
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/3/2025
Municipality:	Lansdowne Borough	**Location:**	Scottdale Road & W Baltimore Ave
Property Type:	Open Space, Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	When Darby Creek breaks its bank, Scottdale Road is badly flooded		
Field Visit Notes:	The creek is flowing at a relatively high velocity. Significant erosion on both sides of the bank.		



Erosion on streambank



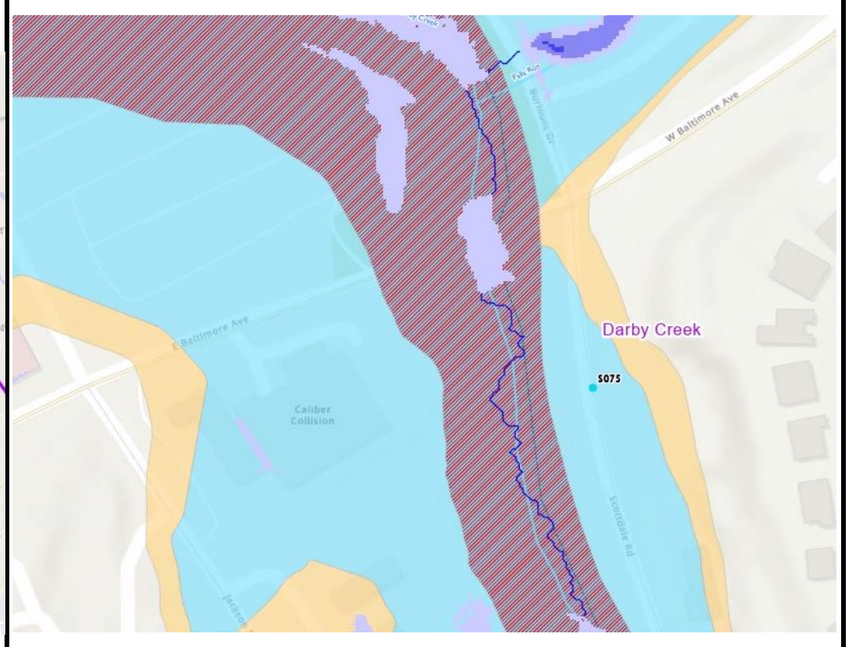
Erosion on streambank

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

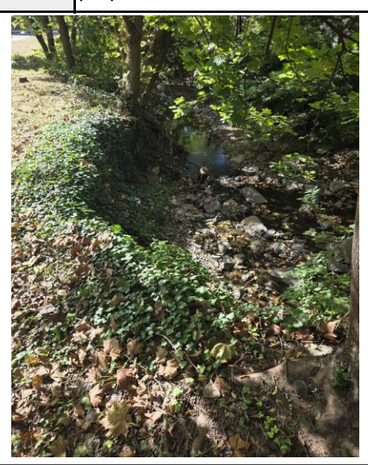
Potential Solutions

- Hoffman Park at the bend of the road downstream of S75 Could be an area that Could help contain the creek volume during storms.
- See the Potential Solution Analysis form for S073 for additional supporting analysis related to this problem location

ID#S076 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Lighthouse Engineering, LLC
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/3/2025
Municipality:	Lansdowne Borough	**Location:**	Lansdowne Swim Club on Burmont Rd
Property Type:	Open Space, Public (other)		
Type of Problem(s):	Flooding, Accelerated Erosion		
Problem Description:	Heavy flooding on Burmont Road and stormwater runoff from W Baltimore Ave causes flooding of the Lansdowne Swim Club parking lot.		
Field Visit Notes:	Evidence of erosion along streambank was apparent. Update 11/5/2025: Lansdowne Borough's Engineer provided photos of previously completed dye testing. The Engineer's proposed solution was additional drainage infrastructure placed in the location of the dye. See below photo.		



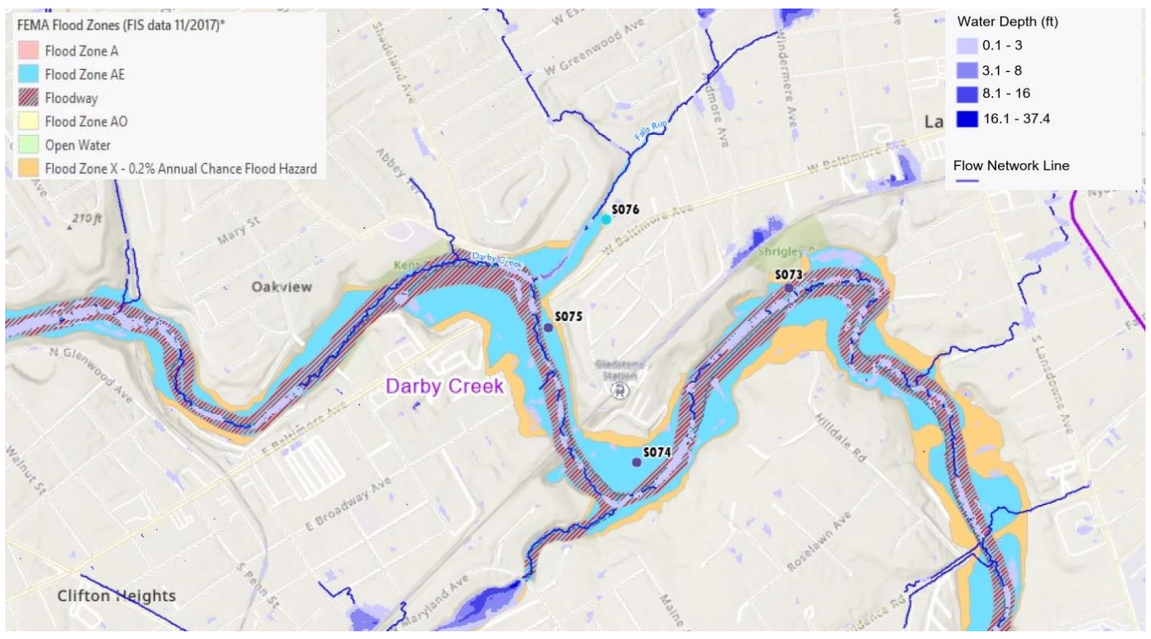
Signs of erosion



Dye test at Lansdowne Swim Club

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install drainage infrastructure to convey runoff from W Baltimore Avenue under parking lot and into creek
- Potential for subsurface storage system / floodplain restoration below parking lot
- Evaluate expanding the floodplain by the entrance to the parking lot
- Evaluate upstream park (Marlyn Park) for opportunities to capture stormwater

ID#S083 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Brookhaven Borough
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Brookhaven Borough	**Location:**	5003 Creek Rd, Brookhaven, PA 19015
Property Type:	Residential		
Type of Problem(s):	flooding		
Problem Description:	Insufficient drainage capacity		
Field Visit Notes:	No evidence of creek overtopping bank, some undercutting. Likely cause is inlet being lower in the road than top of streambank. Surcharge during high flow events in creek floods area, evidenced by deposited anti-skid material surrounding inlet.		



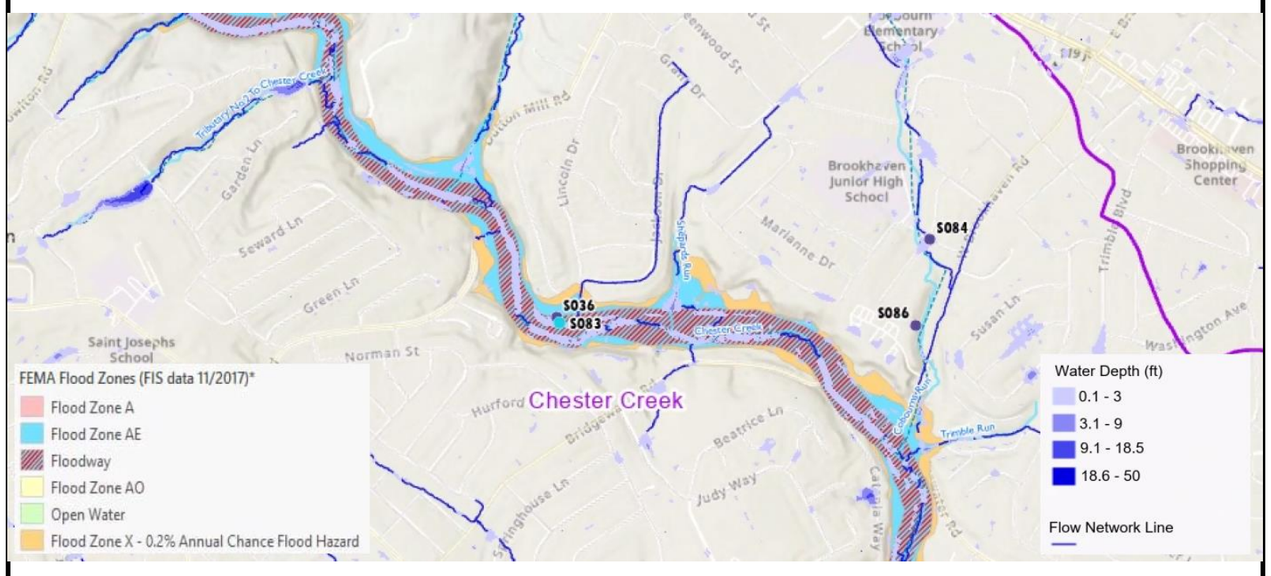
Inlet along Creek road (on left) and outlet to creek (on right)



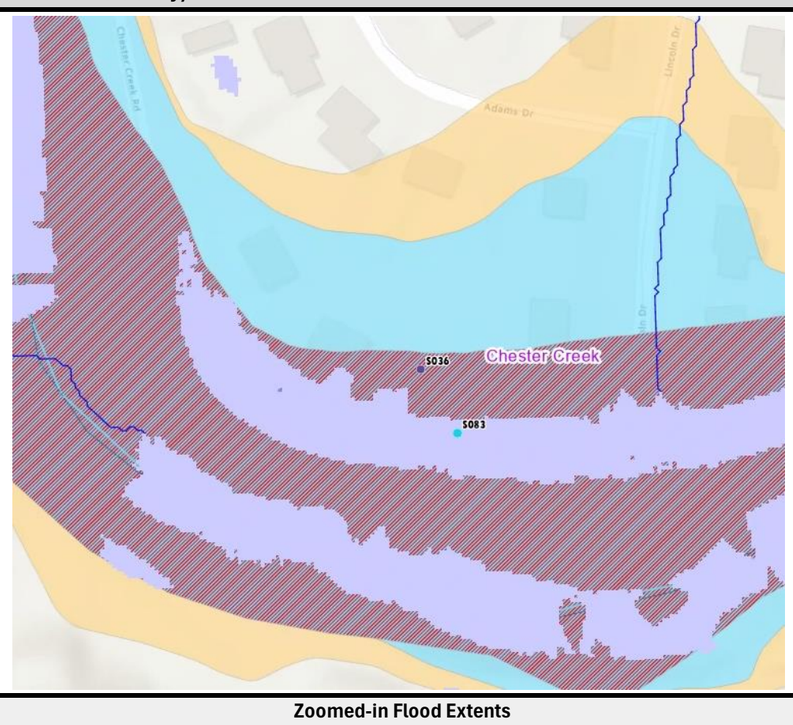
Erosion observed along streambank

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional inlets along Creek Rd.
- Problem area located within FEMA floodway. Elevate road or otherwise floodproof affected structures.
- Stabilize streambanks.

ID#S084 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Brookhaven Borough
Minor Watershed:	Coburns Run	**Problem Area Submission Date:**	8/4/2025
Municipality:	Brookhaven Borough	**Location:**	4112 N Gray Street, Brookhaven, PA 19015
Property Type:	Residential		
Type of Problem(s):	Flooding - insufficient drainage		
Problem Description:	Limited details provided.		
Field Visit Notes:	Buried stream runs under properties through these culverts (photos 1 and 2). Upstream inlet has debris blocking flow through 3-36” concrete pipes. Flow leaves the downstream culvert through a 48” pipe.		

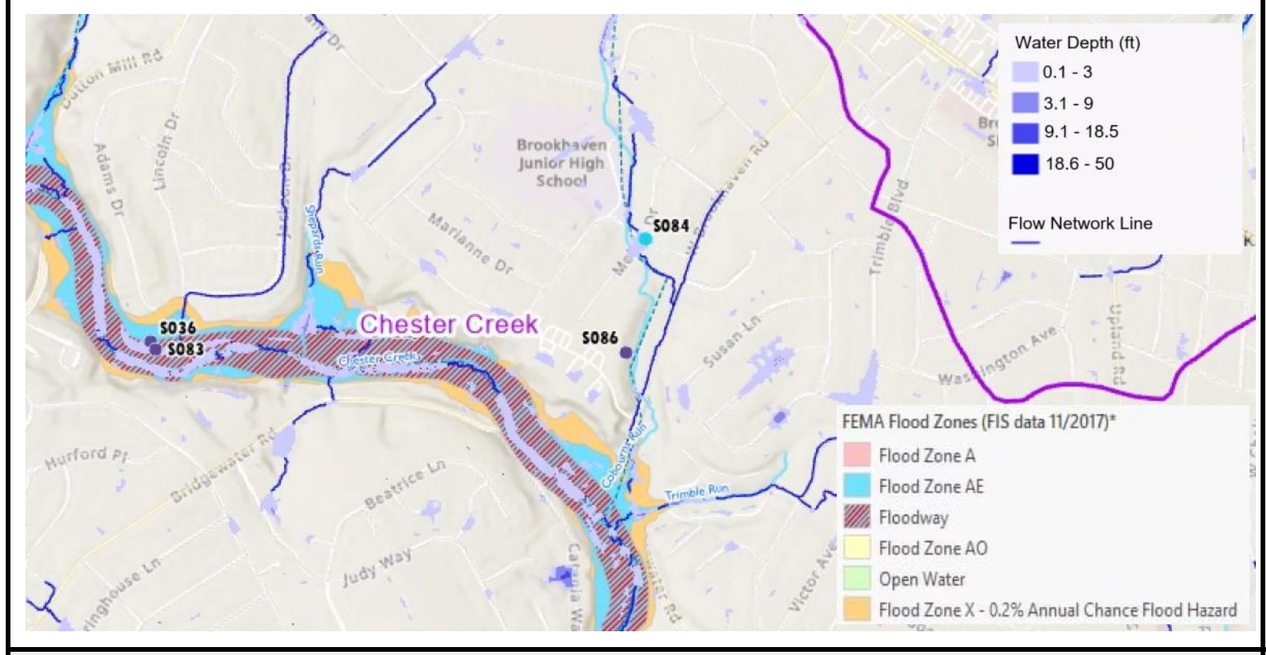


Dual inlets along N Gray St conveying buried stream

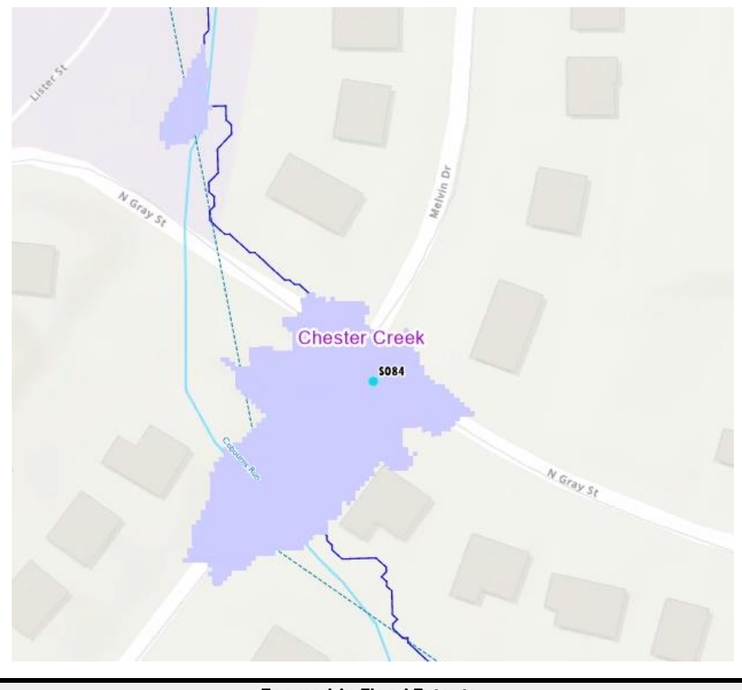


Inlet filled with debris possibly causing inlets to overtop during large events

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Remove debris from inlets.
- Increase culvert sizes.
- Evaluate benefit of stream re-alignmet and restoration.

ID#S086 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Brookhaven Borough
Minor Watershed:	Shepard Run	**Problem Area Submission Date:**	8/4/2025
Municipality:	Brookhaven Borough	**Location:**	3455 Street Road, Brookhaven, PA 19015
Property Type:	Residential		
Type of Problem(s):	Accelerated Erosion - Restricted Capacity		
Problem Description:	Retaining wall being undermined		
Field Visit Notes:	Undermining of wall observed in creek. Culvert pipe going under road could be undersized. No erosion seen on embankment walls. 53 x 60 elliptical concrete culvert.		



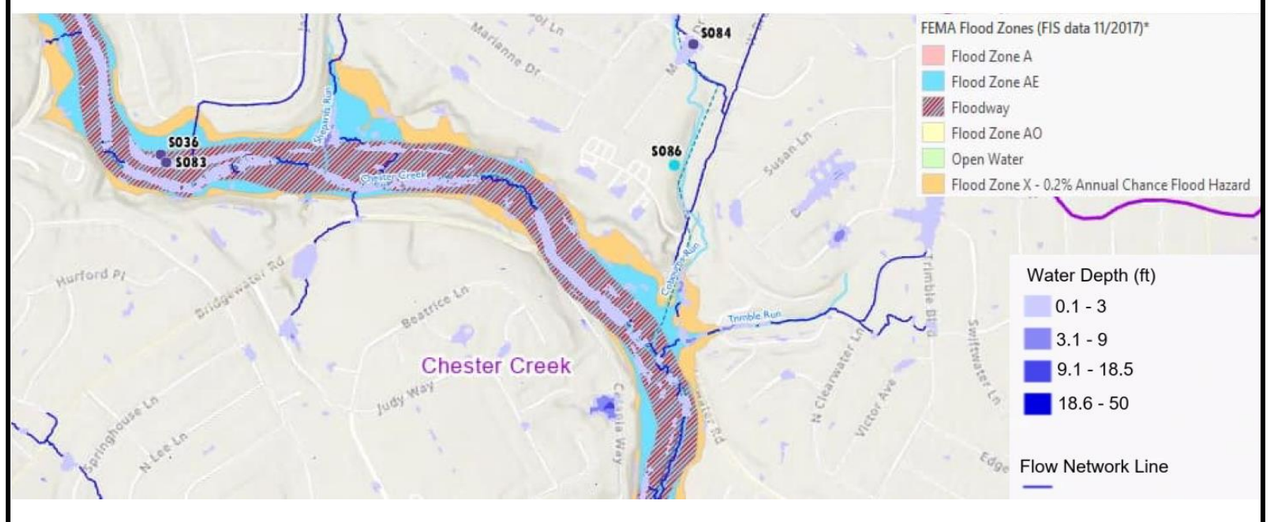
View of rock wall with undermining along stream



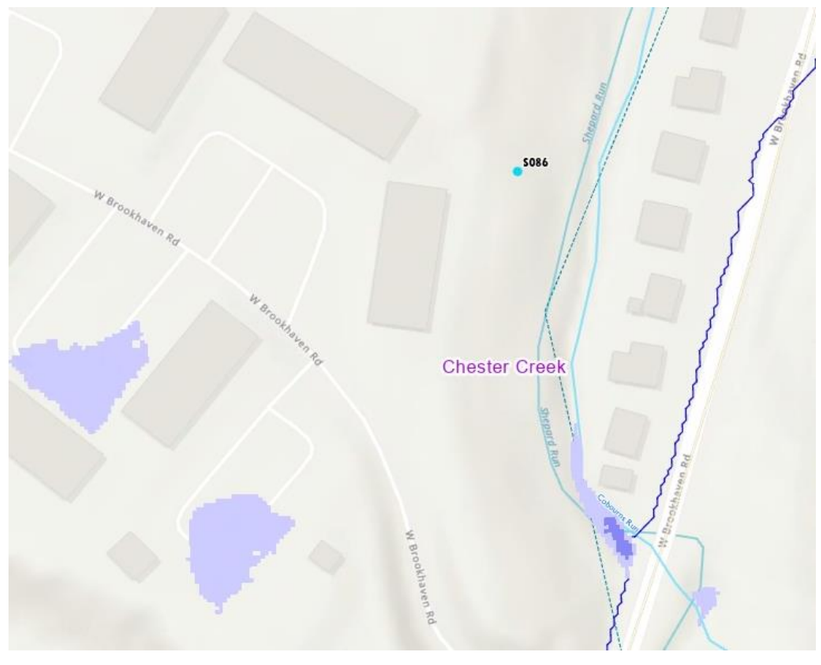
Upstream view of culvert under Brookhaven Rd with gabion wall along stream

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Resize culvert.
- Stabilize retaining wall.
- Potentially widen the stream at this location on natural side to reduce velocity of water through it.

ID#S087 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Ridley Creek	**Source of Problem:**	Brookhaven Borough
Minor Watershed:	Tributary No.2 To Ridley Creek	**Problem Area Submission Date:**	8/4/2025
Municipality:	Brookhaven Borough	**Location:**	2 Cambridge Road, Brookhaven, PA 19015
Property Type:	Open Space		
Type of Problem(s):	Accelerated Erosion,Sedimentation		
Problem Description:	Old stormwater basin damaged by flooding upstream of Cambridge Rd - Insufficient/aging drainage infrastructure		
Field Visit Notes:	Unable to identify stormwater basin damaged due to high amount of hydrophytic vegetation. Some erosion on side slopes of stream. No issues with accelerated sedimentation.		

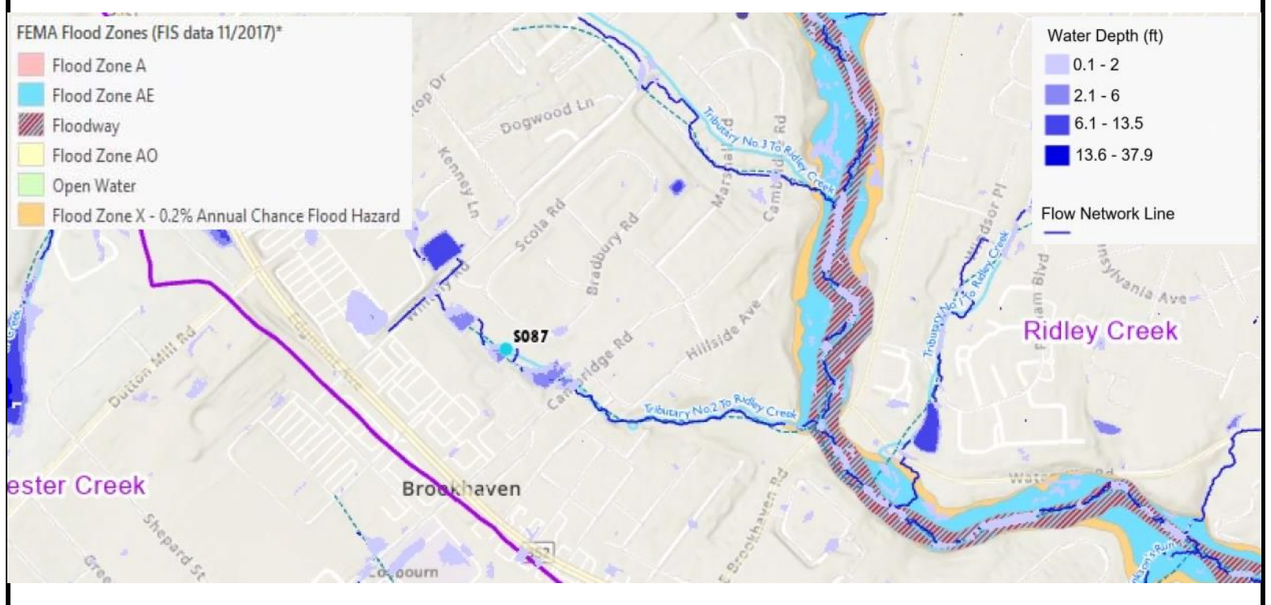


View of stream running along what appears to be part of old stormwater basin



View of culvert near problem area obstructed by dense vegetation growth

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Retrofit existing SCM.
- Stabilize streambanks.

ID#S088 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Civil Collaborative Concepts, LLC
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Darby Borough	**Location:**	Bridge over Darby Creek at S MacDade Blvd & Springfield Rd
Property Type:	Residential, Commercial		
Type of Problem(s):	Flooding		
Problem Description:	Water enters structures		
Field Visit Notes:	Downstream from large green spaces (Collingdale Park, Westmont Park, etc). Obstruction from a fallen tree upstream. Downstream channel seems much narrower. Upstream the channel is significantly wider.		



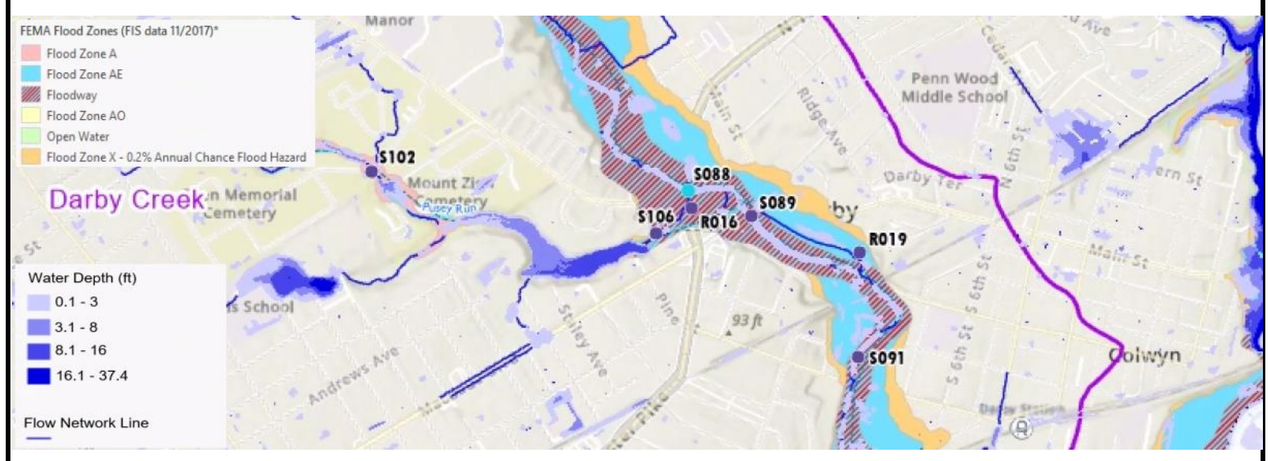
Downed tree and debirs along channel



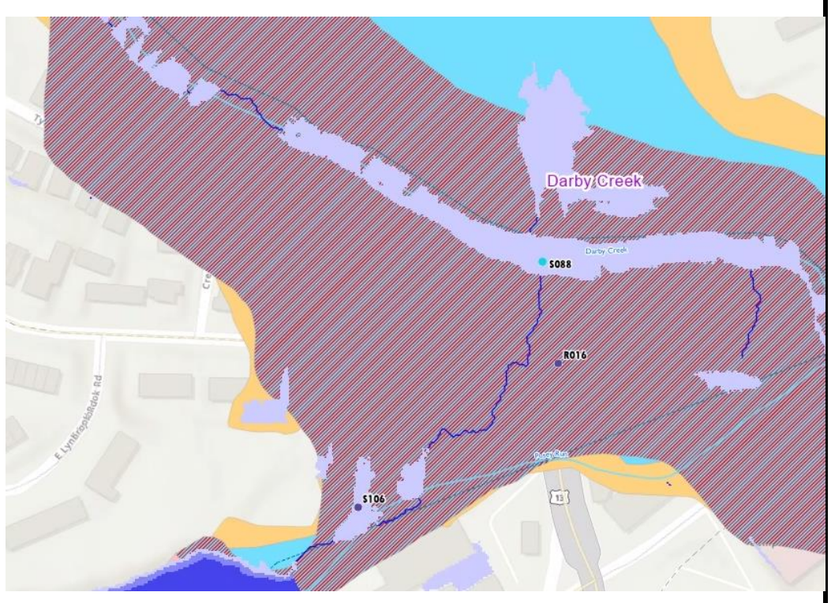
Darby Creek under S MacDade Blvd

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Engineering review of existing sewer capacity with hydraulic analysis. There are several inlets in the vicinity, target which storm event is resulting in surcharge and review upsizing of applicable sewers through to downstream routing.
- Review for opportunities in open space upstream, potential infiltration or detention/slow release systems
- Review for downstream overflow space, potentially at Powell Park
- See the Potential Solution Analysis form for S073 for additional supporting analysis related to this problem location

ID#S089 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	DARBY CREEK	**Source of Problem:**	Civil Collaborative Concepts, LLC
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Darby Borough	**Location:**	Chester Pike & Walnut Street
Property Type:	Residential, Commercial, Open Space, Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Water enters structures and floods roadways and park land		
Field Visit Notes:	Wide Darby Creek channel with high bridge structure. Some debris and a tree obstruction in the creek. Relatively small green area (Powell Park, 1 basketball court) by the creek. Norman Park upstream.		



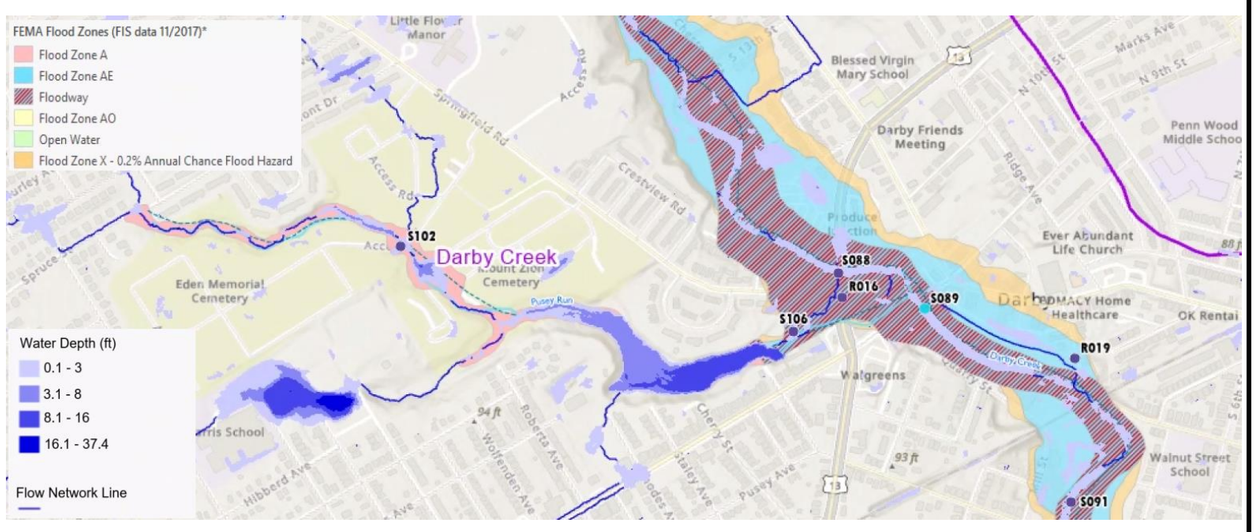
Darby Creek at Chester Pike & Walnut St



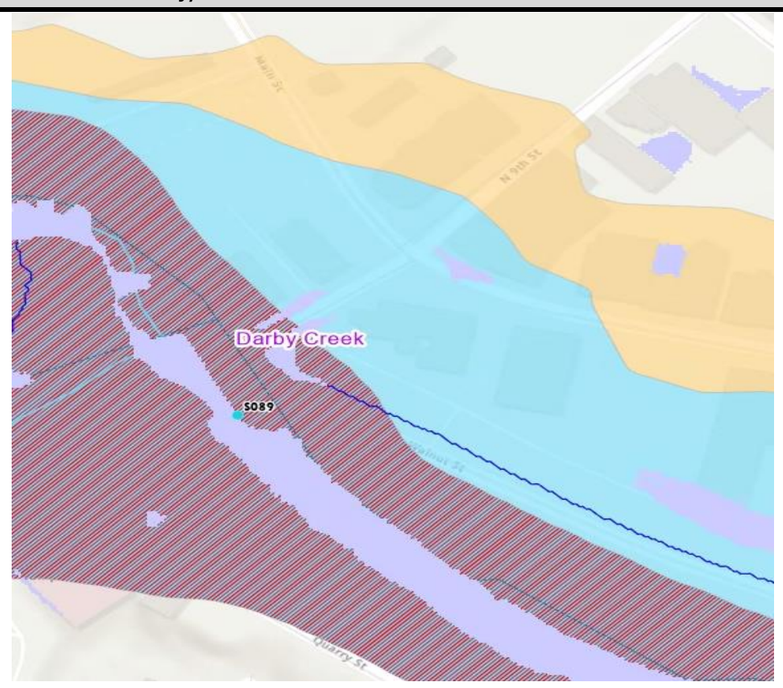
Debris and tree obstruction in creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- See S088 solution notes. Same hydraulic network (problem), and suggested recommendations.
- See the Potential Solution Analysis form for S073 for additional supporting analysis related to this problem location

ID#S090 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Civil Collaborative Concepts, LLC
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Darby Borough	**Location:**	1200 and 1300 blocks Chestnut St.
Property Type:	Residential		
Type of Problem(s):	Flooding - Restricted capacity		
Problem Description:	Water enters structures and floods roadways and park land		
Field Visit Notes:	Wide unused green space between the creek and the road. Darby Creek is shallow, the banks are low and are very vegetated.		



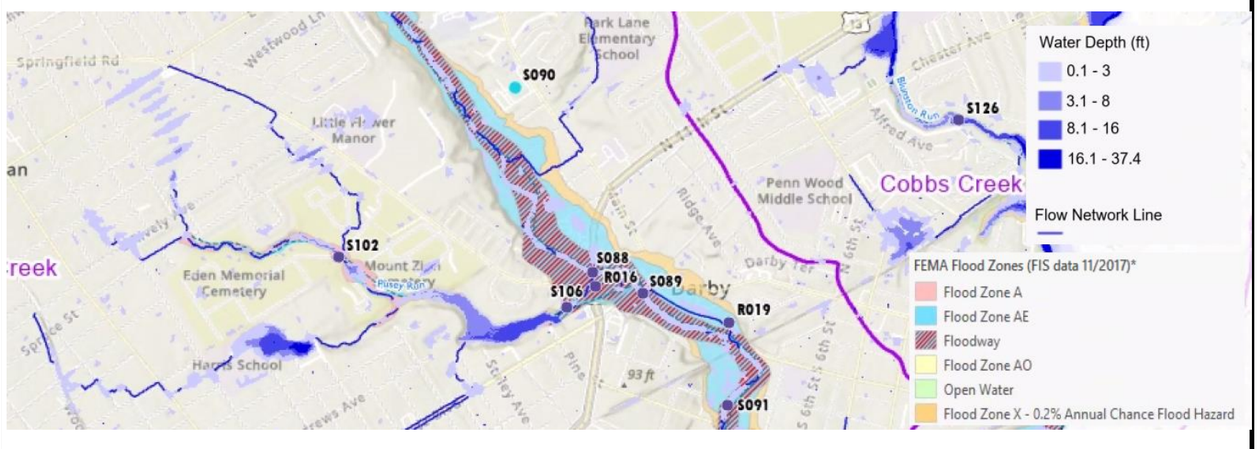
View of Darby Creek near problem area location



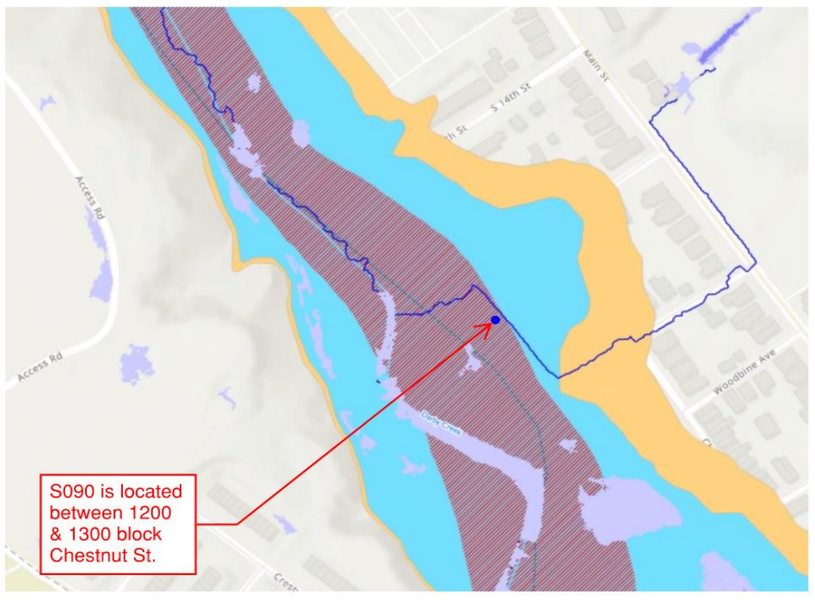
Large unused green space between Darby Creek and roadway

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Watershed level improvements are needed
- Increase downstream conveyance capacity.
- Area adjacent to S090 includes open space which can be used for stream restoration and floodplain restoration.
- Flood control and resiliency measures should be implemented for structures within the floodway.

ID#S093 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Naamans Creek	**Source of Problem:**	G. D. Houtman & Son, Inc
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Bethel Township	**Location:**	3523 Goodley Rd, Garnet Valley, PA 19060
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Restricted Capacity		
Problem Description:	Minor property damage; more concerned about emergency service access		
Field Visit Notes:	See S135 for information on the Goodley Road culvert of Naamans Creek. 3523 Goodley Road driveway culvert of Naamans Creek. Confluence upstream of the three 24" CMP pipe culvert under the driveway. Evidence of damage to culvert and roadway above culvert. Evidence of flooding around driveway and yard around creek.		



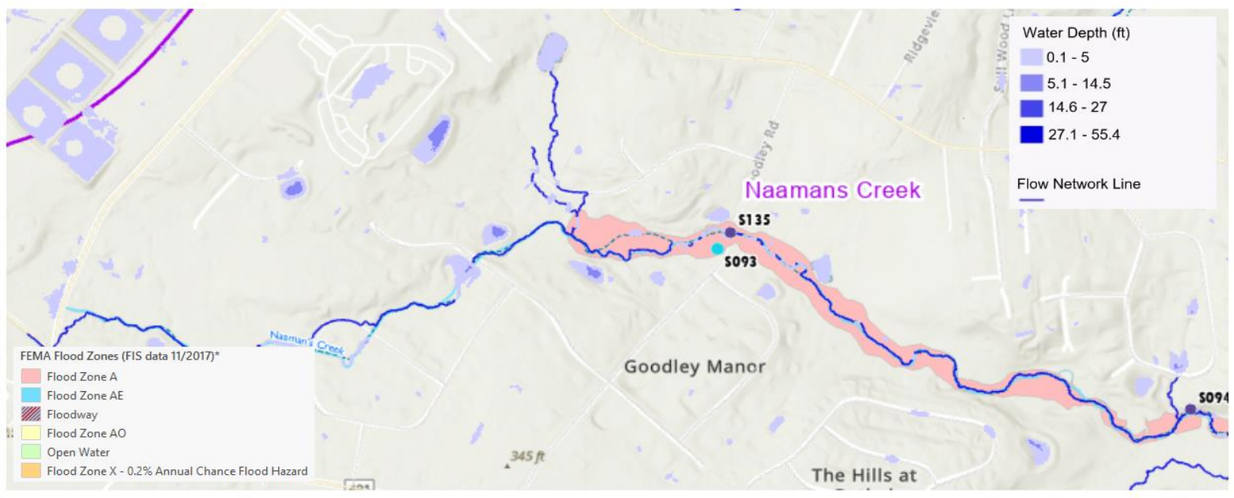
View of culvert discharging into channel leading to Naamans Creek



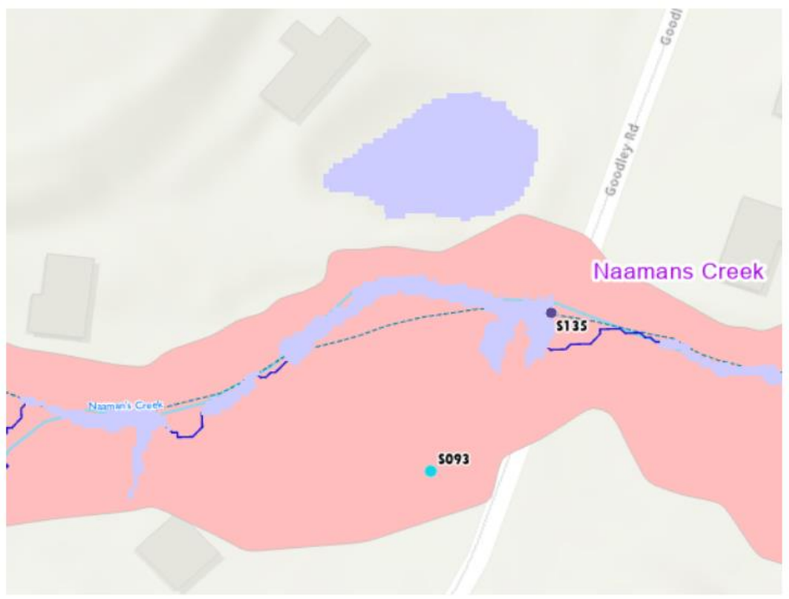
Structural damage and ponding adjacent to culvert opening

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Replace culvert under Goodley Road (Enlarge culvert).
- Raise the road elevation.

ID#S095 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Delaware River	**Source of Problem:**	Civil Collaborative Concepts, LLC
Minor Watershed:	Marcus Hook Creek	**Problem Area Submission Date:**	8/4/2025
Municipality:	Darby Borough	**Location:**	W 7th St & Main St, Marcus Hook, PA 19061
Property Type:	Residential,Rightofway		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Water enters structures and floods roadways		
Field Visit Notes:	Low point observed on W 7th Street and Main Street with signs of flooding. Inlet filter bags left at inlets in front of railroad bridge.		

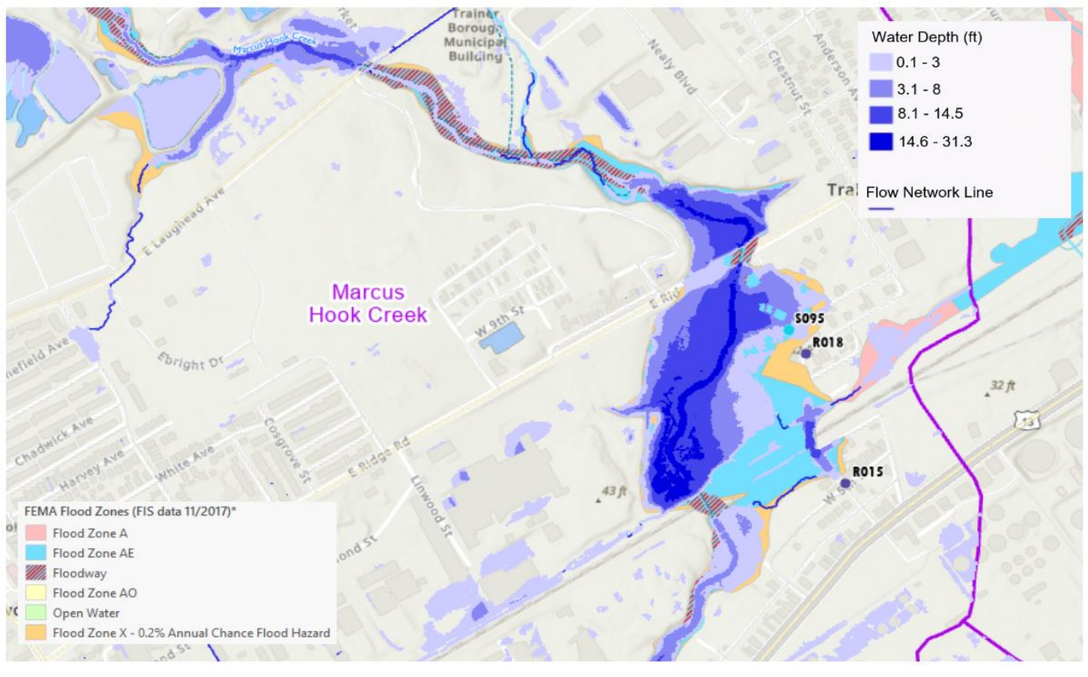


Erosion at lowpoint of W 7th St and Main St intersection

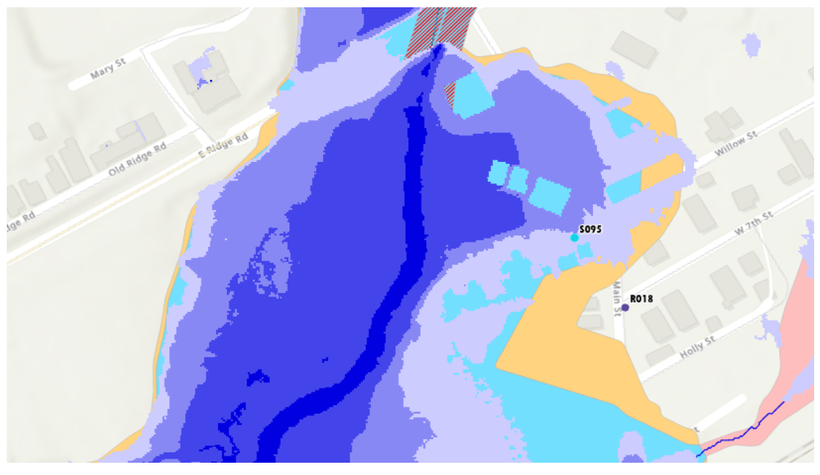


View inside of inlet filled with vegetation/debris

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Remove inlet filter bags and debris from existing inlets.
- Install additional inlets.

ID#S099 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Naamans Creek	**Source of Problem:**	G. D. Houtman & Son, Inc
Minor Watershed:	South Branch Naamans Creek	**Problem Area Submission Date:**	8/4/2025
Municipality:	Bethel Township	**Location:**	1143 & 1161 Kirk Rd, Garnet Valley, PA 19060
Property Type:	Residential,Rightofway		
Type of Problem(s):	Flooding - Insufficient drainage infrastructure		
Problem Description:	Excessive flooding		
Field Visit Notes:	Water from the roadway goes over the uncurbed into the swale inhibiting flow and drainage. Vegetation cleared out few months ago according to resident, helped flow. Culvert crossing the roadway, 24". Swale appears to be ungraded and ponding.		

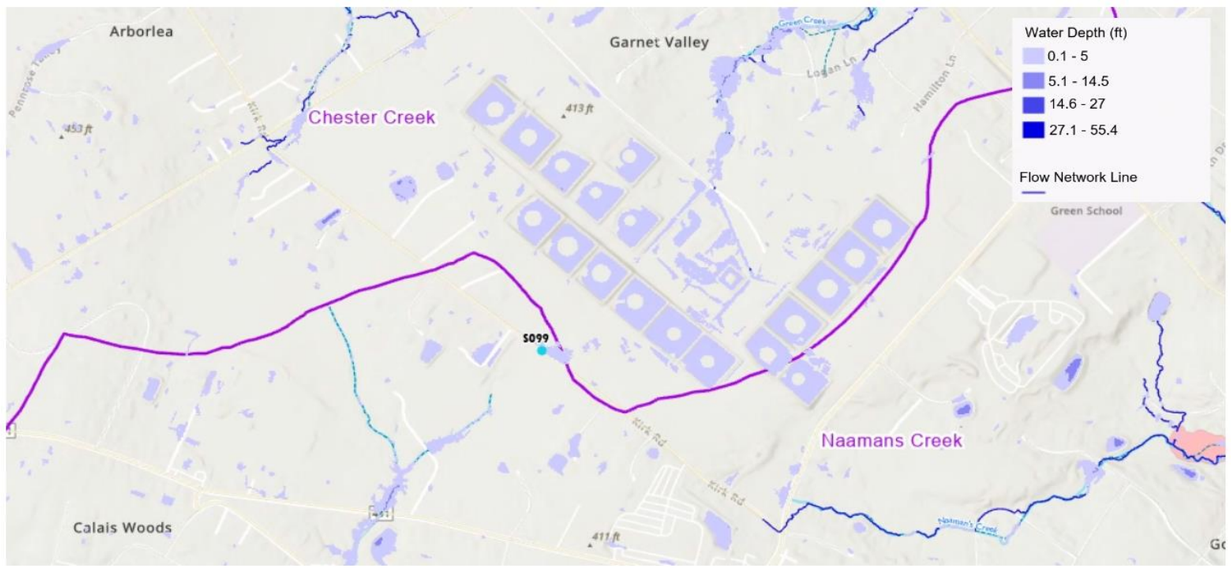


View of erosion within swale along Kirk Road



24" RCP culvert discharge point into swale

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional drainage.
- Kirk Road is flat in the general area and flood waters have a difficulty draining. Grade the road and swale.
- Remove obstructions from swale.

ID#S102 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Stantec-Collingdale Borough Engineer
Minor Watershed:	Not applicable	**Problem Area Submission Date:**	8/4/2025
Municipality:	Collingdale Borough	**Location:**	Eden and Mt Zion Cemeteries at Pusey Run
Property Type:	Other		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation, Water Pollution		
Problem Description:	Several burial sites damaged from flooding and erosion.		
Field Visit Notes:	Tombstones are underwater or in muddy terrains. Significant drainage issue. Water is not draining or flowing where it should. Drove to Collingdale Park to investigate upstream solutions.		

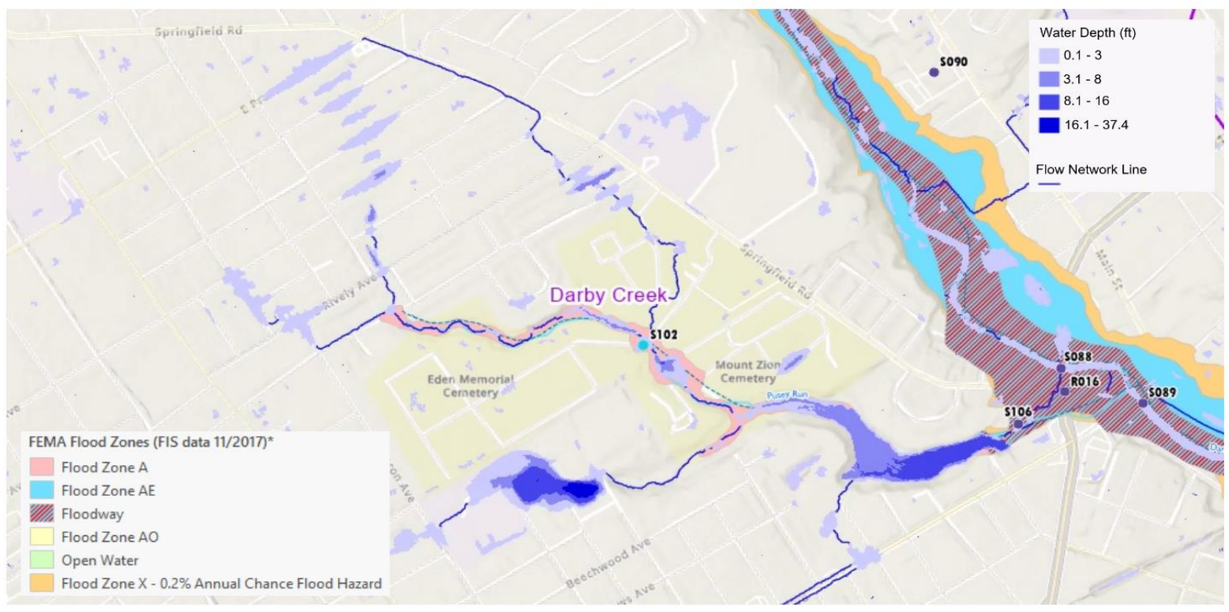


Erosion at cemetery

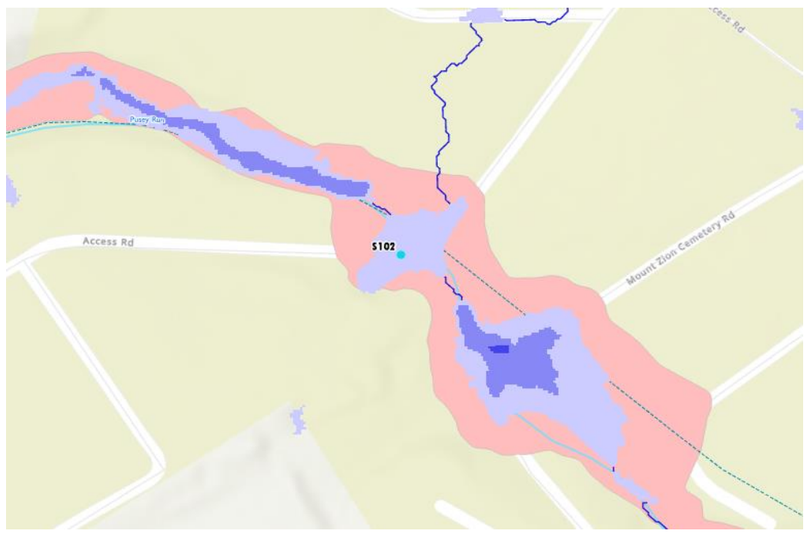


Flooding at cemetery

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Collingdale Park could be used for storage/detention opportunities, but it is not clear if it would help with the problem.
- Consider adding a storm pipe below the access road and discharging into drainage channel. Might need to relocate some of the impacted graves.

ID#S106 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Stantec-Collingdale Borough Engineer
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Collingdale Borough	**Location:**	19 Florence Ave
Property Type:	Residential, Commercial, Right of Way		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation, Water Pollution		
Problem Description:	18 residential homes and 1 commercial business were affected by flooding.		
Field Visit Notes:	Tributary ends on the street based on Google Maps information. Site difficult to access due to fence.		



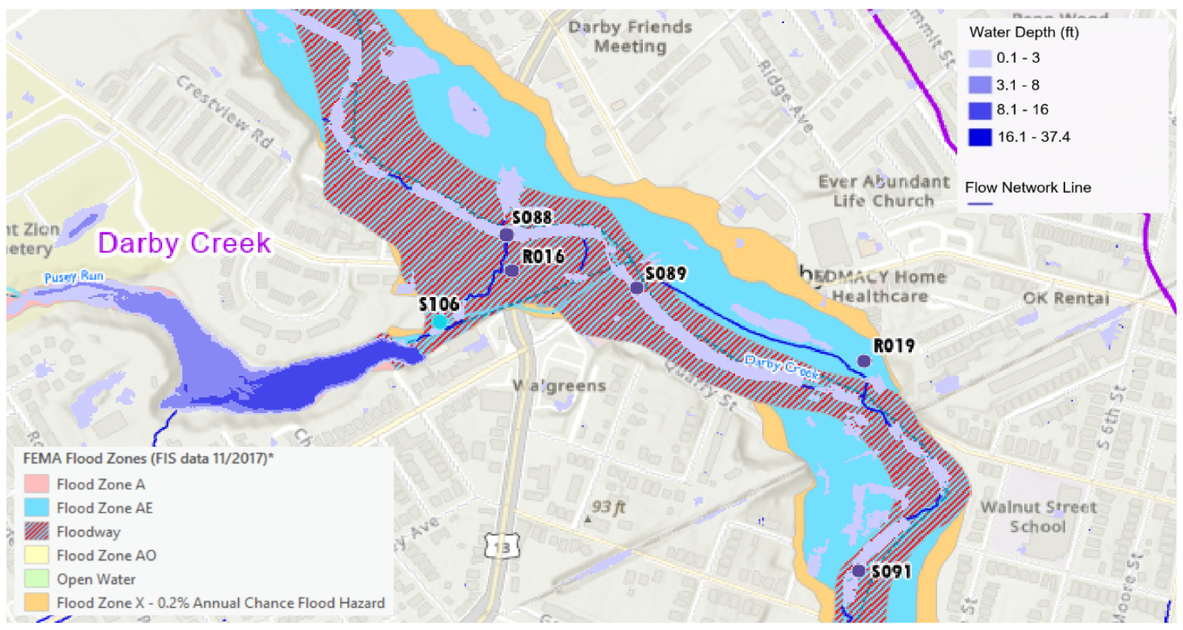
Pipe in area



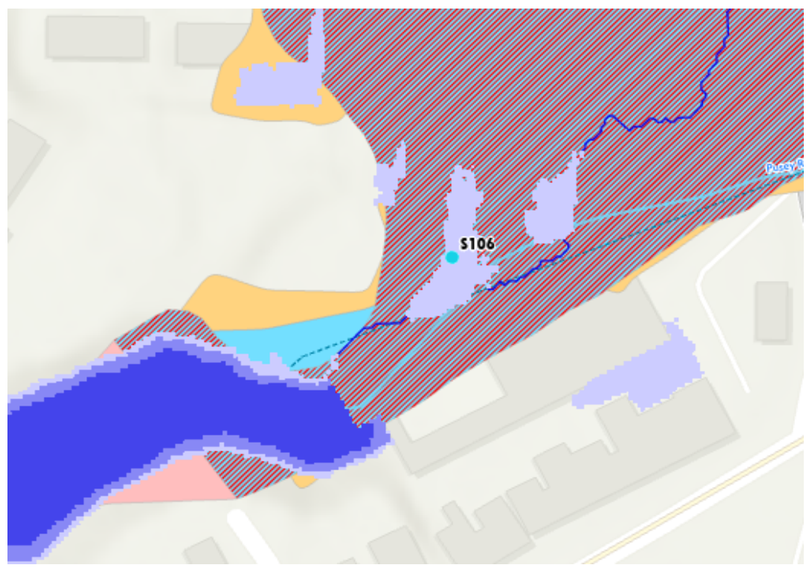
Fence prohibiting site access

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Trash rack in front of culvert, culvert wall and stream bank upgrades to help mitigate flooding and pipe blockages.
- Some funds were obtained via the 2024 DCED FMP grant. Additional funds were requested via the 2025 DCED FMP grant with awards pending.
- Potential upstream opportunities by the park and cemetery.
- See the Potential Solution Analysis form for S073 for additional supporting analysis related to this problem location

ID#S109 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Ridley Creek	**Source of Problem:**	G. D. Houtman & Son, Inc
Minor Watershed:	Vernon Run	**Problem Area Submission Date:**	8/4/2025
Municipality:	Rose Valley Borough	**Location:**	Rabbit Run & Possum Hollow Rd, Rose Valley, PA 19086
Property Type:	Residential		
Type of Problem(s):	Flooding - Insufficient Drainage Infrastructure		
Problem Description:	Storm Water Discharge from Rabbit Run crossing Possum Hollow Road		
Field Visit Notes:	No visual signs of flooding but also no inlets present along W Possum Hollow Rd or Rabbit Run Rd. During large storm events runoff from Rabbit Run Rd goes through properties to creek.		



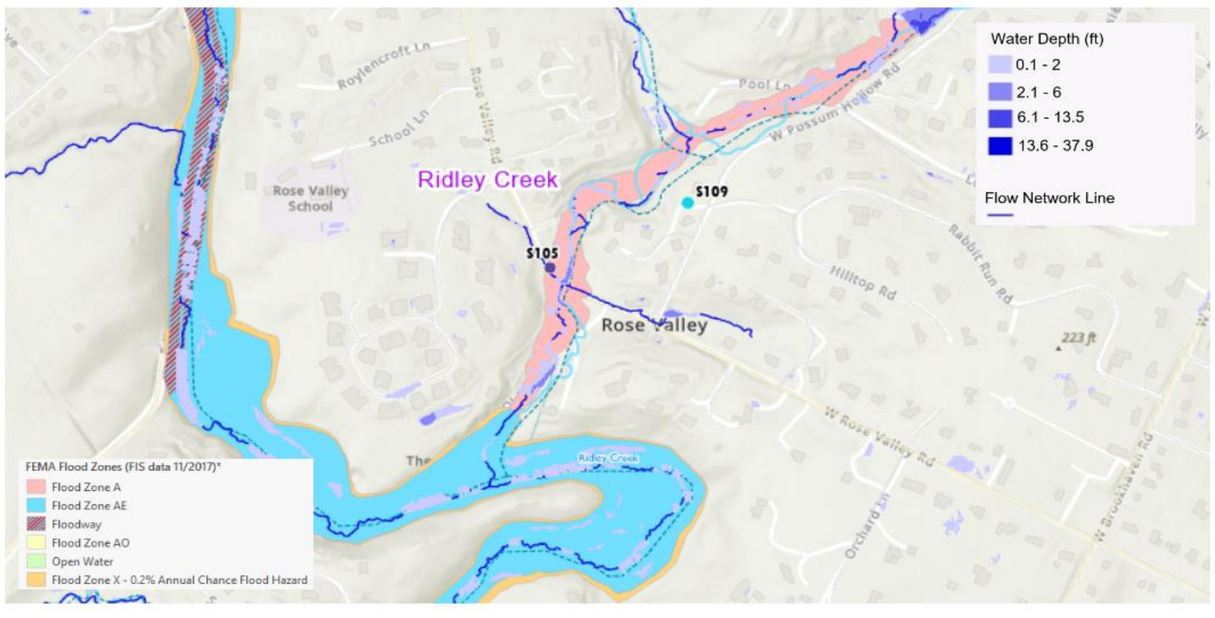
View of Possum Hollow Road with no inlets present



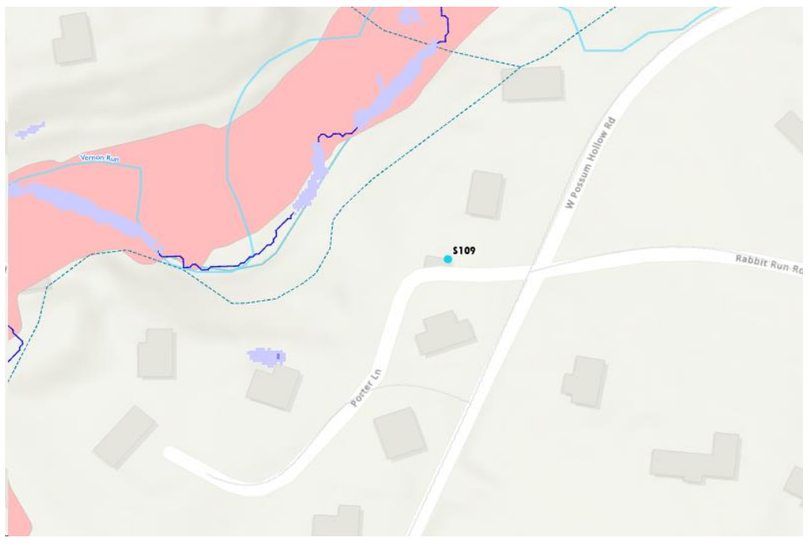
View of Rabbit Run Road looking upgradient. Minor sedimentation where roadway pavements meet.

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional inlets at the intersection of W Possum Hollow Road and Rabbit Run Road.
- Regrade pavement to divert some of Rabbit run flow laterally off Rabbit Run Road.
- Assess stabilizing pathway to stream.

ID#S112 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Ridley Township
Minor Watershed:	Stony Creek	**Problem Area Submission Date:**	8/4/2025
Municipality:	Ridley Township	**Location:**	Waverly Terrace & Agnus Ave, Morton, PA 19070
Property Type:	Residential		
Type of Problem(s):	Flooding - Restricted Capacity		
Problem Description:	Limited details provided.		
Field Visit Notes:	No significant damage visible from erosion or flooding. No visible High water marks. Downstream side of bridge has high wall, sediment deposit, and minor erosion. During a storm event, water could easily get to the road.		



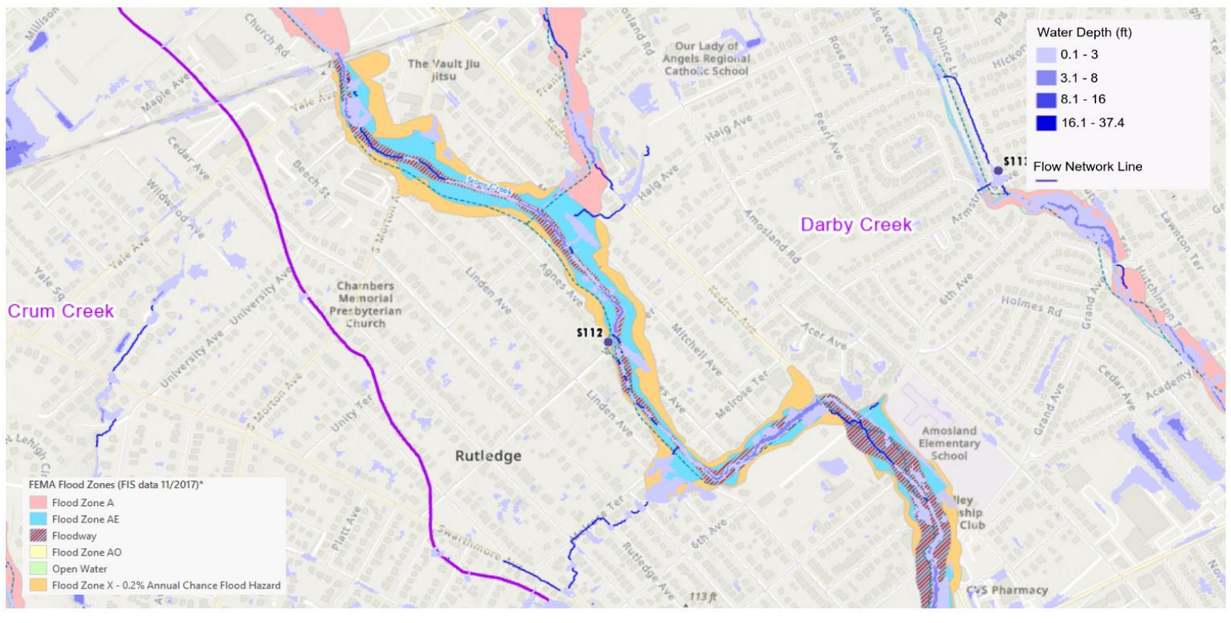
Damaged fence on downstream end of culvert



Concrete retaining wall and sediment deposit within creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Possibility of using the park upstream to capture water before it gets to the end of the road.
- Provide flood control to protect structures immediately adjacent to the floodway.

ID#S113 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Ridley Township
Minor Watershed:	Muckinipattis Creek	**Problem Area Submission Date:**	8/4/2025
Municipality:	Ridley Township	**Location:**	Armstrong Ave & Quince Ln, Holmes, PA 19043
Property Type:	Residential		
Type of Problem(s):	Flooding - Restricted Capacity		
Problem Description:	Periodic Flooding		
Field Visit Notes:	There are numerous inlets at the intersection and along the streets. Difficult to assess the degree of flooding.		

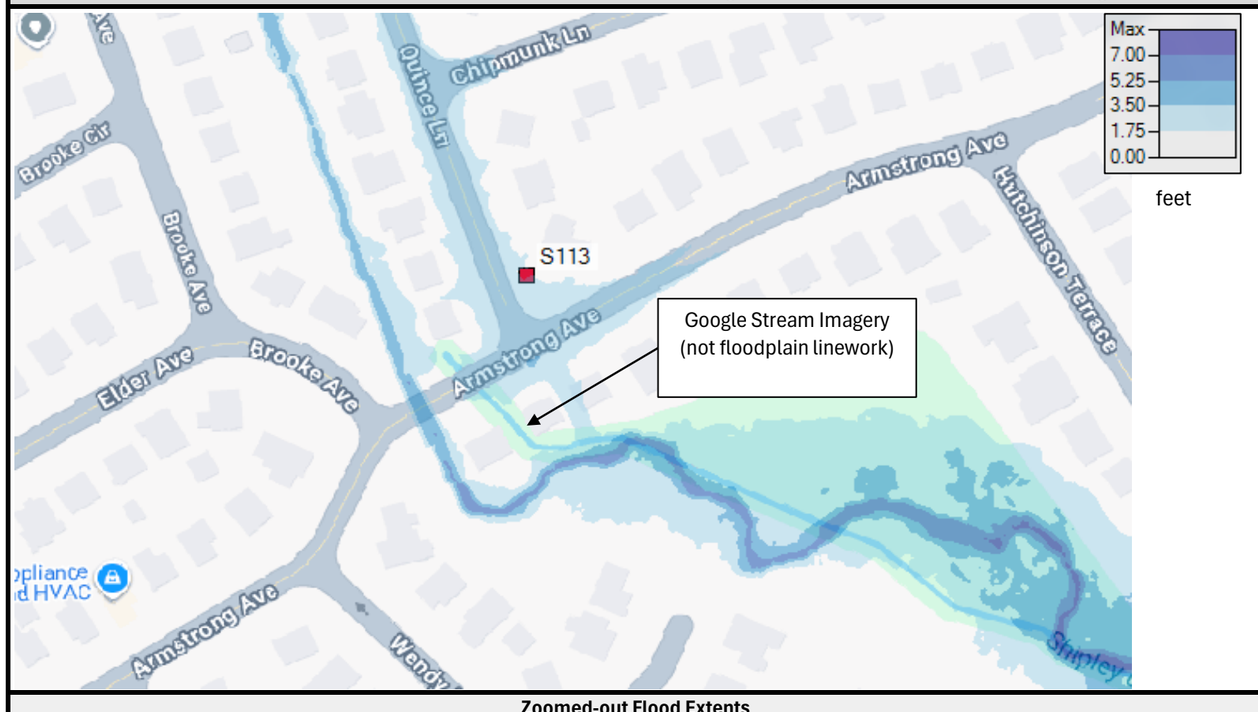


View of multiple curb inlets along Armstrong Ave

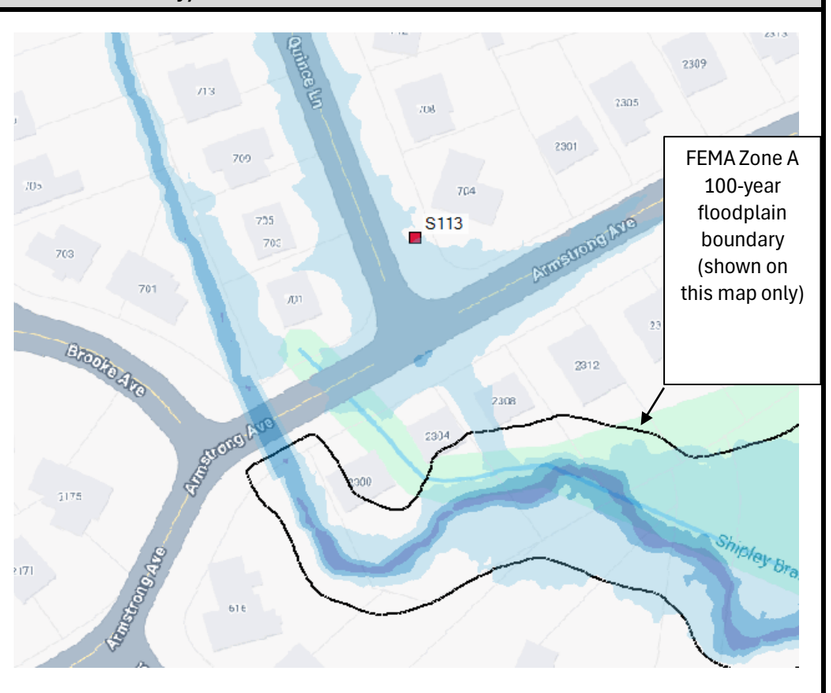


Shipley Branch stream vegetation growth near problem site

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

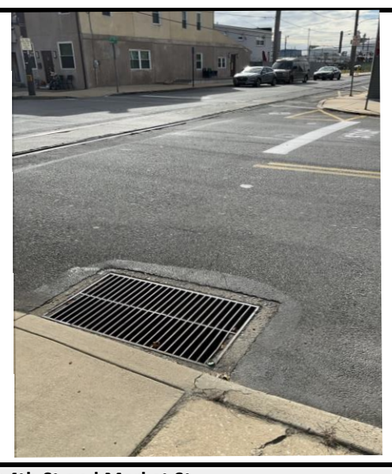
- Potential opportunities for subsurface storage systems in streets.

ID#S114 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Delaware River	**Source of Problem:**	Marcus Hook Borough
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Marcus Hook Borough	**Location:**	Market St and West 4th St, Marcus Hook, PA 19061
Property Type:	Residential,Commercial,Industrial		
Type of Problem(s):	flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Periodic Flooding		
Field Visit Notes:	The intersection at 4th and Market Streets has old infrastructure that may not adequately convey flow. Lack of inlets and stormwater controls along Market Street.		





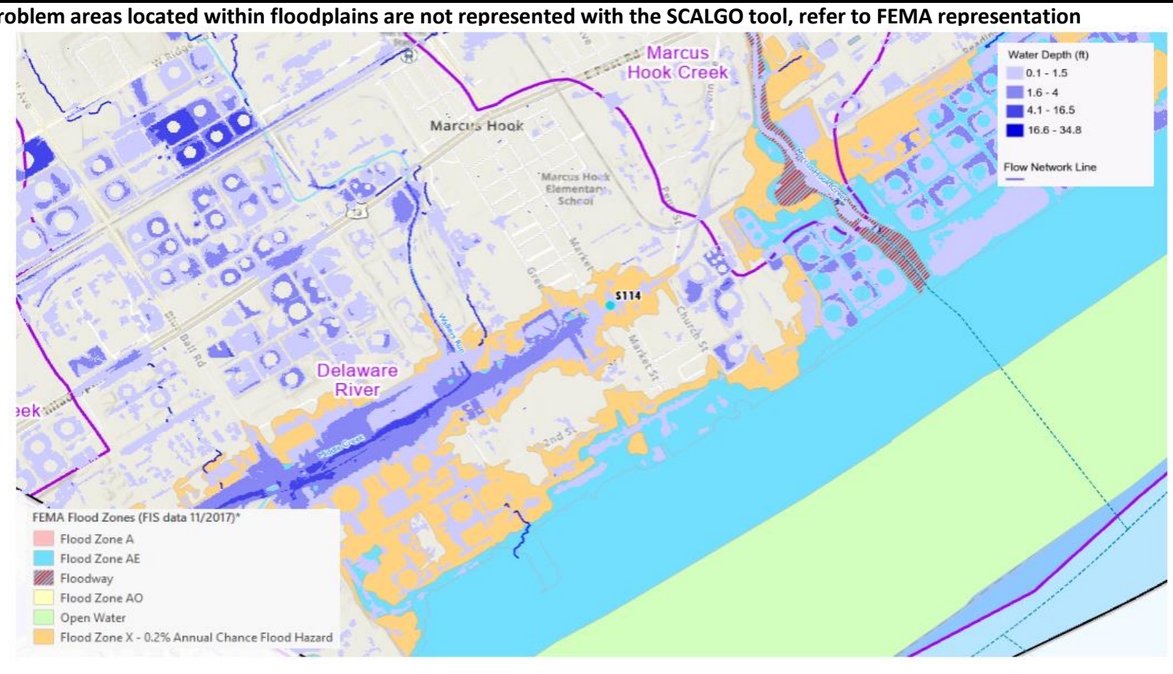
Inside view of aging inlet at intersection of West 4th St and Market St



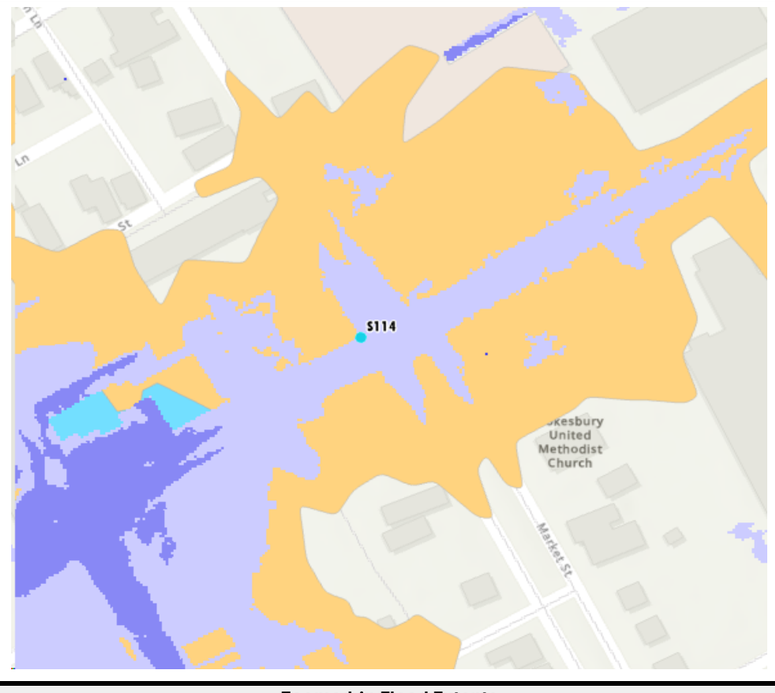
Large green median through Market St which is lacking inlets and could be used for SCM

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- New SCM construction in median green space.
- Additional inlets

ID#S115 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Crum Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Trout Run	**Problem Area Submission Date:**	8/4/2025
Muncipality:	Marple Township	**Location:**	Trout Run at Paxon Hollow Golf Club
Property Type:	Other		
Type of Problem(s):	Accelerated Erosion		
Problem Description:	Portion of Trout Run along the 18th hole is severely eroded.		
Field Visit Notes:	Long and shallow stream with major erosion signs. Very clear water from the stream. There is a damaged and apparently unused bridge upstream. Major signs of erosion on all sides of the bank.		



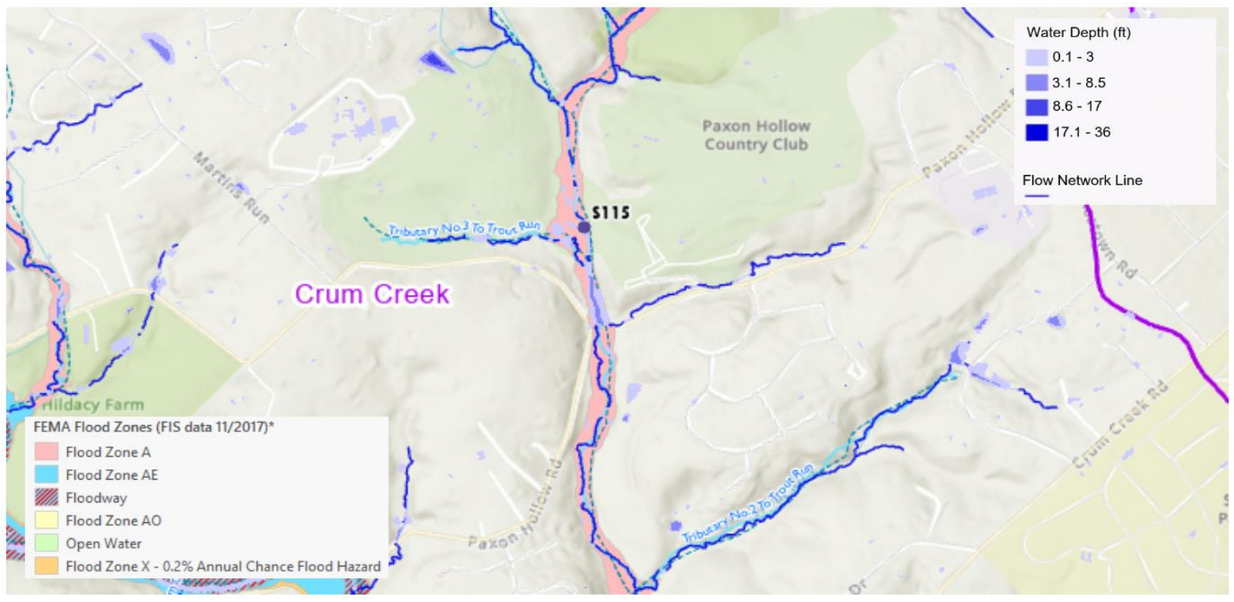
Damaged bridge over Trout Run



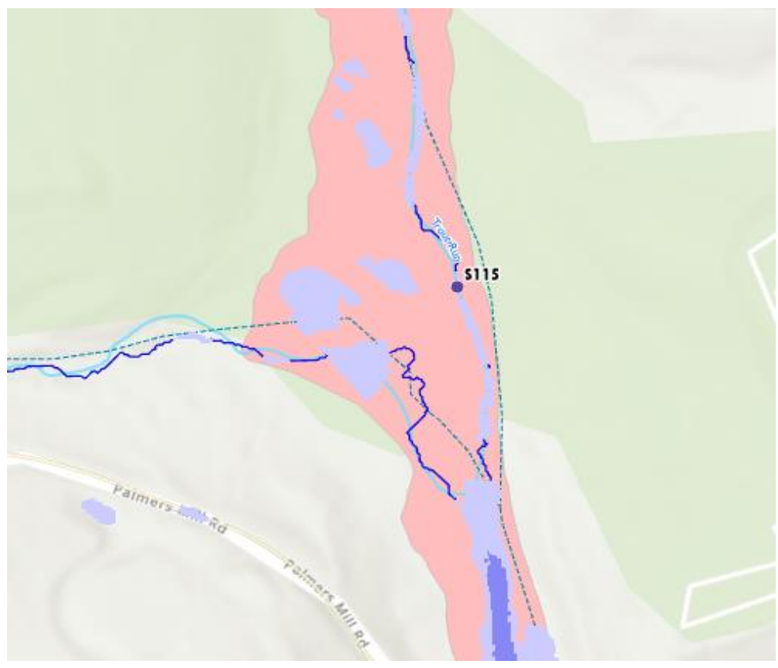
Erosion along streambanks

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Trout Run is subject to FEMA Flood Zone A within the limits of the golf course property, therefore it is recommneded that the site be reviewed for overall safety measure as all portions of the creek appear vulnerable to pedesrian incident during larger rainfall events. The golf course should pursue the following measures: -
Streambank restoration.
- Enhanced riparian buffer to mitigate erosion
- Upgrade of pedestrian bridge
- Consideration of pedestrian barriers along accessible portions of the creek.

ID#S120 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	CHESTER CREEK	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	Hinkson's Run	**Problem Area Submission Date:**	8/6/2025
Municipality:	Parkside Borough	**Location:**	75 Park Valley Ln, Brookhaven, PA 19015
Property Type:	Residential,Open Space,Rightofway		
Type of Problem(s):	flooding,Accelerated Erosion,Sedimentation - Restricted Capacity		
Problem Description:	Roadway and structural damage; excessive erosion to unnamed tributary		
Field Visit Notes:	Erosion and debris buildup observed near the culverts shown in photo 1 which appear to be undersized. Additional flooding, minor erosion, and debris noted about 100’ upstream of culvert (photo 2).		

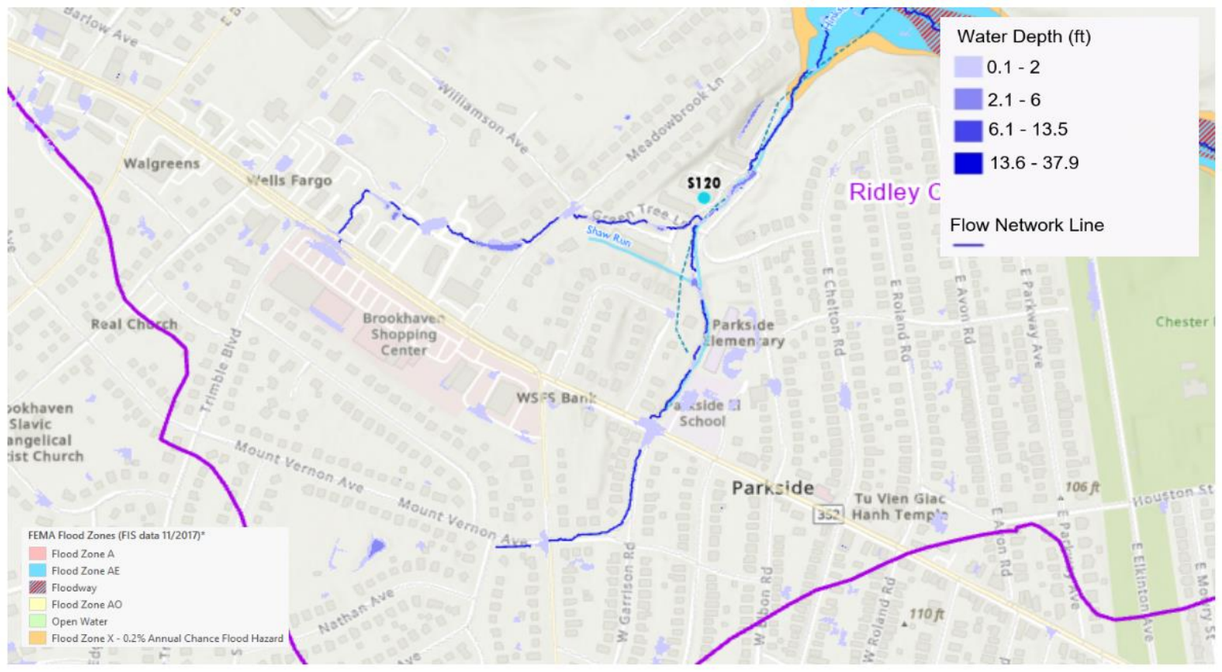


Debris obstructing left side opening of double barrel culvert

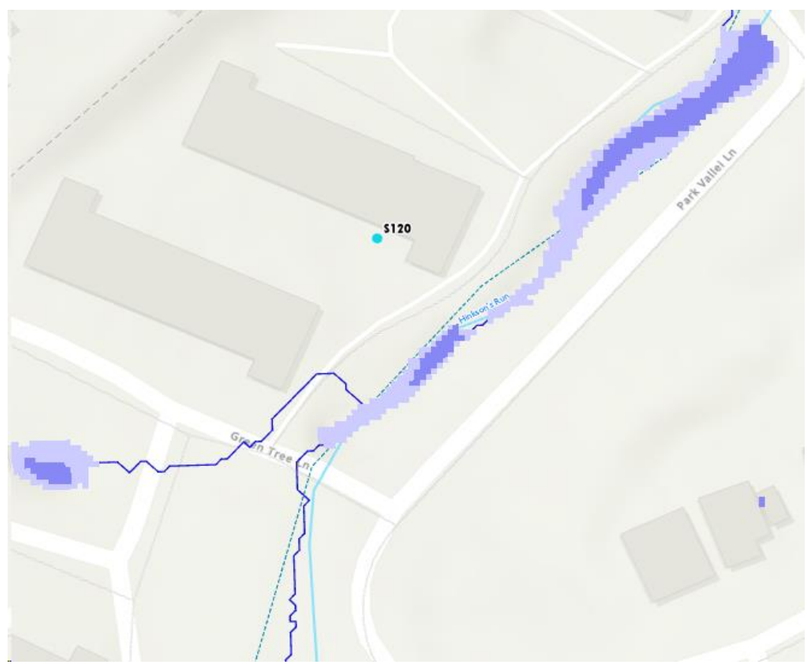


View of erosion and ponding approximately 100' upstream of culvert

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Riparian buffer restoration;
- Streambank restoration
- Remove obstructions from culvert opening.
- Resize culvert.
- Stabilize streambanks.

ID#S121 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	Stony Creek	**Problem Area Submission Date:**	8/6/2025
Municipality:	Parkside Borough	**Location:**	1240 Madison Ave, Prospect Park, PA 19076
Property Type:	Residential, Open Space, Rightofway		
Type of Problem(s):	Flooding,Accelerated Erosion,Sedimentation - Restricted Capacity		
Problem Description:	Roadway and structural damage; excessive erosion to tributary;sedimentation at bridge		
Field Visit Notes:	Recent riparian tree planting. Flooding overtops bridge. Unique design from 1923 where water runs along side bridge and over weir on west side of bridge. Small inflow channel from NW into Stony Creek has signicant erosion. CD has video from Aug 20 2020 storm which didn't overtop bridge. Flooding, erosion, and sedimentation issues are evident. Could possibly be a drainage issues as well.		

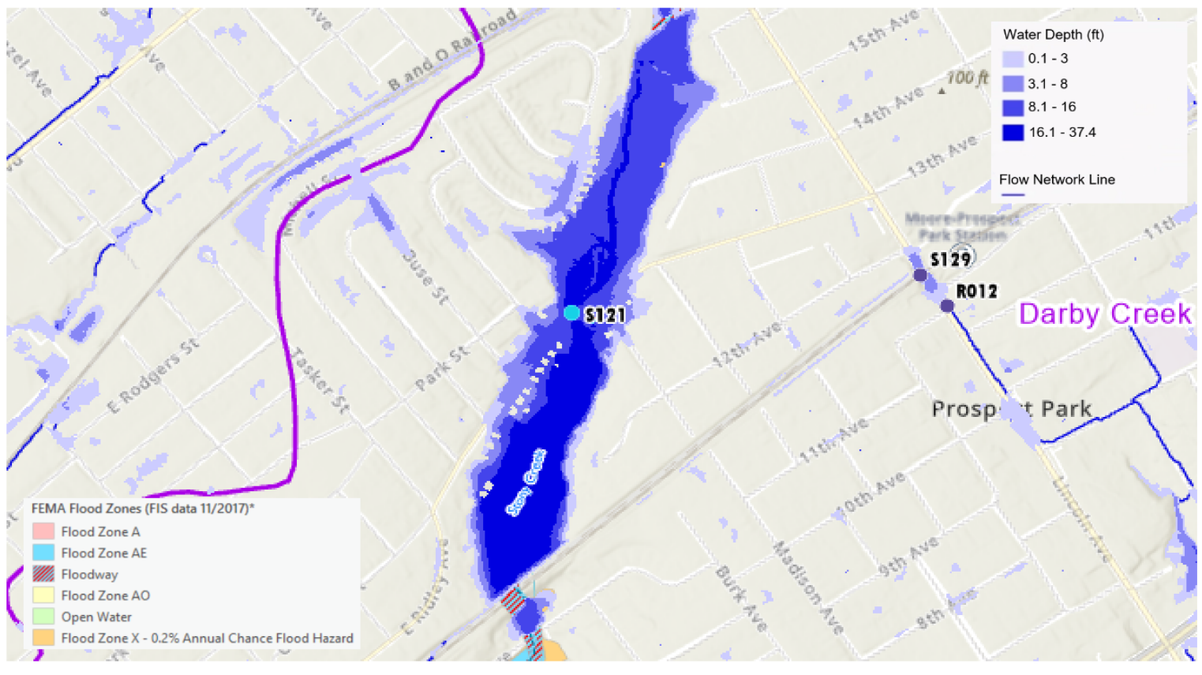


View of CMP conveyance pipe along bridge and damaged streambank

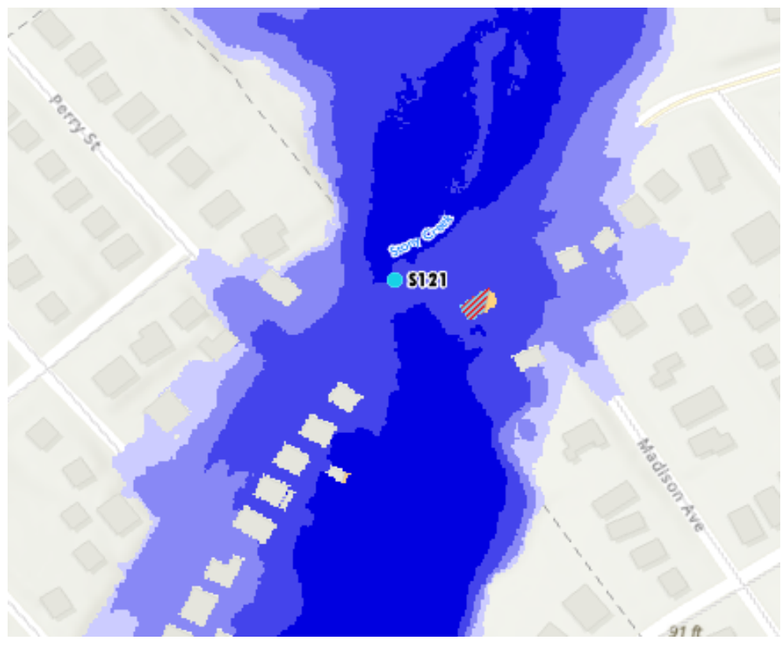


Stony creek tributary running along bridge and view of water flowing over weir

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Riparian buffer restoration (appears to have been recently planted)
- Streambank restoration
- Flooding may be related to stream obstruction at railroad crossing downstream. Additional analysis is recommended.

ID#S123 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Morton Borough
Minor Watershed:	East Branch Stony Creek	**Problem Area Submission Date:**	8/6/2025
Municipality:	Morton Borough	**Location:**	8 Amosland Rd, Morton, PA 19070
Property Type:	Residential		
Type of Problem(s):	Flooding - Restricted Capacity, Insufficient Drainage Infrastructure		
Problem Description:	Periodic Flooding		
Field Visit Notes:	Creek is behind a large vegatated area that makes it difficult to access. By the end of the stream there was bank stabilization done 30 years ago. Spoke to a homeowner in the area who showed us videos of the flooding where the water frequently (multiple times a year) comes halfway to the bridge. The homeowner also noted that they had surveyors there the day before and were told that the culvert is likely undersized. Rainfaill from a week prior is still stagnant in the bank.		

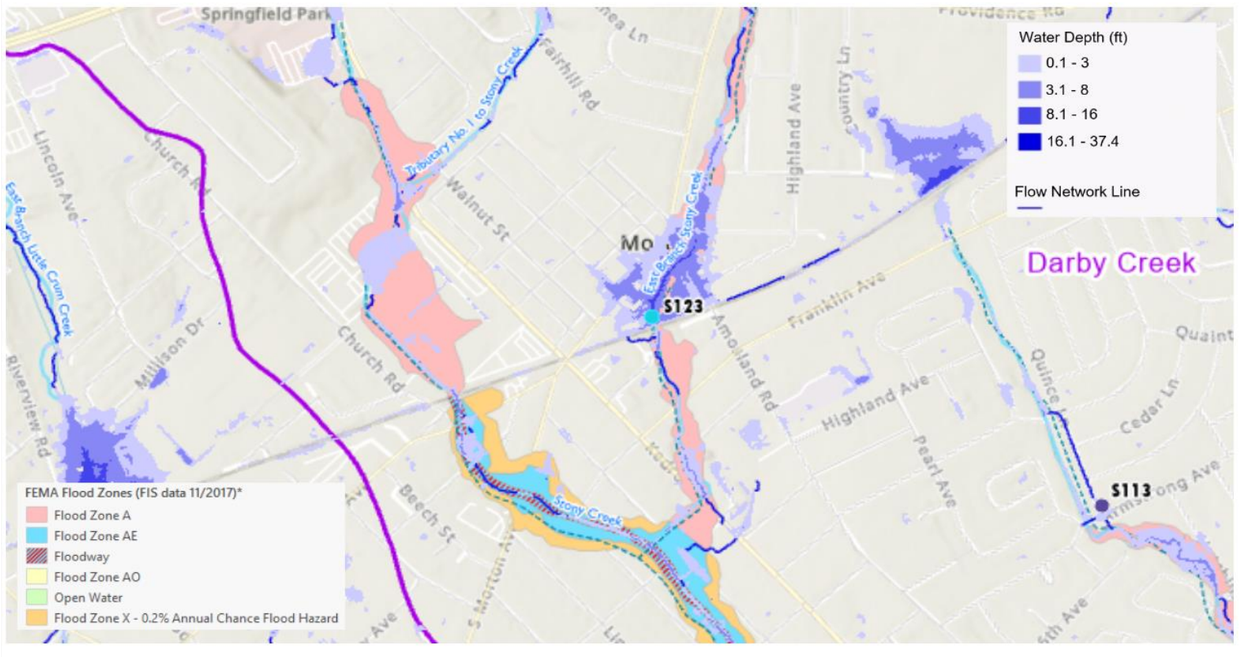


View of backed up culvert through channel under bridge

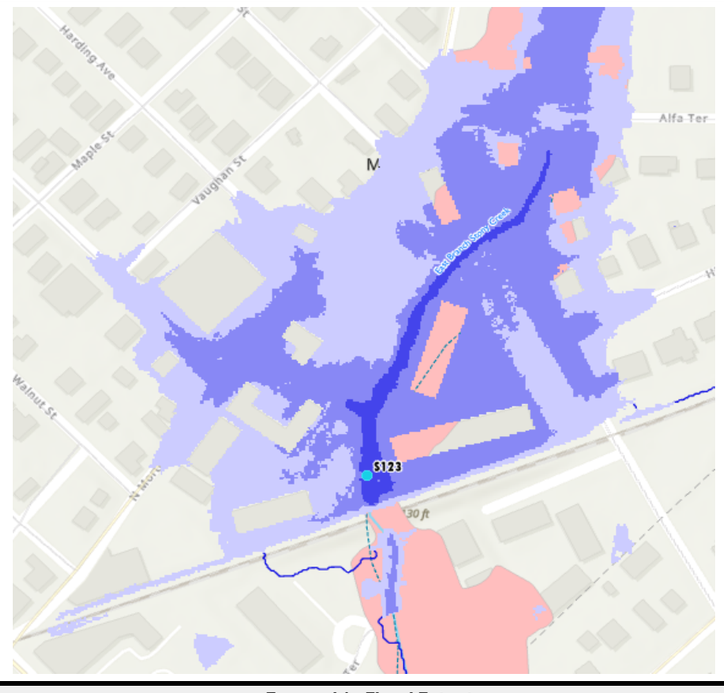


Close up view of stagnant water from previous rainfall

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- SEPTA culvert appears to be undersized. Looking for upstream solutions or upsizing the culvert if SEPTA is willing to.
- Possibility of having bioswales on the green area of the Silver Lake Apartments complex for some retention.
- Possibility of using the Silver Lake Apartments complex parking lots surrounding the channel for subsurface storage.

ID#S126 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Pennoni
Minor Watershed:		**Problem Area Submission Date:**	8/7/2025
Muncipality:	Yeadon Borough	**Location:**	Blunston Run at Karen Drive
Property Type:	Residential, Commercial, Open Space		
Type of Problem(s):	Accelerated Erosion		
Problem Description:	Accelerated erosion		
Field Visit Notes:	Could not access the creek due to the fencing.		

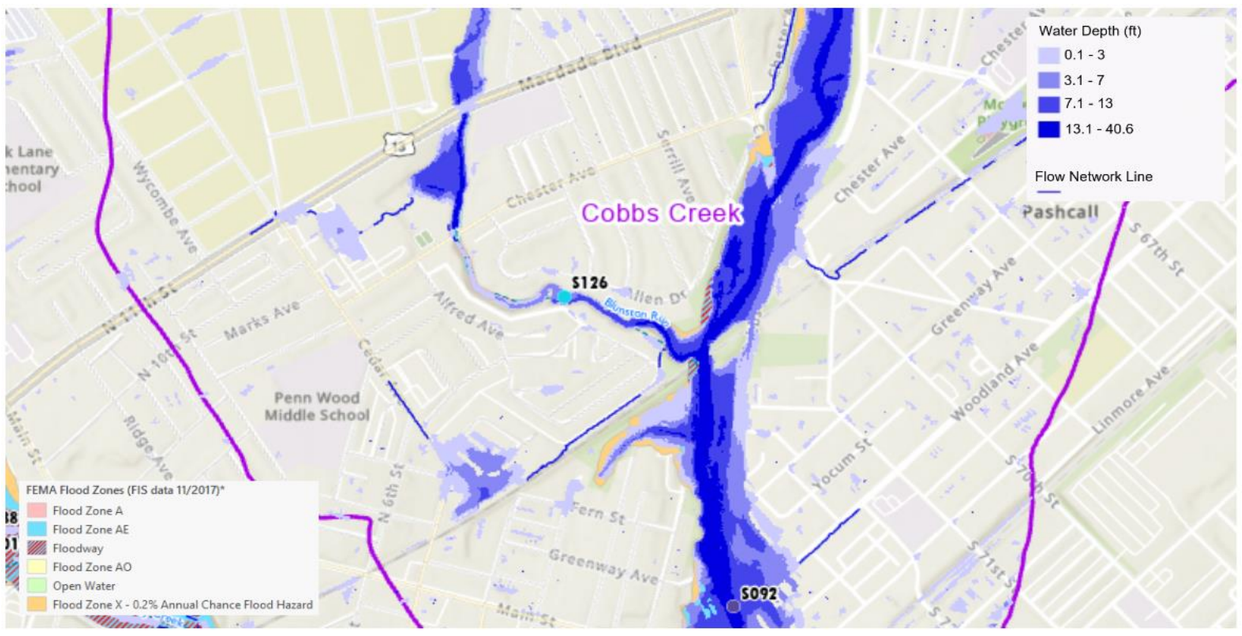


Inlets in the area

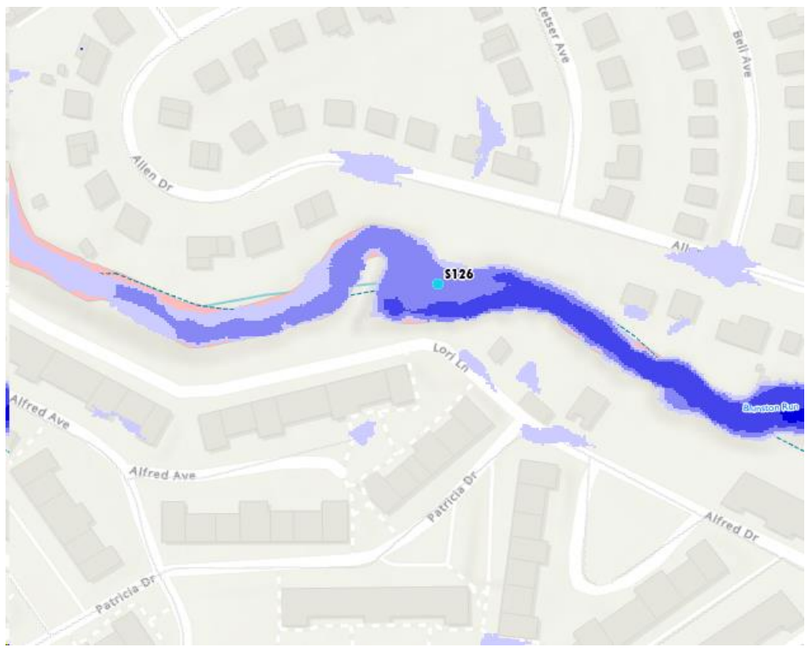


Inaccessible creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

The problem area is reported as erosion focused although it appears to be at a location along Blunston Run that may be subject to flooding problems as well. Additional site visits are recommended to gain full access for a conditions assessment. Stream bank stabilization/restoration projects should be implemented along Blunston Run. Also see S092 advanced solution, as this subwatershed is proposed for additional modeling evaluation towards the Eastwick problem area analysis.

ID#S129 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/7/2025
Municipality:	Prospect Park Borough	**Location:**	Lincoln Ave underpass near Prospect Park Station
Property Type:	Commercial,Rightofway,Otherpublic,Other		
Type of Problem(s):	Flooding - Restricted Capacity, Insufficient Drainage Infrastructure		
Problem Description:	Roadway and structural damage		
Field Visit Notes:	significant flooding regularly occurring. Drainage appears to be an after thought. Large inlets, large drainage area		

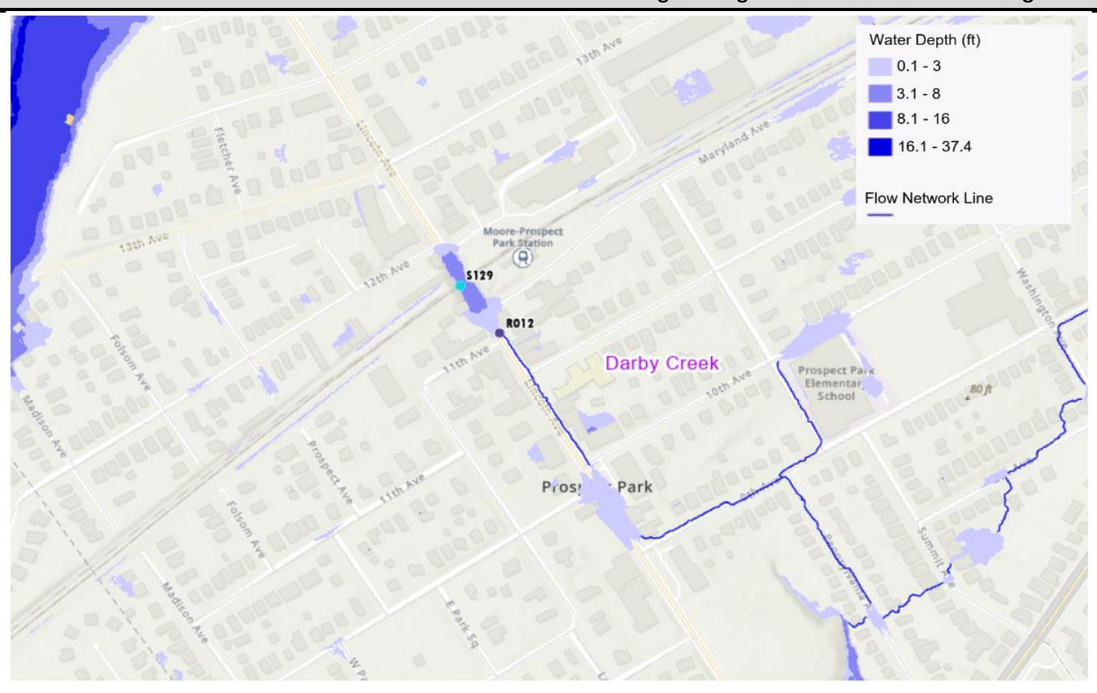


View of inlet under railroad bridge with water marks on wall indicating flooding



View of Lincoln Ave looking upgradient

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Conduct study to determine whether or not inlet/pipe capacity can be increased at the site due to low elevations.
- Consider pump station to dewater low underpass beneath railroad.
- Install new SW basin up gradient along Lincoln Ave to provide additional storage.

ID#S130 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/7/2025
Municipality:	Darby Township	**Location:**	Hook Road & Industrial Drive, Sharon Hill, PA 19079
Property Type:	Commercial,Industrial,Rightofway		
Type of Problem(s):	Flooding - Tidal, Restricted Capacity		
Problem Description:	Roadway and structural damage		
Field Visit Notes:	Per Larry Bak, while not apparent at time of visit, gravel/sediment bar upstream of bridge can be seen at low tide. Flooding on Hook Road likely occurs at the low point, which is approximatley 500' to the west of the bridge. Due to the restricted flow conditions at the bridge, water likely backs up and flows across the cemetery and across Hook Road.		



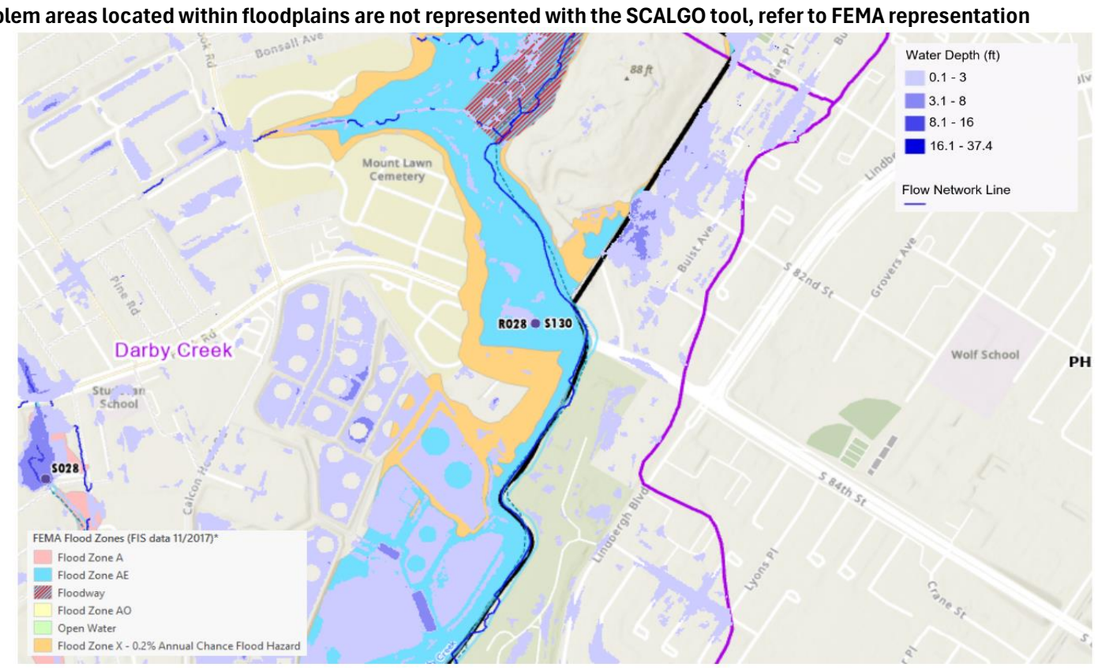
Inlet near problem area obstructed by trash/vegetation



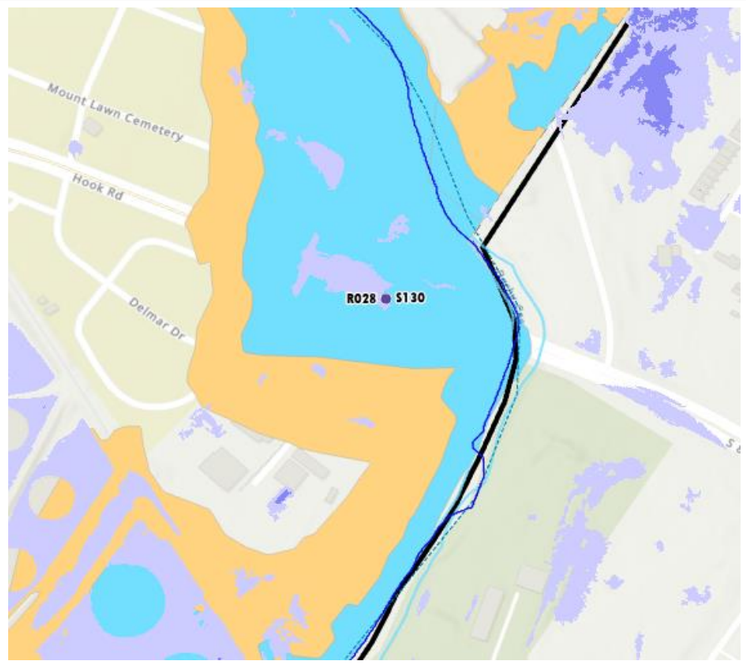
View of Darby Creek. Signs of increased water elevation on far streambank

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Additional stormwater conveyance
- Dredging upstream of bridge
- Construction of a levee to direct flood flows downstream instead of to cemetery and road
- Possible opportunities for increasing floodplain on both sides of creek.

ID#S132 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Brandywine Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Chadds Ford Township	**Location:**	Brandywine Creek at Baltimore Pike
Property Type:	Open Space		
Type of Problem(s):	Flooding, sedimentation		
Problem Description:	According to the Brandywine Flood Study (Brandywine Conservancy, Chester County Water Resources Authority, and University of Delaware, April 2025), HEC-RAS modeling shows that the existing dam at the problem location raises the immediate upstream water surface elevation for the 100- and 500-year floods by 2.2 and 0.6 feet respectively. Removing the dam could potentially further enhance the flood depth reductions provided by replacing the Baltimore Pike and East Penn Railroad bridges (both located immediately downstream) during the 100-year event. Another benefit of removing the dam would be improved fish passage.		
Field Visit Notes:	Downed trees and accumulated sediment were observed at the dam. Upstream bank erosion was also observed, which could eventually threaten the railroad immediately to the west of the creek. Sedimentation was also observed in the creek downstream of the dam, near the Brandywine Museum of Art.		



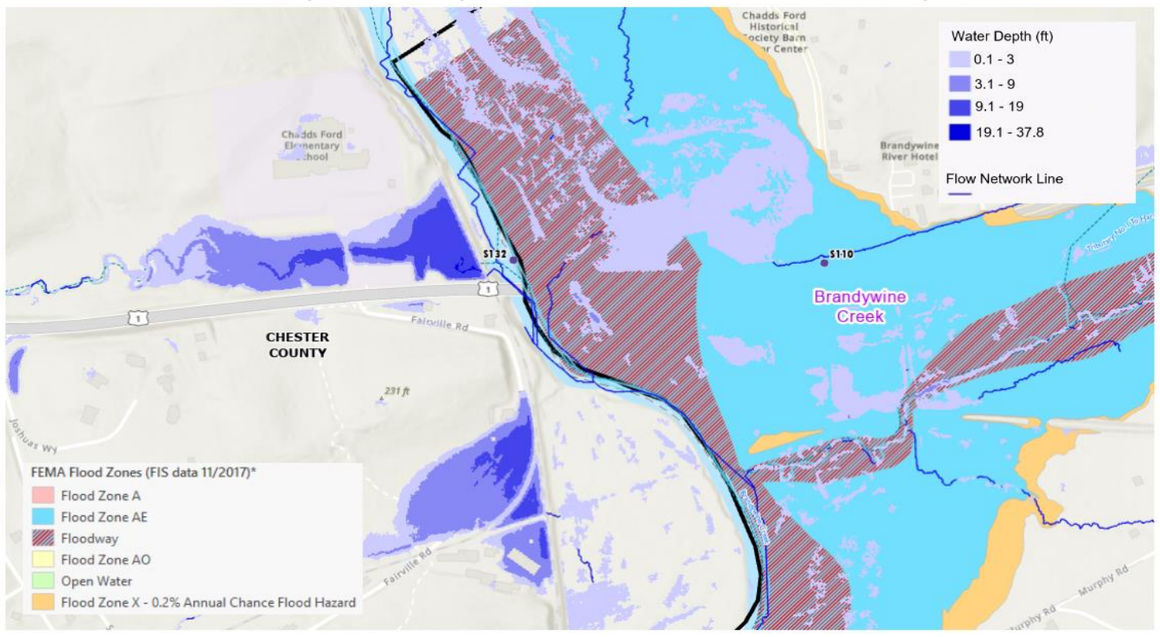
Downed trees present at dam



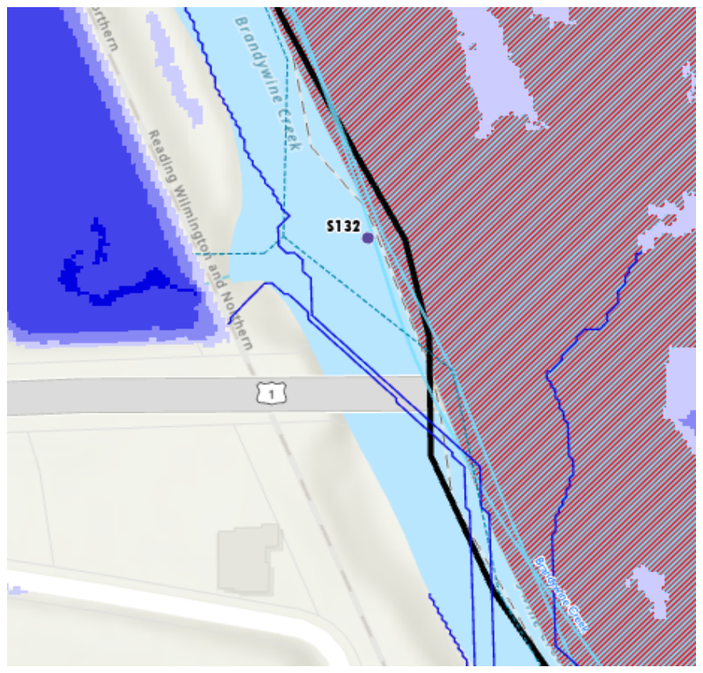
Accumulated sediment in creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

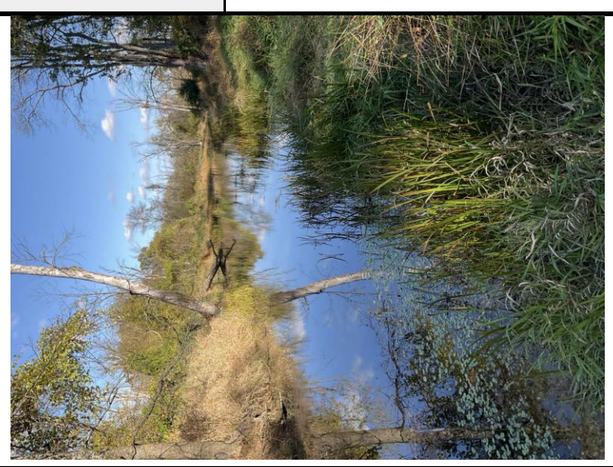
Potential Solutions

- Partial dam upstream of Baltimore Pike proposed to be removed (per Brandywine Flood Study, "PA Dam No. 1 - Chadds Ford/Pennsbury, PA")
- Remove downed trees and accumulated sediment / debris
- Stabilize stream bank on railroad (west) side of creek
- See the Potential Solution Analysis form for S110 for additional supporting analysis related to this problem location

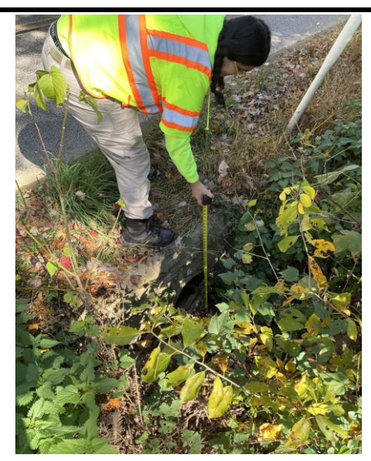
ID#S133 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Brandywine Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Chadds Ford Township	**Location:**	Creek Rd & Camly Ln
Property Type:	Residential, Commercial, Open Space, Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Flooding starts at Creek Road approximately 3/4 mile downstream from marker and works its way approximately 3/4 mile upstream from marker. Old mill races along this length contribute to flooding.		
Field Visit Notes:	At this location, a large floodplain with standing water was observed. At an old mill race, hydrophytic vegetation was observed and there was a 20-inch culvert crossing Creek Road that was filled with sediment.		



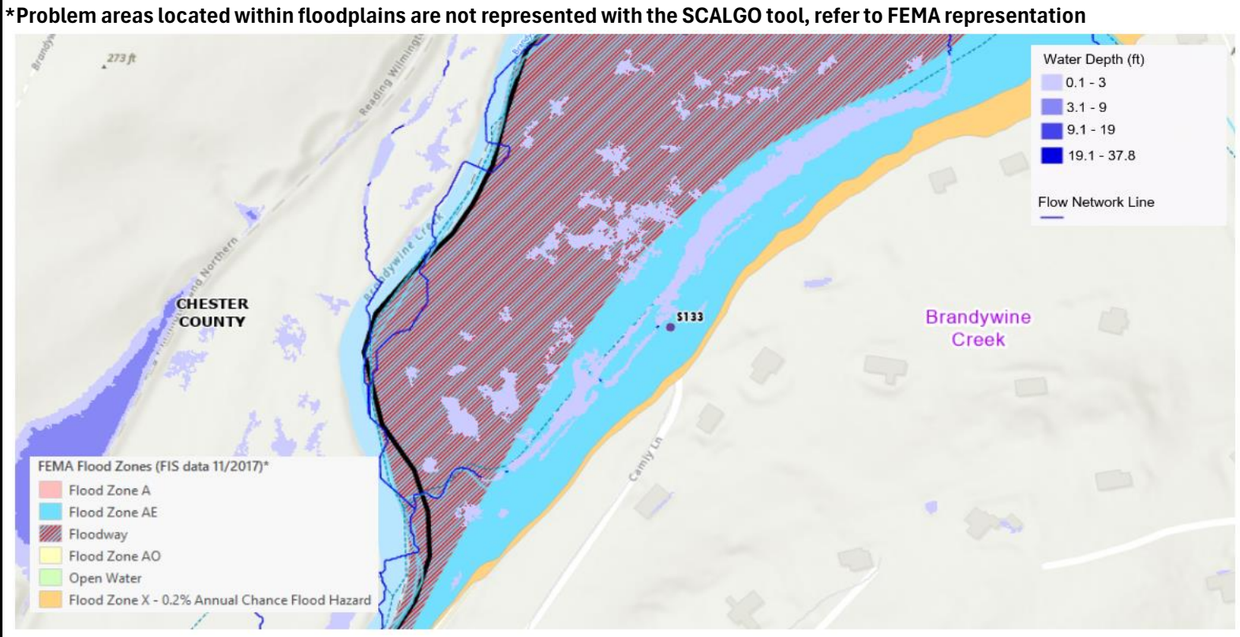
Brandywine Creek at problem area



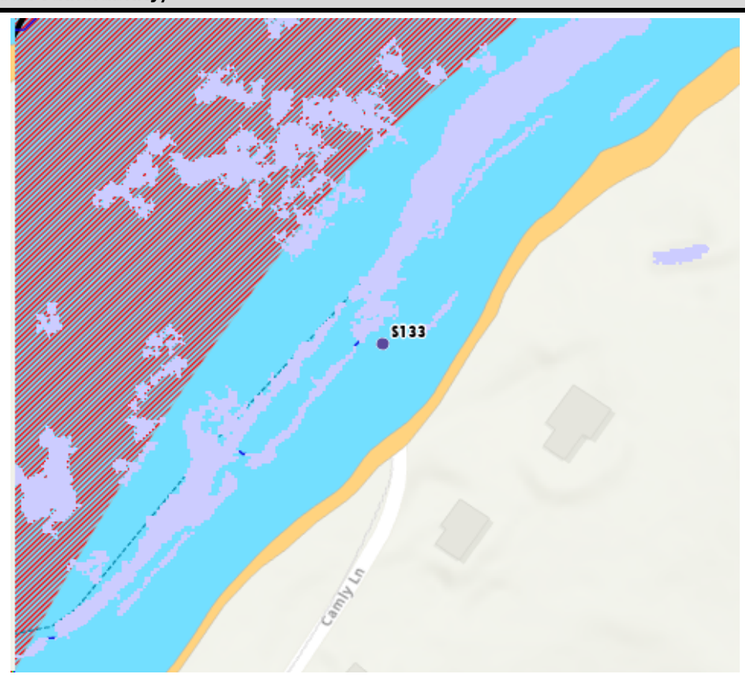
Culvert across Creek Rd

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- See Brandywine Flood Study (Brandywine Conservancy, Chester County Water Resources Authority, and University of Delaware, April 2025) for additional background and analysis on the flooding in this area.
- Remove sediment from culvert and consider removing sediment and debris from Brandywine Creek.
- Evaluate constructing a levee along the flood-prone length of Creek Road or else raise the elevation of Creek Road, which may require harmonization with several streets or driveways.
- Evaluate potential for a large constructed wetland in the floodplain to provide enhanced flood storage.

ID#S134 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	DCPD
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Thornbury Township	**Location:**	159 Creek Rd, Glenn Mills, PA 19342
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Restricted Capacity, Insufficient Drainage Infrastructre		
Problem Description:	Flooding of Creek Road between County border and intersection with Old Gradyville Road. Year first known occurred unknown.		
Field Visit Notes:	Culvert under Creek Road deteriorating and has many branches lodged in opening. Embankment eroding on the upstream side of the culvert. Evidence of high water flows in the area, debris above culvert height.		





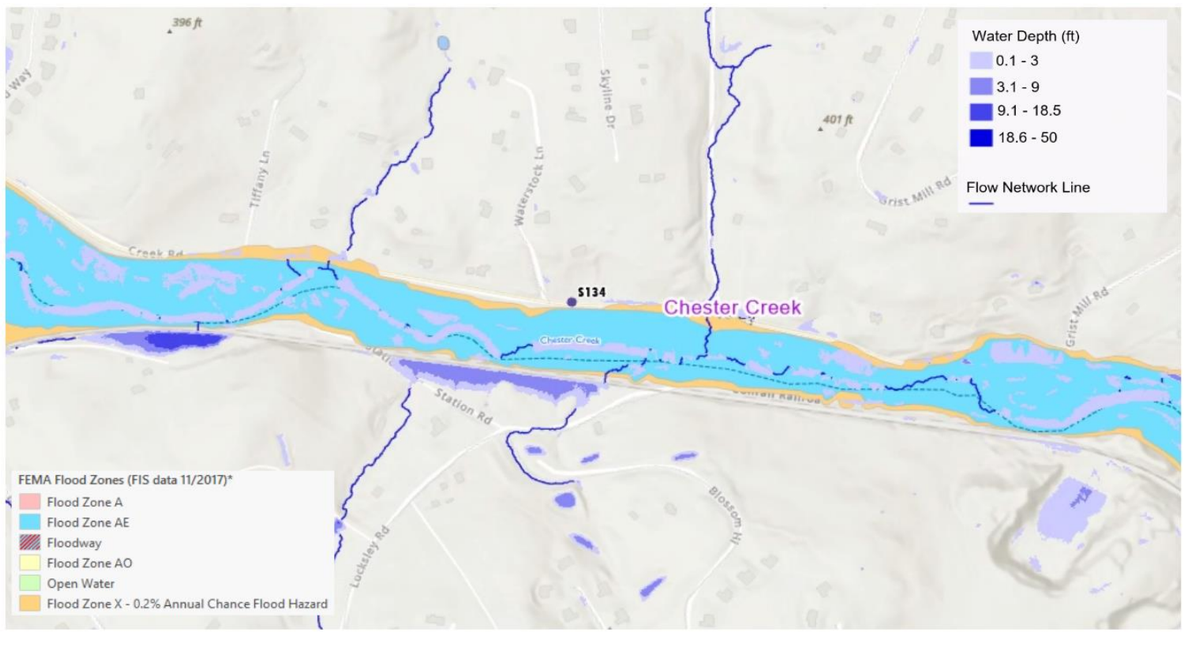
Head on and overall view of debris obstruction in front of culvert



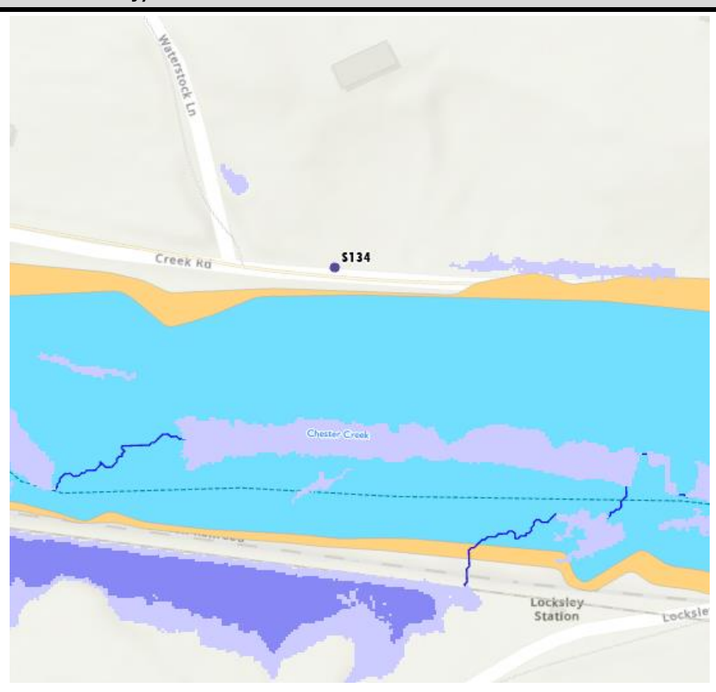
Erosion noted on upstream side of culvert

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Resize culvert
- Stabilize streambanks
- Remove debris

ID#S135 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Delaware River	**Source of Problem:**	DCPD
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Bethel Township	**Location:**	3240 Goodley Rd, Garnet Valley, PA 19060
Property Type:	Right-of-way,Other public		
Type of Problem(s):	Flooding - Restricted Capacity, Insufficient Drainage Infrastructure		
Problem Description:	Flooding of Goodley Road at Naamans Creek due to undersized culvert. Goodley Road is an essential route for Bethel Twp Police and EMS Center located nearby on Bethel Road. Year of first known occurrence unknown.		
Field Visit Notes:	Stream crosses road through a triple barrel 24” culvert. The culvert appears to be in good condition however there are 2 outfalls just upstream which are also 24”. Those 2 outfalls along with the creek itself overwhelm culvert during large events.		



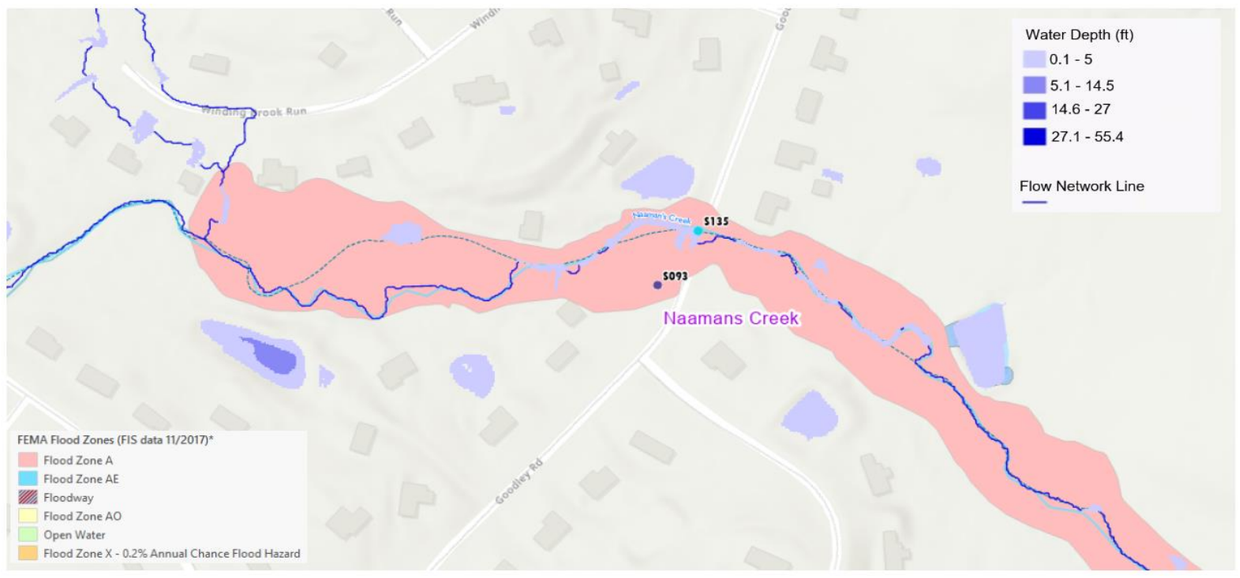
Triple barrel culvert under Goodley Rd



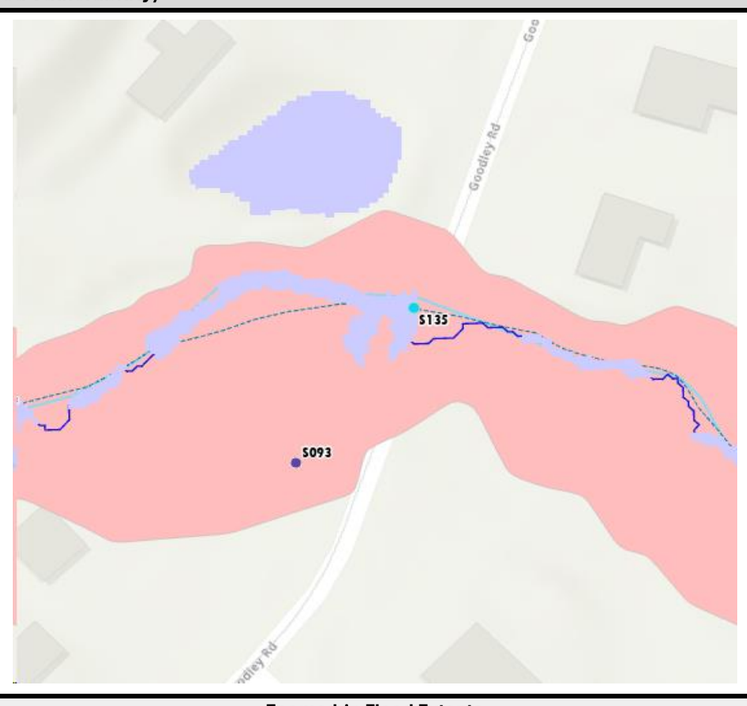
Upstream culvert overgrown with vegetation

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

Bethel Twp has submitted a 2025 application to DCED's Flood Mitigation Project to replace the existing Goodley Rd culvert with a precast concrete box culvert designed to effectively convey majority of flood events.

ID#S136 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	DCPD
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Aston Township	**Location:**	Convent Road Bridge over Chester Creek
Property Type:	Residential,Industrial,Rightofway		
Type of Problem(s):	Flooding - Insufficient/Aging Drainage Infrastructure		
Problem Description:	Flooding caused by antiquated infrastructure, natural channelization, and old mill at the convergence of the east and west branches of Chester Creek.		
Field Visit Notes:	Stream in good condition, minimal erosion. Evidence of flooding upstream on Chester Creek. Does not appear to overtop bridges. Convent Road bridge appears to trap debris during high flows. Sanitary pump station nearby may contribute to flooding.		



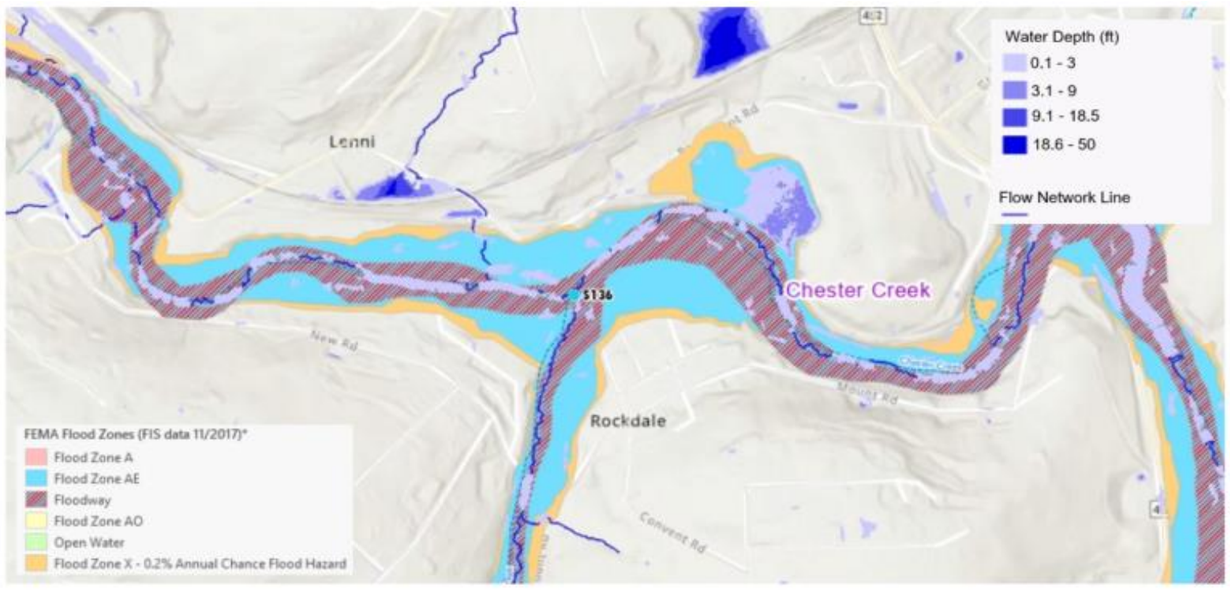
Chester Creek passing under Convent Road bridge



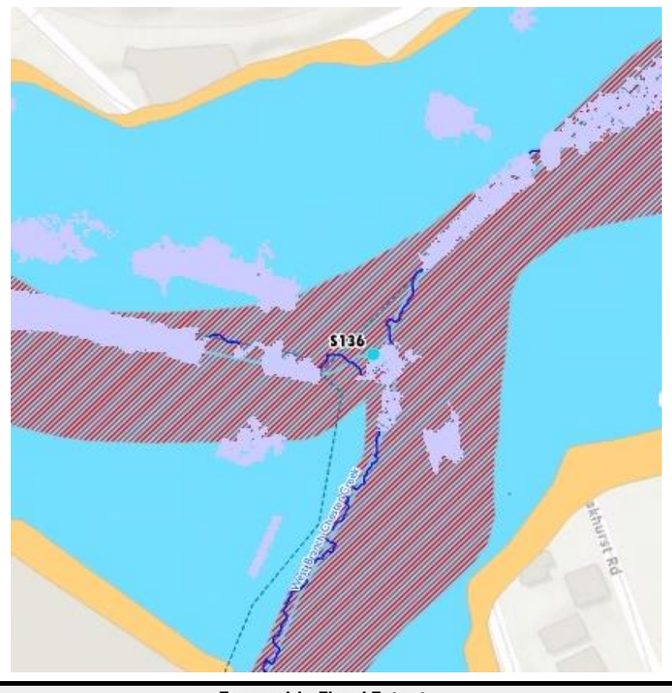
Debris trapped under bridge during large rainfall events

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stabilize streambanks
- Raise elevation of affected structures or otherwise floodproof them.

ID#S137 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Ridley Creek	**Source of Problem:**	DCPD
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Upper Providence Township	**Location:**	W Bishop Hill Rd & Chapel Hill Rd, Media, PA 19063
Property Type:	Residential, Open Space, Rightofway		
Type of Problem(s):	Flooding - Clogging/Obstructions		
Problem Description:	Flooding of Ridley Creek near intersection of Ridley Creek Road and Barren Road.		
Field Visit Notes:	Old Mill Dam upstream from intersection may contribute to issue.		



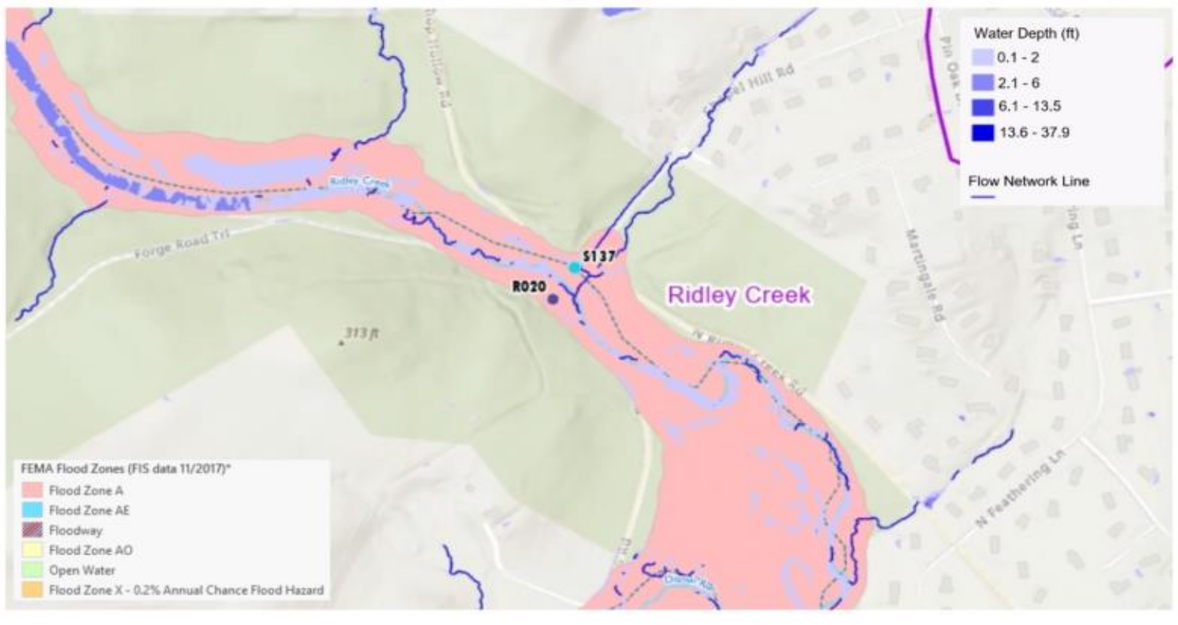
Erosion and sediment deposits along intersection of W Bishop Hill Rd & Chapel Hill Rd



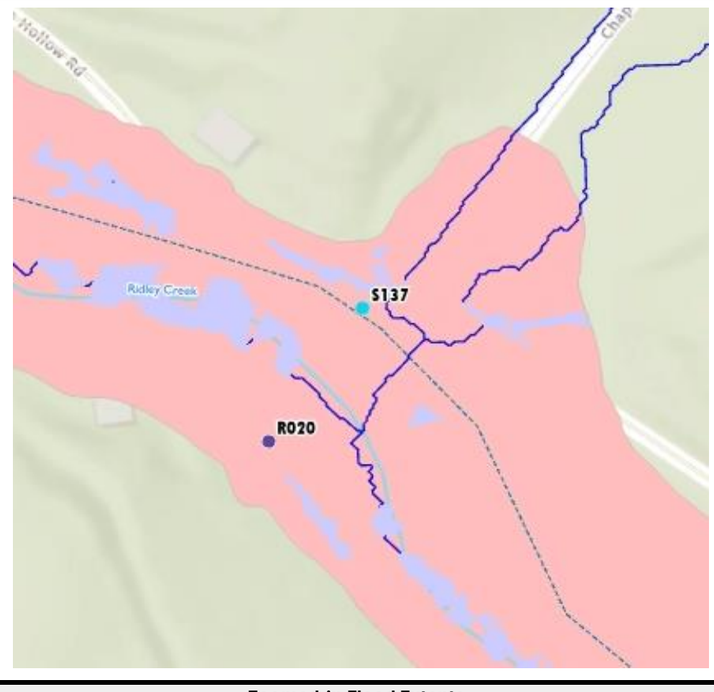
Old mill dam

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Dredge upstream of the dam or remove the dam
- Raise elevation of road or structures to be above floodplain.

ID#S138 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	DCPD
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Upland Borough	**Location:**	Main St & Front St, Brookhaven, PA 19015
Property Type:	Residential,Commercial,Industrial,Rightofway		
Type of Problem(s):	Flooding - Insufficient Drainage Infrastructure		
Problem Description:	Upland Borough experiences flooding over a wide area centered roughly on Main Street.		
Field Visit Notes:	Two shallow inlets shown in photo 1 handle all of the runoff from Main Street as well as a portion of Front, 2nd and 3rd Streets. Lack of drainage for the drainage area appears to be cause of flooding.		



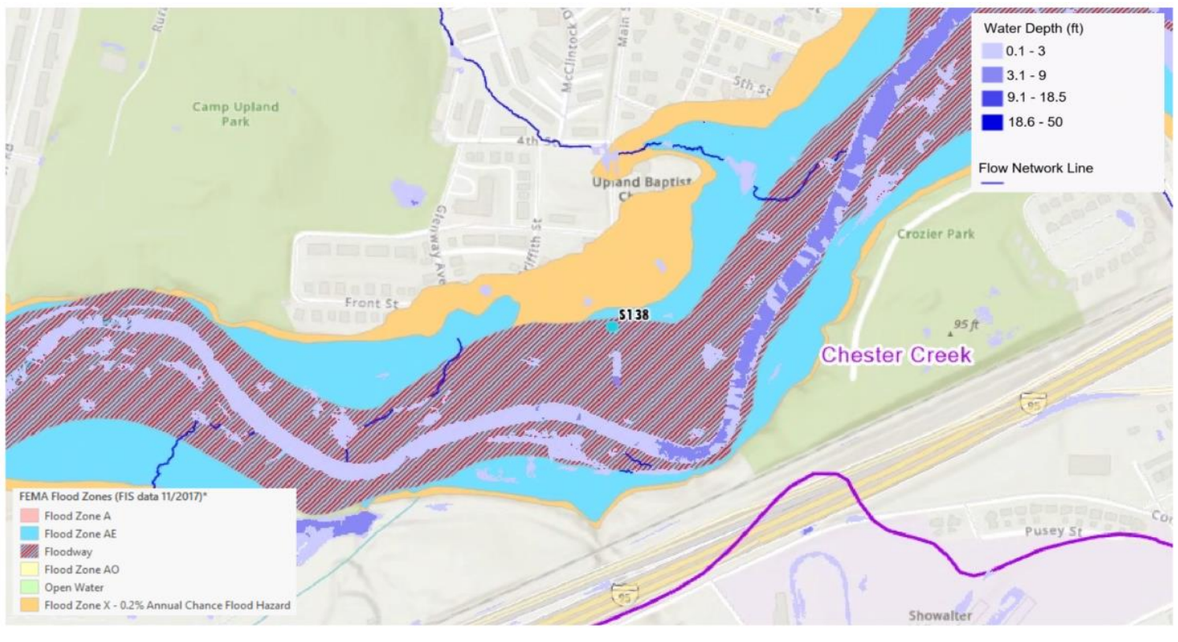
Single inlet at intersection of Main Street and Front Street



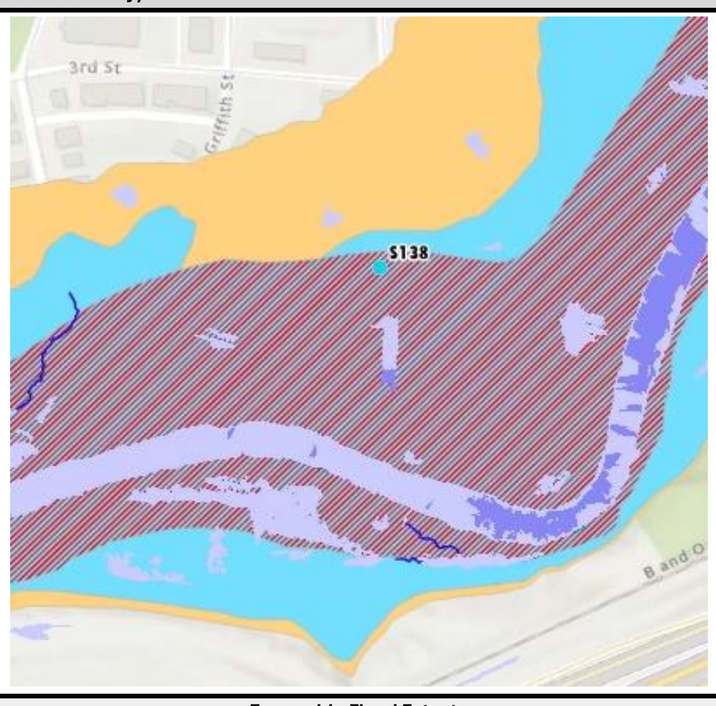
View of Main Street looking upgradient of inlet

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional inlets.
- Large watershed scale suggested upstream and localized flood control such as levees or floodplain restoration are recommended to manage damage caused by flooding.

ID#S139 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Delaware River	**Source of Problem:**	DCPD
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Chester City	**Location:**	1501 W 3rd St, Chester, PA 19013
Property Type:	Residential,Commercial,Rightofway,Otherpublic		
Type of Problem(s):	Flooding - Insufficient/Aging Drainage Infrastructure		
Problem Description:	Storm drain maintenance issues City fire station #81 is located at the southwest corner of the intersection. Year of first known occurrence unknown.		
Field Visit Notes:	Inlets in area have standing water. No observed flooding. Broken water quality snout in one inlet and one inlet full of leaves and debris and sediment catching device.		

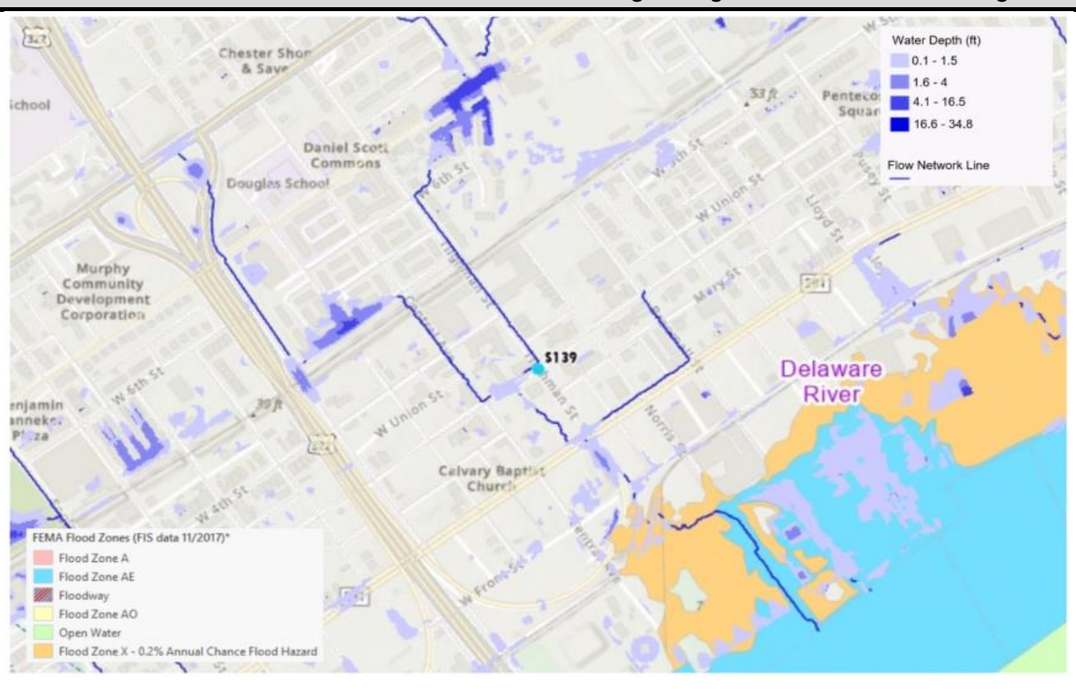


Minor signs of erosion within intersection

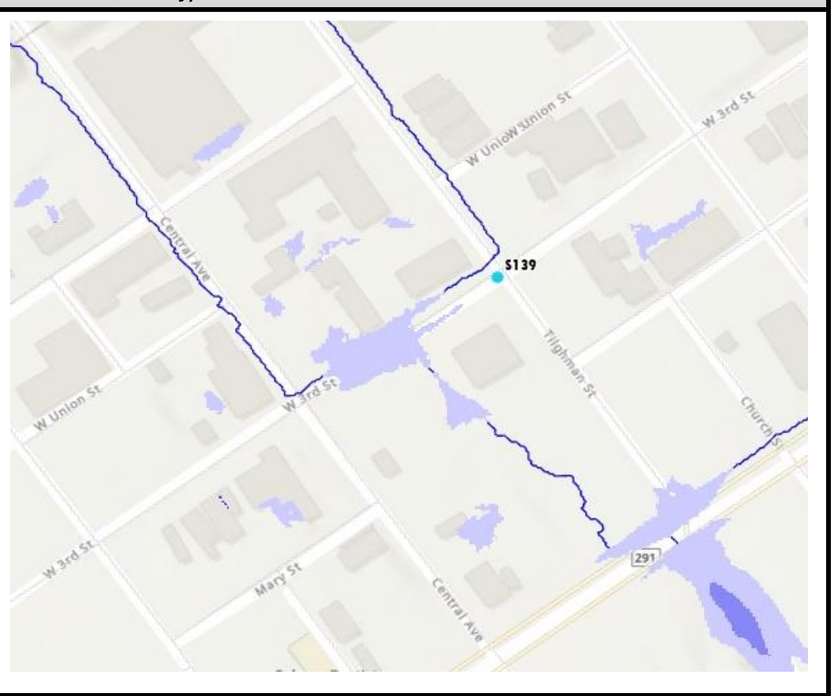


Broken snout/hood inside of inlet

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install additional inlets or improve grading for dewatering of the roadway
- Repair broken hood
- Floodproof affected structures
- Raise road elevation. Water may be surcharging from storm drains when outfalls are innundated by Delaware River Flooding.

ID#S140 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Upland Borough	**Location:**	1596 Parker St
Property Type:	Right of Way, Public (Other)		
Type of Problem(s):	Flooding, Sedimentation		
Problem Description:	Issues include possible flood gate issues, clogged stormwater pipes, and silt in an antiquated system. Year of first known occurrence unknown.		
Field Visit Notes:	Inlets clogged with sediment and an illicit discharge from a leaky pipe was observed. The endwall is deteriorated and there is downstream gully erosion.		



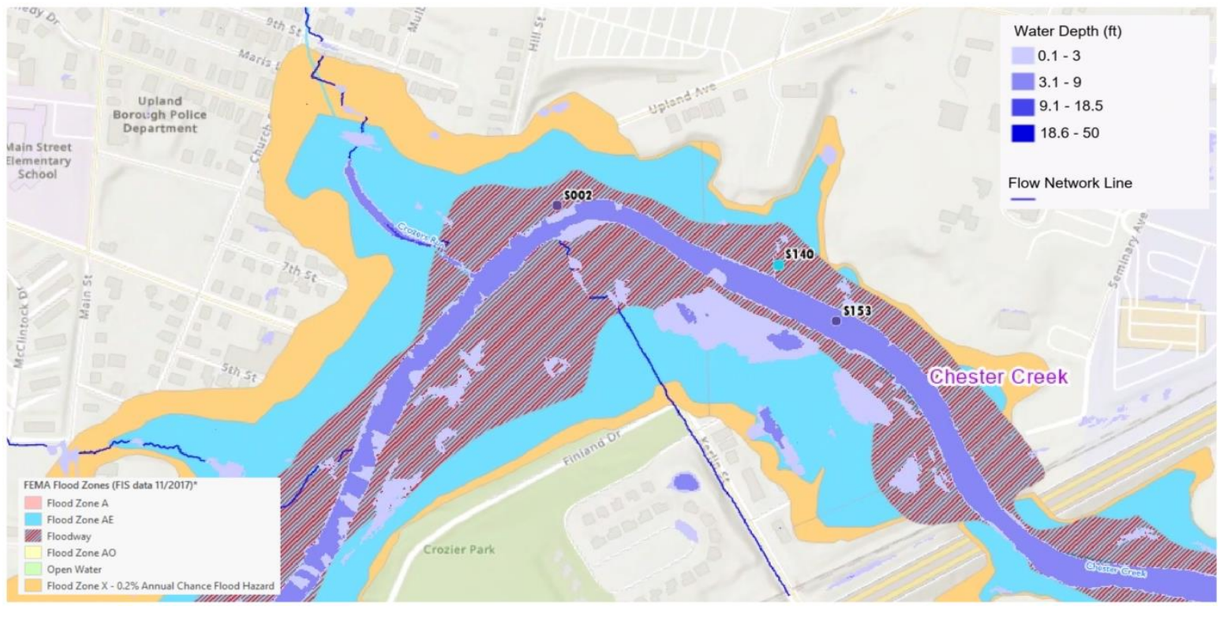
Illicit discharge into street



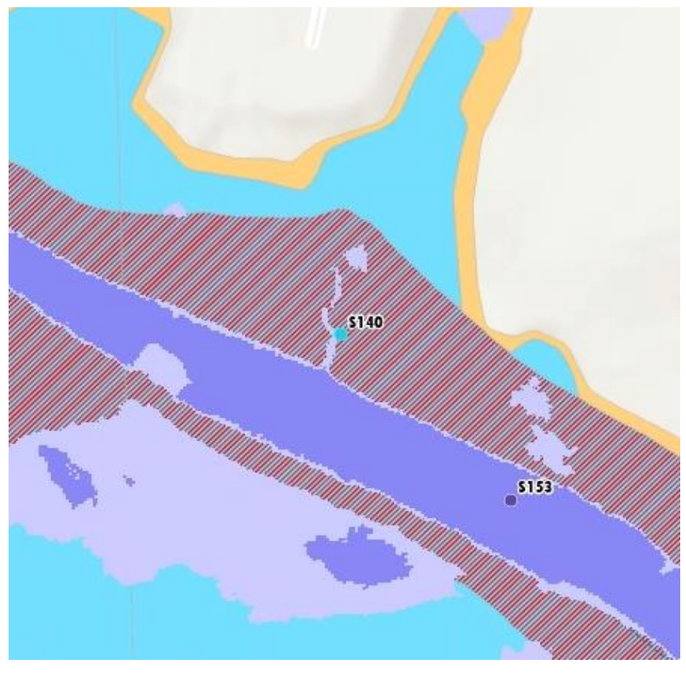
Gully erosion observed

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Remove sediment from inlets
- Investigate source of illicit discharge
- Investigate flood gate issues
- Stabilize upstream streambanks
- Install energy dissipator at outfall
- See the Potential Solution Analysis form for S002 for additional supporting analysis related to this problem location

ID#S141 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Gulph Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Radnor Township	**Location:**	412 N Wayne Ave
Property Type:	Residential, Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Gulph Creek is channelized at this location with limited capacity. Year of first known occurrence unknown.		
Field Visit Notes:	The drainage at this location, including the channel and pipes, appears too constrained to adequately manage the likely amount of runoff from the upstream area.		



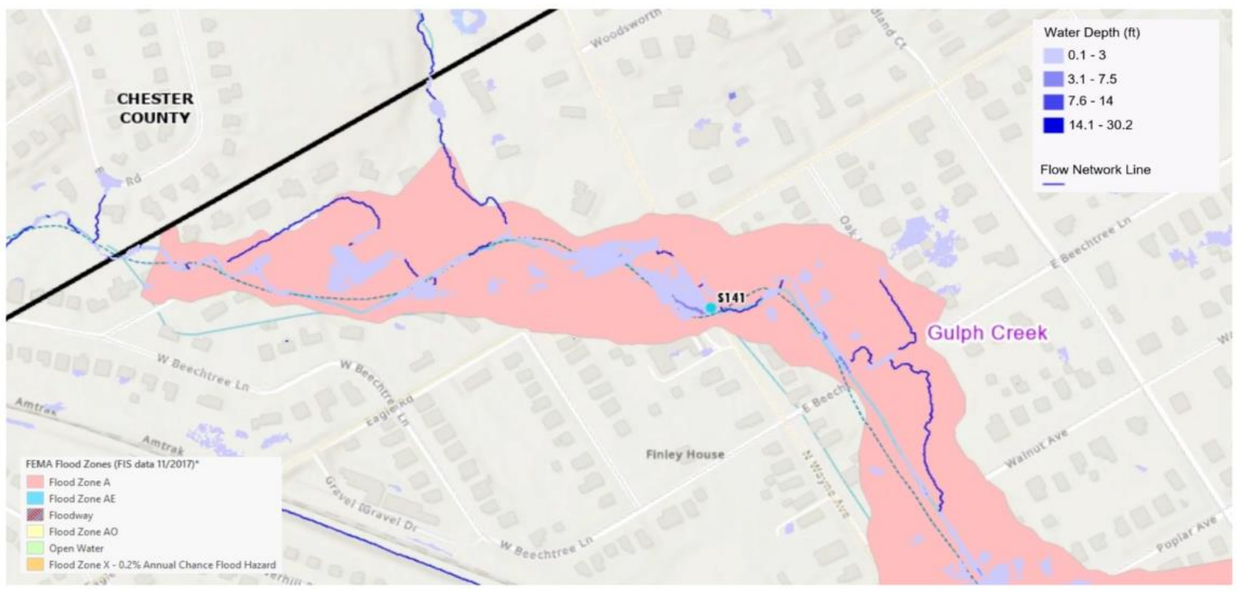
Constrained channel at problem area



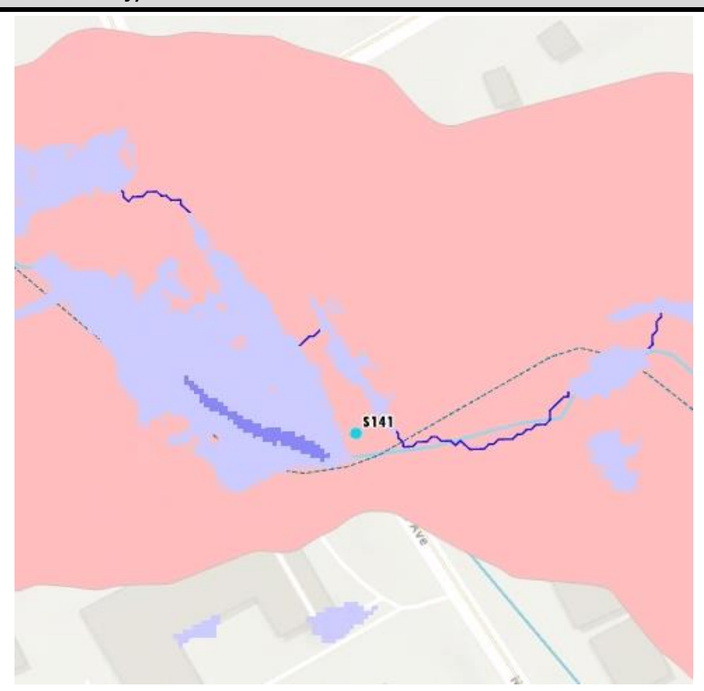
Constrained channel at problem area

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Evaluate potential to expand the existing channel for more storage; would require close coordination with owner of condominiums
- Potential for subsurface storage system in N Wayne Ave and/or Eagle Road, which have significant flat stretches
- Evaluate upstream opportunities to capture stormwater; as the drainage area is largely residential with few open spaces, the best opportunities may be subsurface storage systems in roadways

ID#S142 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	DCPD
Minor Watershed:	Ithan Creek	**Problem Area Submission Date:**	8/12/2025
Municipality:	Radnor Township	**Location:**	Ithan Creek culvert under Meadowbrook Ave, St Davids, PA
Property Type:	Residential,Rightofway		
Type of Problem(s):	Flooding - Restricted Capacity		
Problem Description:	Concrete channelized section of the creek. Year of first known occurrence unknown.		
Field Visit Notes:	Channel too constrained for stormwater volume. Narrow channel with low structure.		



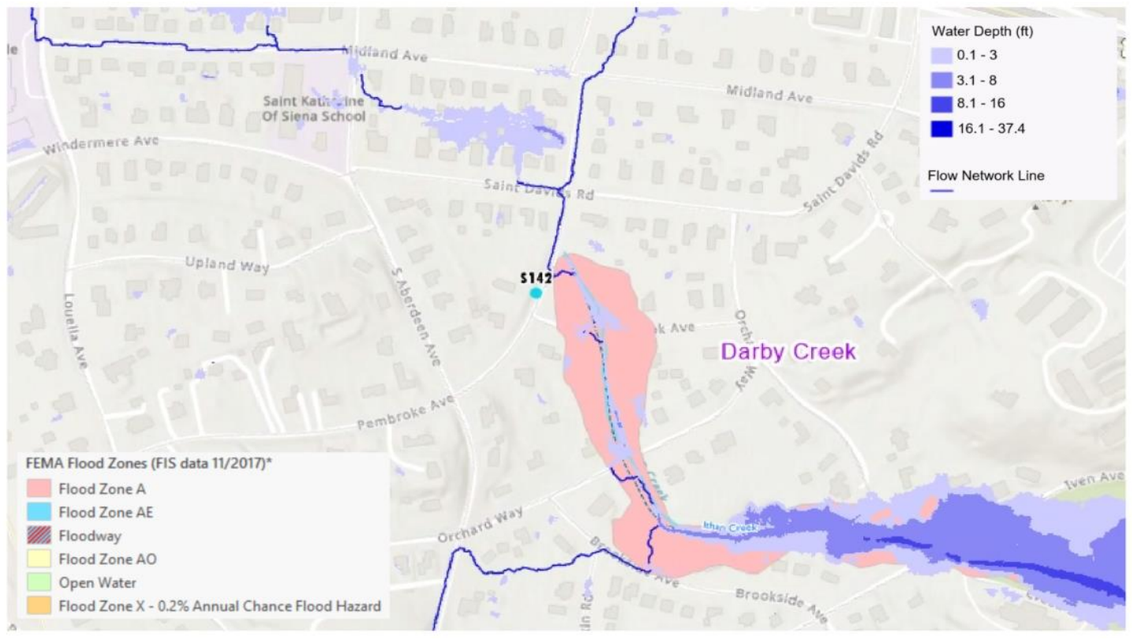
Ithan Creek channel downstream of Meadowbrook Ave culvert



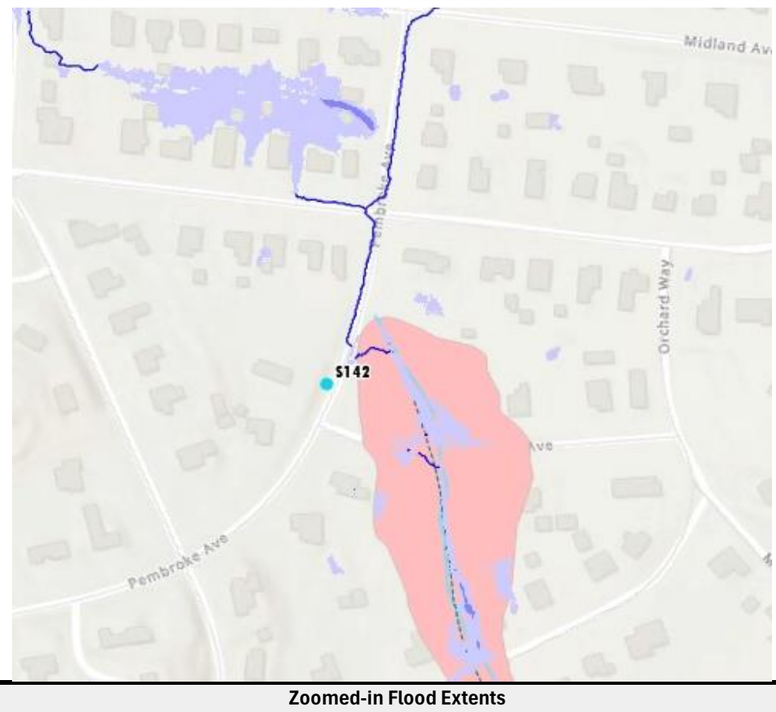
Ithan Creek culvert under Meadowbrook Ave

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Possibility of upstream capture.
- Stream restoration to widen channel and stabilize bed.

ID#S145 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Crum Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Nether Providence Township	**Location:**	700 Avondale Rd
Property Type:	Residential, Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Crum Creek overtops its banks and floods near the adjacent condominiums		
Field Visit Notes:	Prior to visiting #S145, we visited Leiper Park to explore potential stormwater capture opportunities there. At Leiper Park, Crum Creek is very flat and the water is almost stagnant. There is a sewer and petroleum line along the bank of Crum Creek in the park, which would constrain the possibilities for floodplain expansion. There are also tree obstructions in the creek. Evidence of flooding in the park is not apparent. At #S145, next to the creek is a large parking lot with a sign that says "potential flash flood areas". There were signs of erosion along the streambanks.		



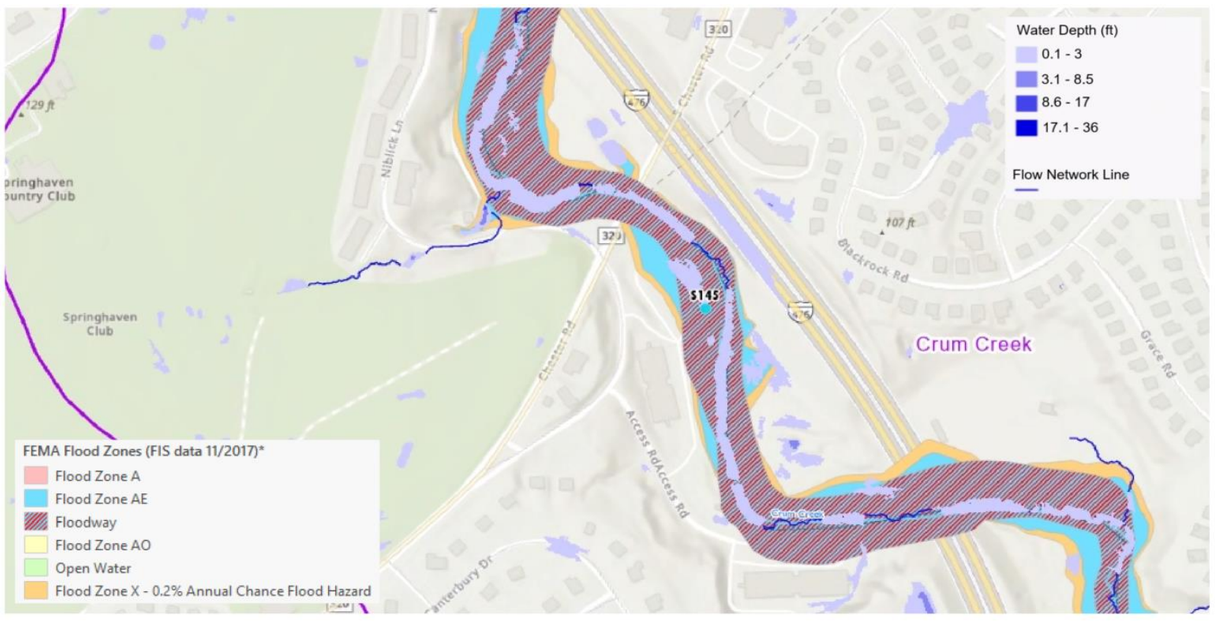
Crum Creek at Leiper Park, upstream of #S145



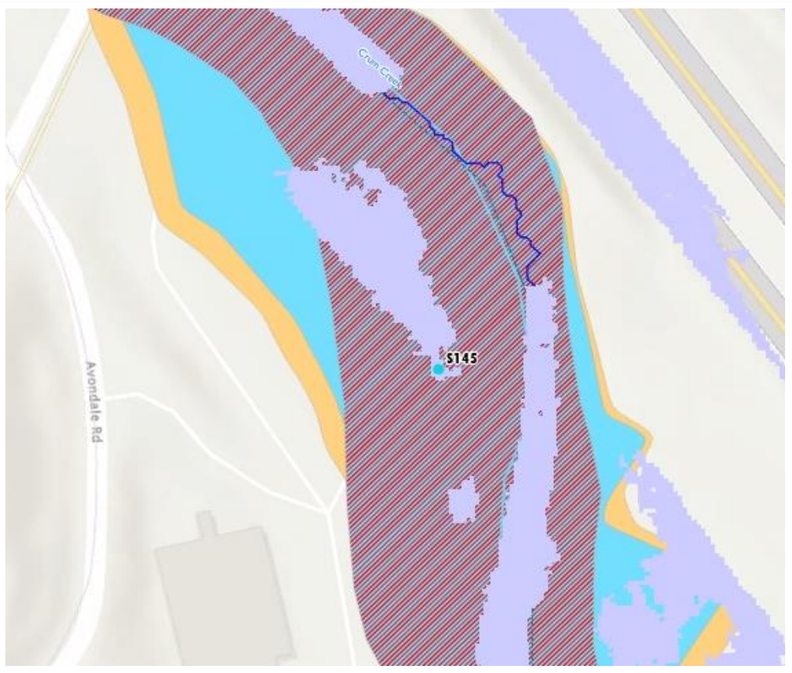
Parking lot at Crum Creek Valley Condominiums

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Evaluate upstream open space areas and parks, such as Leiper Park, for opportunities to capture stormwater
- Potential for subsurface storage system in parking lot
- Streambank stabilization
- Remove obstructions in creek

ID#S150 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	DCPD
Minor Watershed:	Muckinipattis Creek	**Problem Area Submission Date:**	8/12/2025
Municipality:	Clifton Heights Borough	**Location:**	325 S Bishop Ave, Springfield, PA 19064
Property Type:	Rightofway		
Type of Problem(s):	Flooding - Restricted Capacity, Insufficient Drainage Infrastructure		
Problem Description:	Undersized culvert. Year of first known occurrence unknown.		
Field Visit Notes:	All the area is developed. Stream is flowing in a shallow creek that's not very wide. Homeowner said that last year the Twp said they were thinking of building a basin to contain the stormwater. During storm events, water starts at the culvert and backs up to the homeowner's house and basement. The homeowner has seen a significant increase in flooding and sediment in the water this year. The township comes to dig out the plants in the channel. The water gets all the way to the homeowners windows. May was the last time the homeowner had a flood. Update 10/21: Springfield Twp noted PennDOT indicated that they will not enlarge the culvert as it meets their hydrologic requirements. Twp noted that enlarging the culvert would likely shift problem downstream. Twp investigated increasing stormwater storage upstream, but DA includes a largely built-out area with limited oppportunities.		

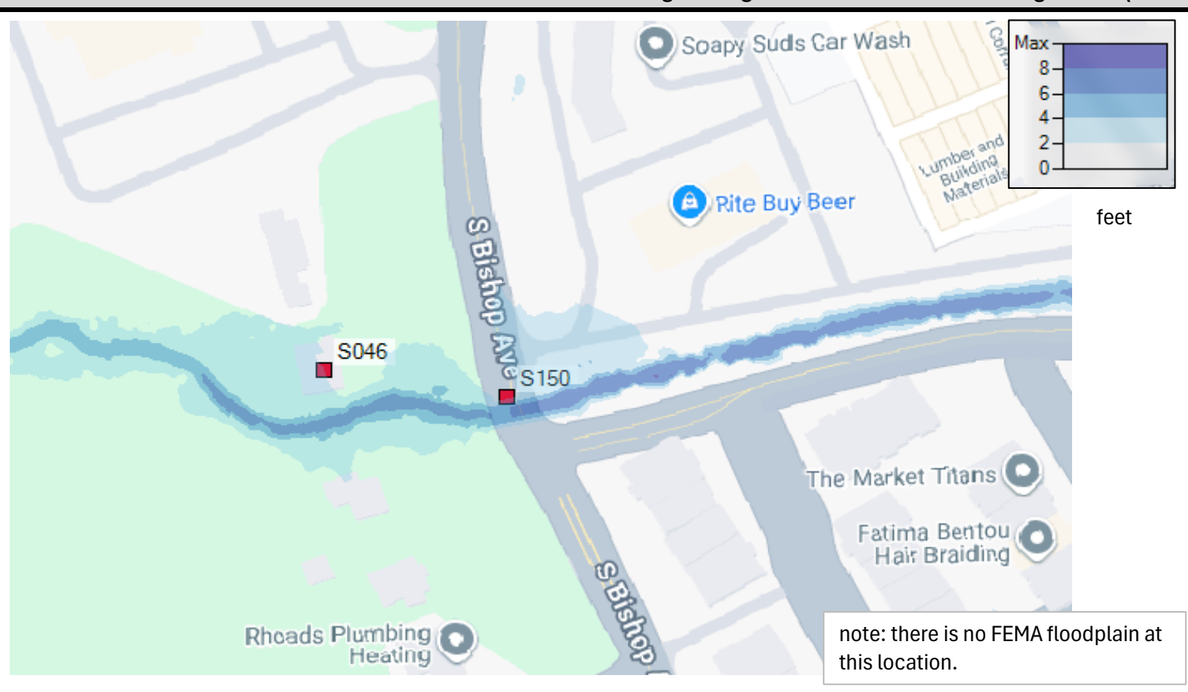


Concrete stream/channel adjacent to residential building

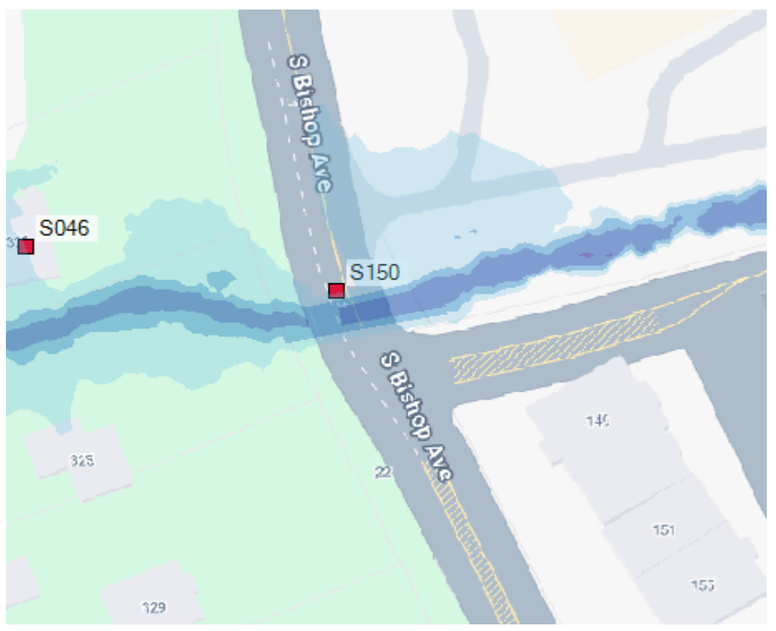


View of trash and debris within culvert

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Increase culvert size for more capacity
- Consider purchasing large green space upstream to restore the floodplain
- Look for storage opportunities at Netherwood Park

ID#S152 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	DCPD
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Colwyn Borough	**Location:**	606 Elmwood Ave, Sharon Hill, PA 19079
Property Type:	Industrial		
Type of Problem(s):	Flooding - Insufficient/Aging Drainage Infrastructure		
Problem Description:	Limited details provided.		
Field Visit Notes:	Large amount of trash and debris throughout the site. There is a berm along perimeter of site (acting as a levee but not maintained/classified as such). There is also an old rail line on the east side of the site that restricts flow in the creek, but we did not get a visual on it.		



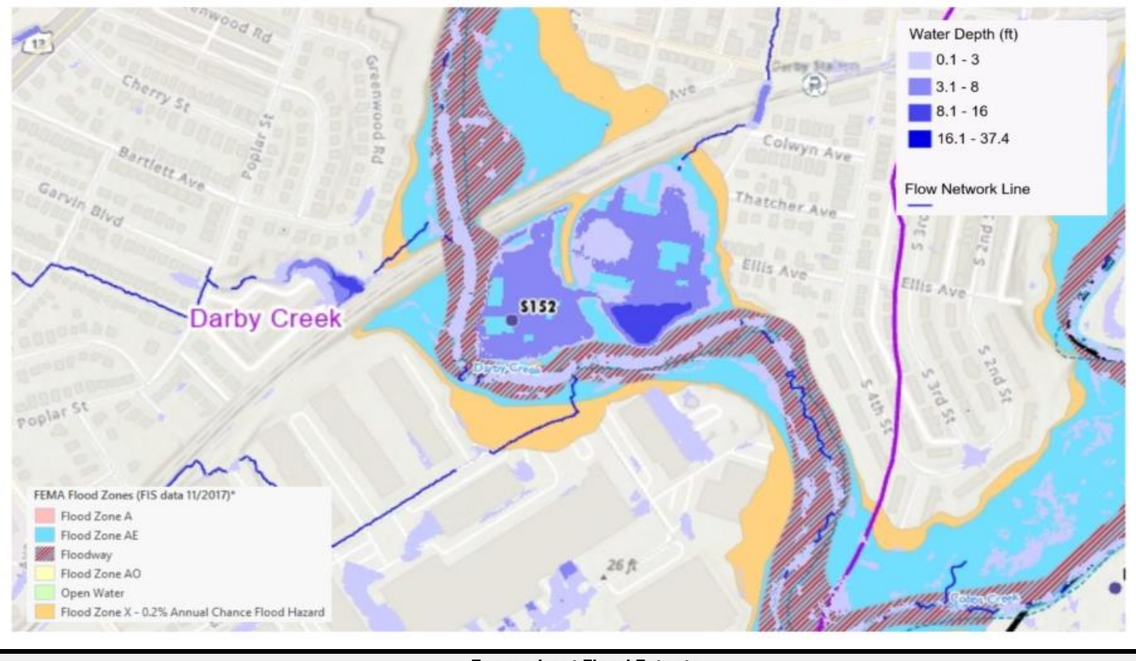
Trash deposited on site near abandoned building



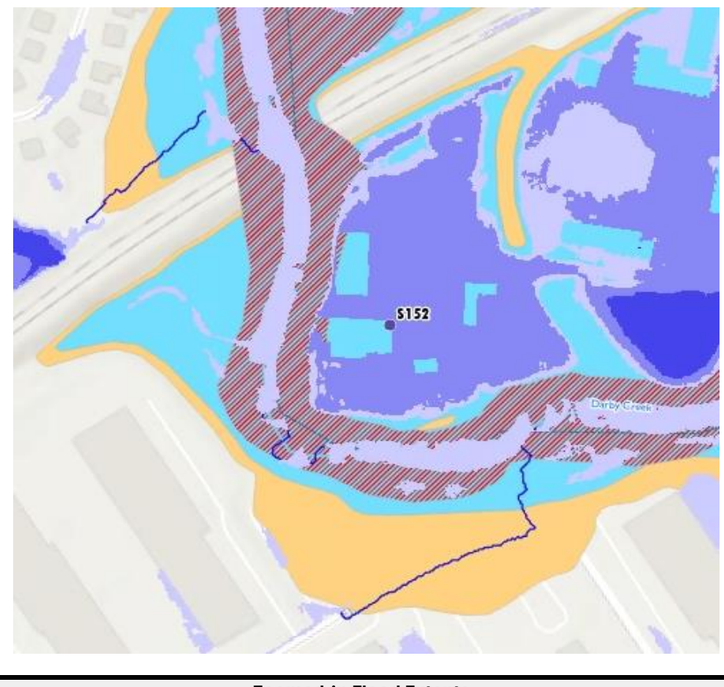
View of berm around site perimeter

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Property is on a list of sites as potential PEMA mitigation locations
- Floyd Park may be suitable for storage opportunities with significant cleanup. Site would be suitable for a large constructed wetland area for flood storage.
- Need additional analysis regarding the removal of the flow restriction in the creek caused by the old rail line.

ID#S153 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/13/2025
Municipality:	Chester City	**Location:**	W 14th St & Parker St
Property Type:	Right of Way, Public (Other)		
Type of Problem(s):	Flooding, Sedimentation		
Problem Description:	Possible flood gate issues, clogged stormwater lines, silt in an antiquated system. Year of first known occurrence unknown.		
Field Visit Notes:	Ponding around inlet on W 14th Street. Downstream outfall is deteriorated and shows some undermining/erosion. See S140 for additional photos.		



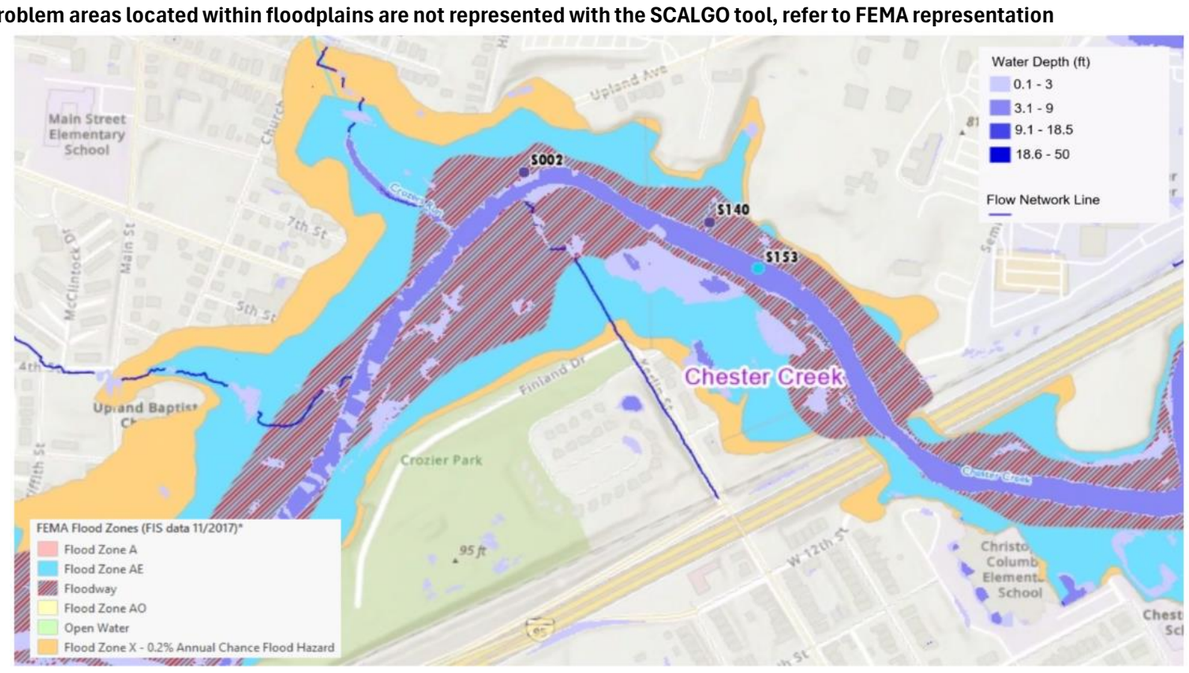
Deteriorating storm pipe to outfall



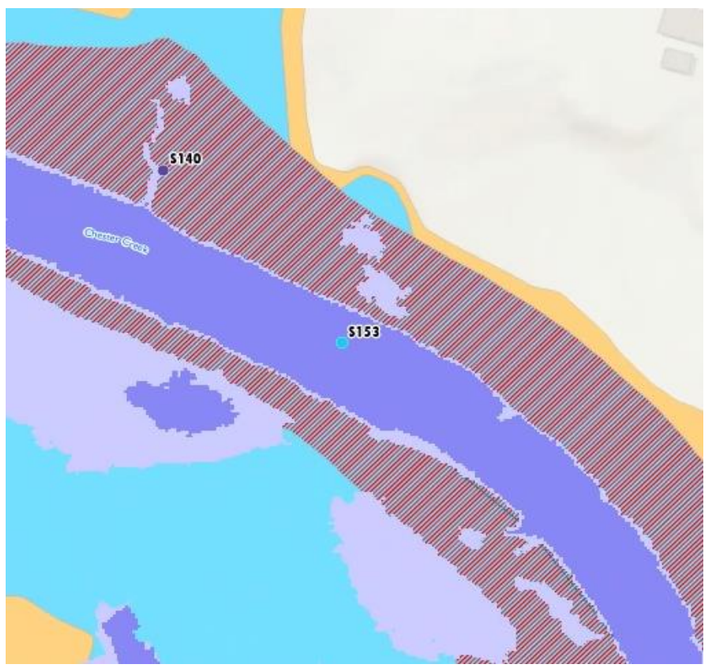
Undermining & erosion at outfall

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Remove sediment from inlets
- Investigate flood gate issues
- Stabilize upstream streambanks
- Replace deteriorated pipes
- Install energy dissipator at outfall
- Evaluate opportunity for construction wetlands west of the creek and north of W 14th St
- See the Potential Solution Analysis form for S002 for additional supporting analysis related to this problem location

ID#S154 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Gulph Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/13/2025
Municipality:	Radnor Township	**Location:**	Eagle Rd & Lynch Rd
Property Type:	Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Concrete channelized section of creek. Year of first known occurrence unknown.		
Field Visit Notes:	There is an open lawn area owned by the Valley Forge Military College (VFMC) that is immediately uphill of where the creek crosses Eagle Road. The creek is very narrow here and the bridge structure is relatively low. There was sediment deposition along the roadway and the inlet there is in need of maintenance.		



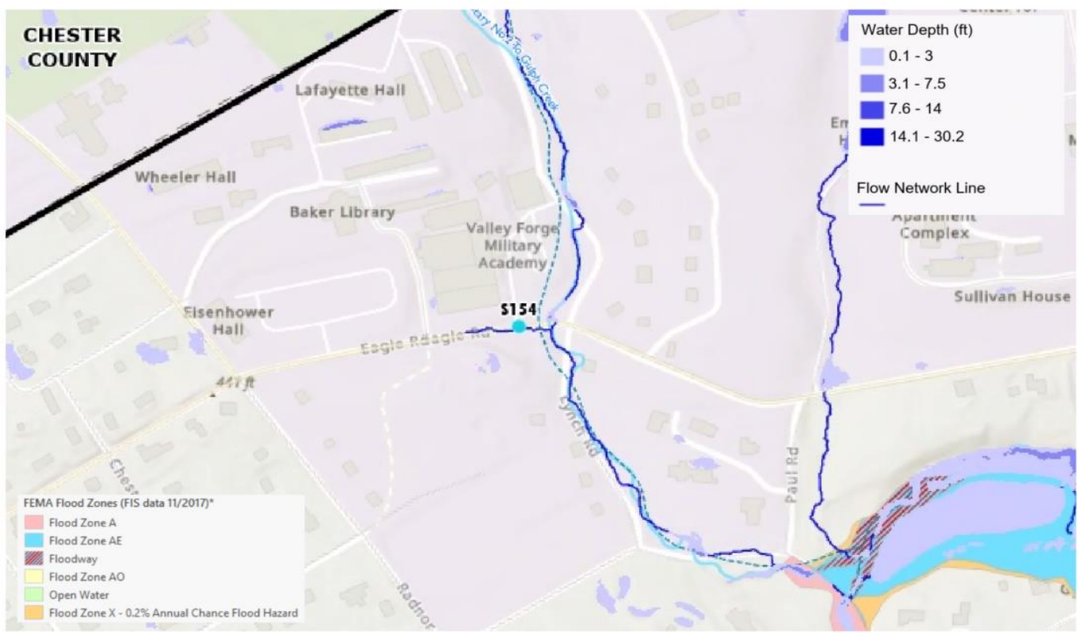
Culvert at Eagle Rd



Lawn area uphill of where the creek crosses Eagle Rd

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Potential for constructed wetlands or flood storage basin in the lawn area adjacen to the channel, north of Eagle Rd
- Potential for subsurface storage systems at parking lots and other paved areas on the campus of the VFMC
- Clean out the culvert and inlet at Eagle Rd

ID#S158 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Water Center at Penn
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/20/2025
Municipality:	Haverford Township	**Location:**	9000 Parkview Dr, Haverford, PA 19041
Property Type:	Residential, Open Space, Otherpublic		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation, Water Pollution - Restricted Capacity		
Problem Description:	Indications of substantial stormwater flows incising banks and blocked by former railroad		
Field Visit Notes:	No major erosion observed; some minor obstructions such as downed trees/debris/old rail support.		



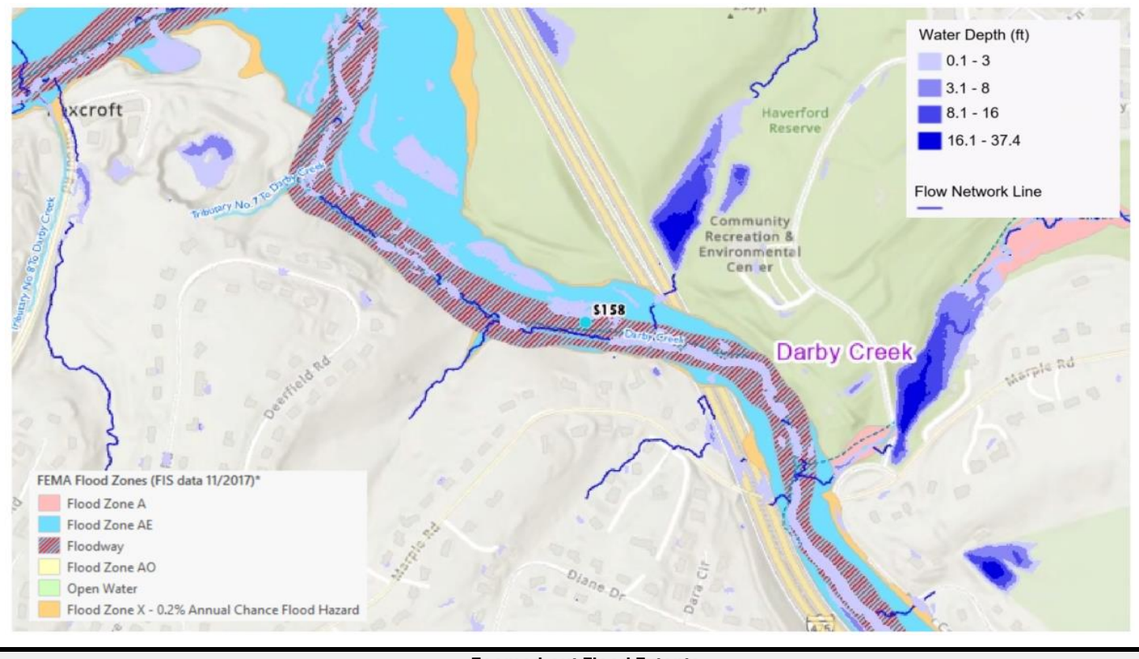
Streambank along Darby creek shows some minor erosion



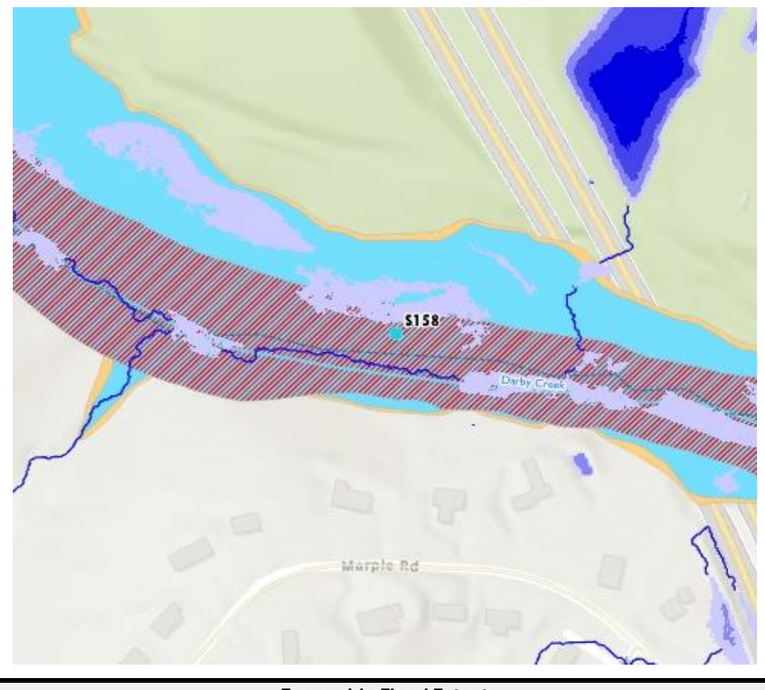
Downed trees and debris trapped against old rail support

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Streambank restoration
- Potential flood storage/wetlands
- Removal of some obstructions/debris
- Inter-County Coordination recommended for large scale watershed flood study

ID#S162 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Kelly Engineers, Middletown Township Engineer
Minor Watershed:	Chrome Run	**Problem Area Submission Date:**	8/21/2025
Municipality:	Middletown Township	**Location:**	Granite Dr & Northbrook Dr
Property Type:	Residential		
Type of Problem(s):	Accelerated Erosion		
Problem Description:	Loss of private property and encroachment of stream bank on dwellings.		
Field Visit Notes:	Evidence of accelerated erosion approximately 500' south of the point, near 201 Northbrook Drive. Small channel has formed carrying water from roof drains as well as overland flow from steep embankment to the stream.		



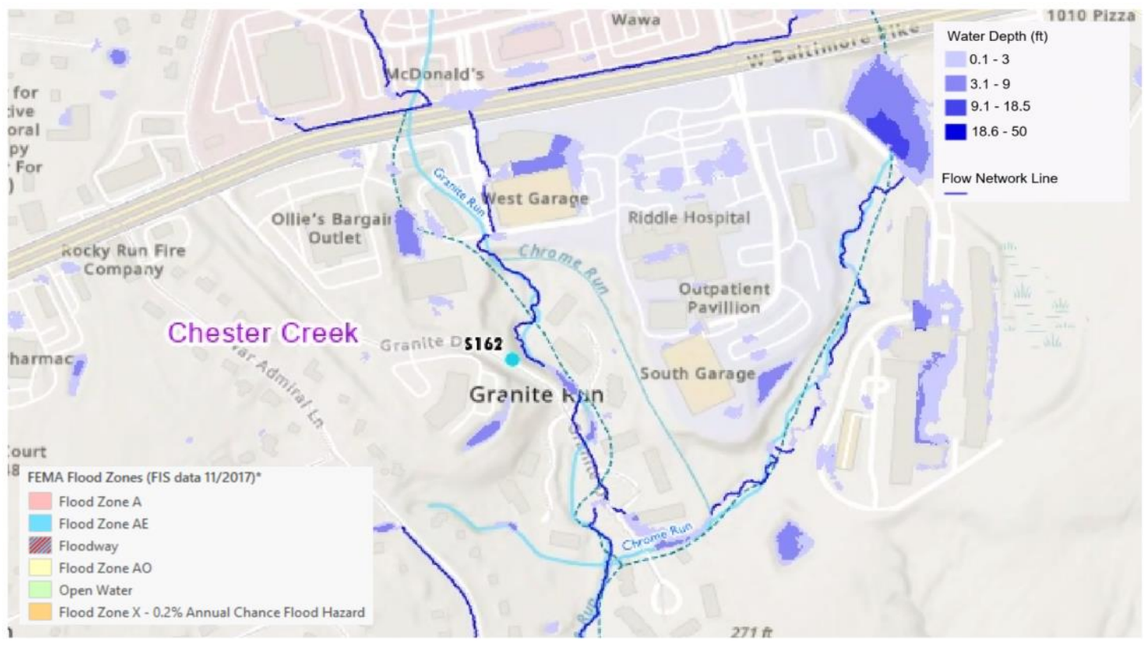
Erosion along streambank



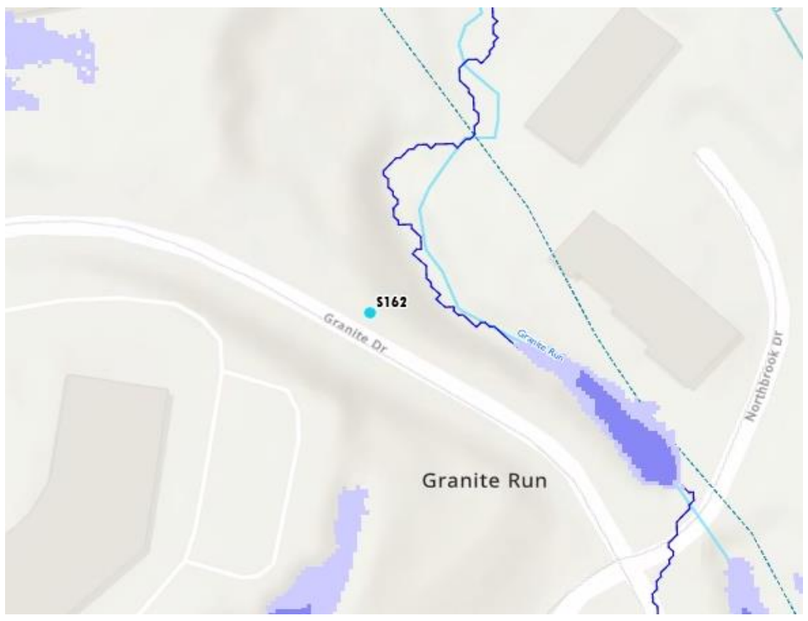
Channel forming along embankment

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stabilize the channel between the roof drain outfalls and the stream or relocate the outfalls
- Potential for bioswale on side(s) of Granite Dr
- Stabilize streambanks
- Evaluate upstream open space areas and parks for opportunities to capture stormwater

ID#S163 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Kelly Engineers
Minor Watershed:	Chrome Run	**Problem Area Submission Date:**	8/21/2025
Municipality:	Middletown Township	**Location:**	4 Lafayette Cir, Media, PA 19063
Property Type:	Residential		
Type of Problem(s):	Flooding,Accelerated Erosion,Sedimentation - Restricted Capacity		
Problem Description:	Flooding into pools and structures		
Field Visit Notes:	Accelerated erosion on stream bank behind house. Invasive bamboo along stream inhibiting vegetation growth. Undercutting of stream bank. Armouring of streambank needed to prevent further erosion. Discharge from cul de sac. No defined channel. Debris.		



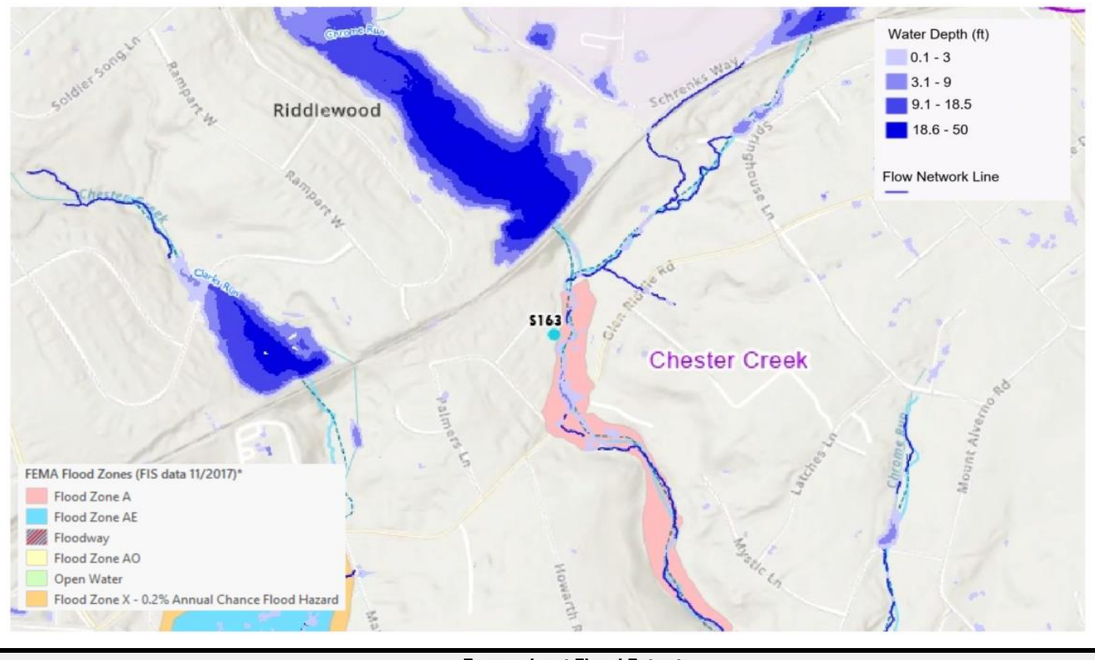
Conveyance pipe flowing into channel entering stream. Fence damage could be due to flooding



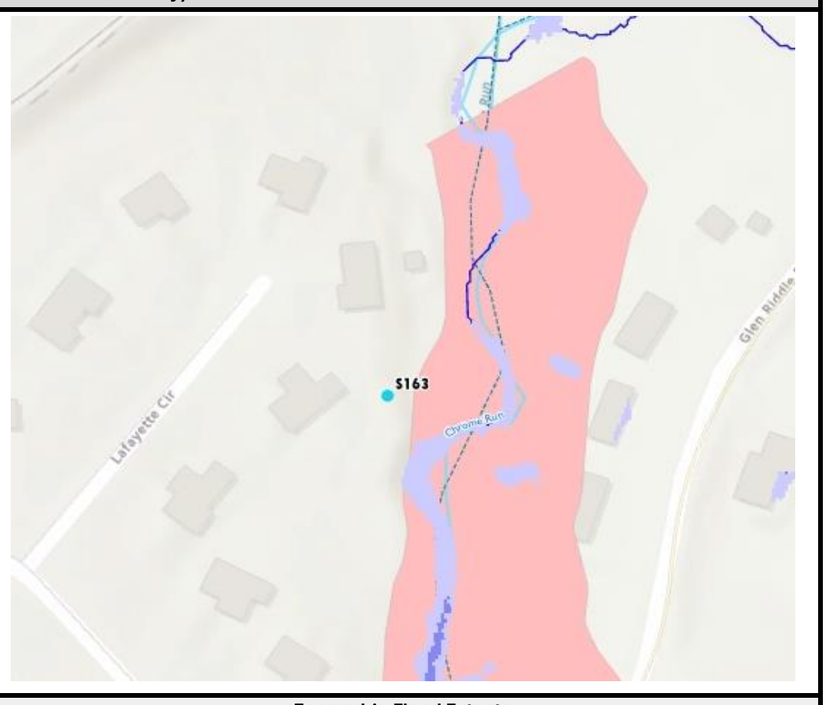
Streambank erosion along creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stabilize streambanks
- Consider new SCM
- Widen the floodplain
- Floodproof affected structures within Flood Zone A

ID#S164 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Ridley Creek	**Source of Problem:**	Kelly Engineers - Township Engineer
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/21/2025
Municipality:	Middletown Township	**Location:**	1301 E Baltimore Pke, Media, PA 19063
Property Type:	Residential,Commercial,Open Space		
Type of Problem(s):	Accelerated Erosion, Sedimentation - Restricted Capacity		
Problem Description:	Significant stream bank erosion just above water treatment intake		
Field Visit Notes:	Minor amounts of sediment erosion upstream. Could not identify intake pipe. Streambanks overgrown. No accelerated erosion identified. Observed stream with minor sediment flowing in it. Wetlands adjacent had some surcharging identified.		



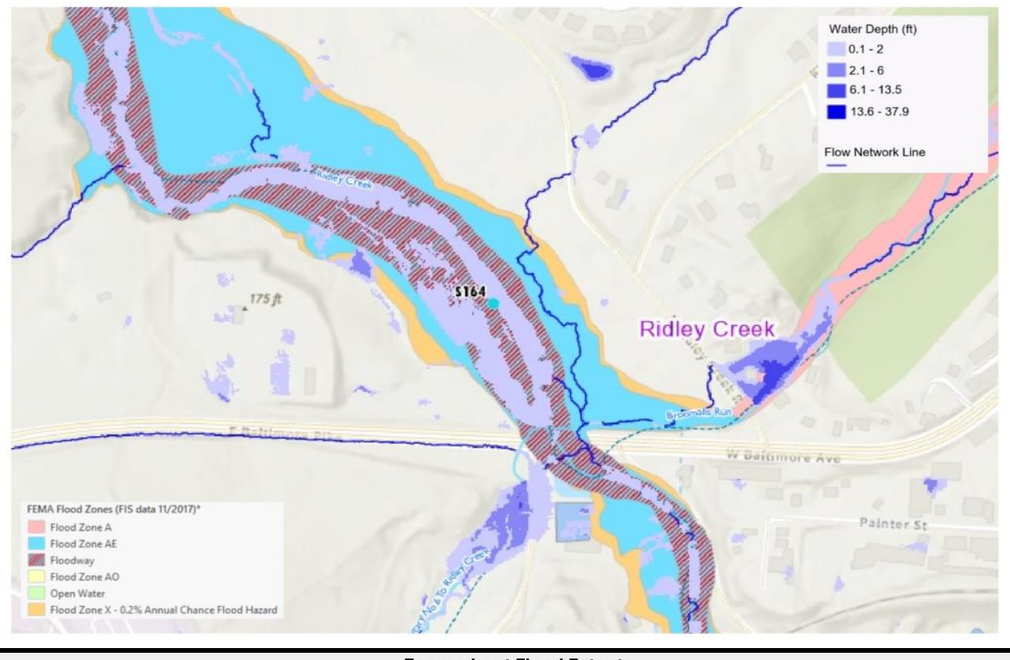
Overgrown streambanks



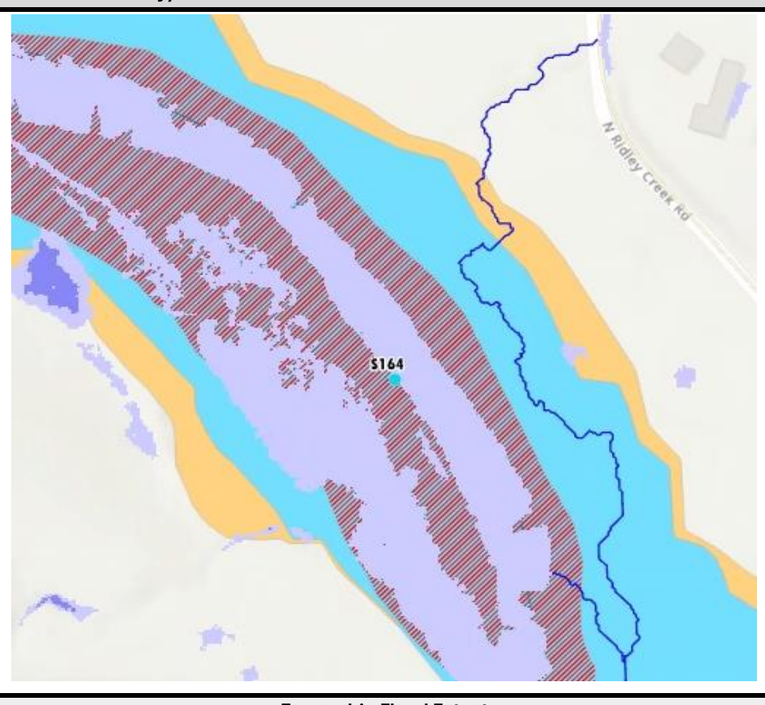
Some minor erosion and signs of high water levels on opposite side of creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stabilize banks near water treatment intake pipe.

ID#S166 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Glenolden Borough
Minor Watershed:	Muckinipattis Creek	**Problem Area Submission Date:**	8/22/2025
Municipality:	Glenolden Borough	**Location:**	Muckinipattis Creek at 511 Harrison Ave, Glenolden, PA 19036
Property Type:	Residential,Open Space		
Type of Problem(s):	Flooding, Accelerated Erosion - Insufficient/Aging Drainage Infrastructure		
Problem Description:	Limited details provided.		
Field Visit Notes:	Residential intersection, private property access, county knocked on door and asked and they permitted viewing of backyard. Inlet across street at intersection, leading to outfall		

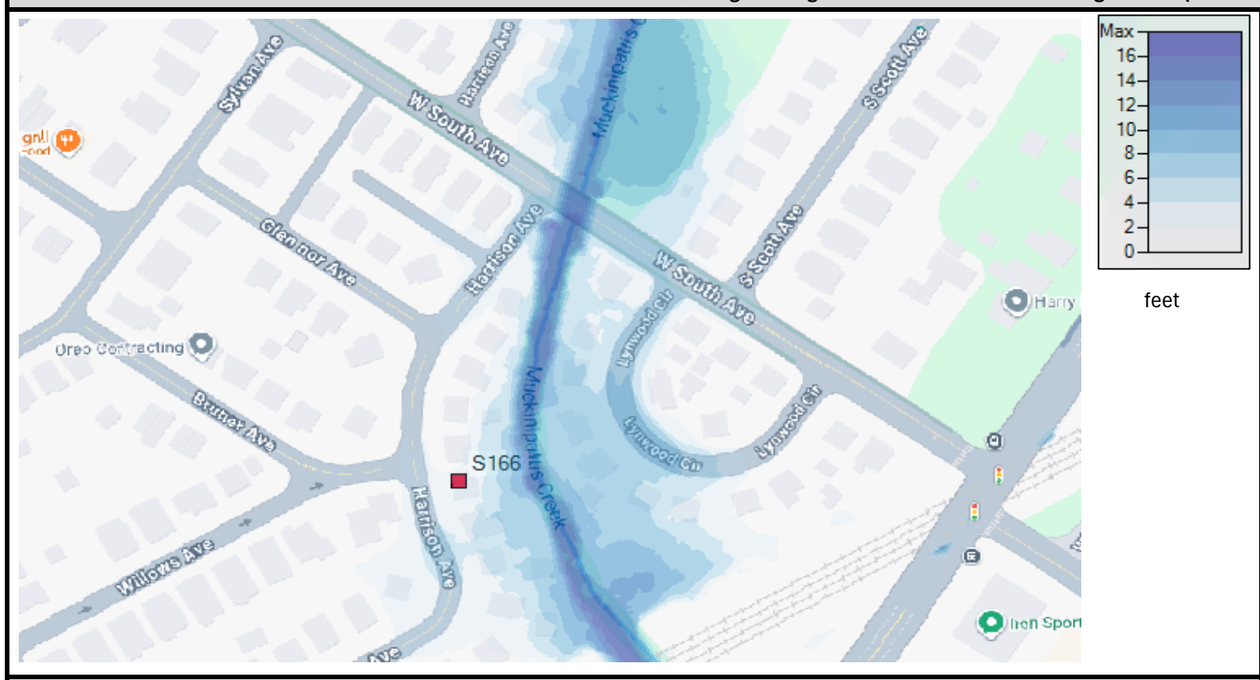


View of creek with erosion along streambank

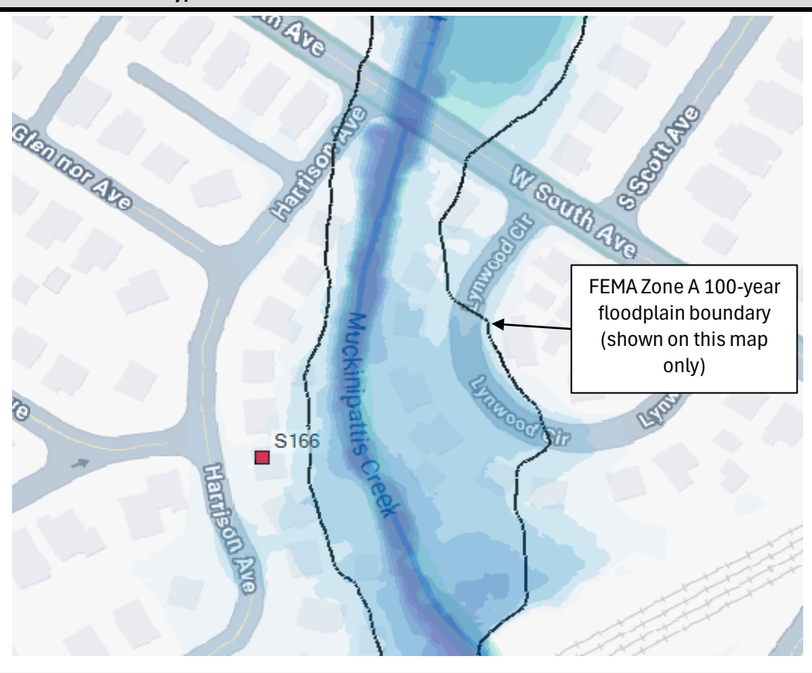


Signs of flooding in adjacent backyard

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

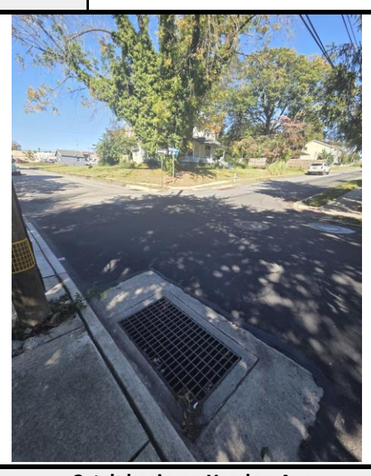
Potential Solutions

- Stabilize streambanks and potentially provide armouring
- Review Glenolden Park for upstream storm water measures to lessen and slow flows

ID#S167 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Pennoni
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/22/2025
Municipality:	Yeadon Borough	**Location:**	600-700 blocks of Yeadon Ave
Property Type:	Residential		
Type of Problem(s):	Flooding		
Problem Description:	Limited details provided		
Field Visit Notes:	The reported flooding might be a result of drainage limitations on Yeadon Ave; evidence of erosion and obstructions in the creek		



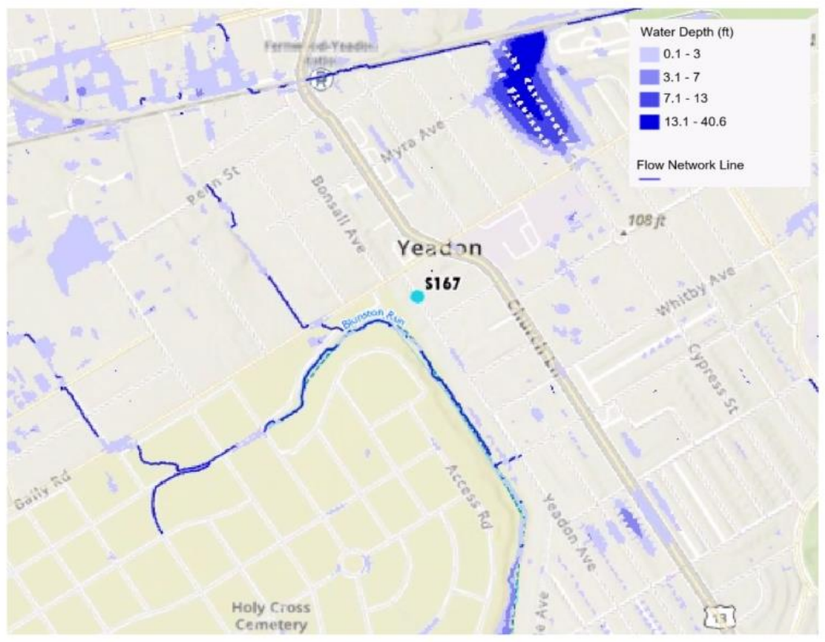
Catch basin on Yeadon Ave



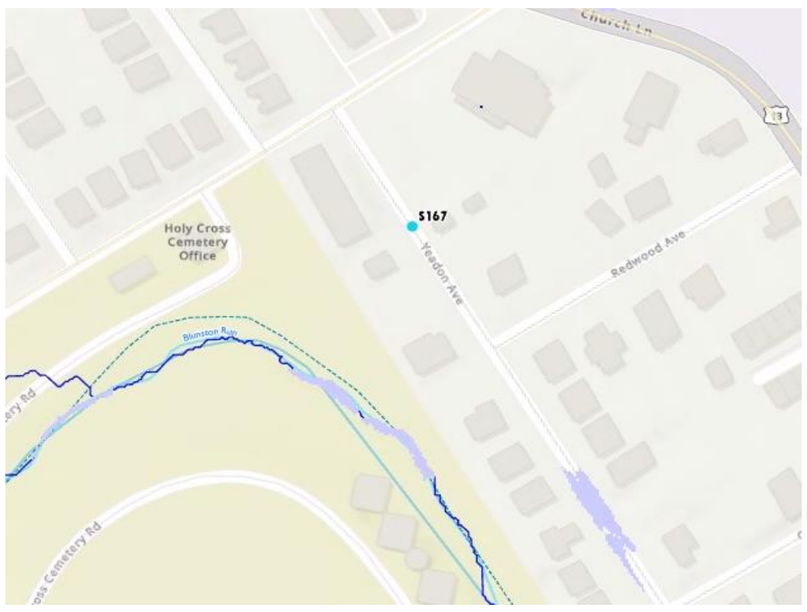
Blunston Run at Holy Cross Cemetery

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Subsurface storage system in Yeadon Ave, which is generally flat
- Possible wetland storage on edge of cemetery
- Potential to expand floodplain on cemetery property

ID#S168 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Chester Heights - Pennoni
Minor Watershed:	Tributary No.3 To West Branch Chester Creek	**Problem Area Submission Date:**	8/22/2025
Municipality:	Concord Township	**Location:**	9 Valleybrook Rd, Glen Mills, PA 19342
Property Type:	Open Space		
Type of Problem(s):	Flooding - Insufficient Drainage Infrastructure		
Problem Description:	Creek will rise to capacity, public park		
Field Visit Notes:	Small amount of flooding near pedestrian bridge in park. Sheet flow runoff, appears no widespread flooding.		



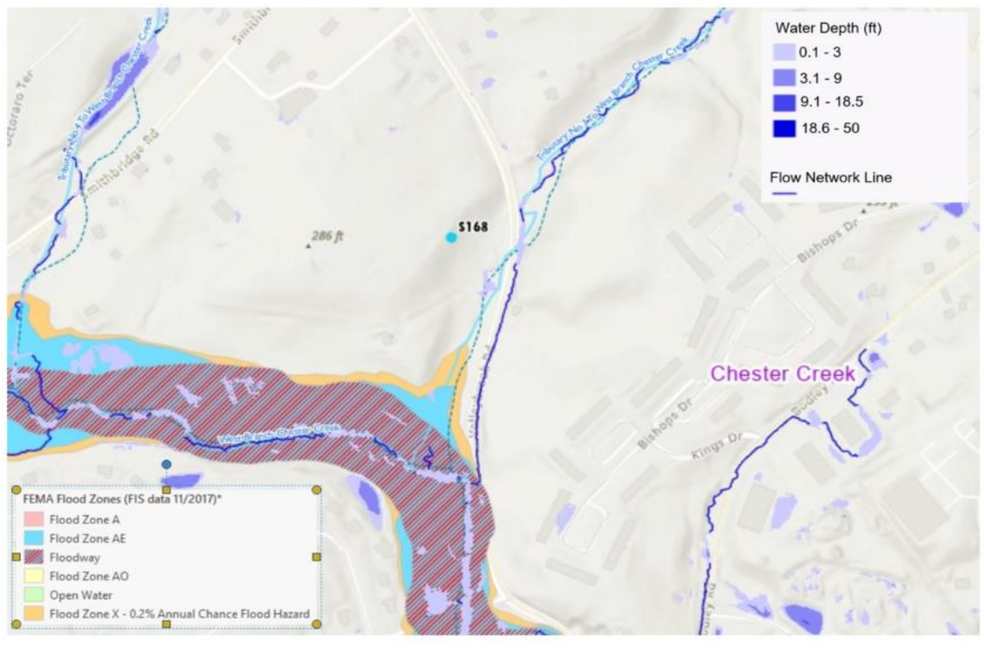
View of sediment deposits/channelization along park walking trail



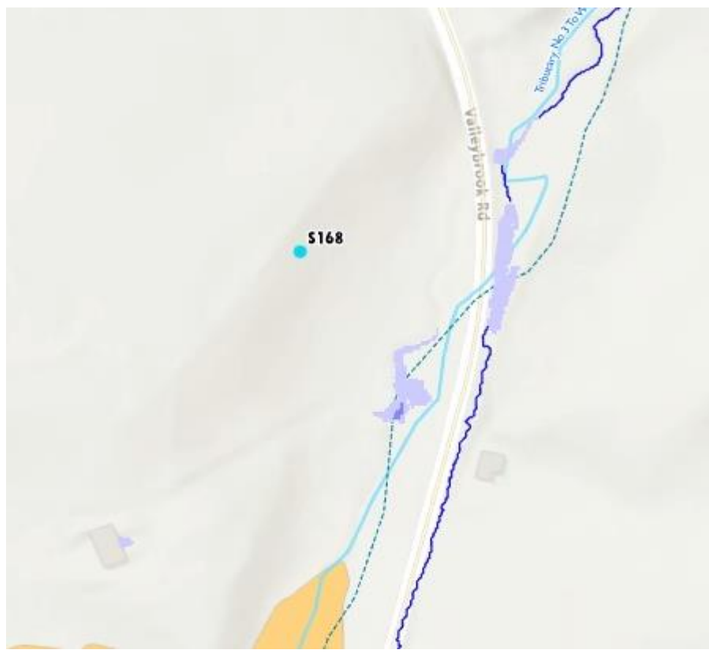
Signs of flooding at pedestrian bridge in park

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Raise elevation of pedestrian bridge
- Expand floodplain.

ID#S169 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Chester Heights Borough - Pennoni
Minor Watershed:	West Branch Chester Creek	**Problem Area Submission Date:**	8/22/2025
Municipality:	Chester Heights Borough	**Location:**	Mattson Road Bridge over Chester Creek West Branch
Property Type:	Residential,Rightofway		
Type of Problem(s):	Flooding - Restricted Capacity		
Problem Description:	Water comes to edge of the road		
Field Visit Notes:	63’ bridge span. County is replacing the Mattson Road bridge.		



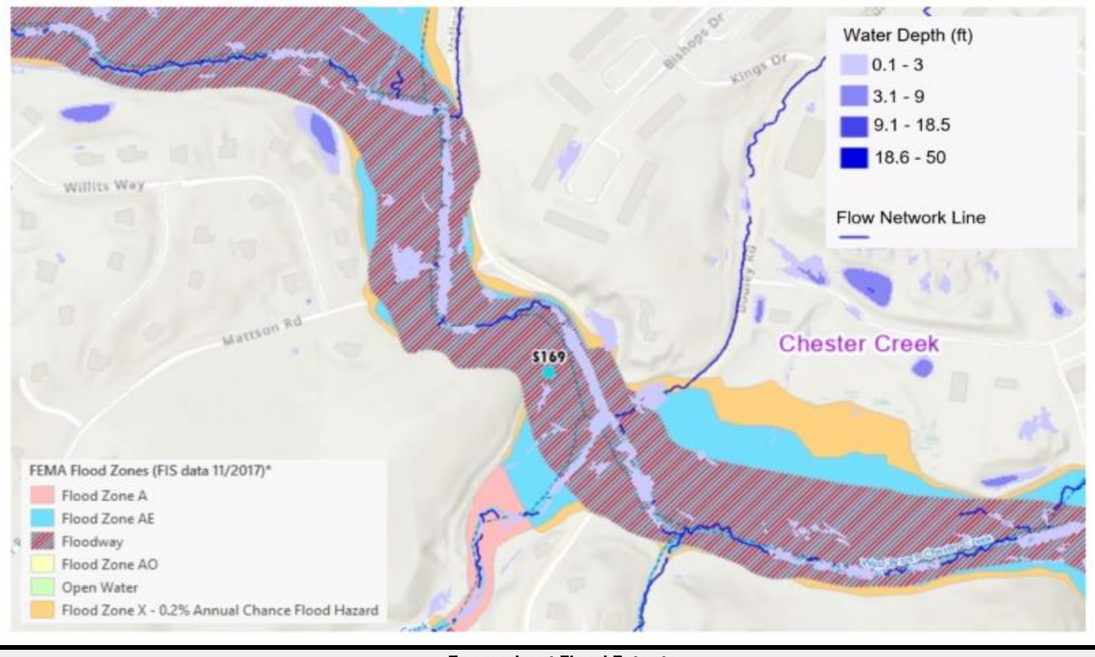
View of bridge culvert with sediment deposits



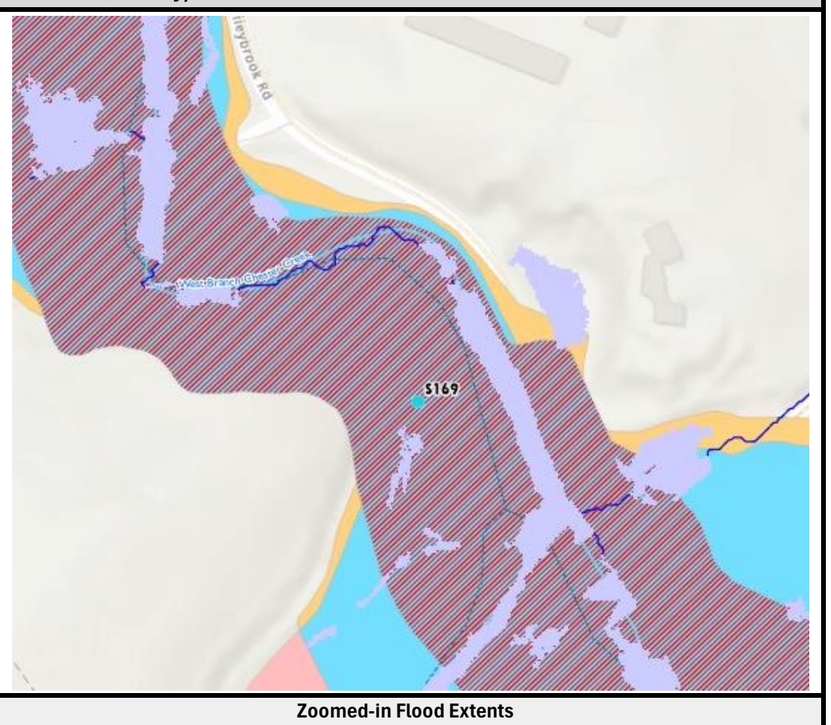
View of creek from top of bridge

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- County is replacing the Mattson Road bridge
- If bridge replacement is not adequate, then consider expanding the floodplain.

ID#S170 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Pennoni
Minor Watershed:	West Branch Chester Creek	**Problem Area Submission Date:**	8/22/2025
Municipality:	Concord Township	**Location:**	219 Cheyney Rd, Glen Mills, PA 19342
Property Type:	Open Space, Rightofway		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation - Restricted capacity, insufficient drainage infrastructure		
Problem Description:	Historic structures/site		
Field Visit Notes:	Gully erosion by side of bridge from an unknown swale. Sediment is deposited on one side of bridge, causing accelerated flow on the other side.		



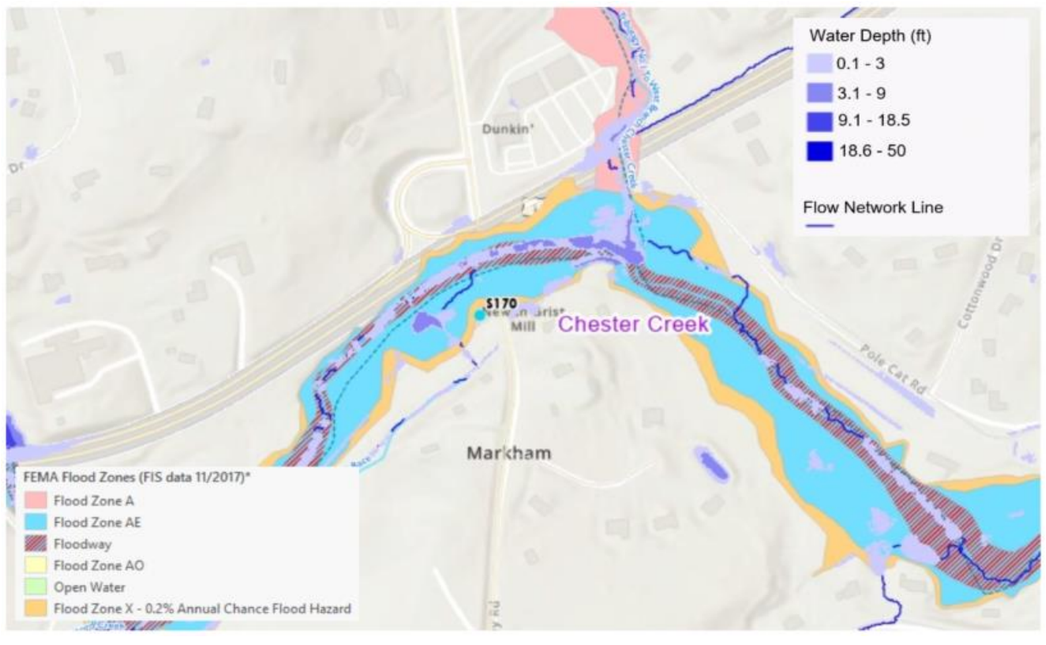
View of sediment buildup on upstream side of bridge



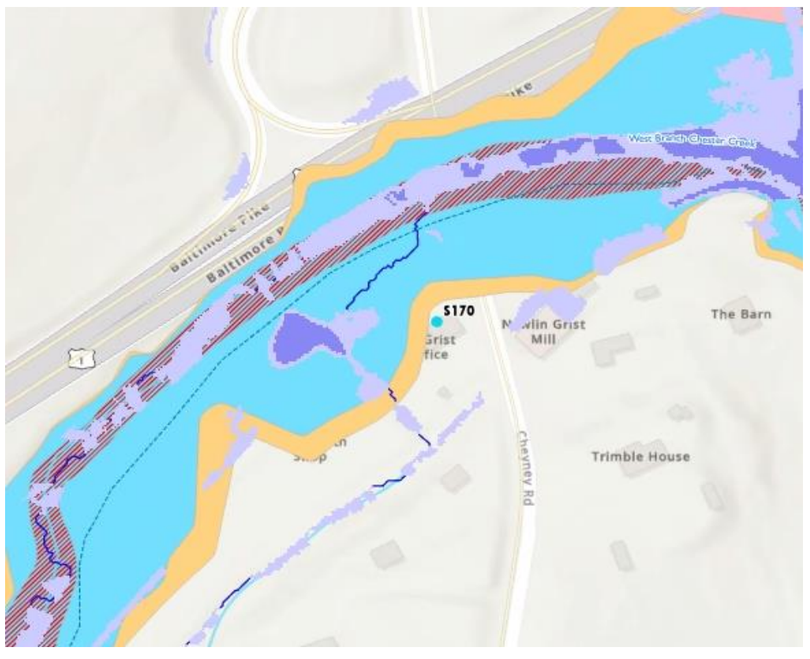
Accelerated flow on downstream side of bridge

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Remove upstream inpervious
- Floodproof nearby structures
- Stabilize streambanks
- Dredge excess sediment
- Drainage improvements (add inlets/pipes).

ID#S171 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Tributary No. 5 to Green Creek	**Problem Area Submission Date:**	8/22/2025
Municipality:	Concord Township	**Location:**	150 Cambridge Dr, Glen Mills, PA 19342
Property Type:	Open Space,Rightofway		
Type of Problem(s):	Flooding, Accelerated Erosion - Restricted Capacity		
Problem Description:	Limited details provided.		
Field Visit Notes:	Creek flows under Featherbed Ln through 72” culvert which appears to be in good condition and functioning properly. Some minor erosion noted on left wingwall of upstream culvert. Additional 48” culvert at downstream end.		



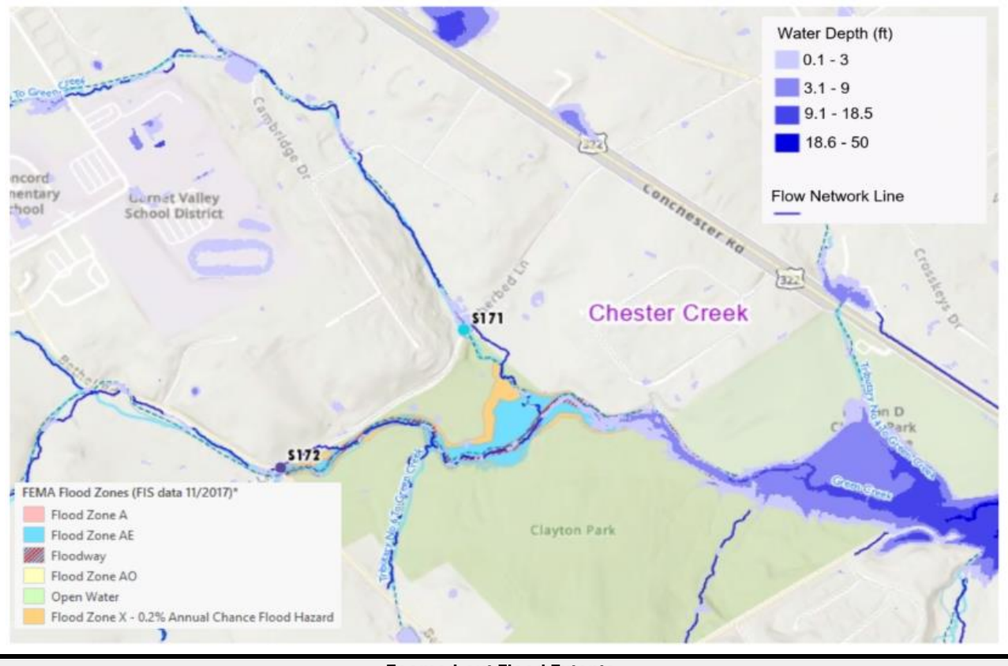
Upstream and downstream ends of 72" culvert under Featherbed Ln



Erosion along left wingwall on upstream end of culvert

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stabilize wingwall
- Resize culvert

ID#S172 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Pennoni
Minor Watershed:	UNT to Green Creek	**Problem Area Submission Date:**	8/22/2025
Municipality:	Concord Township	**Location:**	121-133 Bethel Rd, Glen Mills, PA, 19342
Property Type:	Residential,Open Space,Rightofway		
Type of Problem(s):	Flooding, Accelerated Erosion,Sedimentation - Restricted Capacity, Insufficient/Aging Drainage Infrastructure		
Problem Description:	Limited details provided.		
Field Visit Notes:	Some erosion downstream of box culvert. Confluence of 2 culverts. Rusted culvert Featherbed Road undercutting possible.		



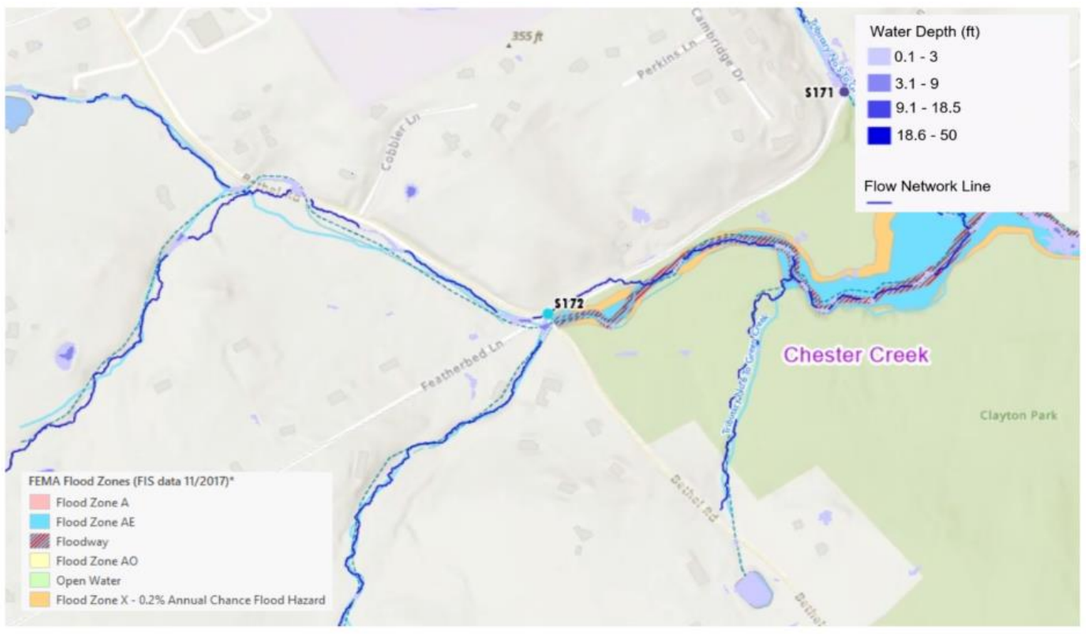
View of box culvert looking downstream



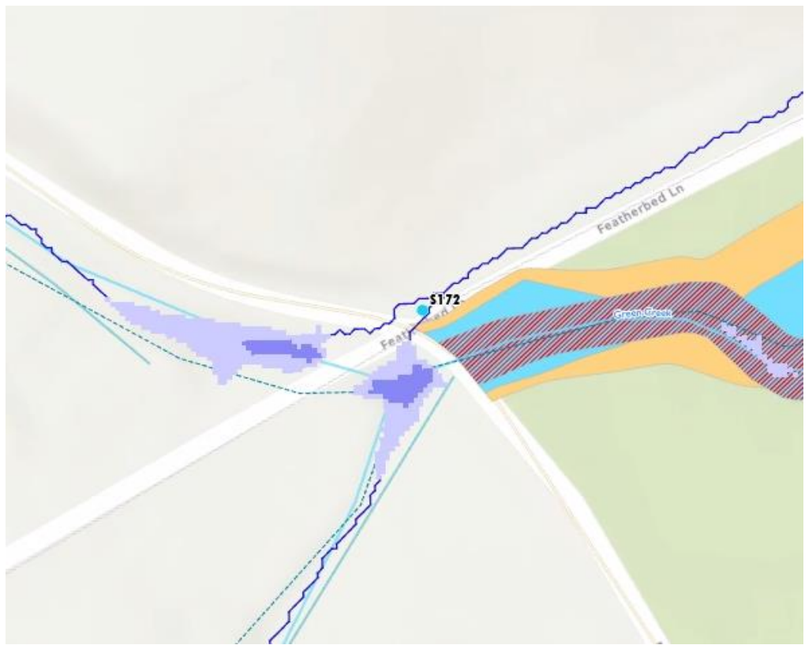
Erosion on downstream side of box culvert

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Repair rusted pipe
- Expand floodplain near confluence
- Stabilize streambanks
- Provide floodplain restoration upstream of Featherbed Lane

ID#S173 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Tributary No. 2 To South Fork West Branch Chester	**Problem Area Submission Date:**	8/22/2025
Municipality:	Concord Township	**Location:**	270 Spring Valley Rd, Glen Mills, PA 19342
Property Type:	Residential,Open Space,Rightofway		
Type of Problem(s):	Flooding,Sedimentation - Restricted Capacity		
Problem Description:	Limited details provided.		
Field Visit Notes:	Space between wing walls on downstream side is 67”. About 4’ of erosion downstream of oval culvert, seems widespread through about 100ft of streambank. 60” width of elliptical culvert. 16 foot headwall on upstream side no wings. Notes mainly on Chester Creek. Closer to the AME church is another smaller elliptical culvert with some erosion. Culverts and rip rap appear to be new.		



Recently constructed culverts

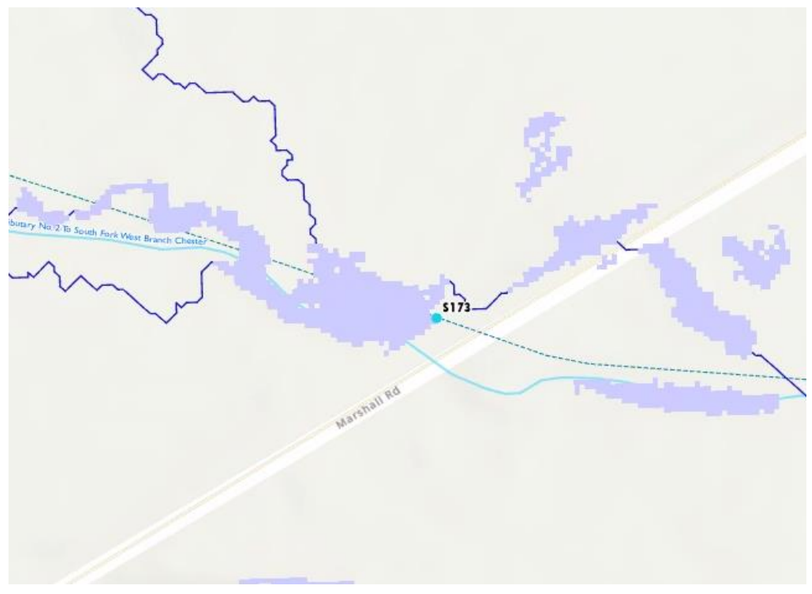


Severe accelerated erosion along streambank

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Streambank stabilization
- Culvert crossings appear to be new construction (assess if new construction reduces flooding.)

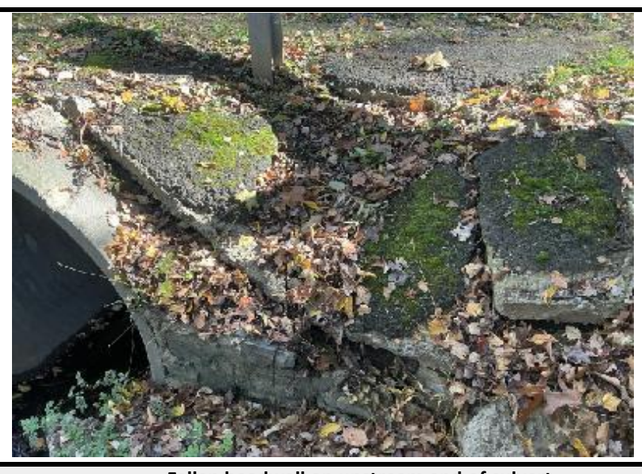
ID#S174 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Tributary No. 3 To West Branch Chester Creek	**Problem Area Submission Date:**	8/22/2025
Municipality:	Concord Township	**Location:**	North Brinton Lake Rd from Mill Rd to James Cloud Cir
Property Type:	Residential,Open Space,Rightofway		
Type of Problem(s):	Flooding,Accelerated Erosion,Sedimentation - Insufficient/Aging Drainage Infrastructure		
Problem Description:	Limited details provided.		
Field Visit Notes:	Chester Creek crossing of Brinton Lake Road. Head wall of culvert has fallen on the upstream side and appears to be in the process of falling down on the downstream side. There is significant erosion on the downstream end along the creek banks for what appeared to be several hundred feet. Upstream side has some minor erosion of creek banks and some debris ahead of the culvert.		

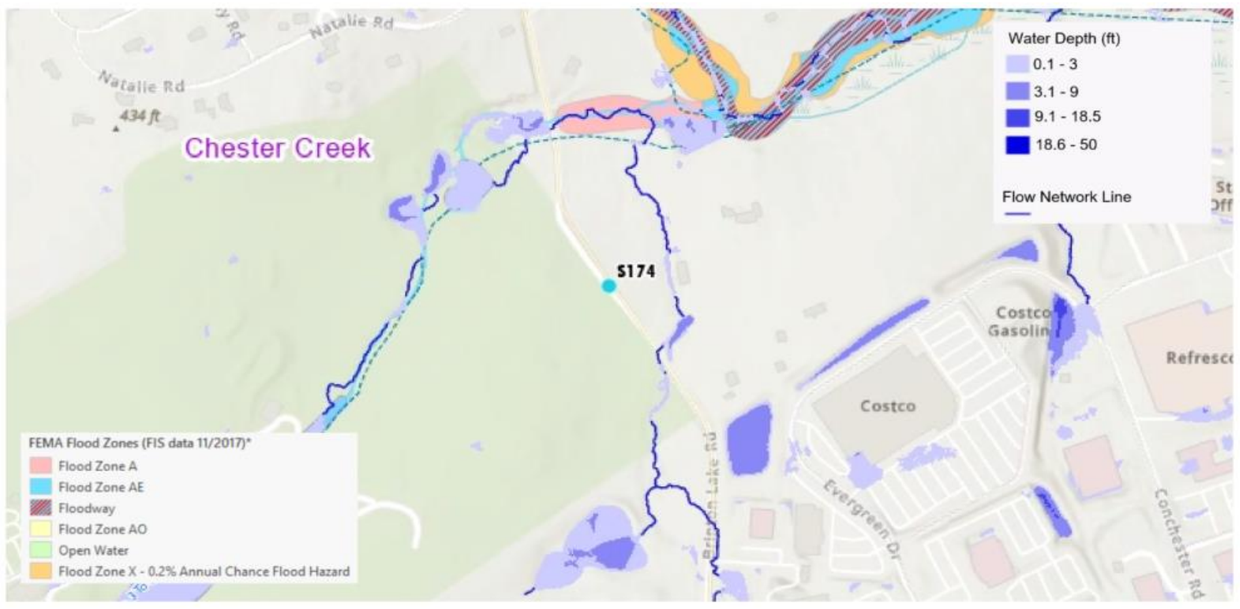


Channelized erosion within problem area

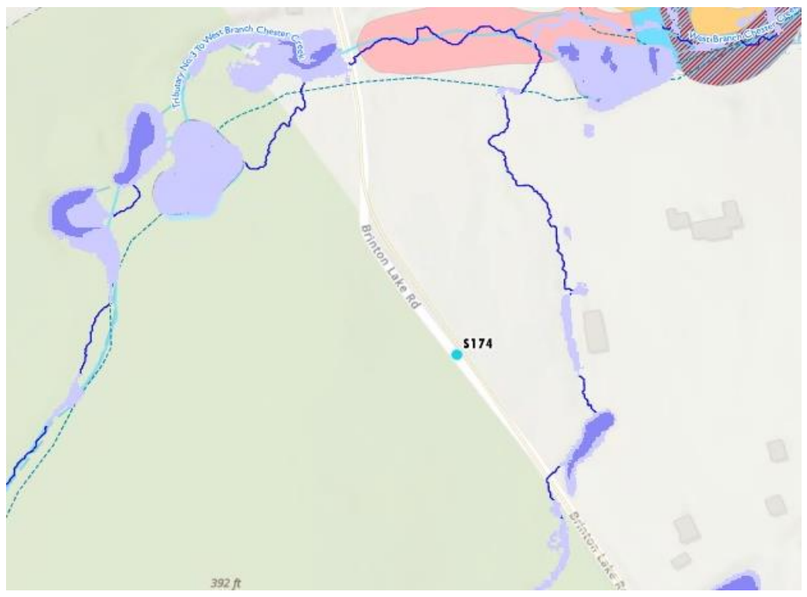


Fallen headwall on upstream end of culvert

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Resize culvert
- Stabilize streambanks

ID#S176 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Concord Creek	**Problem Area Submission Date:**	8/22/2025
Municipality:	Concord Township	**Location:**	Webb Creek along Concord Rd, Glen Mills, PA 19342
Property Type:	Residential,Commercial,Open Space,Rightofway		
Type of Problem(s):	Flooding, Accelerated Erosion ,Sedimentation - Insufficient/Aging Drainage Infrastructure		
Problem Description:	Limited details provided.		
Field Visit Notes:	Some erosion at data point adjacent to electric pole.		



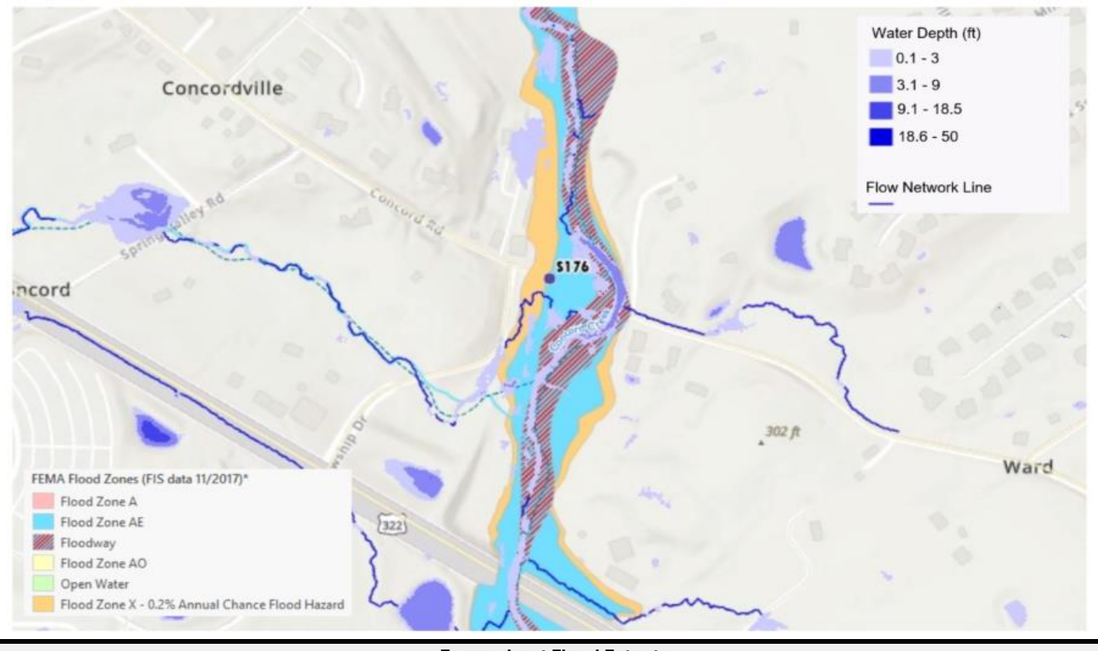
Channelized erosion near data point



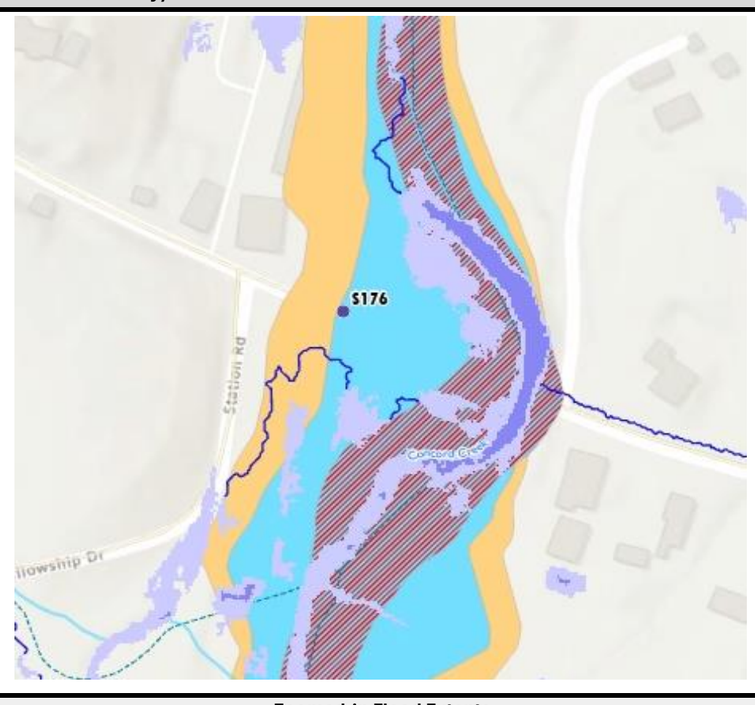
Minor signs of sedimentation from overland flows along Concord Rd

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stabilize Webb Creek Streambank
- Expand the floodplain

ID#S177 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Concord Creek	**Problem Area Submission Date:**	8/22/2025
Municipality:	Concord Township	**Location:**	Temple Road Bridge Over Webb Creek
Property Type:	Open Space, Rightofway		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation - Restricted Capacity		
Problem Description:	Limited details provided.		
Field Visit Notes:	Culvert 9.5 x 26 ft wide. Sedimentation in front of culvert. Downstream 2 24” RCP pipes discharge with no recent indication of discharge. Downstream stream bank eroding. No evidence of overtopping. Heavy vegetation appears to reduce flow.		



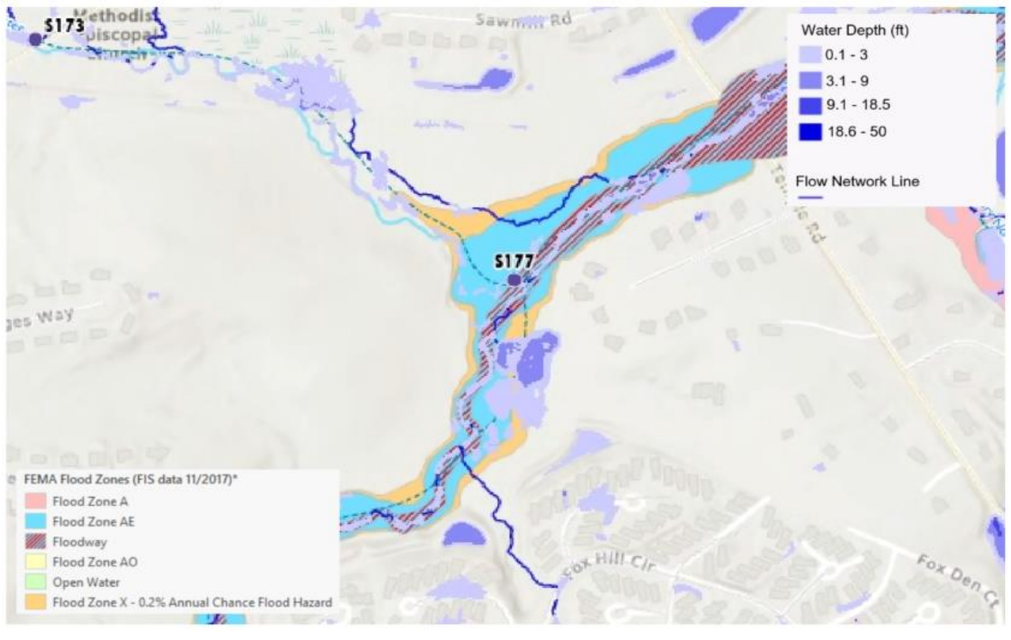
View of sedimentation on upstream end of box culvert



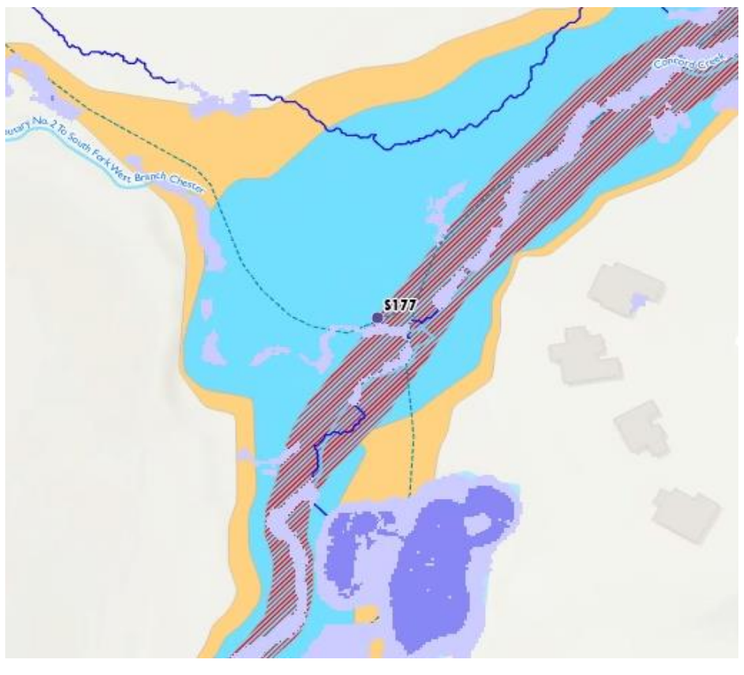
Downstream end of box culvert with 24" outflow

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Dredge the creek channel
- Remove excess vegetation within stream
- Stabilize streambanks
- Expand floodplain

Appendix G – Highest Priority Problem Area Solutions

Appendix G.1 – Potential Solution Analysis: R069

ID#R069 – Newsome Park and Weir Road Culvert
High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Marcus Hook Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	-
Municipality:	Aston Township	**Location:**	Weir Rd & Blackthorn Ln
Property Type:	Residential, Right of Way, Open Space		
Type of Problem(s):	Flooding		
Problem Description:	Flooding occurs due to undersized culvert and additions, patios, expanded driveways, decks, and sheds in the watershed without stormwater control		
Field Visit Notes:	At the south end of Newsome Pond Park, there is a paved loop road extending off of Weir Road. Behind the paved loop is a depression of about 4-ft depth and is behind a number of homes. The depression floods and causes build up of debris at the entrance of a rock banked channel entering another depression to the west of the paved loop with no apparent outlet pipe. Adjacent to both depressions is a stream with some bank erosion. The stream enters a culvert of 50-inch height and 80-inch width. About 20 ft into the culvert, an approximately 8-inch PVC pipe enters the culvert from the direction of the depression in the park. The culvert crosses Weir Road, as seen from two inlets on the road, underneath private property, and out a wall into Marcus Hook Creek in Weir Park. Property owner at 2335 Weir Road testifies that during intense storms, water flows over her yard, the neighbors' yard, and floods the entire baseball fields in Weir Park. She recently replaced her fence that was damaged by flood.		

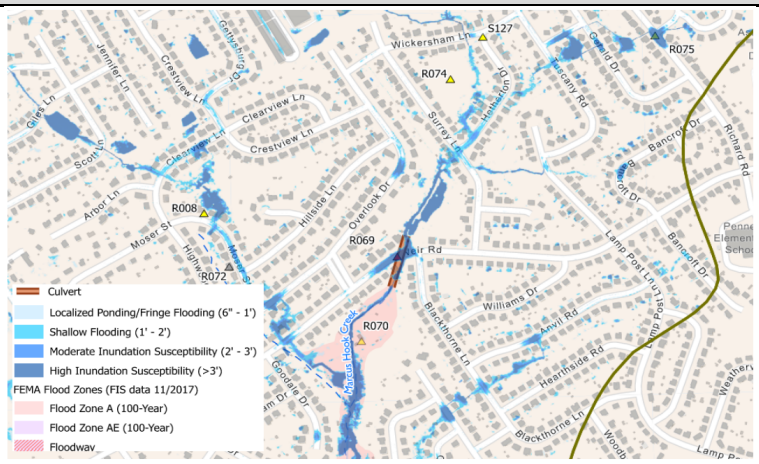


Headwall of storm pipe under Weir Road at Newsome Pond Park

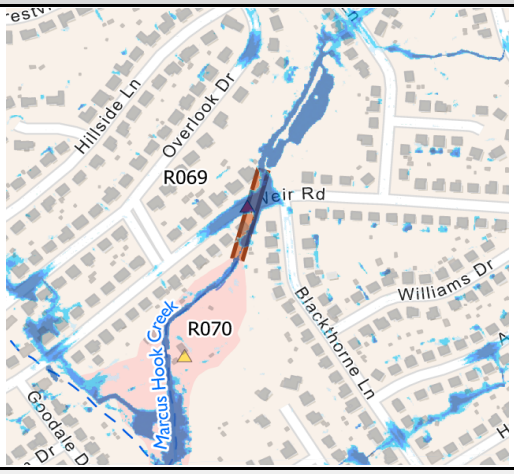


Depressed area behind pavement loop

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

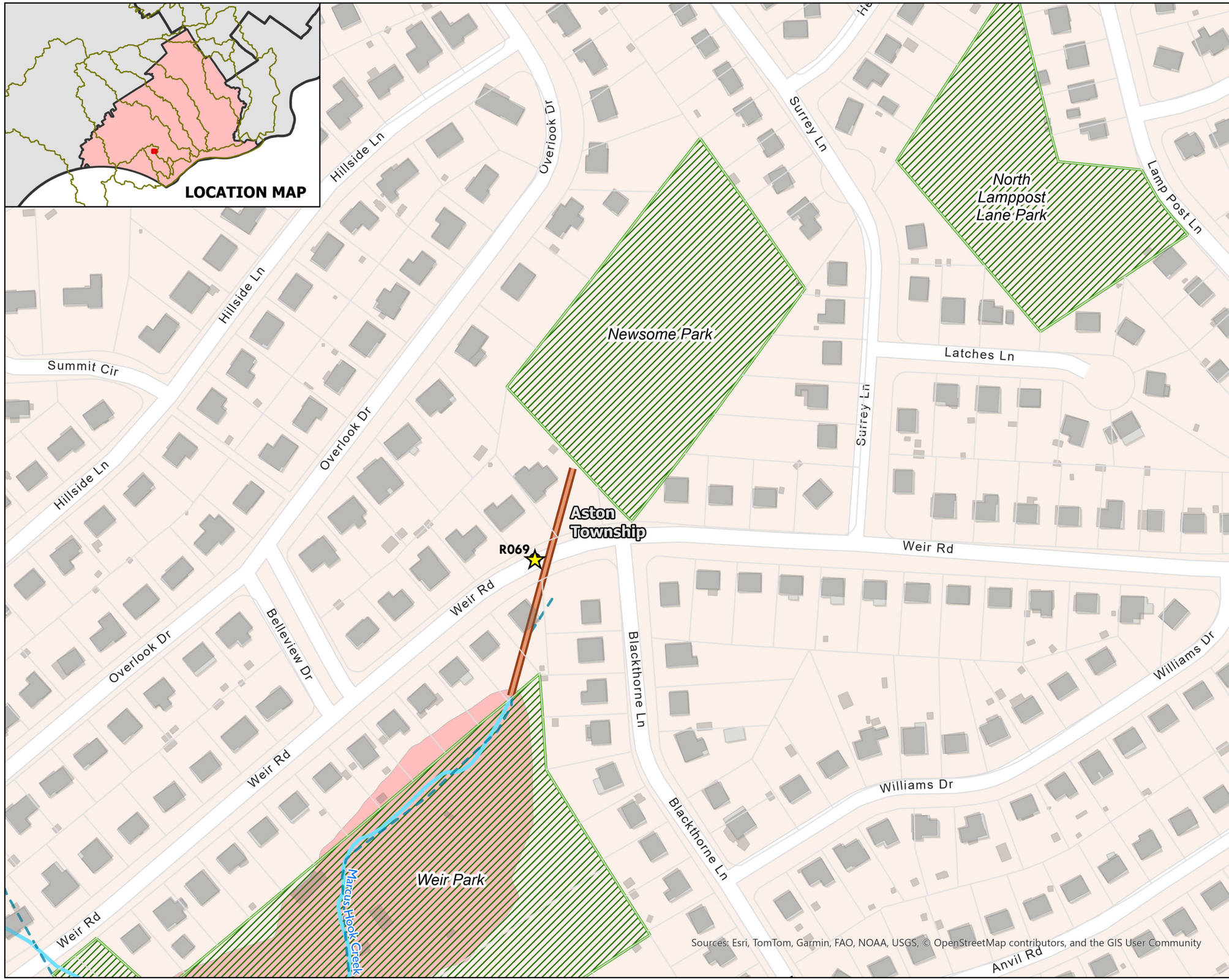
- Improve/upsize the storm pipe under Weir Road (without making downstream flooding worse)
- Stabilize streambanks upstream of the Weir Road pipe crossing
- Investigate opportunities for controlled retention / detention in Newsome Pond Park:
  - Eliminate paved loop and expand depressed areas to create more storage
  - Opportunities for wetlands and / or bioretention w/ new outlet control structure(s)

Supporting Analysis

R069 is located within the Marcus Hook watershed and was therefore included in the 2D HEC-RAS analysis developed for the Marcus Hook Creek Pilot Study, which can be found in Appendix B.1. Flooding of Weir Road and several residential properties in this area is likely the result of the existing culvert being insufficient to efficiently convey uncontrolled runoff from development in the watershed. The recommended strategy for this problem location is twofold (see the associated mapping in Appendix G.1): 1) Create enhanced retention / detention storage at Newsome Park 2) Provide enhanced conveyance under Weir Road and into the open channel at Weir Park.

There are several opportunities for enhancing retention / detention storage at Newsome Park. An approximately10,000 square foot bioretention basin (potential capacity of about 38,000k cubic feet) can be placed at the location of the existing paved loop on the south end of the park. Additionally, more significant storage volume within the wooded areas of the park can be achieved via strategies such as berms, retentive grading, and/or constructed wetlands. Improvements to the creek itself can also help mitigate the flooding, including: widening, step pools, and/or check dams. These improvements within the park would require coordination with stakeholders such as the Aston Township Parks and Recreation Committee, alignment with Township plans for the park, and input from a certified arborist to ensure minimal impacts to healthy mature trees. Downstream conveyance from the park would be improved by upsizing the existing storm culvert (approximately 500 linear feet) extending southward under Weir Road and into Weir Park. Detailed hydraulic modeling would be required to better understand the required sizing of both the storage improvements in the park and the upsized culvert so as to improve local flooding conditions and minimize the risk of negative impacts to downstream properties. The Marcus Hook Creek Pilot Study model may be of use towards additional and more detailed modeling efforts.

Estimated Cost Ranges:
1) Additional analysis: N/A
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: N/A



Delaware County Act 167 Stormwater Management Plan

R069 - Newsome Park and Weir Road Culvert - Additional Analysis

Legend

- Focus High Priority Problem Area
- Existing Culvert
- Streams - USGS NHD*
- Streams - Delaware County*
- County Boundaries
- Municipal Boundaries
- Watersheds
- Delaware County Building Footprints
- Parcels
- County Protected Land

FEMA Flood Zones (FIS data 11/2017)**

- Flood Zone A

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N

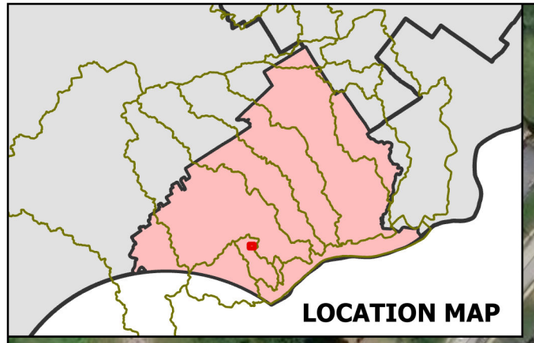
0 150 300 Feet

Map prepared by Jacobs and NTM 6/2/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Delaware County Act 167 Stormwater Management Plan

R069 - Newsome Park and Weir Road Culvert - Additional Analysis



Potential stormwater storage opportunities within the park include berms, retentive grading, and/or constructed wetlands

Proposed bioretention basin at existing paved loop

Proposed upsized storm culvert

Proposed stabilized outfall into Weir Park

R069

Aston Township

Newsome Park

North Lamppost Lane Park

Weir Park

Marcus Hook Creek

Hillside Ln

Summit Cir

Overlook Dr

Belleview Dr

Surrey Ln

Lamp Post Ln

Latches Ln

Weir Rd

Blackthorne Ln

Williams Dr

Anvil Rd

Microsoft, Vantor, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community

Legend

- Focus High Priority Problem Area
- Streams - USGS NHD*
- Streams - Delaware County*
- County Boundaries
- Municipal Boundaries
- Watersheds
- Delaware County Building Footprints
- County Protected Land
- Proposed Upsized Culvert
- Proposed bioretention basin

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N

0 150 300 Feet

Map prepared by Jacobs and NTM 6/3/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Appendix G.2 – Potential Solution Analysis: S002

ID#S002 – Kerlin Street Bridge and Nearby Upland Borough Problem Areas
High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Borough of Upland, PA
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/8/2025
Municipality:	Upland Borough	**Location:**	Kerlin Street Bridge at Chester Creek
Property Type:	Residential, Commercial, Industrial		
Type of Problem(s):	Flooding, Sedimentation		
Problem Description:	Problem causes include stormwater volume, stormwater velocity, stormwater direction, and water obstruction. Limited details provided.		
Field Visit Notes:	The bridge has sediment deposited on the south bank obstructing approximately 50% of flow. Stream follows old stone wall. Old bridge with piers collects debris and leads to sediment deposition. Bridge was recently dredged, but additional deposition was observed.		



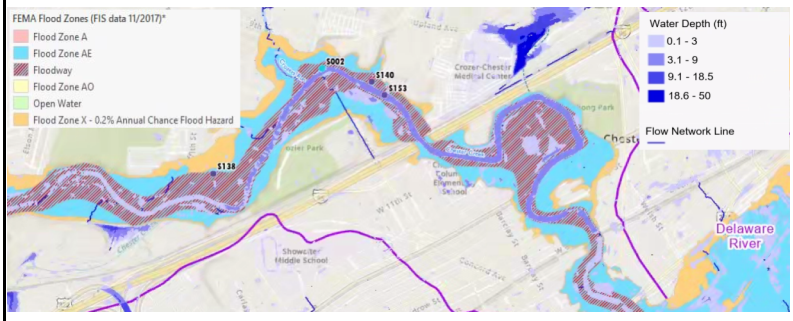
Sediment deposition along streambank



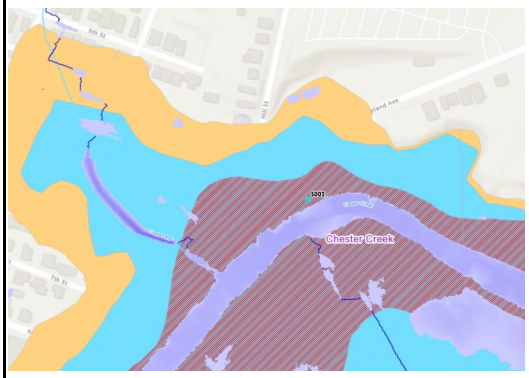
Sediment deposition along streambank

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Remove sediment
- Stabilize upstream streambanks
- Replace/elevate bridge
- Expand floodplain
- Evaluate opportunities for flood storage in Crozer Park

Supporting Analysis

The problem at S002 is located within Upland Borough in the Chester Creek watershed, and was reported as both a flooding and sedimentation problem. Site visit photographs (refer to Appendix G.2) show a high degree of sediment deposition in the vicinity of Kerlin Street Bridge. Though additional analysis is needed, S002 appears to be a stream deterioration situation wherein segments of Chester Creek are continually eroded and excess sediment is then naturally deposited at downstream locations where the physical conditions lead to decreases in velocity, such as at the Kerlin Street bridge and possibly even further downstream at locations S140 and S153 as well. The accumulation of sediment at these locations may be a factor in the observed flooding here, as it limits the conveyance capacity of the creek. There are potentially other factors at play in addition to sedimentation that also may be contributing to the flooding.

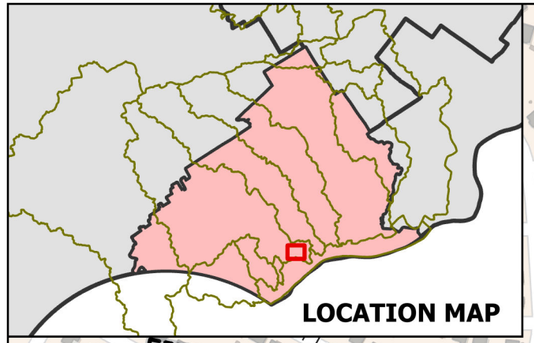
More detailed evaluations are recommended to better understand both the flooding at this location and the source of the observed sedimentation, and how they can be mitigated. A HEC-RAS model of Chester Creek can be adapted or else developed to analyze shear stress / stream power. Such a model would provide insights into the relationship between the creek's shear stresses and velocity profiles, and could be used to determine how much sediment would need to be removed to achieve desired lowered flood depths. It is further recommended to couple HEC-RAS with the Bank Stability and Toe Erosion Model (BSTEM) to simulate the relationship between creek bed and bank processes, which could further illuminate the likely source / mechanism of sedimentation and how it can be prevented. It should be noted that removing sediment from the creek will likely trigger multiple permits and entail substantial costs, including: site clearing and tree removal cost, excavation and removal of unsuitable material, erosion control, temporary construction entrances, permanent seeding, riprap for site restoration, and dewatering. Isolated removal of sediment is essentially a temporary measure. Following any activity to remove sediment, and without implementing any permanent sediment mitigation measures, it can be expected that sediment will immediately begin to collect again at these locations during subsequent storm events. Continued maintenance may be required to consistently maintain mitigatory flood reduction effects provided by the sediment removal. Therefore, in addition to the development of robust maintenance protocols, it is recommended to identify opportunities for permanent outfall energy dissipation, streambank stabilization, and/or forebay creation outside of the floodplain.

Lastly, it should be noted that Crozer Park, which is a public park immediately upstream of S002, could be re-imagined as a "floodable park" and evaluated as an opportunity to create significant flood and/or stormwater storage. With over six (6) acres of apparent open space, Crozer Park appears capable of temporarily storing 500k to 1.3M cubic feet of water. Other large public open spaces upstream of S002 should also be explored for similar opportunities.

Estimated Cost Ranges:
1) Additional analysis: Medium: ($50k-$250k)
2) Local improvements: Low (<$500k)
3) Watershed improvements: Medium ($3M-$10M)

Delaware County Act 167 Stormwater Management Plan

S002 - Upland Borough Problem Areas - Additional Analysis



Upland Borough

Chester Creek Watershed

Delaware River Watershed

Upland Baptist Church

Resurrection Life Church

Main Street Elementary School

Christopher Columbus Elementary School

Chester Upland School of the Arts

5 Point Plaza

Sam & Sam Meats

Phantom Fireworks of Upland

Upland Diner

Episcopal Place at Park Row

Hill Street Park

Upland Sitting Park

Bristol Lord Field

Upland County Park

Camp Upland Park

Crozer Park

Mother's Arch Park

Pusey Lease Area

Kerlin Street Bridge

S002

S140

S153

S138

017

Reimagine Crozer Park as "floodable" park with temporary surface and/or subsurface water storage

Oak Ln, Scott Ln, Knowledge Hall, 11th St, Main St, Woodside Ave, Church St, 12th St, Mulberry St, Wetherill St, W 24th St, W 23rd St, W 22nd St, W 21st St, Deepwater Ln, Clearwater Ln, Patton Ave, John F Kennedy Dr, Crozers Run, 10th St, 9th St, Maris Ln, Mulberry St, Hill St, W 24th St, W 21st St, Upland Ave, Powell Rd, Rural Ave, 6th St, 7th St, Seminary Ave, Crozer Chester Medical Center, Upland Ave, Kerlin St, Parker St, Finland Dr, Concord Ave, Pusey St, W 12th St, W 11th St, Taylor Ter, Main St, Griffith St, Glenway Ave, 4th St, 2nd St, Front St, Race St, Upland Rd, Incinerator Rd, Chester Creek, CSX Transportation Railroad, 95

Legend

- Focus High Priority Problem Area
- Nearby High Priority Problem Area
- County Owned Bridge
- Streams - USGS NHD*
- Streams - Delaware County*
- Railroads
- Municipal Boundaries
- Watersheds
- Delaware County Building Footprints
- County Protected Land
- County Owned Parcels

FEMA Flood Zones (FIS data 11/2017)**

- Flood Zone AE
- Floodway
- Flood Zone X - 0.2% Annual Chance Flood Hazard

Proposed Stream Gage Location

- Primary
- Proposed surface/subsurface storage

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N

0 500 1,000 Feet

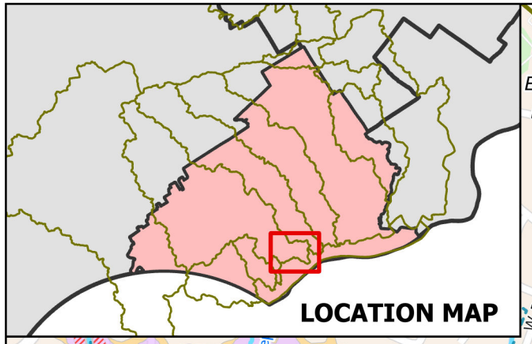
Map prepared by Jacobs and NTM 6/3/2026

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Delaware County Act 167 Stormwater Management Plan

S002 - Upland Borough Problem Areas - Additional Analysis



Legend

- Focus High Priority Problem Area
- Nearby High Priority Problem Area
- Green Stormwater Infrastructure (GSI) Locations*
- County Owned Bridge
- Streams - USGS NHD**
- Streams - Delaware County**
- Railroads
- Municipal Boundaries
- Watersheds
- County Protected Land
- County Owned Parcels

FEMA Flood Zones (FIS data 11/2017)***

- Flood Zone A
- Flood Zone AE
- Floodway
- Open Water
- Flood Zone X - 0.2% Annual Chance Flood Hazard

Proposed Stream Gage Location

- Primary
- Secondary
- Tertiary
- Backup Location
- Proposed Chester Creek Study Area

*Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.

**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

***The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N

0 750 1,500 Feet

Map prepared by Jacobs and NTM 6/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix G.3 – Potential Solution Analysis: S005

ID#S005 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Naamans Creek	**Source of Problem:**	Upper Chichester Township/Southeastern PA SWA
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/24/2025
Municipality:	Upper Chichester Township	**Location:**	2384 2nd Ave, Boothwyn, PA 19061 (adjacent property)
Property Type:	Residential,Commercial,Open Space,Rightofway		
Type of Problem(s):	Flooding - insufficient drainage infrastructure		
Problem Description:	Properties remains wet most of summer, animals get sick from stagnant water unable to drain		
Field Visit Notes:	Water on 2nd Ave flows between properties causing gully erosion deposit in the wooded area. 3rd Ave minimal flooding. Maltesta Ave has inlet and drains with no flooding. Woods area behind the 3 cul de sac flat and mildly saturated.		

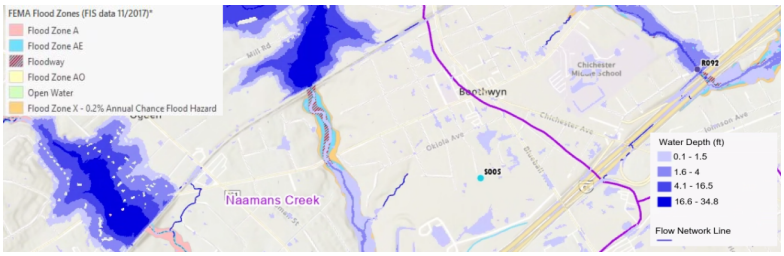


Curb cut at low point in cul-de-sac with channelized erosion path formed behind in grass

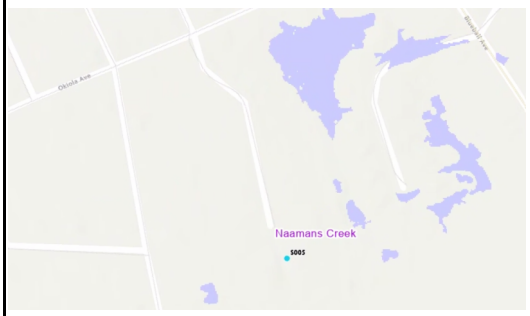


Wooded area behind properties where runoff from street drains to through gully

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

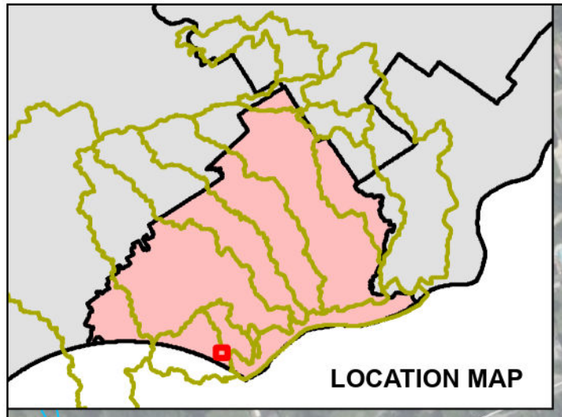
Potential Solutions

- Re-grade and line channel from roadway to rear of properties to allow for more efficient drainage.
- Install inlet at low point of culdesac and underground pipe to forest behind properties.
- Potential for new SCM basin in wooded area.

Supporting Analysis

Multiple properties on Malatesta Ave, 2nd Ave, and 3rd Ave in Boothwyn were reported to experience standing water and saturated grasses. The ponding water has become a hazard to animals in the area. The field visit observed existing drainage infrastructure is inadequate to capture and convey stormwater runoff from the roadways in this area. The National Resources Conservation Service soil maps show this area to have a shallow water table (2-3 ft below the surface) and hydrologic soil group 'D', which indicates low infiltration capacity. Flooding in this area appears to be the result of the runoff from impervious areas and natural hydrology at the site based on preliminary analysis and site assessment. The solution to flooding at this site will require the installation of conveyance measures to redirect water away from the area and directly into a stormwater management facility. Stormwater conveyances that discharge behind the homes at the end of the cul-de-sacs on these roadways are recommended. The outfalls of these drainage networks should be directed towards a non-infiltrating SCM. Upper Chichester Township owns a 4.1-acre plot of land in this area that abuts a wooded site owned by the Upper Chichester School District. Site conditions may be well-suited to the installation of an engineered stormwater treatment wetland, which can provide flood mitigation and ecological benefits. Engineered wetlands require several acres of open space, and while this area generally appears large enough, the presence of wooded areas may limit the required extents of a treatment wetland. Alternatively, bioretention or regenerative step pool conveyance systems could be considered, as they do not require as much open space as a treatment wetland.

Estimated Cost Ranges:
1) Additional analysis: N/A
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: N/A



Delaware County Act 167 Stormwater Management Plan

S005 - Boothwyn Town Center Problem Area - Additional Analysis

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 300 600 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits: © 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maplox

Appendix G.4 – Potential Solution Analysis: S016

ID#S016 – Wynnefield Drive Properties
High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Haverford Township
Minor Watershed:	N/A	**Problem Area Submission Date:**	7/29/2025
Municipality:	Haverford Township	**Location:**	Wynnefield Dr & Linden Dr
Property Type:	Residential, Open Space		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation		
Problem Description:	Problem causes include stormwater volume, stormwater velocity, and water obstruction. Limited details provided.		
Field Visit Notes:	Cobbs Creek is channelized in a tight corridor between a row of homes and a railroad track. Evidence of erosion and flooding of the creek. In the back alley, along the creek, there were sand bags between the curbs, most likely placed there by the residents, which implies hat the creek water level gets high enough to overflow the channel and into garages. Noted visible moss lines on some garage doors.		



Cobbs Creek along back alley off of Wynnefield Dr



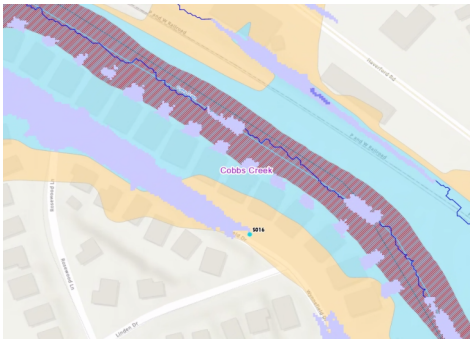
Sand bag placed between curbs along creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Remove sediment and vegetation from channel
- Evaluate upstream opportunities for stormwater capture (e.g., Merwood Park)
- Build up floodwall to protect homes

Supporting Analysis

S016 is located in Haverford Township along the Cobbs Creek and within its watershed. S016 is characterized by a tight stream channel directly adjacent to a private alley which is situated along the backyard of several residential homes with frontages along Wynnefield Drive. Both the alley along with the back portions of most of the homes fall within the FEMA floodway of Cobbs Creek, making this problem area a particularly dangerous and vulnerable site for the residents during larger rainfall events. It should also be noted that the SCALGO analysis tool (utilized for high level flood vulnerability mapping) also shows flood waters within the vicinity of these properties for smaller storms, including the 1-year and 5-year rainfall events.

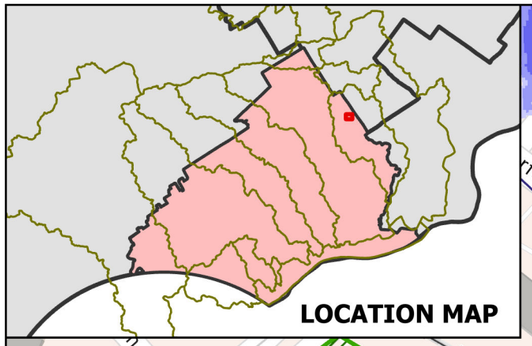
The recommended strategy for this problem location is threefold:
1) Create more capacity in the stream channel
2) Consider the use of an automatic / hydrodynamic flood barrier
3) Explore upstream opportunities for stormwater storage at publicly owned sites.

Additional capacity in the 1000-foot-long channel segment could be created by removing accumulated sediment and vegetation, as well as widening the channel by cutting back on the slope and/or constructing a retaining wall on the railroad side. There is also potential for providing auxiliary flood storage below the alley itself using high-capacity and traffic-rated storage media. A flood barrier using a passive hydrodynamic mechanism (approximately 950 linear feet long) could be installed along the creek-side of the alley to protect the adjacent houses along Wynnefield Drive from flood surges. Upstream public parks (Merwood Park, Normandy Park, and Elwell Field) and one public school (Chestnutwold Elementary School) could provide good opportunities for stormwater capture, most likely in the form of underground systems constructed with high-capacity storage media, that could be especially effective for smaller, more frequent storms while reducing the impacts or larger storms. Implementing any or all of these recommended strategies would entail extensive coordination with stakeholders such as the residents on Wynnefield Drive, SEPTA, Haverford Township Parks and Recreation, and possibly even the Haverford Township School District. Detailed hydraulic modeling would be required to better understand existing flooding extents and frequency, and to evaluate the effectiveness of the proposed solutions at minimizing the risk to both adjacent and downstream properties.

Estimated Cost Ranges:
1) Additional analysis: N/A
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: Medium ($3M-$10M)

Delaware County Act 167 Stormwater Management Plan

S016 -Wynnefield Drive Properties - SCALGO Flood Analysis - 1 Year Rainfall Event



Legend

- Focus High Priority Problem Area
- Nearby High Priority Problem Area
- Green Stormwater Infrastructure (GSI) Locations*
- Streams - USGS NHD**
- Streams - Delaware County**
- Flow Network Line - 1 Year Rainfall
- Railroads
- County Boundaries
- Municipal Boundaries
- Watersheds
- Delaware County Building Footprints
- County Protected Land

Water Depth (ft) - 1 Year Rainfall (2.7 inch runoff)

- 0.1 - 0.9
- 1 - 2.8
- 2.9 - 6
- 6.1 - 11.6
- 11.7 - 33.5

*Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.

**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0

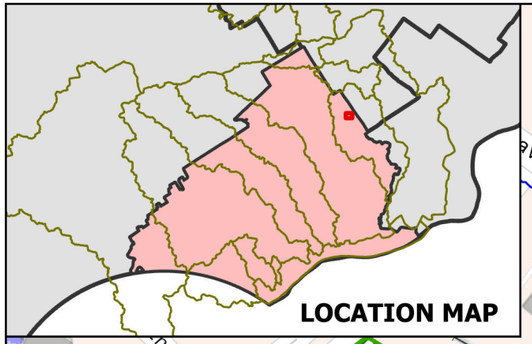
Map prepared by Jacobs and NTM 6/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

S016 -Wynnefield Drive Properties - SCALGO Flood Analysis - 5 Year Rainfall Event



Legend

- Focus High Priority Problem Area
- Nearby High Priority Problem Area
- Green Stormwater Infrastructure (GSI) Locations*
- Streams - USGS NHD**
- Streams - Delaware County**
- Flow Network Line - 1 Year Rainfall
- Railroads
- County Boundaries
- Municipal Boundaries
- Watersheds
- Delaware County Building Footprints
- County Protected Land

Water Depth (ft) - 5 Year Rainfall (4.1 inch runoff)

- 0.1 - 0.9
- 1 - 2.8
- 2.9 - 5.9
- 6 - 11.5
- 11.6 - 33.7

*Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.

**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0

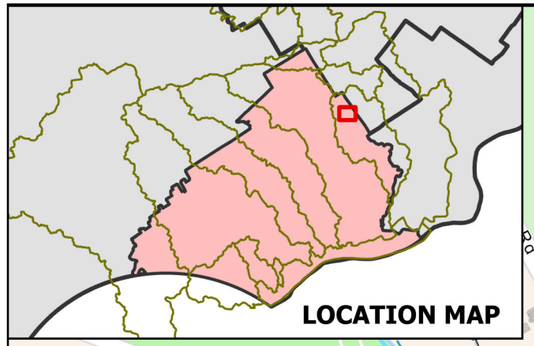
Map prepared by Jacobs and NTM 6/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

S016 -Wynnefield Drive Properties - Additional Analysis



Proposed Solution:
Potential subsurface storage/infiltration system and bioretention at Elwell Field (0.9 acre (+/-), 96k cubic feet (+/-) of storage), Normandy Park (0.3 acre (+/-), 36k cubic feet (+/-) of storage), Merwood Park (1.0 acre (+/-), 106k cubic feet of storage), and Chestnutwold Elementary School (0.8 acres (+/-), 82k cubic feet (+/-) of storage)

Potential opportunities to enhance channel conveyance and storage capacity (remove sediment and vegetation; widen the channel in the direction of the railroad; auxiliary storage below alley); potential to protect Wynnefield Drive properties via automatic flood barrier

Cobbs Creek Watershed

Haverford Township

HAVERFORD VILLAGE

ARDMORE PARK

MONTGOMERY COUNTY
DELAWARE COUNTY

Elwell Field
Normandy Park
Merwood Park
063
S016
S018

Merion Golf Club
Merion Golf Club-East Course
Ardmore Ave Station
Ardmore Junction Station
Wynnewood Road Station
Chestnutwold Elementary School
Saint Denis School
Rusty Nail Tavern
Sam's Brick Oven Pizza

Cobbs Creek
Tributary No.1 To Cobbs Creek
Tributary No.2 To Cobbs Creek

Overhill Rd, Glenbrook Rd, Valley View Rd, Morris Rd, Normandy Rd, Clifford Ave, Cricket Ave, Aubrey Ave, Oakford Rd, Hathaway Ln, Humphreys Rd, Chestnut Ave, Walnut Ave, Spring Ave, Biddle St, Golf House Rd, Taylor Ln, Harvest Ln, Golfview Rd, Sunnybrook Ln, Pine Valley Ln, Overbrook Ter, Cedarbrook Rd, Whitemarsh Rd, Huntington Ln, Shawnee Rd, St Davids Ln, Bala Ln, Woodcrest Ave, Patton Dr, Linden Dr, Poplar Rd, Loraine St, Belmont Ave, Rosemont Ave, Bryn Mawr Ave, Willow Ave, Avon Rd, Haverford Rd, Wynnefield Dr, E Eagle Rd, Kenilworth Rd, Bryn Mawr Ave

HCA 14
HCA 10
HCA 800

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Legend

- Focus High Priority Problem Area
- Nearby High Priority Problem Area
- Green Stormwater Infrastructure (GSI) Locations*
- Streams - USGS NHD**
- Streams - Delaware County**
- Railroads
- County Boundaries
- Municipal Boundaries
- Watersheds
- Delaware County Building Footprints
- County Protected Land

Proposed Stream Gage Location

- Backup Location
- Proposed Channel Improvements and Flood Mitigation Opportunities
- Proposed Underground Stormwater Storage

*Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.

**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 500 1,000 Feet

Map prepared by Jacobs and NTM 6/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Appendix G.5 – Potential Solution Analysis: S027

ID#S027 – Naylors Run Problem Areas
High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Pennoni
Minor Watershed:	Naylors Run	**Problem Area Submission Date:**	7/30/2025
Municipality:	Upper Darby Township	**Location:**	S 69th St & Marshall Rd
Property Type:	Residential, Commercial, Right of Way, Public (Other)		
Type of Problem(s):	Flooding		
Problem Description:	Very busy intersection of S 69th St and Marshall Rd is at a low point and directly on top of the buried Naylors Run; this location has a history of significant flooding, which has resulted in the loss of life		
Field Visit Notes:	Very steep and wide streets drain to the low spot at the intersection. This highly urbanized location is a large bowl that is predominantly impervious with almost no trees; it is easy to see how this area would flood in large storms, especially if inlets are maintained.		

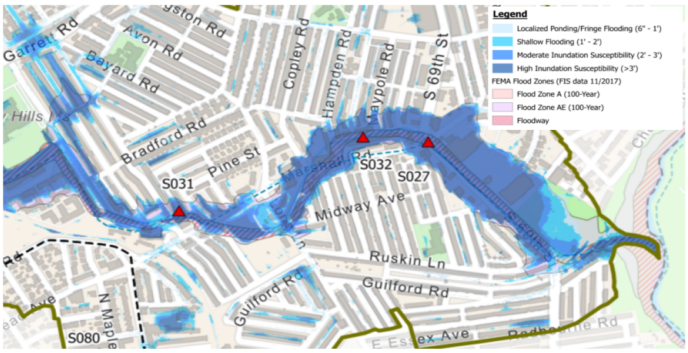


Example of highly impervious and steep street draining to the S 69th St & Marshall Rd intersection



The S 69th St & Marshall Rd intersection is a large bowl in a highly urbanized area

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Install new inlets at intersection and new auxiliary storm pipes under S 69th St to convey runoff to the 69th St Recreation Area; these pipes could potentially be combined with linear green stormwater infiltration (e.g., tree trenches) and would need to kept relatively shallow as they would be bucking grade as they head southeast under S 69th St
- Potential for subsurface storage system at 69th Recreation Area, but it would likely have to be relatively deep as the park sits approximately 14-15' above the elevation of the intersection
- Potential for subsurface storage systems in parking lots at shopping center north of S 69th St (Fresh Grocer, Popeyes, etc.)
- Evaluate upstream open space areas and parks for opportunities to capture stormwater
- Conduct additional detailed flooding study

Supporting Analysis

S027 is one of several high priority problem areas within the Naylors Run watershed, which is part of the larger Cobbs Creek watershed. Naylors Run watershed is of high interest due to its downstream contributions making up a significant portion of the floodwaters impacting the Eastwick community located within the City of Philadelphia. However, this particular area of Upper Darby Township is also prone to multiple instances of flooding along the approximate the length of the culverted portion of the Naylors Run stream. The most significant inundation occurs at the intersection of S 69th Street and Marshall Road, where at least one fatality has been recorded. This intersection is particularly susceptible to flooding due to it being located in a flat bowl at the bottom of several streets, some of which are very steeply sloped with insufficient drainage, as well as it being directly above the culverted Naylors Run. For these reasons, Naylors Run was selected for an additional 2D flood modeling analysis which can be viewed in Appendix B.3.

The recommended flood mitigation strategy for S027 would be multi-phased and would (at least partially) address the other high priority problem locations in the Naylors Run watershed (S031, S032, and S033). The three (3) phase approach would include:
Phase 1) Detailed H&H Model
Phase 2) Local Drainage Improvements
Phase 3) Blue/Green Stormwater Infrastructure

Phase 1 would entail the development of a more detailed hydraulic model that would incorporate existing storm pipes, the pump station in the vicinity of S031, and the Naylors Run Dam. This model, which would be further refined by higher quality datasets and topographic surveys, would be used to better evaluate existing flood conditions and the potential benefits/impacts associated with various proposed drainage solutions. It is likely that the planning-level model referenced in Appendix B.3 would serve as a valuable tool for designating future modeling steps or including more detailed expansion.

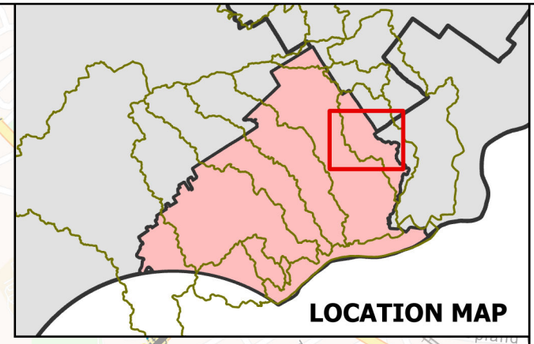
Phase 2 would entail the implementation of local drainage improvements in the vicinity of S027. Specifically, it is proposed to install an auxiliary drainage network consisting of various new catch basins and approximately 2,000 linear feet of new storm pipe extending from Veronica Road to the 69th Street Recreation Area. This drainage network would be relatively shallow, mildly sloped, and sized to convey smaller, more frequent storms or to provide auxiliary conveyance for larger flood events. The new storm pipe would extend "down" S 69th Street, potentially integrated with tree trenches, and into the recreation area where it would drain into a 5-acre underground storage / infiltration system (5 feet deep with a potential storage capacity of 1M cubic feet) that would overflow into Naylors Run. Given that S027 is located at a low point at the intersection of S 69th Street and Marshall Road, the proposed storm pipe would have to "buck" grade, which would result in the underground storage system at the recreation center being relatively deep (20-25 feet). A thorough geotechnical investigation would be required to confirm the feasibility of this concept.
In addition to the above local drainage improvements, it is also recommended to add street inlets to both S 69th Street and Marshall Road, north and east of S027, respectively. This will allow for more efficient use of the existing storm pipes on these streets, especially S 69th Street, which is very steep and likely experiences significant flow bypass during in

Phase 3 would entail the implementation of several large-scale blue/green stormwater infrastructure projects at various large "open" spaces throughout the watershed, with a potential combined storage capacity of 1.6M cubic feet.
Potential projects on publicly owned land can include:
•Constructed wetlands/bioretention basin and/or underground stormwater storage / infiltration systems at Upper Darby High School and Naylors Run Park (760k cubic feet of storage)
• An underground storage / infiltration system at the Beverly Hills Recreation Area (400k cubic feet of storage)
•An underground storage / infiltration system at the Cardington Recreation Area Park (100k cubic feet of storage)
Potential projects on privately owned land can include:
•An auxiliary drainage network (650 linear feet) and constructed wetlands/bioretention basin at a PECO electrical substation (175k cubic feet of storage)
•An underground storage / infiltration system at the shopping center located southeast of the intersection of S 69th Street and Marshall Road (200k cubic feet of storage) that could be connected to the drainage network proposed in the Phase 2.

Estimated Cost Ranges:
1) Additional analysis: Medium ($50k-$250k)
2) Local improvements: High (>$2M)
3) Watershed improvements: High (>$10M)

Delaware County Act 167 Stormwater Management Plan

S027 - Naylors Run Problem Areas - Base plan & High Level HEC-RAS Flood Analysis Results - 100 Year Rainfall



Legend

- Focus High Priority Problem Area
- Nearby High Priority Problem Area
- County Owned Bridge
- County Owned Trail
- Streams - USGS NHD**
- Streams - Delaware County**
- Existing Culvert (Modeled Structure)
- Railroads
- County Boundaries
- Municipal Boundaries
- Naylors Run Subwatershed
- County Protected Land
- County Owned Parcels
- Proposed Area for Detailed Flood Analysis

100-year Flood Vulnerability Category**

Value

- Shallow Localized Ponding or No Ponding***
- Localized Ponding/Fringe Flooding (6" - 1')
- Shallow Flooding (1' - 2')
- Moderate Inundation Susceptibility (2' - 3')
- High Inundation Susceptibility (>3')

**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**Ponding depths are intended for high level visualization of flood vulnerable regions within the study area. See accompanying memo for detailed explanations of study limitations and assumptions.

***Shallow localized ponding areas are defined as locations where model output is less than 6" deep. These depths are comparable to curb height, and are excluded from this map.

N

0 1,000 2,000 Feet

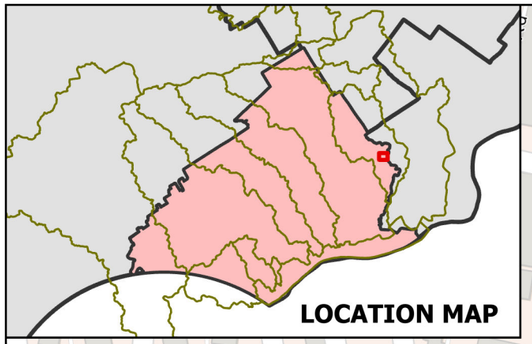
Map prepared by Jacobs and NTM 6/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

S027 - Naylors Run Problem Areas - Additional Analysis



Add storm inlets along steep segments of Marshall Road and S 69th Street to improve efficiency of existing drainage network

Underground stormwater storage/ infiltration system (below parking lots); Area: 2 acres (+/-), Storage Depth: 4 feet (+/-), Storage Volume: 200k cubic feet (+/-)

Auxiliary storm pipe to underground system (w/ new inlets and storm laterals, not shown); Length: 2000 feet (+/-)

Underground stormwater storage/ infiltration system (below playfields at 69th Street Recreation Area), Area: 5 acres (+/-), Storage Depth: 5 feet (+/-), Storage Volume: 1M cubic feet (+/-)

Underdrain / overflow pipe to Naylors Run; Length: 250 feet (+/-)

Approximate location of existing stormwater wetlands

S032

S027

R013

001

081

69th Street Recreation Area

Cobbs Creek Watershed

Rocklyn Rd

Marshall Rd

Perry Ave

Church Ln

Watkins Ave

Montgomery Ave

Copley Rd

Sunoco

The Fresh Grocer of Upper Darby

Popeyes

Wawa

S 69th St

Naylors Run

Cobbs Creek

PHILADELPHIA COUNTY

DELAWARE COUNTY

Cobbs Creek Community Environmental Center

Hampden Rd

Glendale Rd

Littlecroft Rd

Millbank Rd

Calvin Rd

Woodcliffe Rd

Timberlake Rd

Midway Ave

Patterson Ave

Richfield Rd

Maypole Rd

Wiltshire Rd

Shirley Rd

Snowden Rd

Stonehurst Hills Elementary School

Ruskin Ln

Bradford Rd

Guilford Rd

Aberdeen Rd

Le Carra Dr

Clinton Rd

Houston Rd

Hartley Rd

Andover Rd

Briarcliff Rd

Walnut Pl

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Legend

- Focus High Priority Problem Area
- Nearby High Priority Problem Area
- Streams - USGS NHD*
- Streams - Delaware County*
- Existing Culvert (Modeled Structure)
- Railroads
- County Boundaries
- Municipal Boundaries
- Watersheds
- Proposed Stream Gage Location
- Proposed Auxiliary Storm Pipe
- Proposed Underground Stormwater Storage

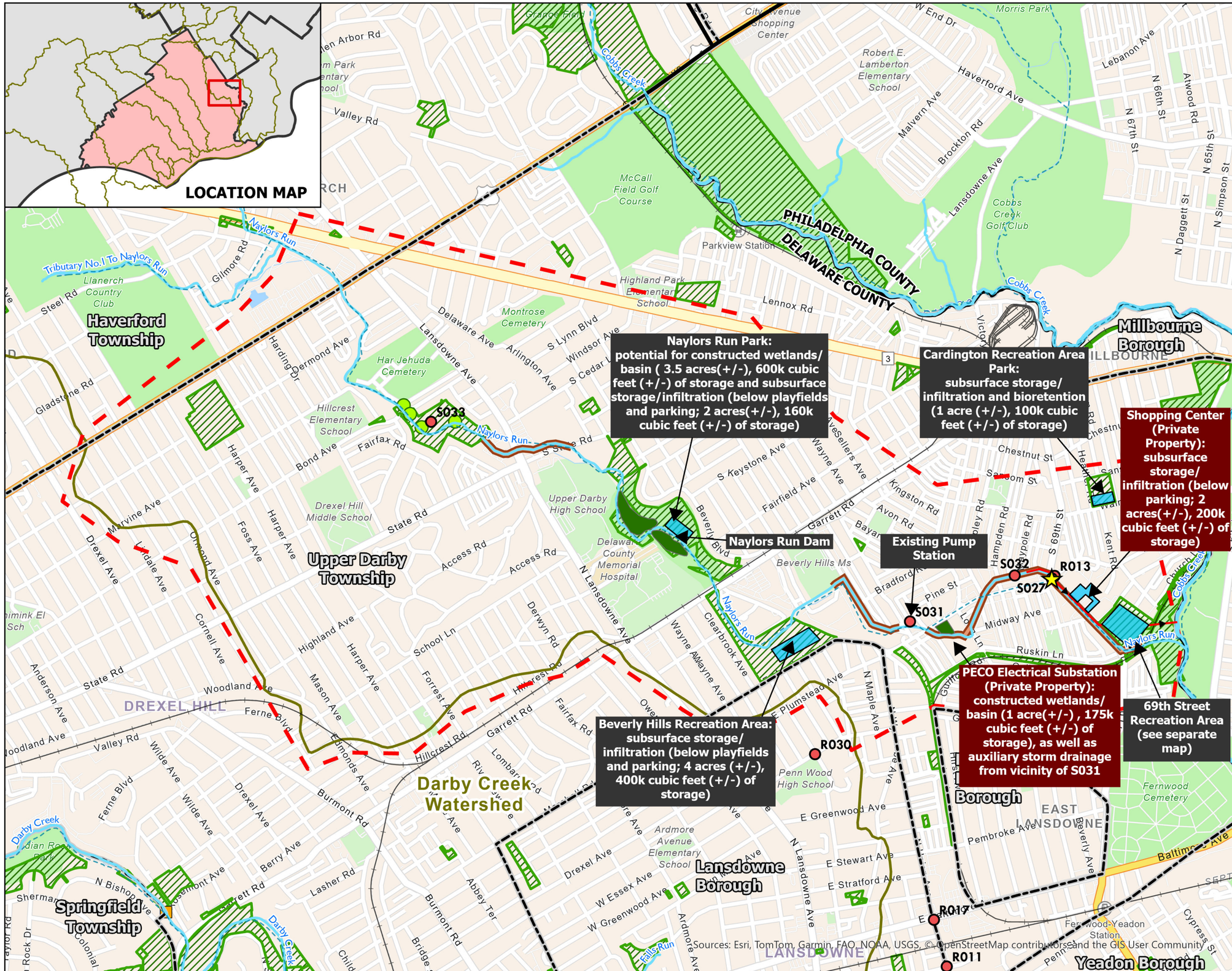
*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 150 300 Feet

Map prepared by Jacobs and NTM 6/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department



Delaware County Act 167 Stormwater Management Plan

S027 - Naylors Run Problem Areas - Additional Analysis

Legend

- Focus High Priority Problem Area
- Nearby High Priority Problem Area
- Green Stormwater Infrastructure (GSI) Locations*
- Existing Stormwater and GSI Projects*
- County Owned Bridge
- Streams - USGS NHD**
- Streams - Delaware County**
- Existing Culvert (Modeled Structure)
- Railroads
- County Boundaries
- Municipal Boundaries
- Watersheds
- County Protected Land
- Proposed Auxiliary Storm Pipe
- Proposed Underground Stormwater Storage
- Proposed Area for Detailed Flood Analysis
- Proposed Wetlands/Basins

*Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.

**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

N

0 1,000 2,000 Feet

Map prepared by Jacobs and NTM 6/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Appendix G.6 – Potential Solution Analysis: S054

ID#S054 – Confluence of Crum Creek and Lewis Run
High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Crum Creek	**Source of Problem:**	Newtown Township
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/1/2025
Municipality:	Newtown Township	**Location:**	Boot Rd & Goshen Rd
Property Type:	Open Space, Right of Way, Public (Other)		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation		
Problem Description:	Limited details provided.		
Field Visit Notes:	Stormwater volume appears to overwhelm the creek. There are not ongoing issues towards the new bridge downstream. There is more erosion upstream.		



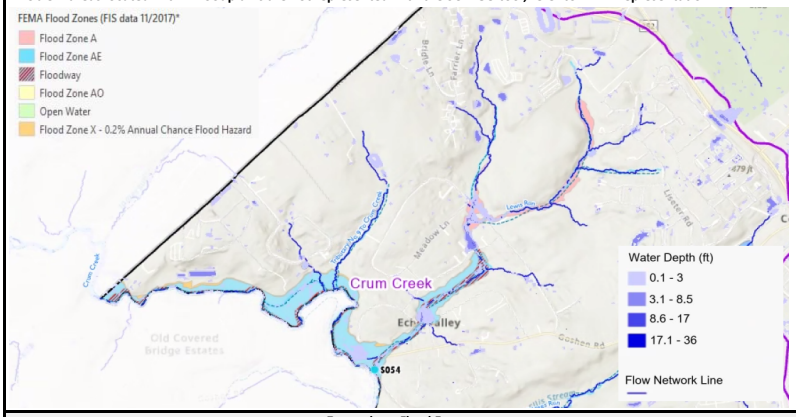
Erosion along creek



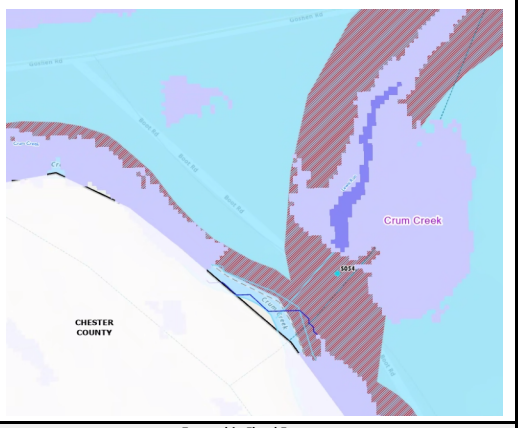
Erosion along creek

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Street channel restoration / stabilization along defined flow path surcharging location.
- More riparian vegetation to reinforce the areas that were eroded. Define riparian buffer along floodplain between creek and roadway. Stabilizing efforts along creek stretch.
- Possibility of storage by the bridge. Pending E&S study and confirmation of flooding characteristics during events.

Supporting Analysis

S054 is located in Newtown Township at the intersection of Boot Rd and Goshen Rd. The problem area is characterized by extreme roadway flooding at the intersection which is located directly downstream of the confluence of Lewis Run Creek with Crum Creek. The location is also in close proximity to the border that Delaware County shares with Chester County. The recommended strategy for this problem area is twofold:
1) Develop a detailed flood model to better understand the flooding extents and frequency
2) Provide additional flow capacity, stabilization, and roadway traffic safety measures for this stretch of Crum Creek.

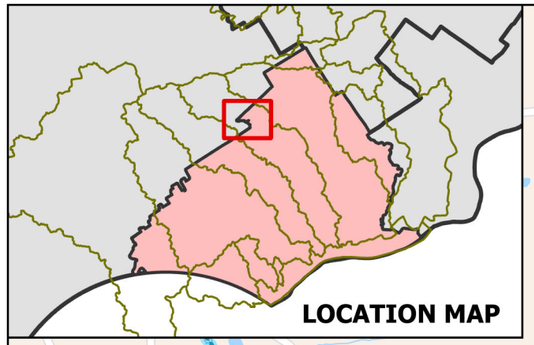
The point of interest for the recommended flood model would be the confluence of the Crum Creek and Lewis Run, the former of which includes a significant tributary drainage area within Chester County. The purpose of the study would be to determine which storm event causes the yearly flooding noted in the problem survey and to evaluate the benefits and potential downstream impacts of any proposed mitigation solutions. Lewis Run appears to be a small sub-watershed which can be easily characterized for modeling. Per Section 4.6 of this Plan, there are proposed stream gages directly upstream and downstream of the area of interest which, once operational, would potentially make this modeling effort substantially easier. Model scenarios should also capture upstream storage opportunities within both Delaware County and Chester County to determine their flood reduction potential.

Potential local improvements include: widening the floodway, stabilizing the banks via vegetative or structural means, and enhancing or expanding the wetlands area at the southeast corner of the intersection of Goshen Road and Boot Road. In addition, traffic calming and safety improvements should be implemented along the creek-side of Boot Road, for approximately 500 linear feet south of the intersection. Currently, this stretch of roadway is very exposed with no visual or physical markers to separate it from the floodplain limits. Drivers of this roadway at night are likely at risk, regardless of creek flooding. Signs warning of potential flooding at this location are also recommended.

Estimated Cost Ranges:
1) Additional analysis: Low (<$50k)
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: N/A

Delaware County Act 167 Stormwater Management Plan

S054 - Confluence of Crum Creek and Lewis Run -Additional Analysis



Legend

- Focus High Priority Problem Area
- Nearby High Priority Problem Area
- Green Stormwater Infrastructure (GSI) Locations***
- Streams - USGS NHD*
- Streams - Delaware County*
- County Boundaries
- Watersheds
- Delaware County Building Footprints
- County Protected Land

FEMA Flood Zones (FIS data 11/2017)**

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone X - 0.2% Annual Chance Flood Hazard
- Proposed Potential Wetland Expansion/ Stabilization
- Lewis Run Sub-watershed
- Proposed Stream Gages
- Proposed Potential Floodway Expansion/ Streambank Stabilization

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N

0 750 1,500 Feet

Map prepared by Jacobs and NTM 6/4/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Appendix G.7 – Potential Solution Analysis: S073 / S091

ID#S073 – Darby Creek Problem Areas
High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Lighthouse Engineering, LLC
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/3/2025
Municipality:	Lansdowne Borough	**Location:**	Scottdale Rd & Hilldale Ave at Shrigley Woods Park
Property Type:	Open Space, Right of Way		
Type of Problem(s):	Flooding, Accelerated Erosion, Sedimentation		
Problem Description:	Heavy flooding causes road closures.		
Field Visit Notes:	Significant signs of erosion all along the streambank. Walked along Scottdale Road and noted that Shrigley Woods Park is more of a wetland than an active park. The road is not very wide and could easily flood and not be usable in case of strong storms. Update 11/5/25: Clarification on survey reports. "Swells" refers to the rising of the stream. Video of flooding of the nearby Hoffman Park Tennis Courts and at Scottdale Road here: https: //www.youtube.com/watch?v=IdEidV3RXzk		



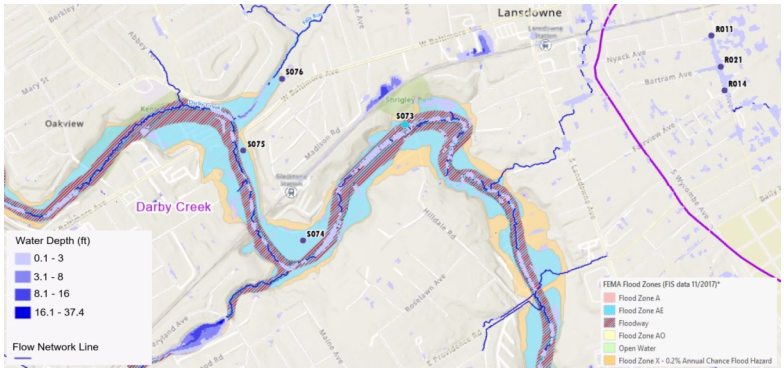
Erosion along streambank



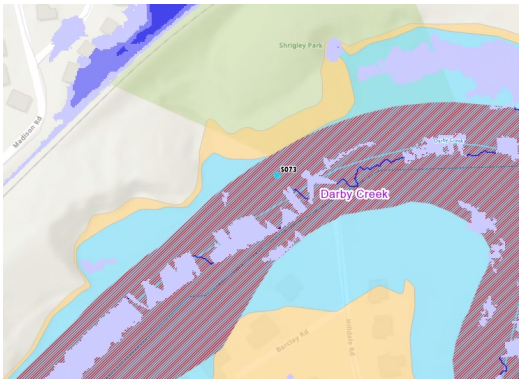
Shrigley Park

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

Comprehensive detailed 2D HEC-RAS model is recommended for the Darby Creek watershed with the focus of capturing all nearby roadway flooding regions, including S073 and several others. Upstream storage/infiltration scenarios to be included, as well as emphasis on the Delco Woods County Park site. See Supporting Analysis.

Supporting Analysis

S073 is one of several locations of high profile roadway flooding along the Darby Creek. Scottsdale Road at the intersection of Hilldale Ave next to the Shrigley Woods Park, has significant flooding occurrences reported more than once per year and lasting for multiple days at a time. Scottsdale Road is located in close proximity to the Darby Creek, and the flooding there is also associated with Problem Ares S075 and S074. 2011 Hurricane Irene video footage provided by the municipalities, show the entire roadway and nearby parks engulfed within the swells of Darby Creek. There are many other locations of the Darby Creek watershed with significant roadway flooding, which also include: S091, S088, S089, and S106. These are located in multiple boroughs including Clifton Heights, Lansdowne, Darby, and Collingdale. Similar to S073, it was reported at S091 (which is Pine Street and its bridge where it crosses the Darby Creek), that flood waters have impacted nearby structures, roadways, and park land, though the observed frequency was less than once per year and the duration was less than one day. Delaware County EMS reported that during the 1999 Hurricane Floyd, the water level reached the top of this bridge.

Before meaningful flood solutions can be developed for these problems, it is recommended that a detailed, watershed-wide HEC RAS model be developed for the Darby Creek, using reports and video from Hurricanes Floyd (1999) and Hurricane Irene (2011) as validation points, alongside available USGS stream gage data and FEMA flood insurance study data, as well as any other collaborative modeling initiatives taking place with the County's other stakeholder partners. This exhibit displays these features alongside strategic proposed stream gages from the Stream Gage Locations Analysis in Section 4.6 which will also be very beneficial to a future modeling analysis of the Darby Creek.

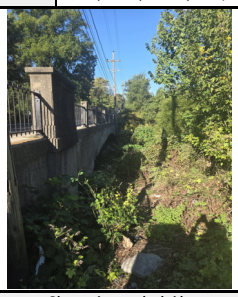
While roadway/bridge flooding was noted at the various impacted locations, at locations S073, S074, and S075, flooding was observed to occur with a relatively high frequency of more than once per year, meaning that Darby Creek is flooding significantly for less than the 100-year event. The detailed flood model would be used to verify which event is causing roadway flooding in all cases, define overtopping, and facilitate scenarios to be run for potential solutions such as floodplain benching / expansion, clearing of channel obstructions, watershed-wide storage opportunities, and other nature-based solutions. The downstream boundary conditions for the model would have to be closely coordinated with the previously completed detailed modeling efforts and proposed solutions developed for the Eastwick neighborhood further downstream, southeast of the confluence of the Darby and Cobbs Creeks.
A key focus of the evaluation will be to determine what degree of upstream storage or infiltration projects can alleviate the downstream instances of roadway flooding. The Delco Woods County Park is at an ideal location, midway through the Darby Creek watershed, and it can be a suitable host to a variety of stormwater measures such as; wetlands, stream restoration, and green stormwater infrastructure. It is recommended that this site be vetted further for future potential.
Additionally, it is strongly recommended that this evaluation be included with other Darby-Cobbs initiatives that the County is proposing for inclusion within the upcoming Pennsylvania Water Resources Development Act (WRDA). Refer to Section 7.5 Funding and Grant Opportunities for more information.

Estimated Cost Ranges:
1) Additional analysis: High (>$250k)
2) Local improvements: High (>$2M)
3) Watershed improvements: High (>$10M)

ID#S091 – Naylors Run Problem Areas
High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Civil Collaborative Concepts, LLC
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Darby Borough	**Location:**	Pine St over Darby Creek
Property Type:	Residential, Commercial		
Type of Problem(s):	Flooding		
Problem Description:	Water enters structures and floods roadways and park land.		
Field Visit Notes:	In the park east of the creek, there is a soccer field and an unused green space. Conveyance under the Pine Street bridge appears to be obstructed by vegetation in the channel. 11/3 update: per Larry Bak (DelCo Emergency Services), during Hurricane Floyd, the water level in the creek rose up to the top of the Pine Street bridge.		



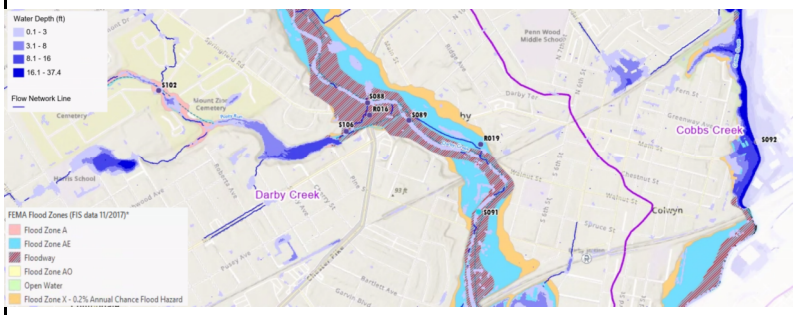
Obstructions under bridge



Green space along creek at Pine St & S 7th St

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



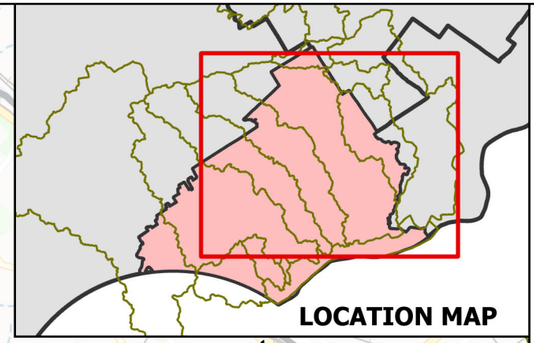
Zoomed-in Flood Extents

Potential Solutions

- Downstream conveyance capacity needs to be increased
- Subsurface floodplain restoration opportunities.
- Combination of subsurface and surface storage at the soccer field area.
- Possibility of expanding the floodplain using the green area between the channel and the soccer field. Possibility of expanding the floodplain downstream as well.
- Look for upstream flood storage opportunities.
- Need to clear obstructions from channel.
- See the Potential Solution Analysis form for S073 for additional supporting analysis related to this problem location

Delaware County Act 167 Stormwater Management Plan

S073 - Darby Creek Problem Areas - Additional Analysis



Legend

- Focus High Priority Problem Area
- Nearby High Priority Flooding Problem Area (Along Darby Creek)
- Existing Stormwater and GSI Projects*
- Existing USGS Stream Gage
- Historical Flooding Locations (Hurricane Irene & Hurricane Floyd)
- FEMA Effective Model Cross Sections
- Streams - USGS NHD**
- Streams - Delaware County**
- Focus Flooded Roadways
- Railroads
- County Boundaries
- Darby Creek Watershed - Beyond Limits of Proposed Additional Study Area
- Darby Creek Watershed - Proposed Study Area

Proposed Stream Gage Location

- Primary
- Secondary
- Tertiary
- Backup Location
- Removed

*Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.

**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines.

N

0 5,000 10,000 Feet

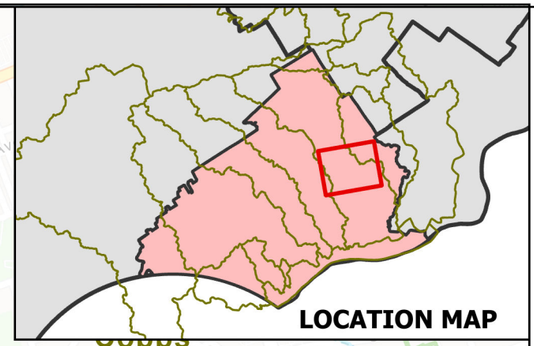
Map prepared by Jacobs and NTM 6/5/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

S073 - Darby Creek Problem Areas - Additional Analysis



Legend

- Focus High Priority Problem Area
- Nearby High Priority Flooding Problem Area (Along Darby Creek)
- Existing Stormwater and GSI Projects*
- Existing USGS Stream Gage
- Historical Flooding Locations (Hurricane Irene & Hurricane Floyd)
- FEMA Effective Model Cross Sections
- Streams - USGS NHD**
- Streams - Delaware County**
- Focus Flooded Roadways
- Railroads
- County Boundaries
- Watersheds
- Darby Creek Watershed - Beyond Limits of Proposed Additional Study Area
- County Protected Land
- County Owned Parcels

Proposed Stream Gage Location

- Primary
- Tertiary
- Backup Location
- Removed

- Darby Creek Watershed - Proposed Study Area
- Potential Areas for Stormwater Management Facilities

*Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.

**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines.

N

0 1,000 2,000 Feet

Map prepared by Jacobs and NTM 6/5/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix G.8 – Potential Solution Analysis: S085

ID#S085 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Brookhaven Borough
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Brookhaven Borough	**Location:**	722 Cambridge Road, Brookhaven, PA
Property Type:	Residential,Open Space		
Type of Problem(s):	Accelerated Erosion		
Problem Description:	Restricted capacity, insufficient/aging drainage infrastructure		
Field Visit Notes:	Inlet location severely eroded with trees downed upstream. About 50' upstream of the inlet there is extreme erosion. Outlet structure is disconnected causing all flow from upstream culvert to flow overland causing erosion.		





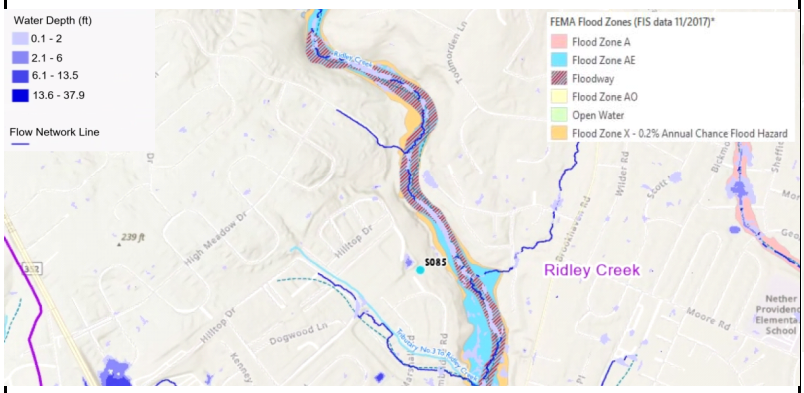
Old disconnected outlet structure (on left) and severe erosion immediately down gradient (on right)



View of inlet location with channelized erosion and downed trees upgradient

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Stabilize streambanks.
- Reduce peak rates either upstream or reconnect outlet structure and retrofit existing basin.

Supporting Analysis

Erosion was reported at point S085 along Ridley Creek between Parkview Drive and Cambridge Road at Brookhaven Memorial Park. Erosion and sedimentation, flooding, and water rescues were reported throughout the length of the stream in Delaware County. As such, the solution at S085 includes local improvements, additional analysis, and watershed-scale improvements.

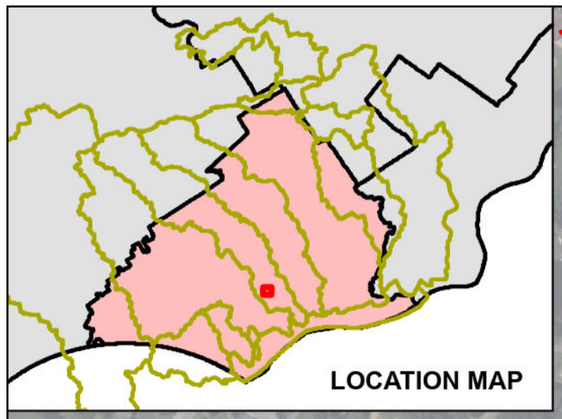
The stream erosion has led to the undermining of stormwater infrastructure at this location and further erosion has potential to cause damage to homes. Recommended local improvements include restoration of existing infrastructure for stormwater conveyance and streambank armoring.

An in-depth analysis of the stream is recommended in coordination with Chester County to identify potential stormwater management controls throughout the watershed, including within the headwaters in Chester County where less development has been established. Analysis can help determine the best areas for stream restoration, as well as areas for stormwater infiltration/retention basins to reduce peak rates and volume in the watershed. Bethel Township owns property upstream of S094 that could be used for such facilities.

Estimated Cost Ranges:
1) Additional analysis: High (>$250k)
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: High ($10M)

Delaware County Act 167 Stormwater Management Plan

S085 - Brookhaven Memorial Park Problem Area - Additional Analysis



Reimagine Brookhaven Memorial Park as a floodable park with temporary surface and/or subsurface water storage

The Mills at Rose Valley/NLT Conservation Easement

Rose Valley Borough

Brookhaven Memorial Park

S085

S085

Brookhaven Borough

Nether Providence Township

Proposed stream restoration area along embankments and stabilize areas of erosion

bing

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 250 500 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits: © 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maptox

Appendix G.9 – Potential Solution Analysis: S092

ID#S092 – Eastwick Problem Areas
High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Cobbs Creek	**Source of Problem:**	Civil Collaborative Concepts, LLC
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Darby Borough	**Location:**	11 Main St
Property Type:	Residential, Commercial, Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Water enters structures and floods roadways		
Field Visit Notes:	Clear signs of erosion. Shallow upstream channel that looks like it could flood easily. Lots of debris obstructing flow path.		



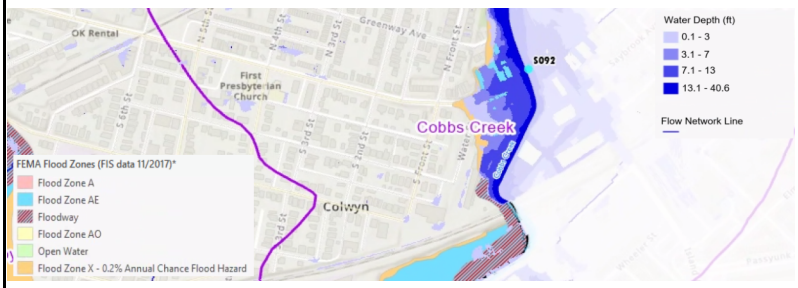
Erosion along streabank



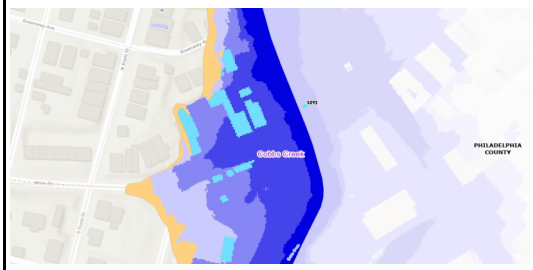
Debris along channel

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Potential to make the floodplain wider upstream and downstream of Woodland Ave
- Upstream floodplain expansion possible on the east side, by the trail
- Clear concrete debris within channel
- Opportunity for large underground stormwater storage system (floodplain restoration) at nearby bus parking lot

Supporting Analysis

S092 is along Woodland Avenue within the Cobbs Creek watershed at the location of the stream itself which is just west of the intersection with South Cobbs Creek Parkway and is also at the border of Delaware County and the City of Philadelphia. Refer to Figure 16 for the location of S092. This problem area is in Darby Borough, and is characterized by Cobbs Creek floodwaters entering roadways and structures. Most notably, this is one of a cluster of reported problem areas that fall within the Eastwick flooding area which is the focus of a number of current flood mitigation studies in partnership with USACE, the City of Philadelphia (Philadelphia Water Department (PWD) and Office of Sustainability), Delaware County, Drexel University, Flood Mitigation Council of Eastwick (FMCE), US Fish and Wildlife Service, and a variety of other stakeholders and organizations. Other high priority problem areas reported from the WPAC survey within this region include S152, which is a privately owned and abandoned warehouse property along the Darby Creek just south of the Amtrak railroad in a heavily wooded and floodable area along the creek. Another problem area is R062, which is the potential site of a flood barrier. R062 is located within the City of Philadelphia.

Analysis incorporated review of the following sources: Draft Integrated Feasibility Report & Environmental Assessment (USACE and PWD 2023); Accumulating climate change influences on extreme coastal, fluvial, and compound flooding in the upper transition zone and Modeling the Effectiveness of Alternative Flood Adaptation Strategies Subject to Future Compound Climate Risk (Drexel University, 2025); and The Eastwick Flood Resilience Strategy (City of Philadelphia's Office of Sustainability, 2026). The available FEMA Floodplains were reviewed, as well as 2D flooding, SCALGO analysis, and several takeaways from the (upstream) analysis of the Naylors Run H&H 2D Flood Model.

Due to the focus on the Eastwick community, the "flood barrier" solution being reviewed at R062 may not necessarily alleviate flooding conditions observed at the problem areas located within Delaware County. Water surface elevations may be increased at the immediate upstream and downstream spans of Cobbs Creek surrounding problem areas S152 (upstream at the abandoned warehouse) and S130 at Hook Road which is directly downstream. It is unclear if flooding at S092 would be negatively impacted by a proposed flood barrier at R062.

Given the potential impacts upstream and downstream associated with a proposed flood barrier project, an additional study is recommended to continue investigating mitigative solutions for these areas. Per the exhibit in Appendix G.9, floodplain benching/restoration and additional wetlands scenarios can be further refined and modeled. It should also be noted that field visits to the S152 abandoned site observed that this location is particularly dangerous in its current condition (lots of trash & debris, overgrown vegetation, potential onsite hazards, unsafe pedestrian access). It is recommended that Delaware County investigate future public acquisition of this property so that it may be dedicated to stream restoration, floodplain restoration/expansion, and improved safety. Similar stakeholder discussions on the topic of land acquisition can also be conducted for other key properties along Cobbs Creek and Darby Creek immediately upstream and downstream of their confluence. Floodplain improvements and expansion, particularly in anticipation of upstream impacts from the levee project should be prioritized as a localized measure.

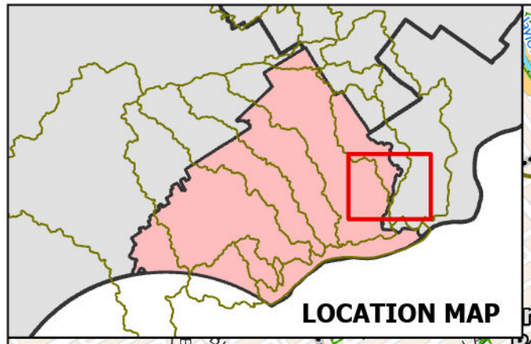
However, as evident from the research conducted by Drexel University, an emphasis on upstream watershed improvements such as nature-based solutions and green stormwater infrastructure, may also play a crucial role in reducing flows occurring close to the confluence of Darby Creek and Cobbs Creek. It is therefore recommended that the next phase investigation review scenarios for upstream storage/infiltration/detention/restoration practices, with a focus on specific project sites throughout Delaware County. Project sites would ideally include parks, wooded areas, stream restoration sites, county-owned properties, and other publicly owned sites. A goal of the analysis should be to model realistic storage volumes and other design metrics for downstream benefits, since many of the studies completed to date have utilized broader, planning level-estimations. The future analysis should be collaborative with applicable municipalities to facilitate successful selection and implementation of project sites.

Additionally, it is strongly recommended that this evaluation be included with other Darby-Cobbs initiatives that the County is proposing for inclusion within the upcoming Pennsylvania Water Resources Development Act (WRDA).

Estimated Cost Ranges:
1) Additional analysis: Medium ($50k-$250k)
2) Local improvements: High (>$2M)
3) Watershed improvements: High (>$10M)

Delaware County Act 167 Stormwater Management Plan

S092 - Eastwick Problem Areas - Additional Analysis



Legend

- Focus High Priority Problem Area
- Nearby High Priority Flooding Problem Area (Along Darby Creek)
- Existing Stormwater and GSI Projects*
- USGS Stream Gage
- Streams - USGS NHD**
- Streams - Delaware County**
- Potential Flood Barrier Project
- Railroads
- County Boundaries
- Municipal Boundaries
- Watersheds
- County Protected Land
- County Owned Parcels
- Eastwick Study Area

FEMA Flood Zones (FIS data 11/2017)***

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone X - 0.2% Annual Chance Flood Hazard
- Additional Study Area

Proposed Stream Gage Location

- Primary
- Secondary
- Backup Location
- Removed

*Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.

**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

***The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N

0 2,000 4,000 Feet

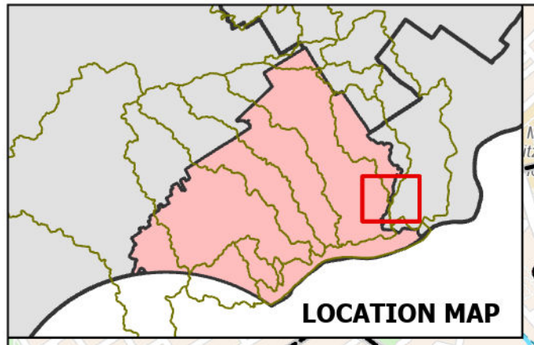
Map prepared by Jacobs and NTM 7/7/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Delaware County Act 167 Stormwater Management Plan

S092 - Additional Analysis- SCALGO 100 Year Flood Analysis



Legend

- Focus High Priority Problem Area
- Nearby High Priority Flooding Problem Area (Along Darby Creek)
- Existing Stormwater and GSI Projects*
- USGS Stream Gage
- Streams - USGS NHD**
- Streams - Delaware County**
- Railroads
- County Boundaries
- Municipal Boundaries
- Watersheds
- Eastwick Study Area (SCALGO limits)
- Additional Study Area (SCALGO limits)
- Potential Flood Barrier Project
- SCALGO Flow Network Line

Water depth (ft) - 100 Year Flood***

Value

- 0.1 - 3
- 3.1 - 7.7
- 7.8 - 13
- 13.1 - 19.4
- 19.5 - 37.8

*Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.

**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation

N

0 1,500 3,000 Feet

Map prepared by Jacobs and NTM 7/7/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community



Delaware County
Act 167 Stormwater Management Plan
S092 -Eastwick Problem Areas - Recommended Future Eastwick Study Focused on Upstream and Downstream Flooding Impacts
Legend
Nearby High Priority Flooding Problem Area (Along Darby Creek)
Focus High Priority Problem Area
Existing Stormwater and GSI Projects*
USGS Stream Gage
Streams - USGS NHD**
Streams - Delaware County**
Potential Flood Barrier Project
Railroads
County Boundaries
Municipal Boundaries
Watersheds
County Protected Land
County Owned Parcels
Eastwick Study Area
Additional Study Area
Proposed Potential Floodplain Benching***
Proposed Potential Wetlands****
Proposed Stream Gage Location
Primary
Secondary
Backup Location
Removed
*Source: Jacobs created point locations of existing stormwater and GSI projects within Delaware County, utilizing WPAC and stakeholder provided submissions of supporting studies and plans.
**Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines
***Source: Retrieved from USACE's Eastwick, Philadelphia County, Pennsylvania Flood Risk Management Continuing Authorities Program Section 205 Draft Integrated Feasibility Report & Environmental Assessment (2023)
****Source: Retrieved from The Eastwick Flood Resilience Strategy from the City of Philadelphia Office of Sustainability (2026)
N
0 1,000 2,000 Feet
Map prepared by Jacobs and NTM 7/7/2026
Jacobs
Newell Tereska & Mackay Engineering
Delaware County Planning Department
LOCATION MAP
Need to further evaluate immediate upstream impacts of potential flood barrier project (i.e. potential for increased water surface elevation)
S092 - Main Street / Woodland Ave Flooding (need to further evaluate for impacts from potential flood barrier project)
Potential additional floodplain benching opportunity in County-protected land
S152 Abandoned Warehouse Property (potential for "floodable" park or constructed wetlands if acquired)
R062 - Site of Potential Flood Barrier Project
S130 - Hook Road Flooding
Need to further evaluate immediate downstream impacts of potential flood barrier project (i.e. potential for increased water surface elevation)
Yeadon Borough
Darby Borough
Cobbs Creek Watershed
Collingdale Borough
Colwyn Borough
Sharon Hill Borough
Darby Creek Watershed
Glenolden Borough
Darby Township
Folcroft Borough
Norwood Borough
Schuylkill River Watershed
Delaware River Watershed
DELAWARE COUNTY
PHILADELPHIA COUNTY
S126
S088
S106
S089
R016
S091
S092
S152
R062
S130
R028
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Appendix G.10 – Potential Solution Analysis: S094

ID#S094 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Naamans Creek	**Source of Problem:**	G. D. Houtman & Son, Inc
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/4/2025
Municipality:	Bethel Township	**Location:**	3241 Charles Griffin Dr, Garnet Valley, PA 19060
Property Type:	Residential		
Type of Problem(s):	Accelerated Erosion - Restricted Capacity		
Problem Description:	Stream bank erosion migrating towards dwelling; trees being uprooted		
Field Visit Notes:	Large erosion along streambank wall. Armouring on streambank observed placed by landowner or township. Large floodplain with debris downstream suggests backing up of stream. Confluence of basin outlet, swales, and stream. Basin filled with debris.		



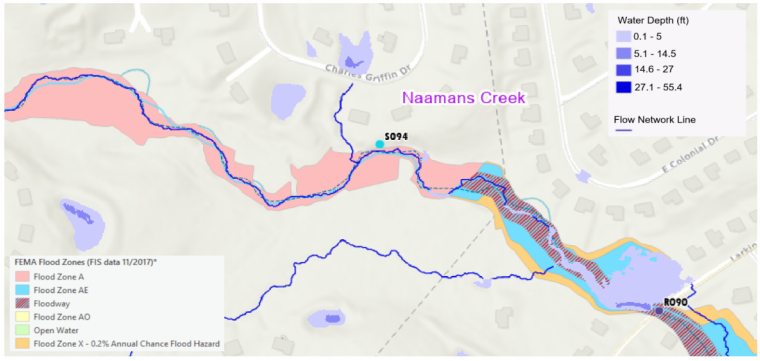
Old SW basin with standing water doesn't appear to be active



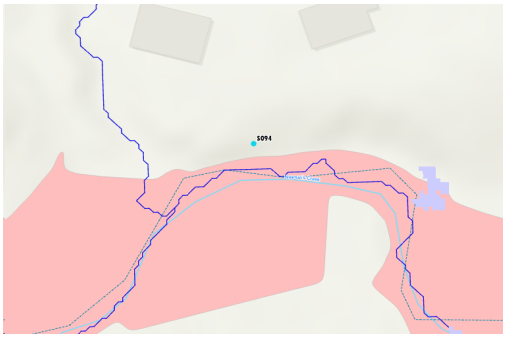
Severe erosion along streambank with rock armouring

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, alternative modeling recommended.**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Structural stream bank stabilization.
- Remove debris from the basin and perform any necessary repairs to make sure it is functional to reduce peak rates.
- Resize the downstream culvert.
- Additional modelling recommended to size stormwater retention/infiltration basin in municipal owned properties in the vicinity of the stream.

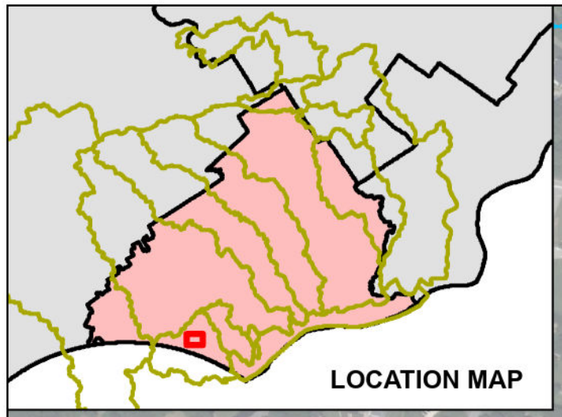
Supporting Analysis

Erosion was reported at point S094, south of Charles Griffin Drive and approximately 0.2 miles upstream of the crossing with Larkin Road. The Delaware River Conservation Plan notes flooding from storms above the 25-year storm at the East Branch Naamans Creek crossing with Naaman's Creek (R090). Erosion and sediment are prevalent throughout the length of the stream from S094 to R090. The stream erosion threatens to undermine homes adjacent to the creek at S094. An immediate solution to the erosion at S094 would be to armor the streambank to prevent future erosion. Given the condition of Naamans Creek and the multiple points of concern along the length of the stream, an in-depth analysis of the stream is recommended. Such as analysis could help determine the best areas for stream restoration, areas for stormwater infiltration/retention basins to reduce peak rates in the watershed, and if structural changes to the impacted roadways will need to be made to resolve the observed issues. Bethel Township owns property upstream of S094 that could be used for these facilities.

Estimated Cost Ranges:
1) Additional analysis: High (>$250k)
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: High ($10M)

Delaware County Act 167 Stormwater Management Plan

S094 - Larkin Road Problem Area - Additional Analysis



Possible location for stormwater detention/ infiltration facility

Proposed stream bank stabilization and stream restoration area along embankments

S135

S093

Township Sewer Plant

Shaffer Preserve

Bethel Townsh

Evaluate culvert at Goodley Road for sizing and increase as necessary.

S094

S094

Upper Chichester Township

R090

Evaluate culvert at Larkin Road for sizing and increase as necessary.

John T. Adkinson Park

Tara Circle

Tara Circle Woods

Woods

Possible location for stormwater detention/ infiltration facility

bing

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Municipal Boundaries
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 400 800 Feet

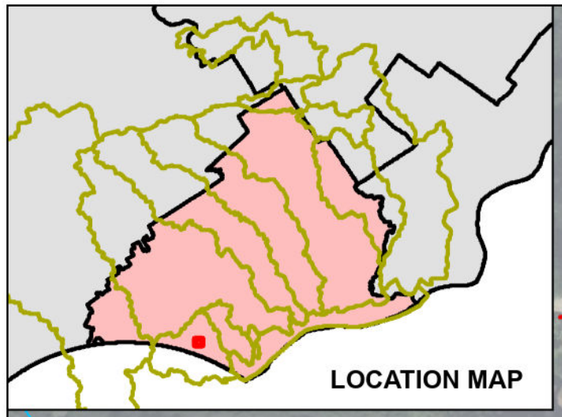
Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits:© 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maplox

Delaware County Act 167 Stormwater Management Plan

S094 - Larkin Road Problem Area - Additional Analysis



S094

Bethel Township

Upper Chichester Township

R090

Proposed stream bank stabilization and stream restoration area along embankments

Evaluate culvert at Larkin Road for sizing and increase as necessary.

Tara Circle Woods

Tara Circle Woods

bing

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Municipal Boundaries
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 150 300 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits: © 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maplox

Appendix G.11 – Potential Solution Analysis: S103

ID#S103 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Delaware River	**Source of Problem:**	G. D. Houtman & Son, Inc
Minor Watershed:	WB Naamans Creek	**Problem Area Submission Date:**	8/4/2025
Municipality:	Bethel Township	**Location:**	3838 Marsh Rd, Garnet Valley, PA19060
Property Type:	Residential		
Type of Problem(s):	Flooding - Restricted Capacity		
Problem Description:	Sediment build up covering left 2 culvert openings		
Field Visit Notes:	4 box culverts, only 2 receive flow from stream. 2 culverts receiving flow are undercut by flow. Streambank erosion, armoring needed in bank. Overtopping on inflow upstream, evidence of sticks and branches caught in fence.		

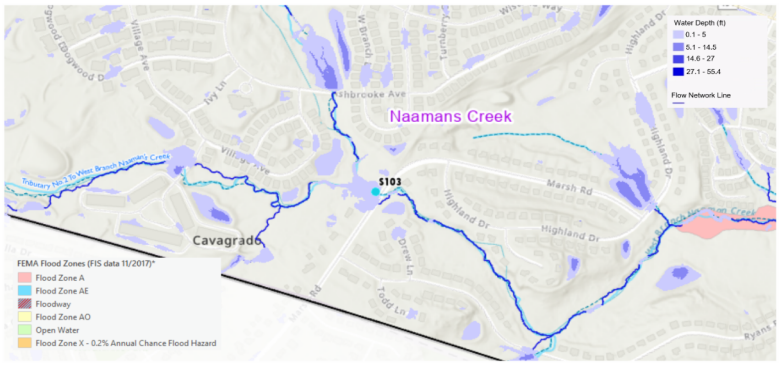


Obstructed box culvert under Marsh Rd

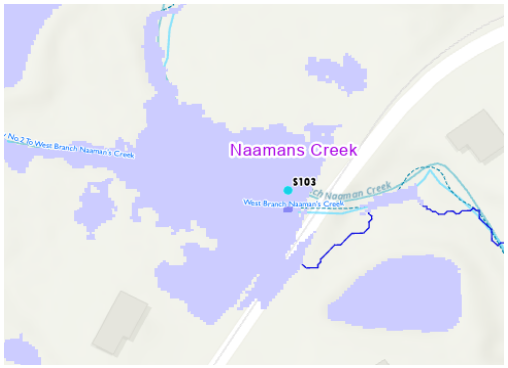


Accelerated erosion along streambank

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

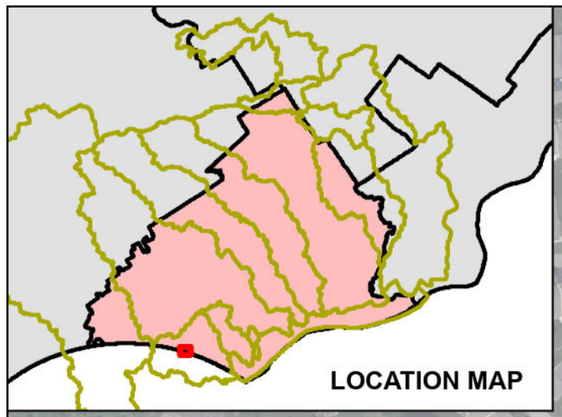
Potential Solutions

- Remove excess sediment and vegetation to clear upstream end of culvert openings.
- Stabilize streambanks.
- If issues persist consider resizing the box culverts and install stormwater retention facility in open space downstream of crossing.

Supporting Analysis

S103 is located at the confluence of West Branch Naaman Creek and a UNT to West Branch Creek at Marsh Road. The field visit observed the stream bed to have significant sedimentation at the crossing preventing two of the four culvert boxes from conveying flow. Sediment removal and stream restoration is recommended at this location to re-establish full use of the existing culverts and to provide a stable streambank. An HY-8 or HEC-RAS analysis is required to determine if the existing culverts are sufficient to pass the desired flow safely when functioning full capacity.

Estimated Cost Ranges:
1) Additional analysis: Low (< $50k)
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: N/A



Proposed stream bank stabilization and stream restoration area along embankments

Bethel Township

S103

S103

Evaluate culvert at Marsh Road for sizing and increase as necessary.

Possible location for stormwater detention/ infiltration facility

bing

Delaware County Act 167 Stormwater Management Plan

S103 - Marsh Road Problem Area - Additional Analysis

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Municipal Boundaries
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 250 500 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits:© 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maptox

Appendix G.12 – Potential Solution Analysis: S104

ID#S104 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Delaware River	**Source of Problem:**	G. D. Houtman & Son, Inc
Minor Watershed:	South Branch Naamans Creek	**Problem Area Submission Date:**	8/4/2025
Municipality:	Bethel Township	**Location:**	1273 Zebley Rd, Garnet Valley, PA19060
Property Type:	Residential		
Type of Problem(s):	Flooding - Restricted Capacity		
Problem Description:	Excessive flooding		
Field Visit Notes:	Stream and outfall from Zebley Road pass under road through 48" double barrel culvert. Some undercutting observed at upstream end of culvert but no signs of overtopping or major flooding.		

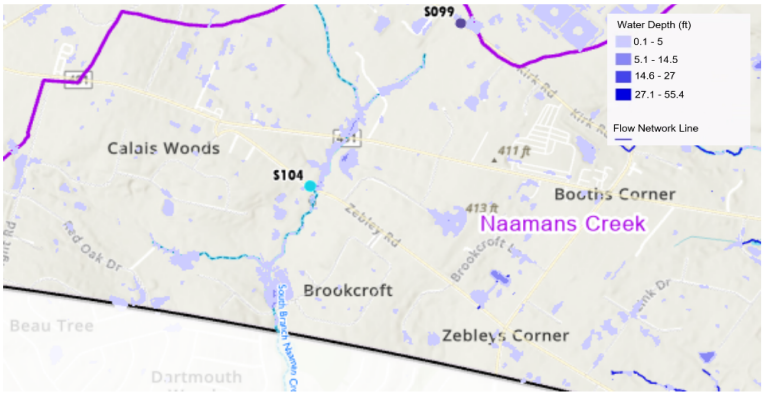


RCP culvert along Zebley Rd discharging into SB Naamans Creek



Double barrel culvert under Zebley Road with slight undercutting

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

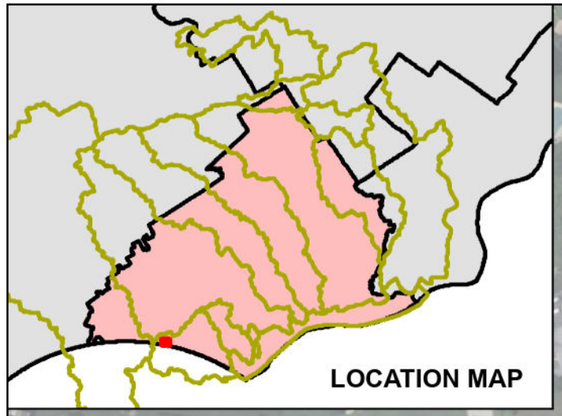
Potential Solutions

- Resize culvert under Zebley Road.
- Stabilize streambanks.
- Openspace downstream of culvert crossing can support watershed scale SCMs.

Supporting Analysis

S104 is located where Naamans Creek South Branch crosses under Zebley Road. The primary mechanism of flooding at this location appears to be the capacity of the culvert at the crossing. A larger culvert should be designed to convey the full volume of flow at this location. Of course, improving the conveyance capacity at this location would result in increased flows downstream, which would have to be mitigated through the use of watershed-level blue/green stormwater management improvements. Fortunately, Bethel Township owns over 10 acres of open space that could potentially be suitable for watershed-level improvements such as constructed wetlands, bioretention/retention basins, and/or infiltration systems.

Estimated Cost Ranges:
1) Additional analysis: Low (< $50k)
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: Medium ($3M-$10M)



S104

Evaluate culvert at Zebley Road for sizing and increase as necessary.

Possible location for stormwater detention/ infiltration facility

Sharon Park

Delaware County Act 167 Stormwater Management Plan

S104 - Zebley Road Problem Area - Additional Analysis

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Municipal Boundaries
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 150 300 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits:© 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maplox

Appendix G.13 – Potential Solution Analysis: S105

ID#S105 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Ridley Creek	**Source of Problem:**	G. D. Houtman & Son, Inc
Minor Watershed:	Vernon Run	**Problem Area Submission Date:**	8/4/2025
Municipality:	Rose Valley Borough	**Location:**	64 Rose Valley Road, Media, PA 19063
Property Type:	Commercial		
Type of Problem(s):	Flooding - Insufficient/aging drainage infrastructure		
Problem Description:	Excessive flooding		
Field Visit Notes:	Low-head dam emergency spillway undercut and stream flow undercutting is causing a possible obstruction in the stream. 2 small creeks flow around low-head dam adjacent to building creating a small flood plain between the 2 creeks and main stream.		



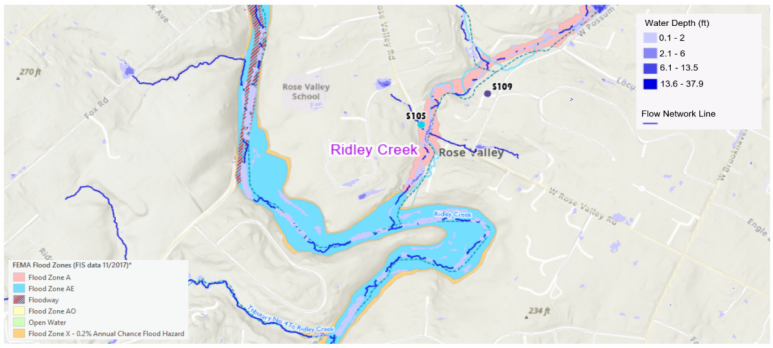
Small channel running through property



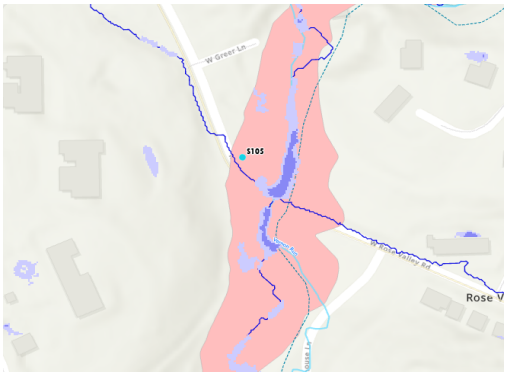
Low-head dam showing signs of undercutting

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Resize culvert under W Rose Valley Road.
- Assess undercutting and stabilize streambanks.
- Remove obstructions.

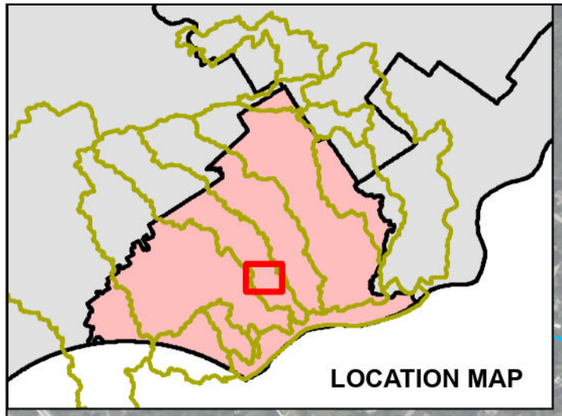
Supporting Analysis

The flooding at S015 appears to be the result of an undersized culvert for Vernon Run at Rose Valley Road (SR 3019) along with the presence of a low-head dam and high velocity channelized flow entering the Vernon Run immediately upstream of the roadway crossing. The recommended solution at this point is twofold. First, replace the culvert to convey greater flows. Second, provide streambank armoring to reduce erosive flows at this location and install energy dissipaters at the incoming channels. Finally, additional analysis is recommended given that flooding at this location, which is 0.2 miles upstream of the confluence of Vernon Run and Ridley Creek, is likely to be influenced by backflow from flooding in Ridley Creek.

Estimated Cost Ranges:
1) Additional analysis: High (>$250k)
2) Local improvements: High (>$2M)
3) Watershed improvements: N/A

Delaware County Act 167 Stormwater Management Plan

S105 - Rose Valley Road Problem Area - Additional Analysis



Thompson Park
Upper Providence Township
S160
Pew Park
Furness Park
E. Knowlton Road
Baxter Wildlife Preserve
Valley Green
S109
S105
Valley Green
Evaluate culvert at Rose Valley Road and Old Mill Road for sizing and increase as necessary.
Stream restoration recommended
Indian Orchards Park
Middletown Library & Open Space
Saul Wildlife Sanctuary
Rose Valley Borough
Todmorden Woods Wildlife Sanctuary
Nether Providence Township
Middletown Township
Woodland Avenue
Knowltonwood Development Open Space
Longpoint Wildlife Sanctuary
S108
S107
Linvill Tract/Middletown Township
The Mills at Rose Valley/NLT Conservation Easement
Proposed stream restoration area along embankments and stabilize areas of erosion
Brookhaven Memorial Park
S085
Brookhaven Borough
Hepford Field
bing

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Municipal Boundaries
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 1,000 2,000 Feet

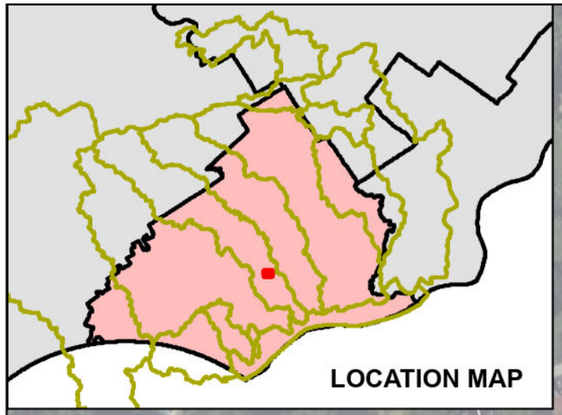
Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits:© 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maplox

Delaware County Act 167 Stormwater Management Plan

S105 - Rose Valley Road Problem Area - Additional Analysis



Nether Providence Township

S109

S105

Remove low head dam

Evaluate culvert at Old Mill Road Crossing for sizing and increase as necessary

Evaluate culvert at Rose Valley Road for sizing and increase as necessary.

Stream Restoration recommended in areas of bank erosion

Valley Green

Saul Wildlife Sanctuary

bing

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Municipal Boundaries
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 150 300 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits: © 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maptox

Appendix G.14 – Potential Solution Analysis: S110

ID#S110 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Brandywine Creek	**Source of Problem:**	Pennoni - Chadds Ford Township Engineer
Minor Watershed:		**Problem Area Submission Date:**	8/4/2025
Muncipality:	Chadds Ford Township	**Location:**	Creek Rd & Baltimore Pike
Property Type:	Residential, Commercial, Open Space, Right of Way, Public (Other), Other		
Type of Problem(s):	Flooding		
Problem Description:	Multiple buildings were a total loss.		
Field Visit Notes:	US 1 bridge over Brandywine Creek has a small stone dam upstream of bridge catching multiple whole trees. Trees and branches lodged in the upper deck below the roadway. Erosion downstream on streambanks observed in some areas.		



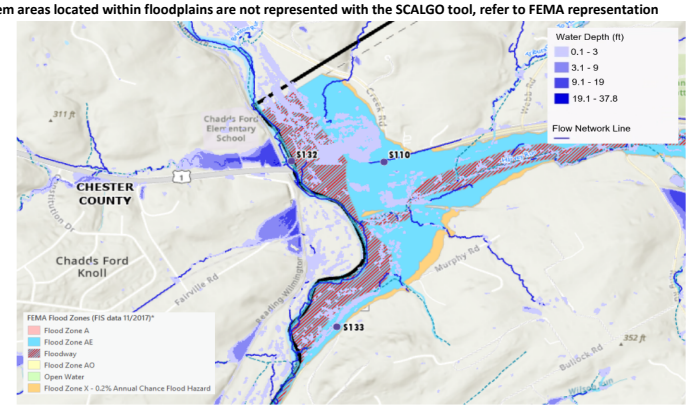
Erosion along streambanks



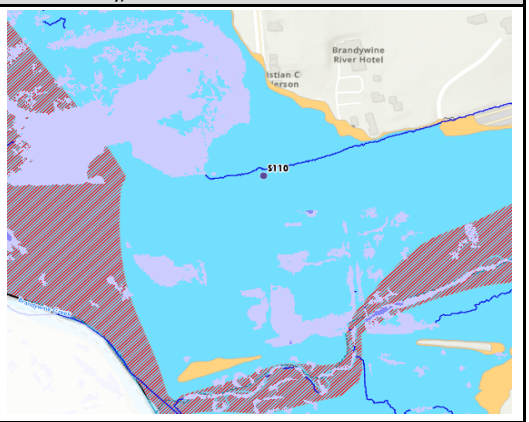
Trees and branches lodged below roadway

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Replace bridges to reduce flow restriction.
- Remove the partial dam.

Supporting Analysis

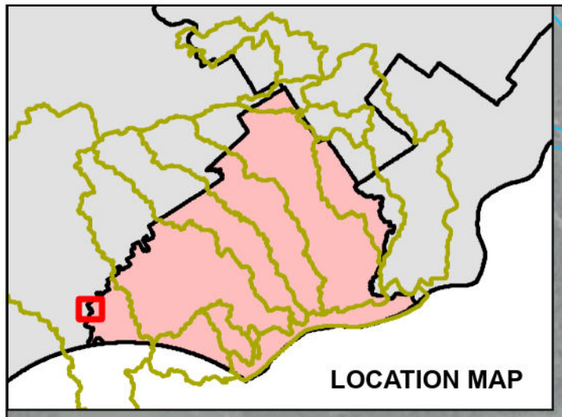
Three problem areas were reported in this area: S110, S132, and R033. All three points are within the FEMA flood zone AE and are located in the vicinity of the Baltimore Pike/U.S. Route 1 crossing of Brandywine Creek. The watershed of the Brandywine to this point includes Montgomery, Chester, and Lancaster Counties, and therefore watershed-scale solutions will require significant coordination with other counties. Some of this work has already begun – the Brandywine Flood Study completed in 2025 evaluated 300 individual sites throughout the watershed. This study entailed in-depth modeling of the flooding at this location and provided specific recommendations for mitigating it.

There are 3 structures in the vicinity of S110 that were found to constrict flow in the Brandywine in the 2025 Flood Study. The field visit to this site confirmed evidence of roadway overtopping and erosion at these structures. The study recommended removal of both the East Penn Railroad Bridge downstream of the problem area and the existing dam upstream of it. The study also recommended replacing the Baltimore Pike/U.S. Route 1 bridge to remove flow obstructions. Given the nature of the proposed projects and stakeholders involved, there are multiple funding sources that can be explored.

Estimated Cost Ranges:
1) Additional analysis: Medium ($50k-250k) - Analysis from 2025 Brandywine Flood Study is assumed to cover concept level analysis
2) Local improvements: High(>$2M)
3) Watershed improvements: N/A

Delaware County Act 167 Stormwater Management Plan

S110 - Brandywine Creek at US1 Problem Area - Additional Analysis



Remove low head dam

Evaluate flow capacity at Baltimore Pike (US 1) and increase as necessary.

Remove historic bridge structure

S133

S132

S110

R033

Brandywine Conservancy

Brandywine Battlefield Park

Turner's Mill/Chadds Ford Twp Hall

Brandywine River Museum & Conservancy

Conservancy & Art Museum

Chadds Ford Township

Legend

Solution Footprint

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- PA_StateRoads2025_07
- Municipal Boundaries
- Problem Areas
- Delaware County Boundary

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 600 1,200 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits:© 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maplox

bing

Appendix G.15 – Potential Solution Analysis: S116

ID#S116 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	Muckinipattis Creek	**Problem Area Submission Date:**	8/6/2025
Municipality:	Darby Township	**Location:**	742 S Garfield Ave, Glenolden, PA 19036
Property Type:	Residential,Open Space,Rightofway		
Type of Problem(s):	Flooding,Accelerated Erosion,Sedimentation - Restricted Capacity, Insufficient Drainage Infrastructure		
Problem Description:	Structure damage; loss of land		
Field Visit Notes:	Tree Obstruction. Major signs of erosion. The creek was low and not flowing. Serious obstruction downstream from trees and plants. Small undersized culvert. Appears to be a lack of drainage capacity. Upstream is a really shallow concrete channel. Large culvert in Sandone Park with significant obstruction.		



Aging concrete culvert showing signs of damage and may be undersized

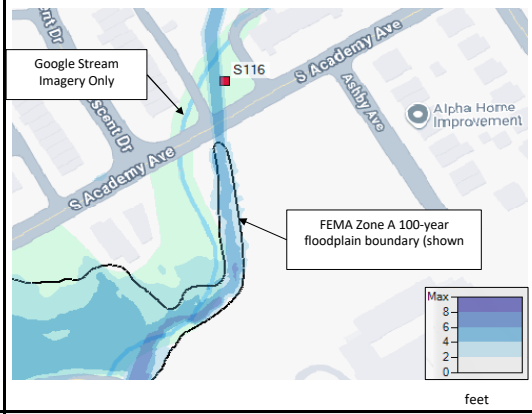


Large culvert in Sandone Park with severe obstruction

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

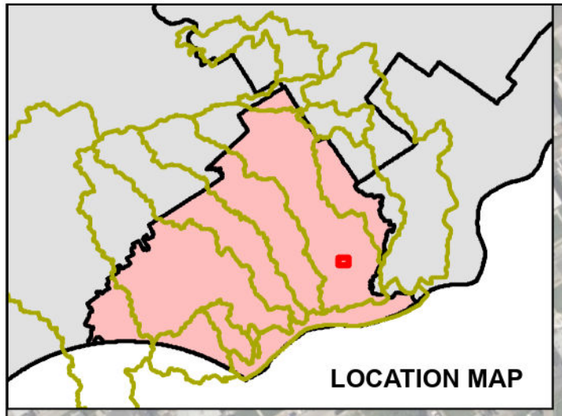
Potential Solutions

- Regrading
- Riparian buffer restoration
- Streambank restoration
- Bridge culvert obstruction study At the James J. Sandone Park
- Large green space downstream of the creek, about 300 ft below the basketball court that could serve as a basin or wetland
- Clear obstruction and upsize culvert
- Possibility of increasing flood storage at the Darby Township School field and James Sandone Park

Supporting Analysis

Flooding, erosion, and sedimentation were reported in the section of the Muckinipattis Creek north of the crossing of S Academy Drive. The area upstream of S116 is currently used as open park space, basketball courts, and the creek bed. The park is 100-ft wide at the narrowest point making it a good candidate for stream restoration to address sedimentation and erosion issues at S116. Stream restoration can help reduce peak flow rates; however, additional improvements are recommended to resolve the flooding problem at this location. Obstructions of the stream crossing at S Academy Drive were observed during the field visit and should be removed as a first step to resolving flooding at this location. Additional analysis of the existing flow capacity of the culvert under S Academy Drive is also recommended. Open space at the southern end of the park area north of S116 is available to provide approximately 16k cubic feet of storage within an infiltration/retention basin.

Estimated Cost Ranges:
1) Additional analysis: Low (< $50k)
1) Additional analysis: High (> $250k)
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: N/A



Stream restoration recommended in vegetated areas while maintaining park features

Possible location for stormwater detention/ infiltration facility

Evaluate culvert at Rose Valley Road for sizing and increase as necessary.

S116

Darby Township

Crescent Park

Westbridge Park/ Playground

Ridley Township

Glenolden Borough

bing

Delaware County Act 167 Stormwater Management Plan

S116 - S. Academy Ave Problem Area - Additional Analysis

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Municipal Boundaries
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 200 400 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits:© 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maplox

Appendix G.16 – Potential Solution Analysis: S117

ID#S117 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	Hermesprata Run	**Problem Area Submission Date:**	8/6/2025
Municipality:	Darby Township	**Location:**	Linden Ave Bridge over Hermesprata Run - Conway Park
Property Type:	Residential,Open Space,Rightofway		
Type of Problem(s):	Flooding,Accelerated Erosion,Sedimentation - Restricted Capacity		
Problem Description:	Severe erosion causing loss of land; felled trees; access to park		
Field Visit Notes:	CMP culvert at bridge above park; lots of green open space adjacent to creek; park is in need of an upgrade; there is an existing fenced off basin at top end of park, but it appears to be related to an adjacent private development.		



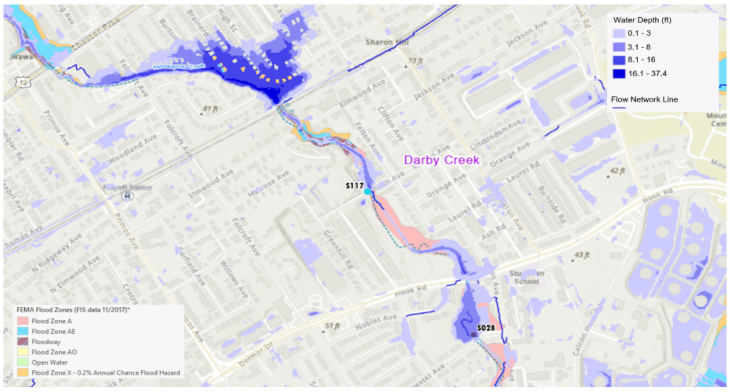
Open green space in park which could be used for SCM



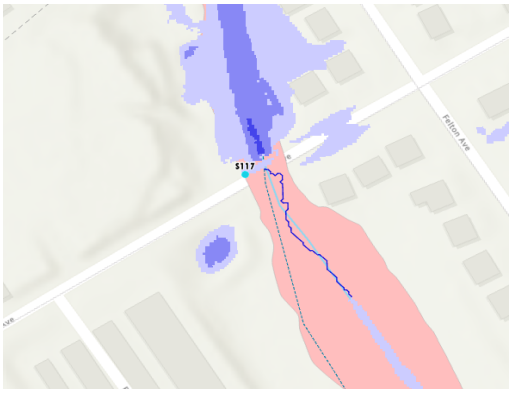
Hermesprata Run flowing under bridge at Conway Park

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Additional flood storage in open space on west side of creek north of Linden Ave as well as park south of Linden Ave (several open areas of grass that appear to be unused).
- Regrading
- Riparian buffer restoration
- Streambank restoration
- Bridge culvert obstruction study
- Culvert lining

Supporting Analysis

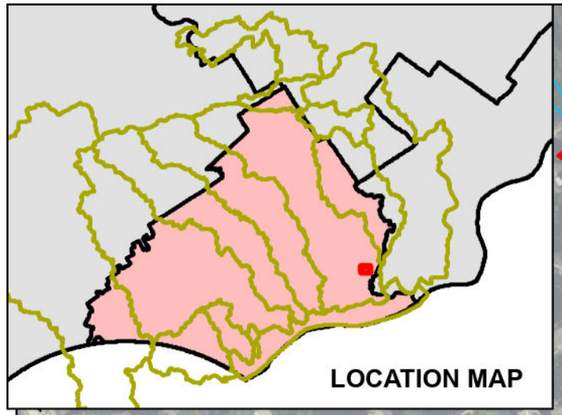
Linden Ave crosses Hermesprota Creek at S117. The point is located adjacent to Conway Park, owned by Darby Township. The park provides opportunities for structural stormwater management to help relieve downstream flooding concerns. There appears to be an existing stormwater management basin at this location that could be evaluated for additional retention capacity. Conway Park north of Linden Ave has the capacity for an infiltration/retention basin to provide approximately 30k cubic feet of storage to manage peak rates at this location. This stormwater basin would be best implemented as part of a watershed-scale plan.

The SCALGO analysis for S117 depicts flooding along the Hermesprota Creek at several roadway crossings upstream and downstream from S117. Flooding was also indicated at points R024, R036, S024, S028, and S096, and several water rescues were reported in the upper portion of the watershed. It is recommended that the first phase of this project entail the development of a more detailed hydraulic model that would incorporate existing storm infrastructure, roadway crossings, and more detailed topographic information. The output of this model could be used to determine the best locations within the watershed for implementation of several stormwater retention and/or infiltration basins, wetlands, or stream restoration, as well as to prioritize sections of the stream for floodway restoration. There are several public parks along the length of the stream that could support stormwater infiltration/retention systems for peak rate management, including approximately 60k cubic feet at 1599 Llanwellyn Ave, Folcroft, 30k cubic feet north of Linden Ave (discussed above), 50k cubic feet south of Linden Ave at Conway Park, 60k cubic feet north of Hook Rd at Conway Park, and 100k cubic feet in the area owned by Darby Townshipp between Noblet Ave and Forrester Ave. Survey responses indicate that Darby Township is already looking into the feasibility of implementing stream restoration and stormwater retention measures between Noblet and Forrester. Many of these sites are actively used as park areas, and multi-use stormwater management measures should be considered to allow for continued recreation opportunities.

Estimated Cost Ranges:
1) Additional analysis: High (> $250k)
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: High (> $10M)

Delaware County Act 167 Stormwater Management Plan

S117 - Linden Ave Problem Area - Additional Analysis



Evaluate culvert at Linden Ave for sizing and increase as necessary.

Possible location for stormwater detention/ infiltration facility

Possible location for stormwater detention/ infiltration facility

Possible location for stormwater detention/ infiltration facility

Stormwater Management and Stream Restoration in review with Darby Township at time of Act 167 Plan Development

S117

S028

Lincoln Park Playground

Conway Park

Darby Township

Folcroft Borough

South Hermersprota Run Park

South Hermesprota Run Park

bing

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Municipal Boundaries
- Problem Areas

treams are shown from two sources: Delaware County and GS National Hydrography Dataset (NHD) Flowlines

The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 200 400 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits:© 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maptox

Appendix G.17 – Potential Solution Analysis: S118 / S119

ID#S118 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	Muckinipattis Creek	**Problem Area Submission Date:**	8/6/2025
Municipality:	Norwood Borough	**Location:**	100 East Amosland Rd, Norwood, PA 19074
Property Type:	Residential,Open Space,Rightofway,Otherpublic		
Type of Problem(s):	Flooding - Insufficient Drainage Infrastructure		
Problem Description:	Roadway and structural damage		
Field Visit Notes:	Intersection is on higher ground. Flood path unclear. No inlets and steep driveways with no direct flow path. Some evidence of damage at maintenance facility. Erosion in vegetated area downstream of point. Exposed sewer pipe.		

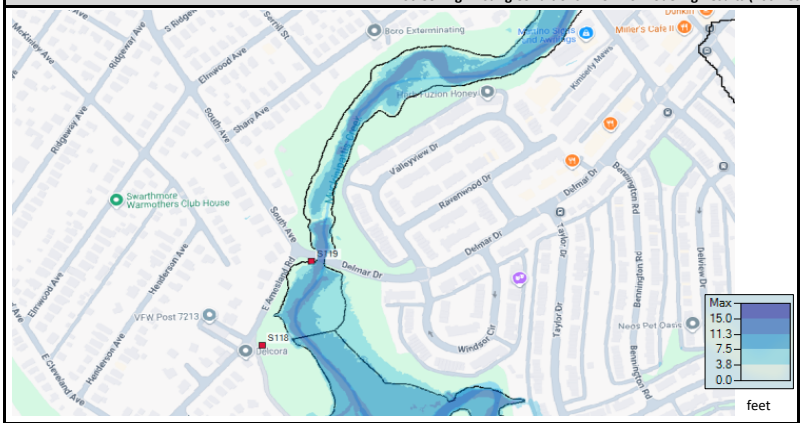


Signs of flooding on roadway at problem area data point with no inlets present

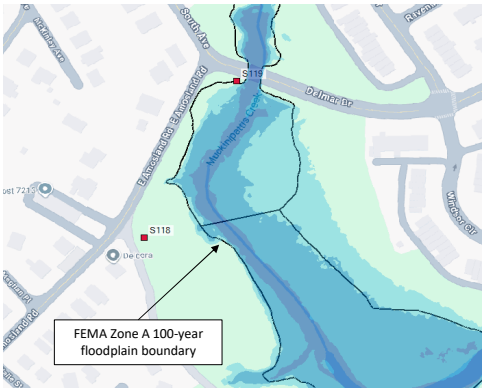


Exposed outfall/sewer pipe with runoff carried debris

Screening Existing Conditions HEC-RAS Modeling Results (100-Year Flood Vulnerability)



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Regrading
- Additional conveyance
- Relocation of maintenance facility Bioswales along Amosland Road (south side)

Supporting Analysis

S118 and S119 were reported on different sides of the intersection of South Ave, Delmar Drive, and E Amosland Road. None of these roads are owned by PennDOT. All three roads are sloped towards the intersection and have residential structures along them. During the site visit, the outfall of one of the culvert pipes was observed to have collapsed, which limits the flow capacity of the structure. This outfall structure should be replaced to restore the intended capacity of the culvert. In addition, the existing vegetated areas on the north and south sides of Delmar Drive can be used for stream restoration or for regenerative step pools/bioswales to capture water being conveyed from the roadways. HEC-RAS modelling performed on the Muckinipattis Creek (see section 4.4.2) found velocities through the bridge up to 7.0, 7.6, and 9.6 ft/s for the 5-, 10-, and 100-year storms, respectively. Confirmation of the pipe capacity should be performed.

Estimated Cost Ranges:
1) Additional analysis: Low (< $50k) (Initial modeling performed in this study included in 4.4.2)
2) Local improvements: Medium ($500k-$2M)
3) Watershed improvements: N/A

ID#S119 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Darby Creek	**Source of Problem:**	Catania Engineering Associates
Minor Watershed:	Muckinipattis Creek	**Problem Area Submission Date:**	8/6/2025
Municipality:	Norwood Borough	**Location:**	Amosland Road/South Avenue/Delmar Drive
Property Type:	Industrial,Open Space		
Type of Problem(s):	Flooding,Accelerated Erosion,Sedimentation - Insufficient Drainage Infrastructure		
Problem Description:	Roadway and structural damage; excessive erosion		
Field Visit Notes:	Outfall pipe collapsed. Intersection is at a low point, good spot for project in road. Review inlet pipe conditions and connectivity.		



View of sedimentation within creek



Area of green space along Amosland Rd which could be used for bioswales

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)



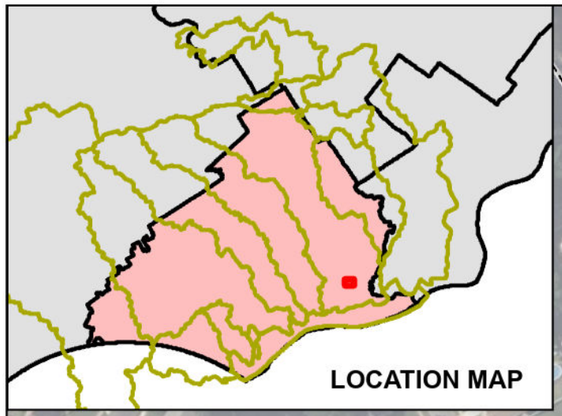
Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Riparian buffer restoration
- Streambank restoration
- Potential opportunity for pavement removal at south corner of Amosland Road and Delmar Drive and implementation of bioretention basin
- Opportunity for bioswales along Amosland Road (south side) and/or Delmar Drive (north side).
- See the Potential Solution Analysis form for S118 for additional supporting analysis related to this problem location



Glenolden Borough

Folcroft Borough

Norwood Borough

Lower Park

Lower Park

S119

S118

S118

Proposed stream restoration area along embankments and stabilize areas of erosion within inflow channels

Confirm pipe capacity and increase the culvert size as needed

Repair collapsed culvert outfall and remove sediment and debris build-up

bing

Delaware County Act 167 Stormwater Management Plan

S118 - Delmar Drive Problem Area - Additional Analysis

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Municipal Boundaries
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 100 200 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits:© 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maptox

Appendix G.18 – Potential Solution Analysis: S144

ID#S144 – Crum Creek Road
High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Crum Creek	**Source of Problem:**	Delaware County Planning Department
Minor Watershed:	N/A	**Problem Area Submission Date:**	8/12/2025
Municipality:	Upper Providence Township	**Location:**	Crum Creek Rd at Media Bypass
Property Type:	Right of Way		
Type of Problem(s):	Flooding		
Problem Description:	Creek has limited holding capacity and floods Crum Creek Road for approximately 3/4 mile upstream and downstream of marker.		
Field Visit Notes:	At this location, Crum Creek is shallow with low banks. The creek is only a few feet away from the road, and its banks are almost level with it. There's a narrow vegetated buffer between the creek and the road. On the other side of the road is steep woodland that is not accessible.		



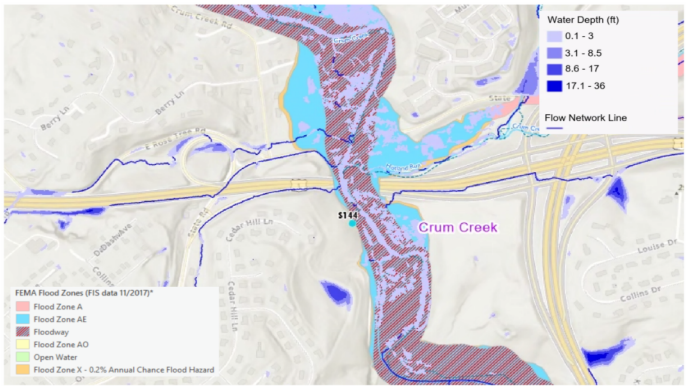
Crum Creek at problem area



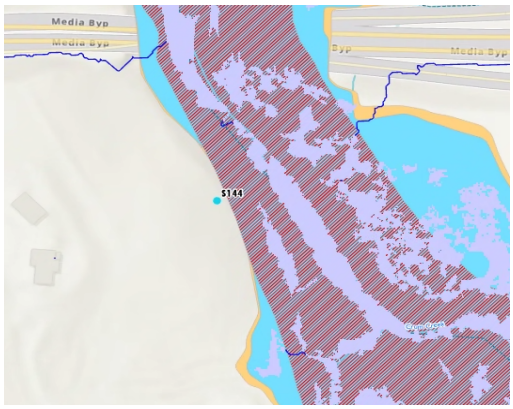
Narrow buffer between creek and road

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

- Evaluate upstream open space areas and parks for opportunities to capture stormwater
- Potential opportunity for constructed wetlands to increase flood holding capacity
- Raise road and/or construct levee along road

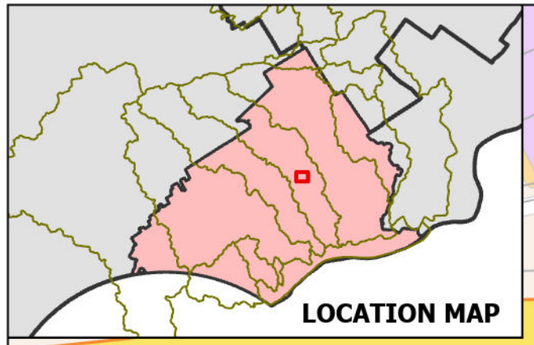
Supporting Analysis

At S144, Crum Creek Road (State Route 2037) is within the flood zone of Crum Creek and has a history of flooding and subsequent impacts to emergency services. Along this stretch of the road, Crum Creek is relatively shallow and only slightly below the level of the road. On the east side of the road, only a narrow vegetated buffer exists between it and the creek, while on the west side the land is very steep and wooded. The risk of roadway flooding can be mitigated through raising its profile by several feet for an approximate length of 2,200 linear feet starting at State Road. Over this stretch of roadway, there are no driveways or intersecting streets; however, Route 1 does cross over it near its northern end, which may limit how much it can be raised there. Raising the profile of Crum Creek Road would require close coordination with PennDOT, regulatory compliance with FEMA, collaboration with other stakeholders, and detailed engineering analyses to determine the desired new roadway design and profile, target freeboard and clearance, and upstream/downstream flooding impacts. Given the nature of the proposed project and stakeholders involved, there are likely multiple funding sources that can be explored.

Estimated Cost Ranges:
1) Additional analysis: N/A (assumed to be part of "local improvements" cost)
2) Local improvements: High (> $2M)
3) Watershed improvements: N/A

Delaware County Act 167 Stormwater Management Plan

S144 - Crum Creek Road - Additional Analysis



Proposed Solution:
Raise approx. 2200 LF of Crum Creek Road (SR2037) starting at State Road. Height of raising to be determined.

S144

R023

060

CRUM CREEK RD

Crum Creek

Hotland Run

Crum Creek Tributary No.3

State Rd

Beatty Hill/NLT Conservation Easement

Marple Township

Upper Providence Township

Springfield Township

Nether Providence Township

Crum Creek Watershed

Martin Park

Kelli Lane SWM Detention Basin Woods

Beatty Road SWM Detention Basin Woods

Smedley County Park Lawton Tract

Louise Dr

Collins Dr

Kelli Ln

Cedar Hill Ln

Old Mill Dr

Dayton Cir

Meadow Ln

Parkview Cir

Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Legend

- Focus High Priority Problem Area
- Nearby High Priority Problem Area
- Streams - USGS NHD*
- Streams - Delaware County*
- Municipal Boundaries
- Watersheds
- Delaware County Building Footprints
- Parcels
- County Protected Land
- County Owned Parcels

FEMA Flood Zones (FIS data 11/2017)**

- Flood Zone A
- Flood Zone AE
- Floodway
- Flood Zone X - 0.2% Annual Chance Flood Hazard

Proposed Stream Gage Location

- Removed

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N

0 250 500 Feet

Map prepared by Jacobs and NTM 6/4/2026

Jacobs | Newell Tereska & MacKay Engineering | Delaware County Planning Department

Appendix G.19 – Potential Solution Analysis: S175

ID#S175 – High Priority Problem - Potential Solution Analysis

Delaware County Act 167 Plan

Major Watershed:	Chester Creek	**Source of Problem:**	Pennoni
Minor Watershed:	West Branch Chester Creek	**Problem Area Submission Date:**	8/22/2025
Municipality:	Concord Township	**Location:**	Chester Creek bridge near 200 Ivy Mills Rd, Glen Mills, PA 19342
Property Type:	Residential,Open Space,Rightofway		
Type of Problem(s):	Flooding,Accelerated Erosion - Restricted Capacity, Insufficient/Aging Drainage Infrastructure		
Problem Description:	Limited details provided.		
Field Visit Notes:	Bridge is 62 ft long. 6 ft from bed to metal span. Signs of flooding on roadway with sediment on side of bridge on roadway. Downstream condition, south of bridge, is severely eroded and there is major debris. Ivy Mill Road is deteriorated on the surface presumably from flooding. Inlet on Ivy Mills Road is completely clogged and not functional. Lots of debris and sediment under bridge. See photos.		



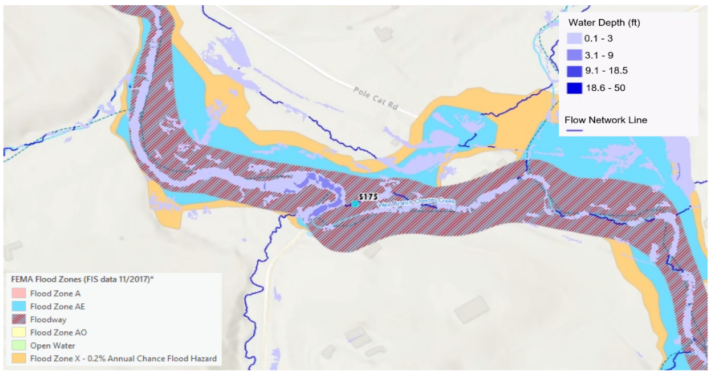
Debris buildup on downstream side of bridge culvert



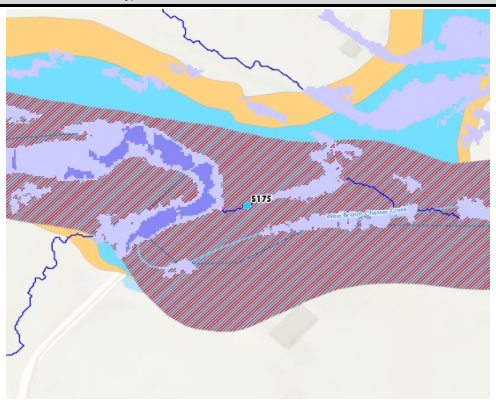
Large sediment deposit under bridge inhibiting flow

Screening Existing Conditions SCALGO Modeling Results (100-Year Flood Vulnerability)

***Problem areas located within floodplains are not represented with the SCALGO tool, refer to FEMA representation**



Zoomed-out Flood Extents



Zoomed-in Flood Extents

Potential Solutions

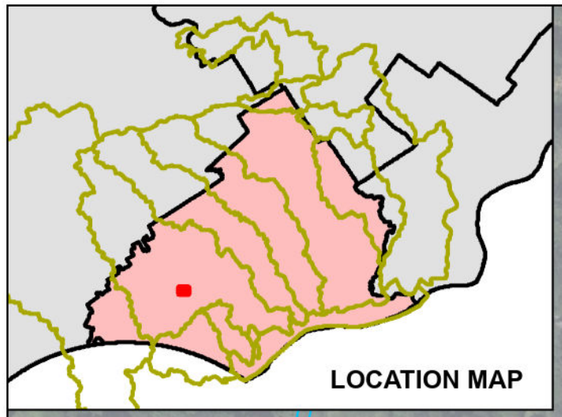
- Remove/Dredge excess sediment
- Remove obstruction in pipe
- Stabilize streambanks
- If issues persist, redesign bridge and increase roadway elevation.

Supporting Analysis

Ivy Mills Road (SR 3036) is conveyed over the bridge at S175. The problem was identified within the FEMA floodway of West Branch Chester Creek. During the field visit, the bridge was recorded as having a height of approximately 6 feet and a width of 62 linear feet. Debris and sediment were observed under the bridge, reducing its flow capacity. An inlet on Ivy Mills Road was also clogged with debris. The solution for this site must start with removal of the debris and sediment at the site and include floodplain restoration and streambank stabilization to prevent future sediment deposition.

Additional studies should be performed to determine if the bridge structure is sized appropriately for the existing flow of the West Branch Chester Creek. There is a private access drive southwest of the Ivy Mills Road bridge structure. A historic mill conservation site is located northeast of the bridge. Designers should consider alternative bridge configurations that will increase the capacity at the bridge crossing, including raising the elevation of the roadway surface. Raising the profile of Ivy Mills Road would require close coordination with PennDOT, regulatory compliance with FEMA, collaboration with other stakeholders, and detailed engineering analyses to determine the desired new roadway design and profile, target freeboard and clearance, and upstream/downstream flooding impacts. Given the nature of the proposed project and stakeholders involved, there are likely multiple funding sources that can be explored.

Estimated Cost Ranges:
1) Additional analysis: N/A (assumed to be part of "local improvements" cost)
2) Local improvements: High (> $2M)
3) Watershed improvements: Medium ($3M-$10M)



Provide stream bank stabilization in areas of erosion

S175

S175

Concord Township

Limits of possible road regrading to elevate above flood levels

Clear sediment and debris from bridge and surrounding area. Evaluate bridge at Ivy Mills Road for flow capacity and change the bridge structure as necessary.

bing

Delaware County Act 167 Stormwater Management Plan

S175 - Ivy Mills Road Problem Area - Additional Analysis

Legend

- Focus High Priority Problem Areas
- Nearby High Priority Problem Areas
- General Problem Areas
- ModellingBoundaries

Type

- Conveyance
- Culvert/Bridge Sizing
- SCM
- Stream Restoration
- <all other values>
- Existing Stormwater Projects
- All Stormwater Problem Area
- Dams
- Water Rescues
- Road Flooding Locations
- Streams
- Streams (NHD Flowlines)
- County Protected Lands
- Municipal Boundaries
- Problem Areas

*Streams are shown from two sources: Delaware County and USGS National Hydrography Dataset (NHD) Flowlines

**The FEMA flood data is based on last effective FEMA Flood Insurance Study (FIS) dated November 2017

N 0 200 400 Feet

Maps prepared by Jacobs and NTM 6/12/2026

Jacobs | Newell Tereska & Mackay Engineering | Delaware County Planning Department

Credits:© 2026 Microsoft Corporation © 2026 Maxar ©CNES (2026) Distribution Airbus DS © Maptox

Appendix H – Public Involvement Documentation

Appendix H.1 – WPAC Meeting #1 7.01.2025

Delaware County Planning Department

Subject	**Watershed Plan Advisory Committee (WPAC) #1 Kickoff Meeting**
Project	Delaware County Act 167 Stormwater Management Plan
Project No.	D3999400
Prepared by	Jacobs
Date/Time	June 01, 2025; 9:30 am –10:30 am EST
Location	Delaware County Emergency Services Room/ Zoom
Participants	**Delaware County Planning Dept.**: Michael Leventry, Kelsey Stanton-Murphy, Abigail Thomas **Jacobs**: Andrew Potts, Courtney Finneran, Monique Epitropou (virtual) **NTM**: Bethany Shumaker, Scott Brown (virtual), Paul DeBarry (virtual) **WPAC & Stakeholder Committees**: See attached

Goal of Meeting: The goal of the meeting was to conduct the first WPAC Meeting and introduce Phase II of the Delaware County Act 167 project.

Agenda

I. Welcome and Introductions
II. Act 167 Overview
III. Phase 1 Review
IV. Phase 2 Activities
V. Schedule/Timeline
VI. Stakeholder Roles & Contributions
VII. Open Discussion
VIII. Adjournment

Action Items

- County to send survey and instructions to WPAC and Stakeholder Committee.
- WPAC (required) and Stakeholder Committee (optional) to fill out survey between July 7-August 4.

I. Introductions
   a. Representatives from Delaware County Planning Department, Jacobs, and NTM were introduced.

b. Each WPAC member and Stakeholder was introduced by their name, municipality, and role with respect to the Program.

II. Overview
   a. The project purpose was presented and outlined: to develop a Countywide stormwater management plan to address issues in critical areas of the County's watersheds.

III. Phase 1 Review
   a. The Phase1: Initial Watershed Assessment review included key actions completed during Phase 1 of the project which are summarized in the Phase 1 Summary Report.
   b. The Phase 1 initial survey responses were discussed, specifically 11 responses from WPAC members.
      i. The question of "What is the most important stormwater related issue?" received three repetitive responses: flooding, funding, and inefficient systems.

IV. Phase 2 Activities
   a. An overview of Act 167 was presented, highlighting the key deliverables.
   b. The presentation focused on Tasks 2, 3, & 4:
      i. Task 2 – Public Engagement: One of the project goals is to prioritize public involvement and input in order to have consistency across municipalities and address key stormwater issues.
         1. Goals for the Stormwater Management Plan were presented. The goals include those based on Act 167, as well as general goals to provide uniformity to municipalities, focus on communities, and address stormwater issues with proactive and well documented solutions.
      ii. Task 3 – Inventory & Assessment
         1. The scope of the Inventory & Assessment task was presented, and the Problem Area Survey was introduced.
         2. An update on the current inventory and data analysis was given.
         3. The Problem Area Survey was presented to the group. Bethany reviewed all survey fields with the participants. The survey is set up for each problem area to have its own form, and multiple problems can be added. Some general information fields only need to be filed once. There is also a field for participants to share potential solutions.
            a. The survey will be emailed to WPAC on July 7. The survey will close in 4 weeks by August 4. Reminders will be sent out prior to close.
         4. Survey Findings and Problem Areas Map examples (Bucks County) were reviewed to show the use of the survey.
      iii. Task 4 – Technical Analysis
         1. The methods which will be used to evaluate possible solutions to stormwater problem areas were outlined.

2. Task 4 will be discussed in depth during WPAC Meeting #2.

V. Schedule / Timeline
   a. The project has a funding deadline for submittal to DEP by August 2026.
   b. The WPAC Meeting Schedule was presented and members were encouraged to email or reach out with questions or concerns at any point during the process.

VI. Stakeholder Roles & Contributions
   a. The WPAC was defined and the group's primary responsibilities were presented. Their role is to ensure that the plan reflects local needs and can be implemented and municipal levels.
   b. The Stakeholder Committee was defined and the groups' primary responsibilities were presented. Their role is to serve as key partners in future implementation activities.
   c. Ground rules for all organizations were outlined.

VII. Open Discussion
   a. The following items were discussed in person/via online chat:
      i. There was a request to review the survey form again and guide members through the process of entering the data.
         1. A more detailed review of the problem area fields in the survey was conducted.
         2. Guidance on how to document problem areas that are long end points (like roads or streams) was given. It is suggested to add one point in the middle or at either end point of the zone.
      ii. What should academic institutions/stakeholders do to help provide the project more information?
         1. Initially it was discussed that the survey is designed for municipal input, however, it has since been decided that the survey will be shared with all members of the Stakeholder Committee in addition to WPAC. Therefore, academic partners will have an opportunity to share their studies and data. Gaps in survey responses will be discussed again at the August meeting.
      iii. A suggestion was given that when sending the survey, encourage respondents to leverage their EACs, shade tree commissions, PRP, and other plans.
      iv. Have you determined who in the municipalities you will be sending the survey to?
         1. If there is trouble managing recipients, the Department and EMS have connections to help facilitate the process.
      v. How are you coordinating with academic researchers to get information they have about some of these watersheds?
         1. If there is a gap from WPAC survey, then the next level will be from 1:1 stakeholders.
         2. Can we see where there are gaps ahead of the 2nd meeting so we can help?

3. The survey closes on 8/4 and the next meeting will be held on 8/19. During those two weeks, County & Consultants will reach out for gaps/additional support.

vi. We have done this before and had a hard time getting data. Are there concerns about the timeline?
    1. The proposed timeline is aggressive but will be working as hard as possible to maintain the schedule.

vii. Comment that it can be challenging to get the most up to date versions of data in Darby Cobbs. Stakeholders volunteered to provide services where needed.
    1. We gathered PRPs in one place, it was hard to use that for modeling though. Lots of sensitivity analyses are required for all the ways the plans can be built out.
    2. Understand the emphasis on municipal source for data, but the County/consultants are encouraged to lean on stakeholder partners, such as the recent Brandywine study and Natural Lands Trust who are working on a Resilience, Conservation, and Management Plan for the Darby Creek Watershed. Municipalities may be experiencing survey fatigue.
    3. Municipal engineers are a huge resource since they often have one engineer working for several municipalities.
    4. Public Works staff may know flooding better than some of the engineers.

viii. Is it too early to ask what the solutions may be? The eastern part of the county was developed prior to studies and includes a lot of impervious areas, which means solutions seem more expensive.
    1. Bucks County solution examples were given in response: Upsizing culverts or updating requirements in specific areas to reduce/slow for more intense flooding/rainfall areas. Riparian buffers. It will be more difficult in parts of the watershed with less space. Members are encouraged to include concepts of solutions in the survey.

ix. A point to consider during the analysis was made, specifically with reference to modeling Darby/Cobbs. Consider spatial patterns of rain instead of taking a design storm and applying it to the entire watershed.

Municipality / Organization	Name	Email	Role	MTG #1
Aston Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Bethel Township	Matthew Houtman	mrh@gdhoutman.com	WPAC	YES
Chadds Ford Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Collingdale Borough	Michael Kozlowski	michael.kozlowski@stantec.com	WPAC	YES
Concord Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Darby Borough	Eileen Mulvena	emulvena.ccc@gmail.com	WPAC	YES
Darby Borough	Eileen Mulvena/Ken Woznicki	ktml@verizon.net	WPAC	YES
Darby Township	Jamie Anderson	JamieA98@yahoo.com	WPAC	YES
East Landsdowne Borough	Eileen Mulvena	emulvena.ccc@gmail.com	WPAC	YES
Eddystone Borough	JP Kelly Engineers	jpkelly@kellyengineers.com	WPAC	YES
Glenolden Borough	Dave Damon	dave@damonengineers.com	WPAC	YES
Haverford Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Lower Chichester Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Marple Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Millbourne Borough	Dennis O'Neill	HEM@HEMENGINC.COM	WPAC	YES
Newtown Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Norwood Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Parkside Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Prospect Park Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Radnor Township	Benjamin Wagner	bwagner@radnor.org	WPAC	YES
Radnor Township	Stephen Norcini	snorcini@radnor.org	WPAC	YES
Rose Valley Borough	Matthew Houtman	gdh@gdhoutman.com	WPAC	YES
Sharon Hill Borough	Dave Damon	dave@damonengineers.com	WPAC	YES
Springfield Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Swarthmore Borough	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Thornbury Township	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Thornbury Township	Michael Ciocco	mjc@cataniaengineering.com	WPAC	YES
Trainer Borough	Eileen Mulvena	emulvena.ccc@gmail.com	WPAC	YES
Upland Borough	Daniel Smith	Dsmith@uplandboro.org	WPAC	YES
Upper Chichester Township	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Upper Chichester Township	Michael Ciocco	mjc@cataniaengineering.com	WPAC	YES
Chester County Stormwater Authority	Seung Ah Byun	sbyun@chesco.org	STAKEHOLDER	YES
Chester-Ridley-Crum Watersheds Association (CRC)	Carly Lare	carly@crcwatersheds.org	STAKEHOLDER	YES
Chester-Ridley-Crum Watersheds Association (CRC)	Danni Scott	danni@crcwatersheds.org	STAKEHOLDER	YES
Chester-Ridley-Crum Watersheds Association (CRC)	Robert Ott	r.ott@com-res.com	STAKEHOLDER	YES
County resident	Maggie Dunn	margaretelizabethdunn@gmail.com	STAKEHOLDER	YES
Delaware County Conservation District	Chris Cook	cookc@co.delaware.pa.us	STAKEHOLDER	YES
Delaware County Conservation District	Karen Wilwol	wilwolk@co.delaware.pa.us	STAKEHOLDER	YES
Delaware County Emergency Services	Larry Bak	bakl@co.delaware.pa.us	STAKEHOLDER	YES
Delaware County Emergency Services	Steve Schultz	schultzs@co.delaware.pa.us	STAKEHOLDER	YES
Delaware County Office of Sustainability (DCOS)	Becca Yurkovich	yurkovichr@co.delaware.pa.us	STAKEHOLDER	YES
Delaware County Office of Sustainability (DCOS)	Josh Mintzer	MintzerJ@co.delaware.pa.us	STAKEHOLDER	YES
Drexel University	Franco Montalto	fam26@drexel.edu	STAKEHOLDER	YES
Eastern Delaware County Stormwater Collaborative (EDCSC)	Jamie Anderson	jamiea98@yahoo.com	STAKEHOLDER	YES
PA Sea Grant	Zach Nemec	zmn5053@psu.edu	STAKEHOLDER	YES
Penn State Cooperative Extension	Meagan Hopkins-Doerr	mxh1135@psu.edu	STAKEHOLDER	YES
University of Pennsylvania Water Center	Ellen Kohler	ejkohler@sas.upenn.edu	STAKEHOLDER	YES
Villanova University	Robert G. Traver	robert.traver@villanova.edu	STAKEHOLDER	YES

Delaware County Planning Department
2 West Baltimore Ave, Suite 202, Media, PA 19063 | 610.891.5200

Countywide Act 167 Stormwater Management Plan Phase II

Watershed Plan Advisory Committee (WPAC) #1 Kickoff Meeting

HYBRID: Delaware County Emergency Services Room 101 (360 N. Middletown Road, Lima, PA 19063) / Zoom
July 1, 2025
9:30 A.M.

Zoom link to be emailed separately

Agenda

1. **Welcome and Introductions**
2. **Act 167 Overview**
3. **Phase I Review**
4. **Phase II Activities**
5. **Schedule / Timeline**
6. **Stakeholder Roles & Contributions**
7. **Open Discussion**
8. **Adjournment**

Appendix H.2 – WPAC Meeting #2 8.19.2025

Project	**Countywide Act 167 Stormwater Management Plan Phase II**
Subject	**Watershed Plan Advisory Committee (WPAC) Meeting #2**
Date/Time	August 19, 2025; 9:00 am –10:00 am EST
Location	HYBRID/Zoom
Participants	**Delaware County Planning Dept.**: Michael Leventry, Kelsey Stanton-Murphy **Jacobs**: Courtney Finneran, Monique Epitropou **NTM**: Bethany Shumaker, Scott Brown **WPAC & Stakeholder Committee Members**: See attached

Goal of Meeting: The goal of the second WPAC Meeting was to discuss overall progress on Phase II of the Delaware County Act 167 project, highlighting Task 3.

Agenda

1. Welcome
2. Recap: Act 167 Overview, Phase I and Phase II Review
3. Task 3: Inventory and Assessment
    a. Problem Area Survey
    b. Problem Area Prioritization
    c. Supplemental Studies
    d. Supplemental GIS Data
    e. Mapping and Data Analysis
4. Task 4: Technical Analysis
    a. Watershed Overview
5. Next Steps
6. Open Discussion; Q&A
7. Adjournment

Action Items

- Municipalities to respond to survey by 8/22.
- Municipalities to share out GIS data (zip) to the County via Dropbox links:
    - **Act 167 GIS Data**
    - **Act 167 Supplemental Studies/Plans**

1. Welcome
   a. Representatives from Delaware County Planning Department, Jacobs, and NTM were re-introduced.

2. Recap: Act 167 Overview, Phase I and Phase II Review
   a. The Phase I: Initial Watershed Assessment review included key actions completed during Phase 1 of the project which are summarized in the August 2024 Phase 1 Summary Report.
   b. The Phase II planned activities/scope were presented along with an overview of the schedule.

3. Task 3: Inventory and Assessment
   a. Problem Area Survey
      i. The Problem Area Survey results and map of responses to date were presented.
      ii. Findings of the survey were presented: approximately 120 problem areas were reported, and the highest number of responses were of flooding or flooding and other problems. The second most frequently reported problem included erosion.
      iii. Members have a final opportunity to fill out the survey through 8/22.
      iv. Delaware County will send a final email reminder to municipalities that have not filled in the problem area survey.
   b. Problem Area Prioritization
      i. The methods for which all reported problem areas will be reviewed were presented. Types of problem areas that are not relevant to the Act 167 were described, as well as the types of problem areas which will be prioritized.
   c. Supplemental Studies
      i. A summary of the supplemental studies was presented including the relevance/use of each with regards to the Act 167 Phase II development.
   d. Supplemental GIS Data
      i. The County asked municipalities to share any GIS data of their stormwater system to support the compiling of stormwater infrastructure GIS data.
   e. Mapping and Data Analysis
      i. Several draft maps were presented: watersheds within the County, DEM/Elevation; land use and characteristics, floodplains, and impaired water bodies.

4. Task 4: Technical Analysis
   a. Watershed Overview
      i. A summary table of the proposed technical analysis approach was presented, including: if the watershed has been included in a previous Act 167, the percentage of land area within the County, full release rate

modeling recommendations, and additional notes. All watersheds will include a problem area analysis.

5. Next Steps
   a. The entire Act 167 phase schedule was presented, as well as the WPAC meeting schedule with topics.
   b. Problem area field visits will be conducted through September into early October, after the selections are made in September.
   c. Modeling analysis will begin in mid-September.
   d. WPAC Meeting #3: penciled in for November 13, MS4 GIS data findings to be shared.

6. Open Discussion; Q&A
   a. The following items were discussed during the call and also in the online chat. Not all questions/comments were answered in the chat, and are included here for documentation:
      i. *Modeling done more recently for Cobbs Creek; please see the Resilient Darby Cobbs website*
         1. Thank you! We will be meeting with Franco [Drexel University] to discuss the modeling.
      ii. *The Brandywine Conservancy may already have that data for the Brandywine.*
      iii. *Upper Ridley (Chesco) was not modeled in Ridley plan. Just used info from the county boundary (only Delco modeled).*
      iv. *The Army Corps of Engineers is currently modeling the Darby/Cobbs as part of the Eastwick Levee project. The contact would be Korin Tangtrakul, Senior Manager of Placed Based Initiatives, Office of Sustainability, City of Philadelphia. There is a modeling repository for the various modeling*
      v. *I wonder if the more recent flooding downstream in the Eastwick neighborhood of Philadelphia makes it more important to remodel Darby Cobbs with more recent climate information.*
         1. There are at least two identified problem areas in that vicinity so it will be getting closer attention for sure.
      vi. *Will the plan consider the new MS4 General Permit and Model Stormwater Management ordinance which is going to be volume reduction based.*
         1. Yes
      vii. *Was the percentage of municipal participation shared in the beginning? Are there obvious gaps in data collection from certain areas? I missed the beginning of the meeting so I apologize if this was covered.*
         1. Yes, 67% of municipalities responded
      viii. *Surprised that there aren't more problem areas - particularly upstream - given the size of the county and larger storm events.*

ix. *Villanova University has been doing flood modeling in the Eastwick area. Please feel free to reach out if you would like any of our findings/publications.*
x. *I assume you have looked at FEMA Flood payments to identify problem areas? I'm sorry if i missed that.*
xi. *I would like to ask about how this study is going to help municipalities understand the impacts of increased impervious cover and large storm events (above the size that stormwater facilities can manage).*
xii. *I think this goes to George s point - a community upstream could be in compliance with SW ordinance and its MS4 permit but it sends LOTS of stormwater downstream during larger storm events because of the large amount of impervious cover.*
xiii. *The first challenge is to understand the current issues and hydrologic scenario so good decisions are made.*
xiv. *Did I understand correctly that the resulting recommendations will have more of a larger focus with upstream changes supplemented by some localized solutions for specific identified stormwater issues?*
xv. *PADEP has yet to determine how collaboration works for individual MS4 permittees.*
xvi. *Is this going to end up being an unfunded mandate?*
    1. Having problems/solutions identified, this plan will support seeking/receiving funding for solutions.
    2. Per PADEP, municipalities can apply for reimbursement for the costs associated with updating their ordinance and being part of the Plan developing process (participating in the WPAC)
    3. This link from DEP has the forms for tracking time for reimbursement:
xvii. *Dennis O'Neal told us Army Corps doing a big project on Eastwick – will Act 167 include or cover this study? Are these studies being coordinated?*
    1. Any study we become aware of will be included in the assessment. Depending on goal of the study, our level of involvement will vary. Will likely be reflected in the problem area assessment.
        a. *If there's less water going to Eastwick, then more water going downstream – since we are located at confluence, we are concerned about what's happening with that project.*
            i. There are 2 problem areas in the Eastwick area. The Phase II team will be taking a closer look at the Eastwick area as planned.
xviii. Someone suggested to meet with Brandywine Conservancy (BC), based on their recent flood study that was released earlier this year, and because they have a lot of projects for flood mitigation. They are looking for partner projects and grant opportunities.
    1. The County is aware of a number of those studies.

a. County reached out to BC and they put us in touch with Chester County Water Resource Authority (CCWRA). That group has been very helpful, we are in touch with them.
b. Action item: Project Team to continue coordination with CCWRA and ensure ongoing communication regarding flood studies

2. *CCWRA did meet with the DelCo project team and gave them data and models*

xix. *Anything we can do to help communities get better information about the impacts of large storm events would be really helpful to them to become more climate resilient and make better investments.*

xx. *What is the outcome of all this? County funding projects? Model ordinance? There are many different things that play into these ordinances, and there is concern about being at the bottom of the watershed knowing it could flood out. Looking upstream, knowing that there are 3 points above this location, what can be done when receiving all of that floodwater. What is the outcome?*

1. The Technical Analysis will help to establish standards and criteria, but the other big output of this project will be recommendations for problem area solutions. The team will provide a summary of what we believe the problem is - what we think the cause is – and then describe some potential solutions. We won't design the solutions – that would be a follow-up action depending on the type of project. The ultimate goal of the Phase II effort is to develop the standards/ordinance, but also to create solutions for the priority problem areas that we identify in the study and confirm in the field.

xxi. *Areas that are further away from the river have higher elevations with more green space. What degree will the large open space properties in the watersheds be assessed for future projects to put something that can resolve downstream area issues?*

1. These are the kinds of things we will be looking into for problem area solutions. For example, if the runoff can't be controlled with release rate standards, perhaps it needs to be stored in upper part of the watersheds via a specific project.
2. Solution identification is an ongoing component of the supplemental studies, and so municipalities are encouraged to share any and all additional information.

xxii. *Can you give feedback for how Townships have to apply for their new MS4 permits coming up? We have to look at partnerships with neighboring municipalities, will there be part of that?*

1. Yes, collaboration between municipalities and counties will be included with the recommendations.

2. Municipalities should share MS4 information with the County so that we can have a countywide dataset that will hopefully support you in your efforts for permits (Action Item).
3. EMA is trying to locate issues that span municipalities and stormwater systems, and tracking the correct source can be challenging given need to call multiple contacts at multiple municipalities . It would be helpful to have a County-wide map to understand where one municipality's system connects to another municipalities system. Sharing the MS4 information is a great way to demonstrate that future collaboration.

xxiii. Jacobs noted they will evaluate the placement of the problem area points located outside the County

xxiv. Are larger storms being looked at?

1. An appropriate design storm for analysis is being considered. Current NOAA Atlas 14 rainfall data (Volume 2) was developed from data through the early 2000s and was published about 2010. An update to NOAA Atlas 14 (referred to as Volume 13) is currently under peer review and is expected to become available sometime mid-2026. This will be too late to include the data for this study as modeling activities are scheduled for late 2025 into early 2026. In addition, NOAA has clearly stated that the provisional data currently under peer review should not be used until it is officially published.
2. NOAA is also working on NOAA Atlas 15 which will consider the effects of climate change on precipitation values. This study won't be completed until late 2026.
3. An option currently being considered is to use the 90% confidence interval on the current NOAA Atlas 14 precipitation data. An initial evaluation indicates that this upper bound may be similar to the average precipitation values in the draft version of NOAA Atlas 14 Volume 13.

7. Adjournment

Municipality / Organization	Name	Email	Role	WPAC 2 (Virtual)
Aldan Borough	J.P. Kelly	jpkelly@kellyengineers.com	WPAC	YES
Aston Township	Bill Defeo	wdefeo@astontwp.net	WPAC	YES
Aston Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Brookhaven Borough	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	YES
Chadds Ford Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Chadds Ford Township	Lacey Faber	lfaber@chaddsfordpa.gov	WPAC	YES
City of Chester	Anthony LaRosa	anthony.larosa@collierseng.com	WPAC	YES
City of Chester	Paul Fritz		WPAC	YES
City of Chester	Debbie Zimmerman		WPAC	YES
Chester Heights Borough	Michael Kissinger	MKissinger@Pennoni.com	WPAC	YES
Clifton Heights Borough	J. P. Kelly	jpkelly@kellyengineers.com	WPAC	YES
Collingdale Borough	Michael Kozlowski	michael.kozlowski@stantec.com	WPAC	YES
Concord Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Concord Township	Dan Moyer		WPAC	YES
Darby Township	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	YES
Eddystone Borough	JP Kelly Engineers	jpkelly@kellyengineers.com	WPAC	YES
Edgmont Township	Jessica Redding		WPAC	YES
Edgmont Township	Ken Kynett		WPAC	YES
Haverford Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Haverford Township	Steven Poole	spoole@havtwp.org	WPAC	YES
Lower Chichester Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Marcus Hook Borough	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	YES
Marcus Hook Borough	Jacqui Guenther		WPAC	YES
Marple Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Middletown Township	J.P. Kelly	jpkelly@kellyengineers.com	WPAC	YES
Millbourne Borough	Dennis O'Neill	HEM@HEMENGINC.COM	WPAC	YES
Morton Borough	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	YES
Nether Providence Township	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	YES
Newtown Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Newtown Township	George Sharretts		WPAC	YES
Newtown Township	Stephen Nease		WPAC	YES
Norwood Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Parkside Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Prospect Park Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Ridley Park Borough	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	YES
Ridley Township	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	YES
Rutledge Borough	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	YES
Springfield Township	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Swarthmore Borough	Bridget Gillen	BGillen@Pennoni.com	WPAC	YES
Thornbury Township	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Tinicum Township	Dave Schreiber	dschreiber@tinicumtownshipdelco.com	WPAC	YES
Upper Chichester Township	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Upper Chichester Township	George Needles	gneedles@upperchitwp.org	WPAC	YES
Upper Darby Township	Khaled Hassan	khassan@pennoni.com	WPAC	YES
Upper Providence Township	J.P. Kelly	jpkelly@kellyengineers.com	WPAC	YES
Brandywine Conservancy	Grant DeCosta	gdecosta@brandywine.org	STAKEHOLDER	YES
Chester County Water Resources Authority	Seung Ah Byun	sbyun@chesco.org	STAKEHOLDER	YES
Chester-Ridley-Crum Watersheds Association (CRC)	Carly Lare	carly@crcwatersheds.org	STAKEHOLDER	YES
City of Philadelphia, Sustainability Office	Korin Tangtrakul	korin.tangtrakul@phila.gov	STAKEHOLDER	YES
Delaware County Conservation District	Chris Cook	cookc@co.delaware.pa.us	STAKEHOLDER	YES
Delaware County Conservation District	Karen Wilwol	wilwolk@co.delaware.pa.us	STAKEHOLDER	YES
Delaware County Emergency Services	Larry Bak	bakl@co.delaware.pa.us	STAKEHOLDER	YES
Delaware County Emergency Services	Steve Schultz	schultzs@co.delaware.pa.us	STAKEHOLDER	YES
Delaware County Office of Sustainability (DCOS)	Becca Yurkovich	yurkovichr@co.delaware.pa.us	STAKEHOLDER	YES
Eastern Delaware County Stormwater Collaborative (EDCSC)	Karen Holm		STAKEHOLDER	YES
PA Sea Grant	Zach Nemec	zmn5053@psu.edu	STAKEHOLDER	YES
Penn State Cooperative Extension	Meagan Hopkins-Doerr	mxh1135@psu.edu	STAKEHOLDER	YES
University of Pennsylvania Water Center	Ellen Kohler	ejkohler@sas.upenn.edu	STAKEHOLDER	YES
Villanova University	Robert G. Traver	robert.traver@villanova.edu	STAKEHOLDER	YES
Villanova University	Virginia Smith	virginia.smith@villanova.edu	STAKEHOLDER	YES

Delaware County Planning Department
2 West Baltimore Ave, Suite 202, Media, PA 19063 | 610.891.5200

Countywide Act 167 Stormwater Management Plan Phase II

Watershed Plan Advisory Committee (WPAC) #2

Zoom

August 19, 2025

9:00 am

https://co-delaware-pa-us.zoom.us/j/86864536194?pwd=I4aLFlLFDGkxc34jLm1yIvQEHoizra.1

Meeting ID: 868 6453 6194

Passcode: 634793

Agenda

1. Welcome
2. Recap: Act 167 Overview; Phase I and Phase II Review
3. Task 3: Inventory and Assessment
    a. Problem Area Survey
    b. Problem Area Prioritization
    c. Supplemental Studies
    d. Supplemental GIS Data
    e. Mapping and Data Analysis
4. Task 4: Technical Analysis
    a. Watershed Overview
5. Next Steps
6. Open Discussion; Q&A
7. Adjournment

Appendix H.3 – WPAC Meeting #3 11.13.2026

Project	**Countywide Act 167 Stormwater Management Plan Phase II**
Subject	**Watershed Plan Advisory Committee (WPAC) Meeting #3**
Date/Time	November 13, 2025; 9:00 am –10:30 am EST
Location	Delaware County Emergency Services / Zoom
Participants	**Delaware County Planning Dept.**: Michael Leventry, Kelsey Stanton-Murphy **Jacobs**: Courtney Finneran, Monique Epitropou, Andrew Potts **NTM**: Bethany Shumaker, Scott Brown **USACE:** Scott Sanderson **WPAC & Stakeholder Committee Members**: See attached

Goal of Meeting: The goal of the third WPAC Meeting was to discuss overall progress on Phase II of the Delaware County Act 167 project, focused on Task 3 and Task 4, and to share an overview of the Army Corp of Engineers assistance opportunities.

Agenda

1. Welcome
2. Recap: Act 167 Overview, Phase I and Phase II Review
3. Task 3: Inventory and Assessment
    a. Mapping and Data Analysis
    b. Problem Area Prioritization
    c. Field Visits to Problem Areas
4. Task 4: Technical Analysis
5. Next Steps/Action Items
6. Special Guest: USACE – Overview and Capabilities
7. Open Discussion; Q&A
8. Adjournment

Action Items

- Municipalities to share out municipal based stormwater infrastructure GIS data (zip) to the County via Dropbox links
    - Act 167 GIS Data
- Municipalities to provide copies of their MS4 Maps via Dropbox link or email

1. Welcome
   a. Representatives from Delaware County Planning Department, Jacobs, and NTM were re-introduced.

2. Recap: Act 167 Overview, Phase I and Phase II Review
   a. The Phase I: Initial Watershed Assessment review included key actions completed during Phase 1 of the project which are summarized in the August 2024 Phase 1 Summary Report.
   b. The Phase II planned activities/scope were presented along with an overview of the schedule.
      i. Task 3 is complete, and Task 4 has been started.

3. Task 3: Inventory and Assessment
   a. Mapping and Data Analysis
      i. Additional maps created since the last meeting were presented: Impervious Cover, Socioeconomically Distressed Areas, Surface Water and Wetlands, Soils, Future Land Use, Existing Stormwater Problem Areas, Flooding, and Obstructions, and Existing Stormwater and Flood Control Facilities
   b. Problem Area Prioritization
      i. Recap of Problem Area Survey Responses
         1. Responses from 33 Municipalities with a 67% response rate
         2. Majority of reported problem areas were flooding related, with erosion being the second most frequently reported problem
      ii. Field Visit Prioritization explained
         1. All reported problems were reviewed and will be included in the solution and analysis phase.
         2. Field visits were determined based on problem type and extent. Field visits were prioritized at sites where severe incidents have occurred and where problem impacts public infrastructure or multiple stakeholders.
   c. Field Visits to Problem Areas
      i. 87 sites were visited over 13 days
         1. In the field, sites were assessed to gain a clearer understanding of problems identified from survey/studies.
         2. In the field, potential solutions to identified problems were discussed and proposed.
      ii. All data collected in the field will inform Task 4 Analysis and Task 7 Plan Implementation.

4. Task 4: Technical Analysis
   a. NTM recapped the proposed technical analysis summary table and presented the modeling approach. The table included if the watershed has been included in a

previous Act 167, the percentage of land area within the County, full release rate modeling recommendations, and additional notes.

b. Traditional Release rate modeling for all watersheds within Delaware County is not currently required due to many watersheds having prior Act 167 plans with suitable release rates for reuse. The watersheds that do not have available release rate maps for reuse require cross county collaboration for an updated analysis, which will be addressed in the future. Lastly, some watersheds are smaller in size and release rate mapping would not be appropriate.
    i. One exception that would warrant future release rate modeling for some watersheds, would be to account for significant changes in rainfall that have occurred in more recent decades. However, due to impending updates to the published rainfall data from NOAA, it is recommended to hold off on such an analysis for the time being.
c. Therefore, a problem area focused analysis has been advocated for by DEP in lieu of traditional release rate modeling. Problem areas have been gathered from the Task 2 WPAC Survey responses and obtained from available studies and publications submitted to the County. The Pilot Model Study was initiated as a result of the emphasis being placed on Problem Area analysis.
d. Review of Pilot Model Study
    i. Focus on evaluation of problem areas – specifically flooding problems.
    ii. Pilot study completed for the Marcus Hook Watershed, due to its small size within Delaware County and inclusion of several problem areas.
        1. HEC-RAS modeling software was used due to its 2 dimensional capability for visualizing riverine flooding over existing topography.
        2. Goals of the pilot study were reviewed, including verification of flooding problem areas, gain deeper understanding of overland flow paths, identify vulnerable locations, and inform proposed solutions analysis.
        3. Limitations of the model include limited existing infrastructure data.

5. Next Steps
    a. Technical analysis will continue.
        i. Field data to be analyzed to develop prioritization for analysis, modeling methodology to be finalized and then applied to some additional areas, and initiate solutions review.
    b. In January, Task 5 standards and criteria for stormwater control will begin.
    c. WPAC Meeting #4 is currently planned for February 2026; progress on modeling efforts and proposed solutions will be shared.
    d. Request of MS4 data from municipalities
    e. Municipal Reimbursements Overview – all municipalities should track their costs.

6. Special Guest: USACE – Overview and Capabilities

a. Scott Sanderson from the US Army Corp of Engineers covered many different programs that can potentially provide technical and/or financial assistance with flood mitigation: Environmental Infrastructure (Sec. 219), Southeastern PA & Lower Delaware River Basin (Sec. 566), Flood Plain Management Services (FPMS), Planning Assistance to the States (Sec. 22), Streambank Stabilization (Sec. 14), Hurricane & Storm Damage Reduction (Sec. 103), Flood Damage Reduction (Sec. 205), Aquatic Ecosystem Restoration (Sec. 206).

7. Open Discussion; Q&A
   a. The following items were discussed during the call:
      i. *Marcus Hook pilot study appeared to have unnatural boundary cut off. Why the watershed was limited to that extent and if there are concerns that its incomplete for things such as impacts and connection to the Delaware River and any tidal concerns that would impact the model such as backwater during high tide.*
         1. An upstream portion of the Marcus Hook watershed was chosen specifically because it was small enough scale to better constrain the amount of time and scope for this first pilot study. We specifically limited to an upstream location to better focus on the surface flooding excluding the tidal impacts. We have not completed this pilot effort and are still reviewing initial results, assumptions, and methodology with the County.

8. Adjournment

Delaware County Act 167 WPAC Meeting Participation

Municipality / Organization	Name	Email	Role	WPAC Mtg #3
City of Chester	Paul Fritz	pfritz@chestercity.com	WPAC	YES
City of Chester	Debbie Zimmerman	dzimmerman@chestertownshippolice.org	WPAC	YES
Collingdale Borough	Michael Kozlowski	michael.kozlowski@stantec.com	WPAC	YES
Concord Township	Dan Moyer	dmoyer@concordtownship.org	WPAC	YES
Edgmont Township	Jessica Redding	Assistant@edgmont.org	WPAC	YES
Edgmont Township	Ken Kynett	Manager@edgmont.org	WPAC	YES
Haverford Township	Steven Poole	spoole@havtwp.org	WPAC	YES
Haverford Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	YES
Lansdowne Borough	Kevin Matson	kmatson@lighthouse-engineers.com	WPAC	YES
Lansdowne Borough	Kevin Laverty	LavertyK@lansdowneborough.com	WPAC	YES
Marple Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	YES
Media Borough	Kevin Matson	kmatson@lighthouse-engineers.com	WPAC	YES
Millbourne Borough	Dennis O'Neill	HEM@HEMENGINC.COM	WPAC	YES
Newtown Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	YES
Norwood Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Parkside Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Prospect Park Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Sharon Hill Borough	Kevin Matson	kmatson@lighthouse-engineers.com	WPAC	YES
Springfield Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	YES
Swarthmore Borough	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	YES
Swarthmore Borough	Sean Halbom	manager@swarthmorepa.org	WPAC	YES
Thornbury Township	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Tinicum Township	David Schreiber	dschreiber@tinicumtownshipdelco.com	WPAC	YES
Tinicum Township	Herbert E. MacCombie, Jr.	HEM@HEMENGINC.COM	WPAC	YES
Tinicum Township	Dennis O'Neill	HEM@HEMENGINC.COM	WPAC	YES
Upper Chichester Township	Lisa Catania	eac@cataniaengineering.com	WPAC	YES
Upper Darby Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	YES
Upper Darby Township	Sindy Mulyono-Danre		WPAC	YES
Brandywine Conservancy	Grant DeCosta	gdecosta@brandywine.org	STAKEHOLDER	YES
Chester-Ridley-Crum Watersheds Association (CRC)	Carly Lare	carly@crcwatersheds.org	STAKEHOLDER	YES
Delaware County Conservation District	Karen Wilwol	wilwolk@co.delaware.pa.us	STAKEHOLDER	YES
Delaware County Emergency Services	Larry Bak	bakl@co.delaware.pa.us	STAKEHOLDER	YES
Eastern Delaware County Stormwater Collaborative (EDCSC)	Jamie Anderson	jamiea98@yahoo.com	STAKEHOLDER	YES

Montgomery County Planning Commission	Jon Lesher	jon.lesher@montgomerycountypa.gov	STAKEHOLDER	YES
Penn State Cooperative Extension	Meagan Hopkins-Doerr	mxh1135@psu.edu	STAKEHOLDER	YES
Villanova University	Robert G. Traver	robert.traver@villanova.edu	STAKEHOLDER	YES
	Amber Jackson	Yerkes Associates		YES
	Kevin Boyle	Yerkes Associates		YES

Appendix H.4 – WPAC Meeting #4 2.26.2026

Project	**Countywide Act 167 Stormwater Management Plan Phase II**
Subject	**Watershed Plan Advisory Committee (WPAC) Meeting #4**
Date/Time	February 26, 2026; 9:30 am –11:00 am EST
Location	Zoom
Participants	**Delaware County Planning Dept.**: Gina Burritt, Michael Leventry, Kelsey Stanton-Murphy **Jacobs**: Monique Epitropou, Courtney Finneran, Elise Ibendahl, Daniel Wible **NTM**: Scott Brown, Paul DeBarry, Bethany Shumaker, Francisco Aguirre **DVRPC:** Amy Verbofsky **WPAC & Stakeholder Committee Members**: See attached

Goal of Meeting: The goal of WPAC Meeting #4 was to discuss overall progress on Phase II of the Delaware County Act 167 project, focused on Task 4 and Task 7, and to share findings from Delaware Valley Regional Planning Commission's investigation into multi-municipal stormwater planning.

Agenda

1. Welcome
2. Recap: Act 167 Overview, Phase I and Phase II Review
3. Task 4: Technical Analysis
    a. Technical Analysis Recap
    b. Modeling Location Prioritization
    c. Stream Gage Location Criteria
4. Task 7: Plan Implementation
5. Next Steps/Action Items
6. Open Discussion; Q&A
7. Special Guest: Amy Verbofsky, DVRPC: *An Investigation into Multi-Municipal Stormwater Planning*
8. Adjournment

Action Items

- PowerPoint and Meeting Minutes to be provided by Jacobs
- Municipalities are to track any costs incurred for reimbursement to PADEP.
- Municipalities to provide copies of their MS4 Maps via Dropbox link or email.

1. Welcome
    a. New representatives from Jacobs and NTM were introduced.

2. Recap: Act 167 Overview, Phase I and Phase II Review
   a. Phase II planned activities/scope were presented along with an overview of the schedule.
      i. Task 3 is complete, and Task 4 is ongoing. Task 7 has been started.

3. Task 4: Technical Analysis
   a. Technical Analysis Recap
      i. NTM reviewed the proposed technical analysis approach. Full release rate modeling is not needed for all watersheds because many have Act 167 plans with suitable release rates. Watersheds without existing release-rate maps will require future cross-county collaboration. Smaller watersheds are not appropriate for release rate mapping.
         1. Future release rate modeling may be needed due to long-term rainfall changes, but it is recommended to wait until NOAA finalizes updated rainfall data.
      ii. DEP supports focusing on problem area analysis instead of full release-rate modeling. Problem areas were identified in Task 2 WPAC Survey responses and existing studies. Flooding was the most common issue reported. The team initiated a Pilot Model Study to refine understanding of these locations.
         1. Goals: verify flooding problem areas, understand overland flow paths, identify additional vulnerable locations and support solutions development.
         2. Limitations: results are based on available data, not detail-level modeling.
         3. HEC-RAS modeling approach and key assumptions were reviewed. Key assumptions include rainfall data (5-, 10-, 100- yr 24-hr duration), infiltration and loss parameters (DVRPC land use & USGS soil data), major features included (roadways & building footprints), and storm sewer flow paths are represented.
      iii. The Marcus Hook Pilot Study was presented. The model provides general insights and should not be used for detailed planning.
      iv. SCALGO modeling tool and approach was introduced.
   b. Modeling Location Prioritization
      i. The process for selecting modeling location was reviewed. Sites were chosen to provide countywide coverage and represent a variety of problem types.
      ii. Three watersheds were selected to model: Marcus Hook, Muckinipattis Creek, and Naylor's Run.
         1. Muckinipattis Creek Rain-On-Grid HEC-RAS model was reviewed by NTM, and results helped verified 9 reported problem areas.
         2. Naylor's Run Rain-On-Grid HEC-RAS model is underway (Jacobs).
   c. Stream Gage Location Criteria
      i. Task 4 includes the recommendation of 75 locations for stream gages throughout Delaware County.
      ii. Criteria used to select locations (in priority order) include confluence points, site ownership, site access, problem areas identified, and opportunities to supplement NOAA precipitation and USGS stream gage coverage.

4. Task 7: Plan Implementation
   a. Goals of Task 7 were reviewed: 1) develop an inventory of conceptual solutions for the identified problems and 2) develop more detailed conceptual solutions for high priority problems.
   b. Jacobs presented two high priority problems in the Marcus Hook watershed and shared draft project solution analysis forms. These examples showed how modeling improved understanding of problems and informed potential solutions.
   c. Next steps include: continue developing and refining project forms for all high priority problems; prepare more detailed solution concepts and analyses for select high priority problems, and develop of matrix of solutions for remaining problems.

5. Next Steps
   a. Technical analysis and solutions development for implementation will continue.
   b. Task 5 standards and criteria for stormwater control and Task 6 model ordinance will begin.
   c. Municipal Reimbursements Overview – all municipalities should track their costs.

6. Open Discussion; Q&A
   a. The following items were discussed during the call:
      i. Slide deck will be shared along with the meeting minutes.
      ii. *Does either model (HEC-RAS or SCALGO) include an overlay for designated floodplains?*
         1. It does. It is not necessarily part of the model but is included on maps for comparison.
      iii. *Will the Act 167 Model SWM Ordinance be coordinated with the new Model being developed by the DEP as part of the new MS4 NOI anticipated to be required in 2028 which will include Volume Management Plans?*
         1. Yes, the team will coordinate the Act 167 Model Ordinance with the upcoming MS4 ordinance and the updated PCSM manual as much as possible. Coordination efforts are underway, but DEP's timeline has shifted and the PCSM manual will now be released after completion of this project. These delays may create challenges, but the team will incorporate updates wherever feasible.

7. Special Guest: DVRPC: *An Investigation into Multi-Municipal Stormwater Planning*
   a. Amy Verbofsky from DVRPC shared information on a project with the goal of better understanding how municipalities in Delaware County are currently meeting their MS4 permit requirements and where additional support may be needed.
   b. Case studies highlighting existing stormwater collaborators were spotlighted and included Berks County MS4 Steering Committee, Perkiomen Watershed Conservancy Municipal MS4 Program, Wyomissing Creek Watershed Coalition, and Eastern Delaware County Stormwater Collaborative.

8. Adjournment

Municipality / Organization	Name	Email	Role	WPAC Meeting #4
Aston Township	Bill Defeo	wdefeo@astontwp.net	WPAC	Yes
Aston Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Brookhaven Borough	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	Yes
Chadds Ford Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Chester Heights Borough	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Concord Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Darby Township	Lisa Catania	eac@cataniaengineering.com	WPAC	Yes
Edgmont Township	Jessica Redding	Assistant@edgmont.org	WPAC	Yes
Edgmont Township	Ken Kynett	Manager@edgmont.org	WPAC	Yes
Edgmont Township	Kevin Boyle	kboyle@yerkes-assoc.com	WPAC	Yes
Haverford Township	Steven Poole	spoole@havtwp.org	WPAC	Yes
Haverford Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Lansdowne Borough	Kevin Laverty	LavertyK@lansdowneborough.com	WPAC	Yes
Lower Chichester Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Marcus Hook Borough	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	Yes
Marple Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Millbourne Borough	Dennis O'Neill	HEM@HEMENGINC.COM	WPAC	Yes
Newtown Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Newtown Township	George Sharretts	sharrettsg@newtowntownship.org	WPAC	Yes
Newtown Township	Stephen Nease	snease@newtowntownship.org	WPAC	Yes
Norwood Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	Yes
Parkside Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	Yes
Prospect Park Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	Yes
Radnor Township	Stephen Norcini	snorcini@radnor.org	WPAC	Yes
Ridley Township	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	Yes
Sharon Hill Borough	Joy Taylor	joythemua@gmail.com	WPAC	Yes
Springfield Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Swarthmore Borough	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Thornbury Township	Jeff Seagraves	jeff@thornbury.org	WPAC	Yes
Thornbury Township	Lisa Catania	eac@cataniaengineering.com	WPAC	Yes
Tinicum Township	Dave Schreiber	dschreiber@tinicumtownshipdelco.com	WPAC	Yes
Tinicum Township	James W. MacCombie, P.E. / Dennis O'Neill	HEM@HEMENGINC.COM	WPAC	Yes
Upland Borough	Daniel Smith	Dsmith@uplandboro.org	WPAC	Yes
Upper Chichester Township	Lisa Catania	eac@cataniaengineering.com	WPAC	Yes
Upper Darby Township	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Upper Darby Township	Sindy Mulyono-Danre	smdanre@upperdarby.org	WPAC	Yes
Upper Providence Township	Ivy Ross	IRoss@UpperProvidence.org	WPAC	Yes
Yeadon Borough	Eric P. Johnson	EPjohnson@Pennoni.com	WPAC	Yes
Yeadon Borough	Corey Hospes	CHospes@pennoni.com	WPAC	Yes
Chester County Water Resources Authority	Kate Hutelmyer	khutelmyer@chesco.org	STAKEHOLDER	Yes
Chester-Ridley-Crum Watersheds Association (CRC)	Carly Lare	carly@crcwatersheds.org	STAKEHOLDER	Yes
Clean Air Council	Alyssa Felix-Arreola	afa@cleanair.org	STAKEHOLDER	Yes
Clean Air Council	Bonita Taylor		STAKEHOLDER	Yes
Darby Creek Valley Association	Jack McCausland	jackdcva1@gmail.com	STAKEHOLDER	Yes
Delaware County Conservation District	Karen Lochman	WilwolK@co.delaware.pa.us	STAKEHOLDER	Yes
Delaware County Emergency Services	Larry Bak	bakl@co.delaware.pa.us	STAKEHOLDER	Yes
Delaware County Emergency Services	Mike Bush	BushM@co.delaware.pa.us	STAKEHOLDER	Yes
Delaware County Emergency Services	Steve Schultz	schultzs@co.delaware.pa.us	STAKEHOLDER	Yes

Municipality / Organization	Name	Email	Role	WPAC Meeting #4
Delaware County Office of Sustainability (DCOS)	Becca Yurkovich	yurkovichr@co.delaware.pa.us	STAKEHOLDER	Yes
Eastern Delaware County Stormwater Collaborative (EDCSC)	Jamie Anderson	jamiea98@yahoo.com	STAKEHOLDER	Yes
Eastern Delaware County Stormwater Collaborative (EDCSC)	Karen Holm	karenholm113@gmail.com	STAKEHOLDER	Yes
Penn State Cooperative Extension	Meagan Hopkins-Doerr	mxh1135@psu.edu	STAKEHOLDER	Yes
University of Pennsylvania Water Center	Ellen Kohler	ejkohler@sas.upenn.edu	STAKEHOLDER	Yes
County resident	Melissa Muroff	melissamuroff@gmail.com	STAKEHOLDER	Yes

Delaware County Planning Department
2 West Baltimore Ave, Suite 202, Media, PA 19063 | 610.891.5200

Countywide Act 167 Stormwater Management Plan Phase II

Watershed Plan Advisory Committee (WPAC) #4

Zoom

February 26, 2026

9:30 am

Zoom: https://co-delaware-pa-us.zoom.us/j/81295788620?pwd=EiHk4pCuTm8v9p9aINWH3NQZ3lpnLZ.1

Meeting ID: 812 9578 8620
Passcode: 065771

Agenda

1. Welcome
2. Recap: Act 167 Overview; Phase I and Phase II Review
3. Task 4: Technical Analysis
    a. Technical Analysis Recap
    b. Modeling Location Prioritization
    c. Stream Gage Location Criteria
4. Task 7: Plan Implementation
5. Next Steps/Action Items
6. Open Discussion; Q&A
7. Special Guest: Amy Verbofsky, DVRPC: *An Investigation into Multi-Municipal Stormwater Planning*
8. Adjournment

Appendix H.5 – WPAC Meeting #5 4.30.2026

Project	**Countywide Act 167 Stormwater Management Plan Phase II**
Subject	**Watershed Plan Advisory Committee (WPAC) Meeting #5**
Date/Time	April 30, 2026; 9:30 am –11:00 am EST
Location	Zoom
Participants	**Delaware County Planning Dept.**: Michael Leventry, Kelsey Stanton-Murphy **Jacobs**: Monique Epitropou, Courtney Finneran, Elise Ibendahl, Daniel Wible, Andy Potts **NTM**: Scott Brown, Bethany Shumaker **WPAC & Stakeholder Committee Members**: See attached

Goal of Meeting: The goal of WPAC Meeting #5 was to discuss overall progress on Phase II of the Delaware County Act 167 project, focused on Task 4 through Task 7.

Agenda

1. Welcome
2. Recap: Act 167 Overview, Phase I and Phase II Review
3. Task 4: Technical Analysis
    a. Naylor's Run Modeling Results
    b. Recommended Stream Gage Locations
4. Task 5: Standards & Criteria and Task 6: Model Ordinance
5. Task 7: Plan Implementation
    a. Solutions Analysis
    b. Matrix
6. Next Steps/Action Items
7. Open Discussion; Q&A
8. Adjournment

Action Items

- PowerPoint and Meeting Minutes to be provided by Jacobs
- Municipalities are to track any costs incurred for reimbursement to PADEP.

1. Welcome
   a. Representatives from Jacobs and NTM were introduced.

2. Recap: Act 167 Overview, Phase I and Phase II Review
   a. Phase II planned activities/scope were presented along with an overview of the schedule.
      i. Presented final technical analysis (Task 4), introduced standards and criteria (Task 5). model ordinance review (Task 6) and discussed solutions under Plan Implementation (Task 7).

3. Task 4: Technical Analysis
   a. Naylor's Run Modeling Results
      i. Modeling location prioritization was reviewed. Sites were chosen to provide countywide coverage and represent a variety of problem areas. Three watersheds were selected to model as part of the Act 167 Plan: Marcus Hook, Muckinipattis, and Naylor's Run. Marcus Hook and Muckinipattis were presented at WPAC Meeting #4.
      ii. Naylor's Run Rain-On-Grid HEC-RAS model has been completed and results were shared by Jacobs. Results verified four (4) survey-reported high priority problem areas in Naylor's Run subwatershed.
   b. Recommended Stream Gage Locations
      i. Criteria used to select locations (in priority order) include confluence points, site ownership, site access, problem areas identified, and opportunities to supplement NOAA precipitation and USGS stream gage coverage.
      ii. The map of final proposed stream gage sites was presented.

4. Task 5: Standards & Criteria and Task 6: Model Ordinance
   a. Standards & Criteria
      i. Required Act 167 stormwater standards were outlined, covering peak runoff rate, stream stability, groundwater recharge, volume control, and water quality, with several relying on existing or forthcoming state standards.
      ii. Proposed peak runoff release rates were presented by watershed, mixing existing standards with 100% release rates and conditional no-detention where appropriate. Several watersheds were flagged for potential future studies to reassess release rates based on updated rainfall data and modeling.
      iii. Most of the county is covered by watersheds that have current Act 167s and release rate standards. These release rate standards will be used as part of this Act 167. Other standards reviewed in this meeting include stream stability, groundwater recharge/volume control, and water quality.

iv. Exemptions and standards for projects disturbing less than one-acre were discussed, consistent with the 2028 MS4/Act 167 Model Ordinance framework. Final exemption thresholds and requirements will largely be determined by individual municipalities, using the County Model Ordinance as a baseline.

b. Model Ordinance
   i. The model ordinance will mimic the 2028 MS4/Act 167 Model Ordinance, with select modifications including added peak rate standards, clarified exemptions, and references to PCSM and E&S manuals.
   ii. Municipal input will be requested on standards and exemptions during plan review.

5. Task 7: Plan Implementation
   a. Solutions Analysis
      i. Goal for Task 7 is to develop an inventory of conceptual solutions for identified problems and develop more detailed conceptual solutions for highest priority problems.
      ii. Several examples of solution strategies within high priority problems in Naylor's Run watershed were shared.
      iii. A draft 3-phased flood reduction strategy was presented, including: development of detailed hydraulic model/conveyance capacity study (Phase 1), a larger drainage and underground storage project (Phase 2), and a mix of blue/green stormwater infrastructure projects (Phase 3).
   b. Matrix
      i. A visual framework was presented linking identified stormwater problem areas to corresponding conceptual solution types to support prioritization and implementation planning. The slide emphasizes a structured, transparent method for moving from modeled problems to potential mitigation strategies across the county.

6. Next Steps
   a. Jacobs and NTM will continue and complete all remaining work for Tasks 5, 6 and 7.
   b. Task 8 draft Stormwater Management Plan will be presented at WPAC Meeting #6 on July 9th, 2026.
   c. The review period for comments on the Plan will be July 9th – July 24th.
   d. Municipal Reimbursements Overview – all municipalities should track their costs.

7. Open Discussion; Q&A
   a. The following items were discussed during the call:
      i. Review period for WPAC to submit comments on Plan will be July 9th – July 24th, 2026 with further communication to come.
      ii. *Dennis O'Neil shared that " Direct Discharges to the Delaware River need to consider tide cycles in the River. Stormwater BMP need to be able to store*

stormwater during times when tides prevent discharge. He shared that any stormwater design or any new ordinance in areas with tidal influences (Darby, Delaware) needed to provide adequate storage of stormwater during times when tides prevent discharge.

1. Consultants concurred and agreed that standards and criteria would include consideration for the tidal areas within the County.

8. Adjournment

Municipality / Organization	Name	Email	Role	WPAC Meeting #5 (Virtual)
Aldan Borough	JP Kelly Engineers	jpkelly@kellyengineers.com	WPAC	Yes
Brookhaven Borough	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	Yes
Clifton Heights Borough	JP Kelly Engineers	jpkelly@kellyengineers.com	WPAC	Yes
Darby Township	Lisa Catania	eac@cataniaengineering.com	WPAC	Yes
Eddystone Borough	JP Kelly Engineers	jpkelly@kellyengineers.com	WPAC	Yes
Edgmont Township	Jessica Redding	Assistant@edgmont.org	WPAC	Yes
Edgmont Township	Ken Kynett	Manager@edgmont.org	WPAC	Yes
Haverford Township	Steven Poole	spoole@havtwp.org	WPAC	Yes
Marple Township	Corey Hospes	CHospes@pennoni.com	WPAC	Yes
Millbourne Borough	Dennis O'Neill	doneill@hemenginc.com	WPAC	Yes
Nether Providence Township	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	Yes
Newtown Township	George Sharretts	sharrettsg@newtowntownship.org	WPAC	Yes
Newtown Township	Corey Hospes	CHospes@pennoni.com	WPAC	Yes
Norwood Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	Yes
Parkside Borough	Lisa Catania	eac@cataniaengineering.com	WPAC	Yes
Ridley Township	Charles Catania, Jr.	cjcjr@cataniaengineering.com	WPAC	Yes
Springfield Township	Corey Hospes	CHospes@pennoni.com	WPAC	Yes
Swarthmore Borough	Corey Hospes	CHospes@pennoni.com	WPAC	Yes
Tinicum Township	Dave Schreiber	dschreiber@tinicumtownshipdelco.com	WPAC	Yes
Tinicum Township	James W. MacCombie, P.E. / Dennis O'Neill	doneill@hemenginc.com	WPAC	Yes
Upper Darby Township	Sindy Mulyono-Danre	smdanre@upperdarby.org	WPAC	Yes
Chester-Ridley-Crum Watersheds Association (CRC)	Carly Lare	carly@crcwatersheds.org	STAKEHOLDER	Yes
Clean Air Council	Alyssa Felix-Arreola	afa@cleanair.org	STAKEHOLDER	Yes
Delaware County Conservation District	Chris Cook	cookc@co.delaware.pa.us	STAKEHOLDER	Yes
Delaware County Conservation District	Karen Lochman	WilwolK@co.delaware.pa.us	STAKEHOLDER	Yes
Delaware County Emergency Services	Mike Bush	BushM@co.delaware.pa.us	STAKEHOLDER	Yes
Eastern Delaware County Stormwater Collaborative (EDCSC)	Jamie Anderson	jamiea98@yahoo.com	STAKEHOLDER	Yes
Montgomery County Planning Commission	Jon Lesher	jon.lesher@montgomerycountypa.gov	STAKEHOLDER	Yes
Penn State Cooperative Extension	Meagan Hopkins-Doerr	mxh1135@psu.edu	STAKEHOLDER	Yes

Delaware County Planning Department
2 West Baltimore Ave, Suite 202, Media, PA 19063 | 610.891.5200

Countywide Act 167 Stormwater Management Plan Phase II

Watershed Plan Advisory Committee (WPAC) #5

Zoom
April 30, 2026
9:30 am

Zoom: https://co-delaware-pa-us.zoom.us/j/84870433331?pwd=2imwZwsS0V2As3c6UibFNvJ9ASHlOS.1

Meeting ID: 848 7043 3331
Passcode: 849785

Agenda

1. Welcome
2. Recap: Act 167 Overview; Phase I and Phase II Review
3. Task 4: Technical Analysis
    a. Naylor's Run modeling results
    b. Recommended Stream Gage Locations
4. Task 5: Standards & Criteria and Task 6: Model Ordinance
5. Task 7: Plan Implementation
    a. Solutions Analysis
    b. Matrix
6. Next Steps/Action Items
7. Open Discussion; Q&A
8. Adjournment

Appendix H.6 – WPAC Meeting #6 7.09.2026

WPAC #6 Meeting Packet to be added.

Appendix H.7 – Act 167 Draft Plan Comments and Responses

Draft Plan Comments & Responses to be added.