WISSAHICKON CREEK WATERSHED STORMWATER MANAGEMENT ORDINANCE

Implementing the Requirements of the Wissahickon Creek Watershed Stormwater Management Plan

ORDINANCE NO._____ OF _____

[*Municipality*],[*County*] COUNTY,

PENNSYLVANIA

Adopted at a Public Meeting held on

_____, 20__

DRAFT APRIL 23, 2014

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ARTICLE I- GENERAL PROVISIONS

Note: For the Philadelphia portion of the watershed, most provisions of this Model Ordinance are addressed in articles or sections of the Philadelphia Home Rule Charter ("Charter"), the Philadelphia Code ("Code"), and the Philadelphia Water Department's Regulations ("Regulations") and Stormwater Management Guidance Manual ("Manual"). To facilitate a comparison between the provisions in the Model Ordinance and the corresponding provisions in Philadelphia, the comparable provisions of the Charter, Code, PWD Regulations and Manual are set forth in each Article and Section below. The Philadelphia Water Department anticipates implementing the Wissahickon Creek Watershed Stormwater Management Plan ("Plan") through the existing provisions in the Charter, Code, PWD Regulations and Manual, and by amending its Regulation and Manual, as necessary to regulate development in a manner consistent with the Plan, rather than by the enactment of a new ordinance.

Section 101. Short Title

Montgomery County Portion of the Watershed

This Ordinance shall be known and cited as the "Wissahickon Creek Stormwater Management Ordinance".

Philadelphia County Portion of the Watershed

Not Applicable.

Section 102. Statement of Findings

Montgomery County Portion of the Watershed

The governing body of the Municipality finds that:

A. Inadequate management of accelerated stormwater runoff resulting from development throughout a watershed increases flood flows and velocities, contributes to erosion and sedimentation, overtaxes the carrying capacity of existing streams and storm sewers, greatly increases the cost of public facilities to convey and manage stormwater, undermines floodplain management and flood reduction efforts in upstream and downstream communities, reduces groundwater recharge, and threatens public health and safety.

B. Inadequate planning and management of stormwater runoff resulting from land development throughout a watershed can also harm surface water resources by changing the natural hydrologic patterns, accelerating stream flows (which increase scour and erosion of streambeds and streambanks, thereby increasing sedimentation), destroying aquatic habitat, and increasing aquatic pollutant concentrations and loadings such as sediments, nutrients, heavy metals, and pathogens. Groundwater resources are also impacted through loss of recharge.

C. A comprehensive program of stormwater management, including minimization of impacts of development, redevelopment, and activities causing accelerated erosion and loss of natural infiltration, is fundamental to the public health, safety, welfare, and the protection of the people

of the Municipality and all of the people of the Commonwealth, their resources, and the environment.

D. Stormwater is an important resource by providing groundwater recharge for water supplies and baseflow of streams, which also helps to protect and maintain surface water quality.

E. Impacts from stormwater runoff can be minimized by using project designs that maintain the natural hydrologic regime and sustain high water quality, groundwater recharge, stream baseflow, and aquatic ecosystems.

F. Federal and state regulations require certain municipalities to implement a program of stormwater controls. These municipalities are required to obtain a permit for stormwater discharges from their separate storm sewer systems under the National Pollutant Discharge Elimination System (NPDES).

G. Nonstormwater discharges to municipal separate storm sewer systems can contribute to pollution of waters of the Commonwealth.

Philadelphia County Portion of the Watershed

Not Applicable

Section 103. Purpose

Montgomery County Portion of the Watershed

The purpose of this Ordinance is to promote the public health, safety, and welfare within the Wissahickon Creek Watershed by maintaining the natural hydrologic regime and by minimizing the harms and maximizing the benefits described in Section 102 of this Ordinance, through provisions designed to:

A. Meet legal water quality requirements under state law, including regulations of 25 Pa. Code 93 to protect, maintain, reclaim, and restore the existing and designated uses of the waters of the Commonwealth.

B. Preserve the natural drainage systems as much as possible.

C. Manage stormwater close to the source.

D. Provide procedures and performance standards for stormwater planning and management.

E. Maintain groundwater recharge to prevent degradation of surface and groundwater quality and to otherwise protect water resources.

F. Prevent scour and erosion of streambanks and streambeds.

G. Provide proper operation and maintenance of all Stormwater Best Management Practices (BMPs) that are implemented within the Municipality.

H. Provide standards to meet National Pollutant Discharge Elimination System (NPDES) requirements.

I. Meet legal water quality requirements under state law, including regulations at 25 Pennsylvania Code Chapter 93.4.a requiring protection and maintenance of "existing uses" and maintenance of the level of water quality to support those uses in all streams, and the protection and maintenance of water quality in "special protection" streams.

J. Address the quality and quantity of stormwater discharges.

K. Provide standards necessary to meet NPDES permit requirements.

L. Implement an illegal discharge detection and elimination program that addresses non-stormwater discharges into the Municipality's separate storm sewer system.

M. Preserve and restore the flood-carrying capacity of streams.

N. Prevent scour and erosion of streambanks and streambeds.

O. Provide proper operation and maintenance of all stormwater management facilities and BMPs that are implemented in the Municipality.

Philadelphia County Portion of the Watershed

Not Applicable

Section 104. Statutory Authority

Montgomery County Portion of the Watershed

The Municipality is empowered to regulate land use and activities that may affect runoff and surface and groundwater quality and quantity by the authority of:

A. Primary Authority.

The Municipality is empowered to regulate land use activities that affect runoff and surface and groundwater quality and quantity by the authority of the Act of October 4, 1978, P.L. 864 (Act 167), 32 P.S. Section 680.1, et seq., as amended, the "Storm Water Management Act" and the (appropriate municipal code).

B. Secondary Authority.

The municipality also is empowered to regulate land use activities that affect runoff by the authority of the Act of July 31, 1968, P.L. 805, No. 247, The Pennsylvania Municipalities Planning Code, as amended.

Philadelphia County Portion of the Watershed

In addition to the Authority under Act 167, the City of Philadelphia also is empowered to regulate land use activities that affect runoff by the authority of the First Class Cities Home Rule Act, Act of

April 21, 1949, P.L. 665, 53 P.S. § 3101 *et seq*., the Charter, and Sections 13-603 and 14-704 of the Code. Additional authority relating specifically to the Wissahickon Watershed comes from Section 14-510 of the Code.

The Philadelphia Water Department's Regulations and Manual prescribe stormwater management requirements for development and post-development stormwater management control.

The Regulations are available online at:
http://www.pwdplanreview.org/WICLibrary/StormwaterRegulations.pdf

The Manual is available online at: http://www.pwdplanreview.org/StormwaterManual.aspx
The site contains several checklists that have been developed to assist the user in complying with the City of Philadelphia's regulations.

Section 105. Applicability

Montgomery County Portion of the Watershed

All Regulated Activities and all activities that may affect stormwater runoff, including Land Development and Earth Disturbance Activities, are subject to regulation by this Ordinance. This Ordinance shall apply to those portions of the Municipality that lie within the Wissahickon Creek Watershed, in accordance with the Stormwater Management Districts established in Section 408.

Regulated Activities include the following:

a) Land development,
b) Subdivisions,
c) Alteration of the natural hydrologic regime,
d) Construction or reconstruction (see definition in Section202.B) of or addition of new impervious or semi-pervious surfaces(i.e., driveways, parking lots, roads, etc.),
e) Construction of new buildings or additions to existing buildings,
f) Redevelopment,
g) Diversion piping or encroachments in any natural or man-made channel,
h) Stormwater BMPs or appurtenances thereto,
i) Earth disturbance activities of equal to or greater than five thousand (5,000) square feet,
j) Any of the above regulated activities which were approved more than five (5) years prior to the effective date of this Ordinance and resubmitted for municipal approval.

Philadelphia County Portion of the Watershed

The Philadelphia Code authorizes the Water Department to establish, by regulation, the threshold of earth disturbance that constitutes a sufficient risk of water pollution requiring Water Department review. (The Philadelphia Code, § 14-704(3)(a)(1).) The Water Department's regulations currently establish that threshold as 15,000 square feet for New Development and Redevelopment. (PWD Regulations, §§ 600.2, 600.3, and 600.4.) New Development is defined to include any human-induced change to an unimproved tract of land where structures or impervious surfaces were removed before January 1, 1970. Redevelopment is defined to include any human-induced change to an improved tract of land, including demolition or removal of existing structures or impervious surfaces and replacement with new impervious structures. It includes replacement of impervious surfaces that have been removed on or after January 1, 1970. (PWD Regulations, § 600.1.)

In addition, any development located in the Wissahickon Watershed Overlay district must comply with the stormwater management provisions for that overlay district. (The Philadelphia Code, § 14-704(3)(a)(3).) No earth moving activity is permitting within the watershed unless done in accordance with approved earth moving plans prepared by a licensed professional engineer in accordance with regulations approved by the City Planning Commission. Such plans must be filed with and approved by the Commission if the earth moving or additional impervious coverage will be 500 square feet or greater, unless the site is designated as being within Category 5 of the City Planning Commission's Impervious Cover Map. Lots in Category 5 larger than one-half acre may be further developed only as follows: (1) the increased surface water runoff leaving the site must not adversely affect adjacent property; (2) the method of handling runoff on the site must be in accord with sound engineering practices and must not significantly accelerate on-site erosion; and (3) such development must not significantly diminish the infiltration capacity of the site. (See The Philadelphia Code, § 14-510(6)&(7).)

The Philadelphia Administrative Code further provides that a building permit is required for clearing, grubbing or earth disturbance of any land in excess of 5,000 square feet, and states that no building permit shall be issued unless an erosion control plan has been approved for the site pursuant to applicable state and local stormwater-management regulations. (The Philadelphia Code, Title 4, Chapter 4-200, Subcode "A", § A-301.1.1.)

Section 106. Exemptions

Montgomery County Portion of the Watershed

A. Table 106.1a summarizes the exemptions from certain requirements in this Ordinance. "Proposed Impervious Surface" in Tables 106.1a includes new, additional, or replacement impervious surface/cover. "Repaving" existing surfaces without reconstruction (see Section 202) does not constitute replacement.

Table 106.1a
Exemptions for the Montgomery County Portion of the Watershed

Article or Section	Type of Project	Proposed New Impervious Cover						
		<1000 sq. ft.			≥1000 to <5,000 sq. ft.			≥5,000 sq. ft.
		Earth Disturbance <5,000 sq. ft.	Earth Disturbance ≥5,000 sq. ft. - 1 acre*	Earth Disturbance > 1 acre	Earth Disturbance <5,000 sq. ft.*	Earth Disturbance ≥5,000 sq. ft. - 1 acre*	Earth Disturbance > 1 acre	All Earth Disturbance Categories
Article III SWM Site Plan Requirements	Development and Redevelopment	Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt
Section 404 Nonstructural Project Design	Development and Redevelopment	Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt
Section 405 Groundwater Recharge	Development and Redevelopment	Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt
Section 406 Water Volume Control Requirements	Development and Redevelopment	Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt
Section 407 Stream Bank Erosion Requirements	Development	Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt
	Redevelopment		Exempt		Exempt	Exempt		

Section 408 Stormwater Peak Rate Control and Management Districts	Development and Redevelopment	Exempt	Exempt	Not Exempt	Exempt	Exempt	Not Exempt	Not Exempt
Erosion and Sediment Pollution Control Plan	Earth Disturbance	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements
		(Refer to municipal earth disturbance requirements, as applicable)						

Notes:
Exempt – Exempt unless a determination is made by the municipality that the project is subject to Section 106.C.
Not Exempt – Not exempt. All provisions apply.
*Not exempt, but if a municipality has adopted the ordinance for the Small Project SWM Site Plan for Residential Development in Appendix B, such a plan may be submitted in lieu of the SWM Site Plan for residential development.

B. Exemptions for Land Use Activities

(Note: Subappendix B contains guidance for preparation of Small Project SWM Site Plans. *This guidance provides property owners who propose such small regulated activities the opportunity to submit SWM Site Plans without having to hire Qualified Persons.)*

1. Disconnected Regulated Activities (Regulated Activities that create Disconnected Impervious Areas) smaller in area than 1000 square feet are exempt from the SWM Site Plan (Section 301) preparation requirements of this Ordinance, except when the associated earth disturbance area is equal to or greater than 5,000 square feet.

2. Disconnected Regulated Activities (Regulated Activities that create Disconnected Impervious Areas), having an area equal to or greater than 1000 square feet and less than 5,000 sq. ft., and with an associated earth disturbance area of less than 5,000 square feet, are exempt only from the peak rate control(Section 408) requirements of this Ordinance in the case of new development, and are exempt from peak rate control (Section 408) and streambank erosion (Section 407) requirements in the case of re-development.

3. Agricultural plowing and tilling are exempt from the rate control and SWM Site Plan preparation requirements of this Ordinance provided the activities are performed according to the requirements of 25 Pa. Code Chapter 102.

4. Forest management and timber operations are exempt from the rate control and SWM Site Plan preparation requirements of this Ordinance provided the activities are performed according to the requirements of 25 Pa. Code Chapter 102.

C. Infiltration Exemptions

1. Depth to Limiting Zone
A minimum of two (2) feet of soil suitable for infiltration must exist between the invert of the infiltration BMP and the top of the nearest limiting zone. Otherwise, the Re_v requirement shall not be applied to the development site, and the entire WQ_v must be treated.

2. Hotspots

Stormwater Hotspots – Below is a list of types of hotspots that may be recognized by the Municipality. If a site is a potential hotspot, it has important implications for how stormwater is managed. First and foremost, untreated stormwater runoff from hotspots concentrated into a collection system, shall not be recharged into groundwater where it may contaminate water supplies. Therefore, the Re_v requirement shall NOT be applied to development sites that lie within a hotspot (the entire WQ_v must still be treated). Second, a greater level of stormwater treatment shall be applied at hotspot sites to prevent pollutant washoff after construction. The Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) stormwater program requires some industrial sites to prepare and implement a stormwater pollution prevention plan.

List of potential 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 Codes
- Marinas (service and maintenance)
- Outdoor liquid container storage
- Commercial/industrial facilities
- Public works storage areas
- Facilities that generate, transfer, store, or dispose hazardous materials
- Commercial container nursery

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).

3. Rate of Infiltration:
When infiltration is not feasible due to poor infiltration rates or hotspot, the water quality volume must be treated by an approved SMP.

D. Additional Exemption Criteria:

1. Exemption Responsibilities – An exemption shall not relieve the Applicant from implementing such measures as are necessary to protect public health, safety, property, water quality, and the environment.

2. Drainage Problems – Where drainage problems exist downstream of the proposed activity, then the Municipality may deny exemptions.

3. Exemptions are limited to specific portions of this Ordinance.

4. HQ and EV Streams – The Municipality shall deny exemptions in High Quality (HQ) or Exceptional Value (EV) waters and Source Water Protection Areas (SWPA).

5. For a development taking place in stages, the entire development plan must be used in determining compliance with these exemption criteria. The starting point from which to consider tracts as "parent tracts" in which future subdivisions and respective impervious area computations are cumulatively considered shall be the date of the municipal ordinance adoption of the original Wissahickon Creek Watershed Stormwater Management Plan Ordinance [Watershed Plan Date].

For example: If a property owner in Montgomery County proposes a 300-square-foot shed after adoption of the municipal stormwater management ordinance, that property owner would be exempt from site plan and peak rate control requirements. If, at a later date, the property owner proposes to construct a garage and driveway adding an additional 1,300 square feet of impervious surface, the applicant would be required to submit a SWM Site Plan or Small Project SWM Site Plan demonstrating the stormwater control requirements for the total impervious surface of 1,600 square feet. .

E. 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, safety, property or the environment.

Philadelphia County Portion of the Watershed

Under the Philadelphia Zoning Code, earth moving plans must be filed and approved by the City Planning Commission for earth moving activities within the watershed except as follows: (1) where the site is designated as being within Category 5 on the Impervious Coverage Map; or (2) where the earth moving or additional impervious coverage will be less than 500 square feet. (See discussion under for the Philadelphia County Portion of the Watershed in Section 105.)

In addition, the Philadelphia Water Department has implemented the exemptions described in Section 106 above through its existing Regulations and Manual. The relevant provisions of the Regulations and Manual are set forth below.

A. General Exemptions: The following cases are exempt from the specified requirements of these Regulations. Redevelopment that results in an area of Earth Disturbance greater than or equal to fifteen thousand (15,000) square feet, but less than one (1) acre, is exempt from the requirements of Section 600.5(b), Channel Protection Requirement. Redevelopment that results in an area of Earth Disturbance greater than or equal to fifteen thousand (15,000) square feet that can demonstrate a twenty percent (20%) reduction in DCIA from Predevelopment Conditions as described in the Manual, is exempt from the requirements of Section 600.5(b),Channel Protection Requirement and 600.5(c), Flood Control Requirement. (See PWD Regulations, § 600.3(a).)

B. Emergency Exemption: Emergency maintenance work performed for the protection of public health and safety is exempt from the requirements of these Regulations. A written description

of the scope and extent of any emergency work performed shall be submitted to the Department within two (2) calendar days of the commencement of the activity. If the Department finds that the work is not an emergency, then the work shall cease immediately and the requirements of these Regulations shall be addressed as applicable. (See PWD Regulations, § 600.3(c).)

C. Special Circumstances: If conditions exist that prevent the reasonable implementation of water quality and/or quantity control practices on site, upon written request by the property owner, the Department may at its sole discretion accept off-site stormwater management practices, retrofitting, stream restorations, or other practices that provide water quality and/or quantity control equal or greater than onsite practices for the volume which the Applicant has demonstrated to be infeasible to manage and treat on site. (See PWD Regulations, § 600.3(d).)

D. Table of Applicable Stormwater Regulations and Exemptions in Chapter 6 of PWD Regulations: Applicants that qualify for exemptions must still comply with any local, state or federal requirements. See also the discussion in Section 110 below which outlines the City's authority to regulate exempt activities through measures necessary to prevent a threat to public health, safety, property or the environment.

E. Infiltration Exemptions: Section 600.5(a)(2)(B) of the PWD Regulations directs Applicant to follow the Hotspot Investigation, Subsurface Stability and Subsurface Infiltration procedures in the Manual to determine if infiltration is appropriate on a Development Site. These procedures are referenced or described in the Manual at Sections 4.3.1 and 7.12 and Appendices A, B and C.

F. Table of Peak Runoff Rates for Management Districts: Development Site in District C that can discharge directly without the use of City infrastructure may do so without control of proposed conditions peak rate of runoff. (See: PWD Regulations, § 600.5. Table of Peak Runoff Rates for Management Districts.)

G. Additional Exemption Criteria: Section 600.3(b)states that an exemption shall not relieve the Applicant, Developer or property owner from implementing the measures as are necessary to protect public health, safety, property, water quality and the environment. Drainage Problems are addressed in the Table of Applicable Stormwater Regulations in Philadelphia, which states that if the proposed development results in stormwater discharge that exceeds stormwater system capacity, causes a combined sewer overflow, or degrades receiving waters, the design specifications presented in these Regulations may be applied to proposed development activities as warranted to protect public health, safety, property, water qualify and the environment. Section 600.1 defines Development Site by reference to a contiguous area of disturbance including across streets and other rights of way, regardless of individual parcel ownership, where lots are developed as one common project, and Section 600.2(c) states that the Regulations apply to the entire Development Site even if the development takes place in phases.

Table 106.1b summarizes the exemptions from certain stormwater requirements in Philadelphia's codes and regulations.

Table 106.1b
Exemptions for the Philadelphia Portion of the Watershed

Guide to Applicable Stormwater Regulations in Philadelphia Portion of the Watershed		Earth Disturbance Associated with Development			
		0-4,999 sq. ft.	500-14,999 sq. ft.*	15,000 sq. ft.-1 acre	> 1 acre
Section 600.5(a) Water Quality Requirement	New Development	N/A**	Yes	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Yes	Yes
Section 600.5(b) Channel Protection Requirement	New Development	N/A**	Yes	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Exempt	Yes (Alternate Criteria)
Section 600.5(c) Flood Control Requirement	New Development	N/A**	Yes	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Yes (Alternate Criteria)	Yes (Alternate Criteria)
Section 600.6 Nonstructural Project Design Requirement	New Development	N/A**	Yes	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Yes	Yes
Section 600.8 Post-Construction Stormwater Management Plan Requirement	New Development	N/A**	Yes	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Yes	Yes

Yes (Alternate Criteria) – requirements of section may be waived depending on post-development site conditions (See Sections 600.3(a)(3), 600.5(b) and 600.5(c), in addition to Section 14-510 of the Philadelphia Code, for further details).

N/A - Not Applicable, development project is not subject to requirements of indicated Regulations section. Voluntary controls are encouraged.

Any local, state, or federal requirements still apply.

*-Applies to Impervious Ground Coverage Categories 1-4 administered by the Philadelphia City Planning Commission.

**– If the proposed development results in stormwater discharge that exceeds stormwater system capacity, causes a combined sewer overflow, or degrades receiving waters, the design specifications presented in these Regulations may be applied to proposed development activities as warranted to protect public health, safety, or property.

Section 107. Repealer

Montgomery County Portion of the Watershed

Any other Ordinances, provisions or regulations of the Municipality inconsistent with any of the provisions of this Ordinance are hereby repealed to the extent of the inconsistencies only. Municipalities with land area in more than one watershed may enact a single ordinance provided that its provisions are at least as restrictive as the provisions herein. The specific peak rate controls and management districts in Section 408 shall be included in the ordinance.

Philadelphia County Portion of the Watershed

Whenever conflicting rules and regulations occur, the most restrictive or that imposes higher standards shall govern, except as otherwise provided, as per: (i) The Code, Title 4, Chapter 4-200, Subcode A, Section A-102, A-102.2; and (ii) The Code, Title 14, Chapter 14-100, Section 14-108(1).

Section 108. Severability

Montgomery County Portion of the Watershed

In the event that a court of competent jurisdiction declares any section or provision of this Ordinance invalid, such decision shall not affect the validity of any of the remaining provisions of this Ordinance.

Philadelphia County Portion of the Watershed

In Philadelphia, severability is addressed in § 1-106 of the Philadelphia Code, which states:

> The provisions of the Code are severable, and if any provision or application is held illegal, such illegality shall not affect the remaining provisions. It is the legislative intent of the Council that the Code would have been adopted if such illegal provision had not been included and any illegal application had not been made.

Section 109. Compatibility with Other Ordinances or Legal Requirements

Montgomery County Portion of the Watershed

Approvals issued pursuant to this Ordinance do not relieve the Applicant of the responsibility to secure required permits or approvals for activities regulated by any other applicable code, rule, act, or Ordinance, including Title 25PA Code, Chapter 92, 102 & 105.

Philadelphia County Portion of the Watershed

In Philadelphia, compatibility with other ordinances or legal requirements is addressed in the following Sections of the Code, Regulations and Manual:

A. The Code, Title 4, Chapter 4-200, Subcode A, Section A-102.4, which states that the provisions of the administrative code and technical codes shall not be deemed to nullify any applicable provisions of other local, state or federal laws.

B. The Code, Title 14, Chapter 14-100, Section 14-108(1), which states that the Zoning Code is intended to complement other municipal, state, and federal regulations that affect land use, but is not intended to revoke or repeal any other public law, ordinance, regulations, or permit

C. The Table at the end of Section 600.3 of the PWD Regulations, which state that for exempt activities and activities not subject to PWD's stormwater regulations, any other local, state and federal regulations apply.

D. Section 600.4(a) of the PWD Regulations, which states that all Earth Disturbance must comply with the Erosion and Sediment Control requirements of the Pennsylvania Department of Environmental Protection (PADEP) as specified in 25 PA Code Chapter 102.

E. Section 600.8 of the PWD Regulations, regarding Post Construction Stormwater Management Plan (PCSMP) approval, which states that for any activities that require state or federal permits, proof of application or approval of those permit(s) shall be included as part of the plan.

F. Section 600.9 of the PWD Regulations, regarding permit requirements by other government entities, which states that other government entities may require permits for certain regulated Earth Disturbance activities, and that the requirements for these permits must be met prior to commencement of Earth Disturbance.

G. Section 5.2.2 of the Manual, which states that other state and federal permits may be required for development on a given site, includes NPDES permits and Water Obstruction and encroachment permits under 25 PA Code Chapter 105.

Section 110. Duty of Persons Engaged in the Development of Land

Montgomery County Portion of the Watershed

Notwithstanding any provision(s) of this Ordinance, including exemptions, any landowner or any person engaged in the alteration or development of land that may affect stormwater runoff characteristics shall implement such measures as are reasonably necessary to prevent injury to health, safety, or other property. Such measures also shall include actions as are required to manage the rate, volume, direction, and quality of resulting stormwater runoff in a manner that otherwise adequately protects health, safety, property, and water quality.

Philadelphia County Portion of the Watershed

In Philadelphia, the duty of persons engaged in the development of land to implement measures as are reasonably necessary to prevent injury to health, safety, or other property is addressed in the following Code Sections and Regulations:

A. The Code, Title 4, Chapter 4-200, Subcode A, Section A-102.5, which states that requirements necessary for public safety, health and the general welfare, not specifically covered by the technical codes or applicable standards, shall be determined by code officials;

B. The Code, Title 4, Chapter 4-200, Subcode A, Section A-503.1, which states that notwithstanding other provisions, nothing shall prevent the code official from instituting appropriate remedies to protect occupants or the public from conditions which pose an immediate threat to health or safety.

C. The Code, Title 4, Chapter 4-200, Subcode PM, Section PM-301.2, which requires the exterior of all property and premises to be maintained in a safe and sanitary condition.

D. The Code, Title 4, Chapter 4-200, Subcode PM, Section PM-302.4, which regulates drainage from roofs, paved areas, yards, courts, and other open areas.

E. PWD Regulations, Section 600.3, which state that an exemption shall not relieve the Applicant, Developer or property owner from implementing such measures as are necessary to protect public health, safety, property, water qualify and the environment. See also the Table of Applicable Stormwater Regulations in Philadelphia, which states that for exempt activities, if development results in stormwater discharge that exceeds stormwater system capacity, causes a combined sewer overflow, or degrades receiving waters, the design specifications presented in the Regulations may be applied to proposed development activities as warranted to protect public health, safety, or property.

F. PWD Regulations, Section 600.7, which states that the existing points of concentrated drainage that discharge onto adjacent land shall not be altered in any manner that could cause property damage without written permission of the owner of the adjacent land.

Section 111. Erroneous Permit

Montgomery County Portion of the Watershed

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.

Philadelphia Portion of the Watershed

In Philadelphia, erroneous permits are addressed in the following Code Sections:

A. The Code, Title 1, Chapter 1-100, §1-111,which states that the penalty for a person who makes a false, deceitful or misleading statements in applications for any license or permit issued under the provisions of The Philadelphia Code shall be a fine of three hundred (300) dollars plus costs of prosecution.

B. The Code, Title 4, Chapter 4-200, Subcode A, Section A-302.9, which states that code officials are authorized to revoke a permit or approval issued pursuant to the provisions of this code and the technical codes if the permit was issued in error, the permit was issued on the basis of incorrect, inaccurate or incomplete information in the application or construction documents, or the permit was issued on the basis of false statement or misrepresentation of fact in the application or construction documents.

ARTICLE II-DEFINITIONS

Section 201. Interpretation

Montgomery County Portion of the Watershed

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 words "shall" and "must" are mandatory; the words "may" and "should" are permissive.

Philadelphia County Portion of the Watershed

For the Philadelphia Portion of the Watershed, rules of interpretation are already enacted as part of the Zoning Code. (The Philadelphia Code, Chapter 14-200, Sections 14-201.)

Section 202. Definitions

Montgomery County Portion of the Watershed

Accelerated Erosion – The removal of the surface of the land through the combined action of man's activity and the natural processes at a rate greater than that which would occur because of natural process alone.

Agricultural Activities – Activities associated with agriculture such as agricultural cultivation, agricultural operation, and animal heavy use areas. This includes the work of producing crops including tillage, land clearing, plowing, disking, harrowing, planting, harvesting crops, or pasturing and raising of livestock and installation of conservation measures. Construction of new buildings or impervious area is not considered an agricultural activity.

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 a developer to show the actual locations of building components and changes from the original contract documents. These documents, or a copy of same, are turned over to the Municipality 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.

BMP (Best Management Practice) – Activities, facilities, designs, measures or procedures used to manage stormwater impacts from Regulated Activities, to meet State Water Quality Requirements, to promote groundwater recharge and to otherwise meet the purposes of this Ordinance. Stormwater BMPs are commonly grouped into one of two broad categories or measures: "structural" or "non-structural." In this Ordinance, non-structural BMPs or measures refer to operational and/or behavior-related practices that attempt to minimize the contact of pollutants with stormwater runoff, or to provide other environmental or aesthetic benefits such as low impact designs, riparian or forested buffers; whereas structural BMPs or measures are those that consist of a physical device or practice that is installed to capture and treat stormwater runoff. Structural BMPs include, but are not limited to, a wide variety of practices and devices, from large-scale retention ponds and constructed wetlands, to small-scale underground treatment systems, infiltration facilities, filter strips, bioretention, wet ponds, permeable paving, grassed swales, sand filters, detention basins, and manufactured devices. Structural Stormwater BMPs are permanent appurtenances to the project site.

BMP Manual- *Pennsylvania Stormwater Best Management Practices Manual*, No. 363-0300-002 (December 2006).

Buffer – The area of land immediately adjacent to any stream, measured perpendicular to and horizontally from the top-of-bank on both sides of a stream (see Top-of-bank).

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.

Conservation District – A conservation district, as defined in section 3(c) of the Conservation District Law (3 P. S. § 851(c)), that has the authority under a delegation agreement executed with DEP to administer and enforce all or a portion of the regulations promulgated under 25 Pa. Code 102.

Conveyance – A facility or structure used for the transportation or transmission of something from one place to another.

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 semifluid. A dam may include a refuse bank, fill, or

structure for highway, railroad, or other purposes that impounds or may impound water or another fluid or semifluid.

DEP (or PADEP) - The Pennsylvania Department of Environmental Protection.

Design Storm – The magnitude and temporal distribution of precipitation from a storm event measured in probability of occurrence that such magnitude will be equaled or exceeded in any one year (e.g., the 20% chance, or so-called 5-year (recurrence interval) storm), and duration (e.g., twenty-four (24) hours), used in the design and evaluation of stormwater management systems. Also see Return Period.

Detention Volume- The volume of runoff that is captured and released into the waters of the Commonwealth at a controlled rate.

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 to become dry until the next rainfall event.

Developer – A person who seeks to undertake any regulated earth disturbance activities at a project site in the Municipality.

Development – Any human-induced change to improved or unimproved real estate, whether public or private, including, but not limited to, land development, construction, installation, or expansion of a building or other structure, land division, street construction, and site alteration such as embankments, dredging, grubbing, grading, paving, parking or storage facilities, excavation, filling, stockpiling, or clearing.

Development Site (Site) – See Project Site.

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.

Directly Connected Impervious Area(DCIA) – An impervious or impermeable surface that is directly connected to a stormwater drainage or conveyance system, leading to direct runoff, decreased infiltration, decreased filtration, and decreased time of concentration.

Disconnected Impervious Area (DIA) – An impervious or impermeable surface that is disconnected from any stormwater drainage or conveyance system, and is redirected or directed to a pervious area, which allows for infiltration, filtration, and increased time of concentration.

Disturbance – See Earth Disturbance.

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.

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 Plan – See Stormwater Management Site Plan.

Earth Disturbance Activity– A construction or other human activity which disturbs the surface of land including, but not limited to, clearing and grubbing, grading, filling, excavations, embankments, land development, agricultural plowing or tilling, timber harvesting activities, road maintenance activities, mineral or fluid 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 Plan – A plan that is designed to minimize accelerated erosion and sedimentation.

Exceptional Value Waters – Surface waters having quality that satisfy one (1) or more of the conditions established in Pennsylvania Code Title 25 Environmental Protection, Chapter 93, Water Quality Standards, §93.4b(b).

Existing Condition – The dominant land cover during the 5-year period immediately preceding a proposed Regulated Activity. If the initial condition of the site is undeveloped land, the land use shall be considered as "meadow" unless the Municipality determines that the natural land cover has a lower Curve Number (CN) or Rational "c" value, such as forested lands.

FEMA – Federal Emergency Management Agency.

Flood – A temporary condition of partial or complete inundation of land areas from the overflow of streams, rivers, and other waters of the Commonwealth.

Floodplain – Any land area susceptible to inundation by water from any natural source or delineated by applicable FEMA maps and studies as being a special flood hazard area. Included are lands adjoining a river or stream that have been or may be expected to be inundated by a 100-year flood, i.e., the flood of magnitude that has a one (1) percent chance of being equaled or exceeded in any given year.

Floodway – The channel of a watercourse and those portions of the adjoining floodplains that are reasonably required to carry and discharge the 100-year frequency flood. Unless otherwise specified, the boundary of the floodway is as indicated on Flood Insurance Rate Maps (FIRMs) 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 fifty (50) feet from the top-of-bank on each side 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 associated activities necessary for the management of forest lands. These include timber inventory and 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.

Groundwater – Water beneath the earth's surface that supplies wells and springs and is within the saturated zone of soil and rock.

Groundwater Recharge – The replenishment of existing natural underground water supplies from precipitation or overland flow.

HEC-HMS – The U.S. Army Corps of Engineers, Hydrologic Engineering Center (HEC) - Hydrologic Modeling System (HMS). This model was used to model the Wissahickon Creek Watershed during the Act 167 plan development and is the basis for the standards and criteria of this Ordinance.

High Quality Waters – Surface waters having quality that satisfy one (1) or more of the conditions established by Pennsylvania Code Title 25 Environmental Protection, Chapter 93, Water Quality Standards, § 93.4b(a).

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 at 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 (HSG) – Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSGs (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. The NRCS defines the four groups and provides a list of most of the soils in the United States and their group classifications. The soils in the area of the development site may be identified from a soil survey report that can be obtained from local NRCS offices or conservation district offices. Soils become less pervious as the HSG varies from A to D (NRCS).

Impervious Surface (Impervious Area) – A surface that prevents the infiltration of water into the ground. Impervious surfaces (or areas) shall include, but not be limited to, roofs, additional indoor living spaces, patios, garages, storage sheds and similar structures, swimming pools, and any new streets or sidewalks. Decks, parking areas, and driveway areas are not counted as impervious areas if they do not prevent infiltration.

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 has remained undeveloped, but is 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 – Movement of surface water into the soil, where it is absorbed by plant roots, evaporated into the atmosphere, or percolated downward to recharge groundwater.

Infiltration basin- A shallow impoundment that is designed to infiltrate stormwater into the soil. Infiltration basins are believed to have a high pollutant removal efficiency, and can also help recharge the groundwater, thus restoring baseflows to stream systems. Infiltration basins can be problematic at many sites because of stringent soil requirements.

Infiltration Structures – A structure designed to direct runoff into the underground water (e.g., French drains, seepage pits, seepage trenches, or infiltration galleries).

Inflow – The flow entering the stormwater management facility and/or BMP.

Inlet – The upstream end of any structure through which water may flow.

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 -A type of topography or landscape characterized by surface depressions, sinkholes, rock pinnacles/uneven bedrock surface, underground drainage and caves. Karst is formed on carbonate rocks, such as limestone or dolomite.

Land Development – Any of the following activities:

(i) The improvement of one (1) lot or two (2) or more contiguous lots, tracts, or parcels of land for any purpose involving:

a. A group of two (2) or more residential or nonresidential buildings, whether proposed initially or cumulatively, or a single nonresidential building on a lot or lots regardless of the number of occupants or tenure, or
b. The division or allocation of land or space, whether initially or cumulatively, between or among two (2) 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) A subdivision of land;

(iii) Development in accordance with Section 503(1.1) of the PA Municipalities Planning Code.

Limiting Zone – A soil horizon or condition in the soil profile or underlying a stratum 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 sufficient 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.

Main Stem (Main Channel)– Any stream segment or other runoff conveyance used as a reach in the Wissahickon Creek Watershed hydrologic model.

Manning Equation (Manning Formula) – A method for calculation of velocity of flow (e.g., feet per second) and flow or discharge 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.

Municipal Engineer – A professional engineer (PE) licensed as such in the Commonwealth of Pennsylvania, duly appointed as the Engineer for a Municipality, planning agency, or joint planning commission.

Municipality – [*Municipal Name*], [*County Name*] County, Pennsylvania.

Natural Condition – Pre-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.

Nonpoint Source Pollution – Pollution that enters a waterbody from diffuse origins in the watershed and does not result from discernible, confined, or discrete conveyances.

Nonstormwater Discharges – Water flowing in stormwater collection facilities, such as pipes or swales, which are not the result of a rainfall event or snowmelt.

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 – National Pollutant Discharge Elimination System, the federal government's system for issuance of permits under the Clean Water Act, which is delegated to DEP in Pennsylvania.

NRCS – Natural Resource Conservation Service of the U.S. Department of Agriculture (previously the Soil Conservation Service (SCS)).

Open Channel – A conveyance channel that is not enclosed.

Outfall – "Point source" as described in 40 CFR § 122.2 at the point where the Municipality's storm sewer system discharges to Surface Waters of the Commonwealth.

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.

Peak Discharge – The maximum rate of stormwater runoff from a specific storm event.

Pipe – A culvert, closed conduit, or similar structure (including appurtenances) that conveys stormwater.

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.

Pre-construction – Prior to commencing construction activities.

Pre-development Condition – Undeveloped/natural condition.

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 control requirements (WQ_v) of Section 406. For example, any inlets draining to an infiltrating system should be sumped and trapped to prevent the system from becoming clogged with excess sediment.

Project Site – The specific area of land where any regulated activities in the Municipality are planned, conducted, or maintained.

Qualified Person- Any person licensed by the Pennsylvania Department of State or otherwise qualified by law to perform the work required by the Ordinance.

Rational Formula – A rainfall-runoff relation used to estimate peak flow; Q = CiA

Reach – Any stream segment or other runoff conveyance used in the Wissahickon Creek Watershed hydrologic model.

Recharge – The replenishment of groundwater through the infiltration of rainfall, other surface waters, or land application of water or treated wastewater.

Recharge Volume (Re_v) – The volume of stormwater, in cubic feet, required to be infiltrated on site, where practicable and appropriate.

Reconstruction – Demolition and subsequent rebuilding of impervious surface.

Record Drawings – Construction drawings revised to represent the as-built conditions.

Recurrence Interval– See Return Period.

Redevelopment – Any development that requires demolition or removal of existing structures or impervious surfaces at a site and replacement with new impervious surfaces. 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 Disturbance Activities or any activities that involve the alteration or development of land in a manner that may affect stormwater runoff.

Regulated Earth Disturbance Activity–Activity involving earth disturbance subject to regulation under 25 PA Code 92, 25 PA Code 102, or the Clean Streams Law.

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 – Replacement of an impervious surface that does not involve reconstruction of an existing paved (impervious) surface (e.g., addition of a new layer of asphalt over an existing paved surface).

Replacement Paving – Reconstruction of and full replacement of an existing paved (impervious) surface (e.g., demolition and removal of surface layer, foundation, and base course; and subsequent reconstruction of the entire sequence).

Retention Volume/Removed Runoff - The volume of runoff that is captured and not released directly into the surface waters of the Commonwealth during or after a storm event.

Return Period – The average interval, in years, within which a storm event of a given or greater magnitude can be expected to recur. For example, the 25-year return period rainfall would be

expected to recur on the average of once every twenty-five (25) years, or conversely would have a four (4) percent chance of occurrence or exceedance in any given year.

Riparian Buffer – An area of land adjacent to a body of water and managed to maintain the integrity of stream channels and shorelines to 1) reduce the impact of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals, and 2) supply food, cover and thermal protection to fish and other wildlife.

Riparian Forest Buffer – A type of riparian buffer that consists of permanent vegetation that is predominantly native trees, shrubs, and forbs along surface waters that is maintained in a natural state or sustainably managed to protect and enhance water quality, stabilize stream channels and banks, and separate land use activities from 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 – Earth disturbance activities within the existing road cross-section, such as grading and repairing existing unpaved road surfaces, cutting road banks, cleaning or clearing drainage ditches, and other similar activities.

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 – Any part of precipitation that flows over the land surface.

SALDO – Subdivision and Land Development Ordinance.

Sediment -Soils or other materials transported by surface water as a product of erosion.

Sediment Basin – A barrier, dam, or retention or detention basin located and designed in such a way as to retain rock, gravel, sand, silt, clay or other material transported by water during construction.

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.

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 zones through which contaminants, if present, are likely to migrate and reach drinking water wells or surface water intakes.

Spillway – A conveyance that is used to pass the peak discharge of the maximum design storm that is controlled by the stormwater facility.

Standard Grading Permit - The permit required to be issued by the Municipality before any grading activities are allowed to commence on a site within the Municipality. Such permits typically require information including, but not limited to, a contour map of the site showing existing and proposed contours, a plot plan showing streams and drainage courses on or within fifty (50) feet of the site, drainage structures, neighboring streets and alleys, trees, and floodplain zones on or within fifty (50) feet of the site, soil classifications.

State Water Quality Requirements – The regulatory requirements to protect, maintain, reclaim, and restore water quality under Title 25 of the Pennsylvania Code and the Clean Streams Law.

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.

Storm Frequency – The number of times that a given storm "event" occurs or is exceeded on average in a stated period of years (see Return Period).

Storm Sewer – A system of pipes and/or open channels that convey intercepted runoff and stormwater from other sources but exclude domestic sewage and industrial wastes.

Stormwater – Drainage runoff from the surface of the land resulting from precipitation or snow or ice melt.

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 (SMF) – 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. Typical stormwater management facilities include, but are not limited to, detention and infiltration basins, open channels, storm sewers, pipes, and infiltration structures.

Stormwater Management Plan – The watershed plan, known as the "Wissahickon Creek Watershed Act 167 Stormwater Management Plan," for managing those land use activities that will influence stormwater runoff quality and quantity, and that would impact the Wissahickon Creek Watershed adopted by Montgomery and Philadelphia Counties as required by the Act of October 4, 1978, P.L. 864 (Act 167).

Stormwater Management Site Plan (SWM Site Plan) –The plan prepared by the Applicant or the Applicant's representative indicating how stormwater runoff will be managed a project site to meet the requirements of this Ordinance. Small Project SWM Site Plans may be prepared for certain projects.

Stream – A natural watercourse.

Stream Buffer – The land area adjacent to each side of a stream essential to maintaining water quality (see 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 – The division or redivision of a lot, tract, or parcel of land by any means into two (2) or more lots, tracts, parcels, or other divisions of land including changes in existing lot lines for the purpose, whether immediate or future, of lease, partition by the court for distribution to heirs or devisees, transfer of ownership, or building or lot development; provided, however, that the subdivision by lease of land for agricultural purposes into parcels of more than ten (10) acres not involving any new street or easement of access or any residential dwelling shall be exempted. As defined in The Pennsylvania Municipalities Planning Code, Act of July 31, 1968, P.L. 805, No. 247.

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.

Timber Operations – See Forest Management.

Time-of-concentration (Tc) – The time required for surface runoff to travel from the most remote point of a watershed to the watershed outlet.

Top-of-bank – Highest point of elevation in a stream channel cross-section at which a rising water level just begins to flow outside of the channel and over the floodplain.

Undeveloped Condition – Natural condition (see also Pre-development Condition).

USDA - United States Department of Agriculture.

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.

Water Volume Control (see Section 406)– The storage capacity, in acre-feet, required to capture and treat a portion of stormwater runoff from the developed or redeveloped areas of the site.

Waters of the Commonwealth – Rivers, streams, creeks, rivulets, impoundments, ditches, watercourses, storm sewers, lakes, dammed water, 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 the Commonwealth.

Watershed – Region or area drained by a river, watercourse or other surface water of the Commonwealth.

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.

Wetland – Those areas that are inundated or saturated by surface 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 for a minimum of three (3) consecutive years.

<u>Philadelphia County Portion of the Watershed</u>

For the Philadelphia Portion of the Watershed, the definitions necessary to regulate development in a manner consistent with the Plan are already enacted as part of the Zoning Code (The Philadelphia Code, Chapter 14-200, Section 14-203) or are included in the Water Department's Regulations (PWD Regulations, Section 600.1).

ARTICLE III-STORMWATER MANAGEMENT (SWM) SITE PLAN REQUIREMENTS

Section 301. SWM Site Plan Contents

Montgomery County Portion of the Watershed

The SWM Site Plan shall consist of a general description of the project, including calculations, maps, and plans. A note on the maps shall refer to the associated computations and Erosion and Sediment (E&S) Control Plan by title and date. The cover sheet of the computations and E&S Control Plan shall refer to the associated maps by title and date. All SWM Site Plan materials shall be submitted to the Municipality in a format that is clear, concise, legible, neat, and well organized; otherwise, the Municipality may not accept the SWM Site Plan for review.

The following items shall be included in the SWM Site Plan:

A. General

1. General description of the project.

2. All stormwater management facilities must be located on a plan and detailed description of proposed stormwater management techniques, including drainage and construction specifications of the materials to be used for the stormwater management facilities.

3. Complete hydrologic, hydraulic, and structural computations for all stormwater management facilities.

4. An erosion and sediment control plan. The applicant is required to obtain a letter of approval or adequacy from the Conservation District for the Erosion and Sediment Control Plan.

5. A general description of proposed nonpoint source pollution controls.

6. The SWM Site Plan Application and completed fee schedule form and associated fee.

7. The SWM Site Plan Checklist.

B. Maps

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, floodplains, hydrologic soil groups, closed topographic depressions and recharge areas. Land development, existing recharge areas, and any other requirements specifically outlined in the municipal SALDO also shall be included.

Map(s) of the project area shall be submitted on 24-inch x 36-inch sheets and/or shall be prepared in a form that meets the requirements for recording at the offices of the Recorder of

Deeds of [*County Name*] County. If the SALDO has more stringent criteria than this Ordinance, then the more stringent criteria shall apply. The contents of the map(s) shall include, but not be limited to:

1. The location of the project relative to highways, municipal boundaries, or other identifiable landmarks.

2. Existing contours at intervals of two (2) feet or less. In areas of slopes greater than [10] percent, 5-foot contour intervals may be used.

3. Existing streams, lakes, ponds, or other waters of the Commonwealth within the project area.

4. Other physical features including flood hazard boundaries, stream buffers, existing drainage courses, areas of natural vegetation to be preserved, and the total extent of the upstream area draining through the site.

5. The locations of all existing and proposed utilities, sanitary sewers, and water lines within fifty (50) feet of property lines.

6. A map, which may be done as an overlay, showing soil names and boundaries.

7. Limits of earth disturbance, including the type and amount of impervious area that is proposed.

8. Proposed structures, roads, paved areas, and buildings.

9. Final contours at intervals of two (2) feet or less. In areas of steep slopes (greater than ten [10]percent), 5-foot contour intervals may be used.

10. The name of the development, the name and address of the owner of the property, and the name of the individual or firm preparing the plan.

11. The date of submission.

12. A graphic and written scale of one (1) inch equals no more than fifty (50) feet; for tracts of twenty (20) acres or more, the scale shall be one (1) inch equals no more than one hundred (100) feet.

13. A north arrow.

14. The total tract boundary and size with distances marked to the nearest foot and bearings to the nearest degree.

15. Existing and proposed land use(s).

16. A key map showing all existing man-made features beyond the property boundary that would be affected by the project.

17. Location of all open channels.

18. Overland drainage patterns and swales.

19. A15-foot wide access easement around all stormwater management facilities to provide ingress to and egress from a public right-of-way, where necessary, or appropriate at discretion of the Municipality.

20. The location of all erosion and sediment control facilities.

21. 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 located within this Municipality.

22. A statement, signed by the Applicant, acknowledging that any revision to the approved drainage plan must be approved by the Municipality, and that a revised erosion and sediment control plan must be submitted to the Municipality and County Conservation District for approval. *Philadelphia does not have a County Conservation District)*

23. The following signature block for the Design Engineer:

"I, (Design Engineer), on this date (date of signature); hereby certify that this drainage plan meets all requirements of the Department of Environmental Protection's (DEP's) regulations and this Ordinance."

C. Supplemental Information to be Submitted to the Municipality

1. The following information shall be submitted by the Applicant and shall include:

   a. The overall stormwater management concept for the project designed.
   b. Stormwater runoff computations required by this Ordinance.
   c. Stormwater management techniques to be applied both during and after development.
   d. Expected project time schedule.
   e. Development stages or project phases, if so proposed.
   f. An Operations and Maintenance (O&M) Plan in accordance with Section 702 of this Ordinance.

2. 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.

3. An Approved Highway Occupancy Permit from the Pennsylvania Department of Transportation (PennDOT) District office when drainage towards PennDOT property is proposed.

D. Stormwater Management Facilities

1. When infiltration measures such as seepage pits, beds, or trenches are used, the locations of existing and proposed septic tank infiltration areas and wells must be shown.

2. All calculations, assumptions, and criteria used in the design of the stormwater management facilities must be shown.

Philadelphia County Portion of the Watershed

In Philadelphia, the contents and format of Existing Resource and Site Analysis (ERSA) plans, Conceptual Stormwater Management Plans, and Post Construction Stormwater Management Plans must comply with the requirements in the Regulations and the Manual, as set forth in Sections 600.6, 600.7 and 600.8 of the Regulations, Section 3.1, 3.3 and 5.3 of the Manual, and the checklists referenced in the Manual.

Section 302. Plan Submission

Montgomery County Portion of the Watershed

The Municipality requires submission of a complete SWM Site 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:

1. National Pollutant Discharge Elimination System (NPDES) Permit for Stormwater Discharges from Construction Activities, when required.

2. Any other permit under applicable state or federal regulations.

B. Six (6) copies of the SWM Site Plan shall be submitted and distributed as follows:

1. Three (3) copies to the Municipality accompanied by the requisite fees, as specified in this Ordinance.

2. Two (2) copies to the County Conservation District.

3. The Montgomery County Planning Commission will be notified by letter regarding submission of the SWM Plan to the municipality and MCCD, and that no SWM Plan need be submitted to MCPC.

C. If any submissions to the agencies listed above are found to be incomplete, the municipalities have the option of notifying the applicant and requesting specific information missing from the submission. The application review clock will not start until the municipality has determined that the submission is complete.

D. Additional copies shall be submitted as requested by the Municipality, County Conservation District, or DEP.

Philadelphia County Portion of the Watershed

In Philadelphia, the requirements and procedures for plan submission, including proof of required permits, the submittal process, and procedures for responding to and returning incomplete

submissions are as set forth in 600.8(c)(2) and (3) of the Regulations, Section 3.1, 3.2, 3.3,5.2, 5.2.1, 5.2.2,and 5.4, 5.4.1and 5.4.2 of the Manual, and the checklists referenced in these sections of the Manual.

Section 303. SWM Site Plan Review

Montgomery County Portion of the Watershed

A The SWM Site Plan must be consistent with this Ordinance. If any submissions are found to be incomplete, the municipalities have the option of notifying the applicant and requesting specific information missing from the submission. The application review clock will not start until the municipality has determined that the submission is complete.

B. The Municipality will notify the applicant in writing within (___) days whether the SWM Site Plan is approved or disapproved. If the SWM Site Plan involves a Subdivision and Land Development Plan, the notification period is (___) days. If a longer notification period is provided by other statute, regulation, or ordinance, the applicant will be so notified by the Municipality. If the Municipality disapproves the SWM Site Plan, the Municipality shall cite the reasons for disapproval in writing.

Philadelphia County Portion of the Watershed

In Philadelphia, the site plan review requirements are specified in the sections of the Code and Regulations described below.

A. Code, Title 14, Ch. 14-700, § 14-704(3)(b), which prohibits the issuance of a zoning or building permit unless the Water Department confirms that the proposed activity and related stormwater management plan complies with the regulations of the Water Department designed to reduce the risk of water pollution, and further provides that the propose stormwater management plan will be deemed to comply if the Water Department fails to approve or disapprove the plan within 45 calendar days after it receives a copy of the application.

B. Code, Title 14, Chapter 14-700, § 14-704(3)(c), which requires that a stormwater management plan submitted with a permit plan must comply with the Water Department's regulations.

C. PWD Regulations at § 600.7(a)(1), which states that all Stormwater Management Practices must meet the requirements of the Water Department's regulations.

D. PWD Regulations at § 600.8(c)(3), which requires that all Post Construction Stormwater Management Plan materials must be submitted to the Water Department in accordance with the submittal procedures in the Manual.

E. The Manual at Section 5.4.1 and 5.4.2, which outlines the procedures for addressing and returning incomplete submittals and for notifying applicants of plan deficiencies identified by the Water Department during the review process.

Section 304. Modification of SWM Site Plans

Montgomery County Portion of the Watershed

A modification to a submitted SWM Site Plan that involves a change in BMPs or techniques, or that involves the relocation or redesign of BMPs, or that is necessary because soil or other conditions are not as stated on the SWM Site Plan as determined by the Municipality shall require modification and resubmission of the SWM Site Plan in accordance with this Article.

Philadelphia County Portion of the Watershed

In Philadelphia, modifications of Stormwater Management Site Plans are addressed in Section 600.8(c)(3) of the Regulations, which states that all Post Construction Stormwater Management Plans materials must be submitted to the Water Department in accordance with the submittal procedures as outlined in the Manual, and in Section 5.4.2 of the Manual on the Technical Review Process, which addresses modifications and resubmissions.

Section 305. Resubmission of Inconsistent or Noncompliant SWM Plans

Montgomery County Portion of the Watershed

A disapproved SWM Site Plan may be resubmitted, with the revisions addressing the municipality's concerns, to the municipality in accordance with this Article. The applicable review fees must accompany a resubmission of a disapproved SWM Site Plan.

Philadelphia County Portion of the Watershed

In Philadelphia, the resubmission of Stormwater Management Site Plans is addressed in Section 600.8(c)(3) of the Regulations, which states that all Post Construction Stormwater Management Plan materials must be submitted to the Water Department in accordance with the submittal procedures as outlined the Manual. Section 5.4.1 of the Manual addresses procedures in situations when a submission is incomplete. Section 5.4.2 of the Manual on the Technical Review Process addresses resubmissions.

ARTICLE IV - STORMWATER MANAGEMENT

Montgomery County Portion of the Watershed

Section 401. General Requirements

A. For any of the activities regulated by this Ordinance, unless preparation of a Stormwater Management (SWM) Site Plan is specifically exempted, the preliminary or final approval of subdivision and/or land development plans, the issuance of any building or occupancy permit, the commencement of any earth disturbance activity shall not proceed until the Property Owner or Applicant or his/her agent has received written approval from the Municipality of a SWM Site Plan that demonstrates compliance with the requirements of this Ordinance, and a written approval of an adequate Erosion and Sediment (E&S) Control Plan from the Municipality or County Conservation District, when and as required.

B. SWM Site Plan approved by the municipality shall be on-site throughout the duration of the regulated activity.

C. The municipality may, after consultation with the Department of Environmental Protection (DEP), approve measures for meeting the state water quality requirements other than those in this Ordinance, provided that they meet the minimum requirements of, and do not conflict with, state law including but not limited to the Clean Streams Law.

D. For all regulated earth disturbance activities, Erosion and Sediment (E&S) control Best Management Practices (BMPs) shall be designed, implemented, operated and maintained during the Regulated Earth Disturbance activities (e.g., during construction) to meet the purposes and requirements of this Ordinance and to meet all requirements under Title 25 of the Pennsylvania Code and the Clean Streams Law.

E. Impervious areas:

1. The measurement of impervious areas shall include all of the impervious areas in the total proposed development even if development is to take place in stages.

2. For development taking place in stages, the entire development plan must be used in determining conformance with this Ordinance.

3. For projects that add impervious area to a parcel, Sections 403 through 408 shall apply to the total impervious area within the limits of earth disturbance.

F. Stormwater discharges onto adjacent property shall not be created, increased, decreased, relocated, or otherwise altered without written notification of the adjacent property owner(s)by the applicant. Such stormwater discharges shall be subject to the requirements of this Ordinance.

G. All Regulated Activities shall include such measures as necessary to:

1. Protect health, safety and property;

2. Meet the water quality goals of this Ordinance by implementing measures to:

   a. Minimize disturbance to floodplains, wetlands, and wooded areas.

   b. Maintain or extend riparian buffers.

   c. Avoid erosive flow conditions in natural flow pathways.

   d. Minimize thermal impacts to waters of the Commonwealth.

   e. Disconnect impervious surfaces by directing runoff to pervious areas, wherever possible.

3. To the maximum extent practicable, incorporate the techniques for Low Impact Development Practices described in the *Pennsylvania Stormwater Best Management Practices Manual* (BMP Manual) or the Philadelphia Stormwater Management Guidance Manual.

H. The design of all facilities over karst shall include an evaluation of measures to minimize adverse effects.

I. Infiltration BMPs should be dispersed on site, made as shallow as practicable, and located to maximize use of natural onsite infiltration features while still meeting the other requirements of this Ordinance.

J. Storage facilities should completely drain both the volume control and rate control capacities over a period of time not less than 24 and not more than 72 hours from the end of the design storm.

K. Design storm volumes and precipitation intensities to be used in the analysis of discharge or runoff should be obtained from the Precipitation-Frequency Atlas of the United States, Atlas 14, Volume 2, Version 3.0, U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Weather Service, Hydrometeorological Design Studies Center, Silver Springs, Maryland. NOAA's Atlas 14 can be accessed at: http://hdsc.nws.noaa.gov/hdsc/pfds/.

L. For all regulated activities, SWM BMPs shall be designed, implemented, operated, and maintained to meet the purposes and requirements of this Ordinance and to meet all requirements under Title 25 of the Pennsylvania Code, the Clean Streams Law, and the Storm Water Management Act.

M. Various BMPs and their design standards are listed in the BMP Manual[1.]

Philadelphia County Portion of the Watershed

The Philadelphia Water Department implements the general requirements above under Sections 600.2(c), 600.3(d), 600.4(a), 600.7(a)(1) and (2), and 600.8(a) of its Regulations and Section 4.1, 4.3.1 and 5.3.1 of the Manual.

Section 402. Permit Requirements by Other Governmental Entities

Montgomery County Portion of the Watershed

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.

Philadelphia County Portion of the Watershed

See the requirements for the Philadelphia County Portion of the Watershed as set forth under Section 109 of the Model Ordinance, above.

Section 403. Erosion and Sediment Control During Regulated Earth Disturbance Activities

Montgomery County Portion of the Watershed

A. Additional erosion and sediment control standards and criteria are recommended to be applied where infiltration BMPs are proposed. They shall include the following:

    1. These areas shall be protected from sedimentation and compaction during the construction phase.

    2. BMPs shall not be constructed, nor the areas receive runoff, until the entire drainage areas tributary to the infiltration BMPs have achieved final stabilization.

Philadelphia County Portion of the Watershed

In Philadelphia, additional erosion and sedimentation control standards and criteria are as described in the Manual

Section 404. Nonstructural Project Design to Minimize Stormwater Impacts

Montgomery County Portion of the Watershed

The design of all regulated activities should include the following to minimize stormwater impacts: *(See SubappendixA-3 for a Nonstructural Project Design Checklist.)*

A. The Applicant should find practicable alternatives to the surface discharge of stormwater, the creation of impervious surfaces, and the degradation of waters of the Commonwealth and must maintain as much as possible the natural hydrologic regime of the site.

B. An alternative is practicable if it is available and capable of implementation after taking into consideration existing technology and logistics in light of overall project purposes and other municipal requirements.

Philadelphia County Portion of the Watershed

In Philadelphia, the Philadelphia Water Department implements nonstructural project design and sequencing to minimize stormwater impacts under Section 600.6 of its Regulations.

Section 405. Groundwater Recharge Requirements

Montgomery County Portion of the Watershed

A. Infiltration Best Management Practices (BMPs) shall meet the following minimum requirements unless the site qualifies for an exemption from the infiltration requirements of this ordinance as listed in Section 106:

1. Infiltration BMPs intended to receive runoff from developed areas shall be selected based on suitability of soils and site conditions and shall be constructed on soils that have the following characteristics:

   a. A minimum soil depth of twenty-four (24) inches between the bottoms of the infiltration BMPs and bedrock or other limiting zones.

   b. An infiltration rate sufficient to accept the additional stormwater load and dewater completely as determined by field tests conducted by the Applicant's Qualified Person.

   c. All open-air infiltration facilities shall be designed to completely infiltrate the recharge (infiltration) volume (Re_v)within three (3) days (72 hours) from the end of the design storm.

   d. All subsurface and contained facilities such as capture-and-reuse systems must have storage available equivalent to the Water Volume Control amount within three (3) days (72 hours) from the end of the design storm.

   e. Pretreatment (See Section 202) shall be provided prior to infiltration.

2. The size of the infiltration facility shall be based upon the following volume criteria:

Where practicable and appropriate the recharge volume shall be infiltrated on site. The recharge volume shall be equal to one (1.0) inch of runoff (I) over all proposed impervious surfaces.

The Re_v required shall be computed as:

$$Re_v = (1/12) * (I)$$

Where:
Re_v = Recharge Volume (cubic feet)
I = Impervious Area within the limits of earth disturbance (square feet)

An asterisk (*) in equations denotes multiplication.

B. Soils - A detailed soils evaluation of the project site shall be developed by the Applicant to determine the suitability of infiltration facilities. The evaluation shall be performed by a Qualified Person, and, at a minimum, address soil permeability, depth to bedrock, and subgrade stability. The general process for designing an infiltration BMP shall be:

1. Analyze hydrologic soil groups as well as natural and man-made features within the site to determine general areas of suitability for infiltration practices. In areas where development on fill material is under consideration, conduct geotechnical investigations of sub-grade stability; infiltration must be implemented if these tests are not completed.

2. Perform field tests, such as double ring infiltrometer or hydraulic conductivity tests (at the level of the proposed infiltration surface) to determine the appropriate hydraulic conductivity rate. Percolation tests are not accepted for design purposes.

3. Design the infiltration structure for the required recharge volume (Re_v) based on field tests at the elevation of the proposed infiltration surface.

4. If on-lot infiltration structures are proposed by the Applicant's Qualified Person, the Applicant must demonstrate to the Municipality that the soils are conducive to infiltrate on the lots identified.

5. The Applicant must install an impermeable liner in detention basins where the possibility of groundwater contamination exists. A detailed hydrogeologic investigation may be required by the Municipality.

Philadelphia Portion of the Watershed

In Philadelphia, the Philadelphia Water Department implements groundwater recharge requirements under Section 600.5(a)(2) of its Regulations and Sections 4.3.1 and 7 and Appendix B of its Manual.

Section 406. Water Volume Control Requirements

Montgomery County Portion of the Watershed

The low impact development practices provided in the BMP Manual shall be utilized for all regulated activities to the maximum extent practicable. Water Volume Controls shall be implemented using the *Design Storm Method* in Subsection A or the *Simplified Method* in

Subsection B below. For regulated activity areas equal to or less than one (1) acre that do not require hydrologic routing to design the stormwater facilities, this Ordinance establishes no preference for either methodology; therefore, the applicant may select either methodology on the basis of economic considerations, the intrinsic limitations on applicability of the analytical procedures associated with each methodology, and other factors. All regulated activities greater than one (1) acre must use the Design Storm Method.

A. The *Design Storm Method* (CG-1 in the BMP Manual) is applicable to any size of regulated activity. This method requires detailed modeling based on site conditions.

1. The post-development total runoff volume for all storms equal to or less than the 2-year, 24-hour storm event shall not be increased.

2. For modeling purposes:
   a. Existing (predevelopment) nonforested pervious areas must be considered meadow.
   b. Twenty (20) percent of existing impervious area, when present, shall be considered meadow in the model for existing conditions.

B. The *Simplified Method* (CG-2 in the BMP Manual) provided below is independent of site conditions and should be used if the *Design Storm Method* is not followed. This method is not applicable to regulated activities greater than one (1) acre, or for projects that require design of stormwater storage facilities. For new impervious surfaces:

1. Stormwater facilities shall capture at least the first two (2) inches of runoff from all new impervious surfaces.*(Note: An asterisk (*) in equations denotes multiplication.)*

   Volume (cubic feet) = (2/12) * Impervious Surfaces (square feet)

2. At least the first one (1) inch of runoff from new impervious surfaces shall be permanently removed from the runoff flow-- i.e., it shall not be released into the surface waters of the Commonwealth. Removal options include reuse, evaporation, transpiration, and infiltration.

   Volume (cubic feet) = (1/12) * Impervious Surfaces (square feet)

3. Wherever possible, infiltration facilities should be designed to accommodate infiltration of the entire permanently removed runoff; however, in all cases at least the first half (0.5) inch of the permanently removed runoff should be infiltrated.

4. This method is exempt from the requirements of Section 408, Peak Rate Controls.

<u>Philadelphia County Portion of the Watershed</u>

In Philadelphia, the Philadelphia Water Department implements water quality control requirements under Section 600.5(a)(1) of its Regulations.

Section 407. Stream Bank Erosion Requirements (Channel Protection)

Montgomery County Portion of the Watershed

If a perennial or intermittent stream passes through the site, the Applicant shall create a riparian buffer extending a minimum of fifty (50) feet to either side of the top-of-bank of the channel. The buffer area shall be established and maintained in an undisturbed state. This buffer area may be maintained as a meadow with minimal mowing of the grassed area, or as a forested buffer, being planted with appropriate native vegetation (refer to Appendix B of the BMP Manual for plant lists). If the applicable rear or side yard setback is less than fifty (50) feet, the buffer width may be reduced to twenty-five (25) percent of the setback to a minimum of ten (10) feet. If an existing buffer is legally prescribed (i.e., deed, covenant, easement, etc.) and it exceeds the requirements of this Ordinance, the existing buffer shall be maintained. *[Note: The Municipality may select a smaller buffer width (above) if desired, but the selected buffer may not be less than ten (10) feet]*. This does not include lakes or wetlands.

Applicants shall adhere to the following Stream Bank Erosion/Channel Protection Requirements:

A. In addition to the control of water quality volume (in order to minimize the impact of stormwater runoff on downstream stream bank erosion), the primary requirement is to design a BMP to detain the proposed conditions 2-year, 24-hour storm event to the existing conditions 1-year flow using the SCS Type II distribution. Additionally, provisions shall be made (such as adding a small orifice at the bottom of the outlet structure or a sand filter) so that the proposed conditions 1-year, 24-hour storm event takes a minimum of twenty-four (24) hours to drain from the facility from a point when the maximum volume of water from the 1-year, 24-hour storm event is captured (i.e., the maximum water surface elevation is achieved in the facility). Release of water can begin at the start of the storm (i.e., the invert of the water volume control orifice is at the invert of the facility).

B. The minimum orifice size in the outlet structure to the BMP shall be three (3) inches in diameter, where possible, and a trash rack shall be installed to prevent clogging. On sites with small drainage areas contributing to this BMP that do not provide enough runoff volume to allow a 24-hour attenuation with the 3-inch orifice, the calculations shall be submitted showing this condition. Orifice sizes less than three (3) inches can be utilized, provided that the design will prevent clogging of the intake. It is recommended that the design, to accommodate maintenance, include a replaceables and or porous media filter cartridge.

Philadelphia County Portion of the Watershed:

In Philadelphia, the Philadelphia Water Department implements channel protection requirements under Section 600.5(b) of its Regulations. In addition, riparian buffer requirements apply under the Code at Title 14, Chapter 14-700, Section 14-704(5).

Section 408. Stormwater Peak Rate Control and Management Districts

Montgomery County Portion of the Watershed

A. The Wissahickon Creek Watershed has been divided into stormwater management districts as shown on the Management District Map (Ordinance Appendix A).

The peak rate requirements specified in Table 408.1 below shall be implemented in addition to all other applicable requirements.

Standards for managing peak rates of runoff from each subarea in the Wissahickon Creek Watershed for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events are shown in Table 408.1. Development sites located in each of the management districts must control proposed condition runoff rates to existing condition runoff rates for the design storms in accordance with Table 408.1.

TABLE 408.1

PEAK RATE CONTROL STANDARDS BY STORMWATER MANAGEMENT DISTRICT IN THEWISSAHICKON CREEK WATERSHED

District	Proposed Condition Design Storm		Existing Condition Design Storm
A	2-year	Reduce to	1-year
	5-year		5-year
	10-year		10-year
	25-year		25-year
	50-year		50-year
	100-year		100-year
B	2-year	Reduce to	1-year
	5-year		2-year
	10-year		5-year
	25-year		10-year
	50-year		25-year
	100-year		50-year
C*	Conditional Direct Discharge District		

In District C, development sites that can discharge directly to the Wissahickon Creek Main Channel and to the Schuylkill River main channel without use of City infrastructure may do so without control of proposed conditions peak rate of runoff.

Projects that are required to obtain a NPDES Permit for stormwater discharges associated with construction activities are required to show no increase in peaks from existing conditions.

When adequate capacity in the downstream system does not exist and will not be provided through improvements, the proposed conditions peak rate of runoff must be controlled to the Predevelopment Conditions peak rate as required in District A provisions for the specified Design Storms. The Predevelopment Condition for new development is the existing condition. For redevelopment purposes in Philadelphia County, the Predevelopment Condition shall be determined according to the procedures found in the Philadelphia Stormwater Guidance Manual.

B. General - Proposed condition rates of runoff from any regulated activity shall not exceed the peak release rates of runoff from existing conditions for the design storms specified on the Stormwater Management District Watershed Map (Ordinance Appendix A).

C. District Boundaries - The boundaries of the stormwater management districts are shown on an official map that is available for inspection at the municipal and County Planning offices. A copy of the official map at a reduced scale is included as Ordinance Appendix A. The

exact location of the stormwater management district boundaries as they apply to a given development site shall be determined by mapping the boundaries using the 2-foot topographic contours (or most accurate data required) provided as part of the drainage plan.

D. Sites Located in More than One (1) District - For a proposed development site located within two (2) or more stormwater management districts, the peak discharge rate from any subarea shall meet the management district criteria in which the discharge is located.

E. Off-site Areas - Off-site areas that drain through a proposed development site are not subject to release rate criteria when determining allowable peak runoff rates. However, on-site drainage facilities shall be designed to safely convey off-site flows through the development site.

F. Site Areas - Where the site area to be impacted by a proposed development activity differs significantly from the total site area, only the proposed impact area utilizing stormwater management measures shall be subject to the management district criteria. In other words, unimpacted areas bypassing the stormwater management facilities would not be subject to the management district criteria.

G. Alternate Criteria for Redevelopment Sites - For redevelopment sites, one of the following minimum design parameters shall be accomplished, whichever is most appropriate for the given site conditions as determined by [*Municipality*];

1. Meet the full requirements specified by Table 408.1 and Sections 408.A through 408.F.

or

2. Reduce the total impervious surface on the site by at least twenty (20) percent based upon a comparison of existing impervious surface to proposed impervious surface.

H. Stormwater Control Measures which increase storage or infiltration volume, and which are not associated with new land development or redevelopment activity that increases runoff volume above existing levels, are exempt from the peak rate requirements of this ordinance, so long as peak outflow is not increased.

Philadelphia County Portion of the Watershed

In Philadelphia, the Philadelphia Water Departments implements stormwater peak rate control for management districts under Sections 600.5(c) of its Regulations, titled Flood Control Requirement, or the alternative criteria set forth in Section 600.3(a)(2) of its Regulations. The Table of Peak Runoff Rates for Management Districts at the end of Section 600.5 of the Regulations lists the attenuation requirements of each district in the watershed as set forth below.

Table of Peak Runoff Rates for Management Districts

District	Column A NRCS Type II 24-hour Design Storm applied to Proposed Condition	Column B NRCS Type II 24 –hour Design Storm applied to Predevelopment Condition
A	2 – year	1 – year
A	5 – year	5 – year
A	10 – year	10 – year
A	25 – year	25 – year
A	50 – year	50 – year
A	100 – year	100 – year

C* Conditional Direct Discharge District

SMPs shall be designed such that peak rates from Column A are less than or equal to Peak Rates from Column B.

*In District C, a Development Site that can discharge directly without use of City infrastructure may do so without control of proposed conditions peak rate of runoff.

For Conditional Direct Discharge Districts, the proposed conditions peak rate of runoff for a Development Site that discharge to City infrastructure must be controlled to the Predevelopment Conditions peak rate as required in District A provisions for the specified Design Storms.

The Predevelopment Condition shall be defined according to the procedures found in the Manual.

Section 409. Calculation Methodology

Montgomery County Portion of the Watershed

A. Stormwater runoff from all development sites with a drainage area of greater than 200 acres shall be calculated using a generally accepted calculation technique that is based on the NRCS soil cover complex method. The Qualified Person must consult with the municipality to gain approval of design methods prior to design.

Table 409.1 summarizes acceptable computation methods and the method selected by the Qualified Person shall be based on the individual limitations and suitability of each method for a particular site. The Municipality may allow the use of the Rational Method to estimate peak discharges from drainage areas that contain less than 200 acres. The Soil Cover Complex Method shall be used for drainage areas greater than 200 acres.

TABLE 409.1
Acceptable Computation Methodologies For
Stormwater Management Plans

Montgomery County Portion of the Watershed

METHOD	METHOD DEVELOPED BY	APPLICABILITY
WINTR-20	USDA NRCS	Applicable where use of full hydrology computer model is desirable or necessary.
WINTR-55	USDA NRCS	Applicable for land development plans within limitations described in TR-55.
HEC-HMS	US Army Corps of Engineers	Applicable where use of full hydrologic computer model is desirable or necessary.
Rational Method or commercial computer package based on Rational Method)	Emil Kuichling(1889)	For sites less than 200 acres and with times of concentration less than 60 minutes (tc< 60 min), or as approved by the Municipality and/or Municipal Engineer
Other Methods	Varies	Other computation methodologies approved by the Municipality and/or Municipal Engineer.

**Note: Successors to the above methods are also acceptable.*

B. If a hydrologic computer model such as HydroCAD or HEC-HMS is used for stormwater runoff calculations, then the duration of rainfall shall be 24 hours. The rainfall distribution should reference NRCS Type II.

C. For the purposes of existing conditions flow rate determination, undeveloped land shall be considered as "meadow", unless the natural ground cover generates a lower curve number or Rational 'C' value (i.e., forest).

D. Times-of-concentration for overland flow shall be calculated using the methodology presented in Chapter 3 of Urban Hydrology for Small Watersheds, NRCS, TR-55 (as amended or replaced from time to time by NRCS). Times-of-concentration for channel and pipe flow shall be computed using flow velocities as determined by Manning's equation.

E. The Manning equation is preferred for 1-D, gradually-varied, open channel flow. In other cases, appropriate, applicable methods should be applied, however, early coordination with the municipality is necessary.

F. Outlet structures for stormwater management facilities shall be designed to meet the performance standards of this Ordinance using the generally accepted hydraulic analysis technique or method of the Municipality.

G. The design of any stormwater detention facilities intended to meet the performance standards of this Ordinance shall be verified by routing the design storm hydrograph through these facilities using the Storage-Indication Method. For drainage areas greater than 200 acres in size, the design storm hydrograph shall be computed using a calculation method that produces a full hydrograph. The Municipality may approve the use of any generally accepted full hydrograph approximation technique that shall use a total runoff volume that is consistent with the volume from a method that produces a full hydrograph.

<u>Philadelphia County Portion of the Watershed</u>

In Philadelphia, Section 600.7(a)(8) of the Regulations states that acceptable calculation methods are provided in the Manual. Section 5.3 of the Manual summarizes the calculation methods that are acceptable to the Philadelphia Water Department.

ARTICLE V - INSPECTIONS

Montgomery County Portion of the Watershed

Section 501. Inspections

A. The Municipality may inspect all phases of the installation of the Best Management Practices (BMPs) and/or stormwater management facilities as deemed appropriate by the Municipality.

B. During any stage of the work, if the Municipality determines that the BMPs and/or stormwater management (SWM) facilities are not being installed in accordance with the approved SWM plan, the Municipality, may suspend or revoke, in whole or in part, any existing permits or other approvals and issue a cease and desist order until a revised SWM Site Plan is submitted and approved, as specified in this Ordinance, and until the deficiencies are corrected.

C. A final inspection of all BMPs and/or SWM facilities may be conducted by the Municipality to confirm compliance with the approved Stormwater Management Site Plan prior to the issuance of any occupancy permit.

D. The developer shall be responsible for providing as-built plans of all SWM BMPs included in the approved SWM Site Plan. The as-built plans and an explanation of any discrepancies, which were reviewed and received approval by the Municipality, shall be submitted to the Municipality.

E. The as-built submission shall include a certification of completion signed and sealed by a Qualified Person verifying that all permanent SWM BMPs have been constructed according to the approved plans and specifications. If any licensed Qualified Persons contributed to the construction plans, they must sign and seal the completion certificate.

F. Final plans based upon the Record Drawings must be submitted to the Municipality for the project to be eligible for the issuance of a Certificate of Occupancy.

Philadelphia County Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Article V through existing provisions of the Charter, Code and Regulations, as set forth in the Table below.

Paragraph In Section 501	Corresponding Provisions of the Charter, Code and Regulations
A	Charter, Article V, Ch. 10, §5-1001(b), §5-1002(c) & (f), &§5-1004 Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 4, §A-401 Code, Title 13, Ch. 13-600, §13-603(4) Code, Title 14, Ch. 14-300, §14-306(1)(a) PWD Regulations, §600.10(a)& (e), &600.11(f)
B	Charter, Article V, Ch. 10, §5-1002(e) Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 3, §A-302.9& Ch. 5, §A-504&§A-505 Code, Title 13, Ch. 13-600, §13-603(4) Code, Title 14, Ch. 14-300, §14-306(1)(d)&(e) PWD Regulations, §600.10(c) & §600.16(d)
C	PWD Regulations, §600.10(e)

D	PWD Regulations, §600.10(d)
E	Code, Title 4, Ch. 4-200.0, Subcode “A”, Ch. 3, §A-304 PWD Regulations, §600.10(d)
F	PWD Regulations, §600.10(d)&(e)

ARTICLE VI-FEES AND EXPENSES

Montgomery County Portion of the Watershed

Section 601. Municipality SWM Site Plan Review and Inspection Fees

Fees may be established by the Municipality to defray costs incurred by the Municipality. All fees shall be paid by the Applicant. A fee schedule shall be established by resolution of the municipal Governing Body, which may be based on the size of the Regulated Activity or the Municipality's costs for processing SWM Site Plans and conducting inspections. The Municipality may periodically update the fee schedule to ensure that its costs are adequately reimbursed.

Section 602. Expenses Covered by Fees

The fees authorized by this Ordinance may at a minimum cover:

A. Administrative costs.

B. Review of the SWM Site Plan by the Municipality.

C. Site inspections.

D. Inspection of SWM facilities and drainage improvements during construction.

E. Final inspection at the completion of the construction of the SWM facilities and drainage improvements presented in the SWM Site Plan.

F. Any additional work required to enforce any permit provisions, correct violations, and assure proper completion of necessary remedial actions.

Philadelphia Portion of the Watershed

In Philadelphia County, fees are authorized by the Charter, Code and Regulations, as set forth in the provisions listed in the Table below.

Section	Corresponding Provisions of the Charter, Code and Regulations
601	Charter, Article V, Ch. 8, §5-901& Article VIII, Ch. 4, §8-407(a) Code, Title 4, Ch. 4-200.0, Subcode A, Ch. 9, §A-901 PWD Regulations, Ch. 3, §308.1 and 600.8(d)
602	Charter, Article V, Ch. 8, §5-901& Article VIII, Ch. 4, §8-407(a) Code, Title 4, Ch. 4-200.0, Subcode A, Ch. 9, §A-901 PWD Regulations, Ch. 3, §308.1 and 600.8(d)

ARTICLE VII-MAINTENANCE RESPONSIBILITIES

Section 701. Performance Guarantee

Montgomery County Portion of the Watershed

A. For subdivisions and land developments, the Applicant shall provide a financial guarantee to the Municipality for the timely installation and proper construction of all stormwater management facilities as required by the approved SWM Site Plan. The amount of the guarantee shall be equal to or greater than the full construction cost of the required controls.

B. For other regulated activities, the Municipality may require a financial guarantee from the Applicant.

Philadelphia County of the Watershed

Not Applicable, except when the Water Department grants permission to an owner of property to construct stormwater management facilities in any street upon which his property abuts, in which case the property owner must enter into an agreement with the City, in form satisfactory to the Law Department, to comply with the requirements of the Code and to construct the sewer without expense to the City, and the contractor selected by the property owner must file a bond with the City, in an amount fixed by the Law Department, conditioned upon compliance with the Water Department's regulations and specifications, as per Section 13-406 of the Code.

Section 702. Responsibilities for Operation and Maintenance (O&M) of Stormwater Facilities and Best Management Practices (BMPs)

Montgomery County Portion of the Watershed

A. The owner of any land upon which stormwater facilities and BMPs will be placed, constructed, or implemented, as described in an O&M Plan, shall record the following documents in the Office of the Recorder of Deeds for _____ County, within_____ (__)days of approval of the O&M plan by the Municipality:

1. The O&M Plan, or a summary thereof,
2. O&M Agreements under Section 704, and
3. Easements under Section 705.

B. The Municipality may suspend or revoke any approvals granted for the project site upon discovery of failure on the part of the owner to comply with this Ordinance.

C. The following items shall be included in the O&M Plan:

1. Map(s) of the project area, in a form that meets the requirements for recording at the offices of the Recorder of Deeds of _____County, shall be submitted on_____-inch x-_____inch sheets. The contents of the map(s) shall include, but not be limited to:

a. Clear identification of the location and nature of stormwater controls and BMPs,
b. The location of the project site relative to highways, municipal boundaries or other identifiable landmarks,
c. Existing and final contours at intervals of two (2) feet, or others as appropriate,
d. Existing streams, lakes, ponds, or other bodies of water within the project site area,
e. Other physical features including flood hazard boundaries, sinkholes, streams, existing drainage courses, and areas of natural vegetation to be preserved,
f. The locations of existing and proposed utilities, sanitary sewers, and water lines within fifty (50) feet of property lines of the project site,
g. Proposed final changes to the land surface and vegetative cover, including the type and amount of impervious area that would be added,
h. Proposed final structures, roads, paved areas, and buildings, and
i. At the discretion of the Municipality, a 15-feet wide access easement around all stormwater controls and BMPs that would provide ingress to and egress from a public right-of-way.

2. A description of how each stormwater facility and BMP will be operated and maintained, and the identity and contact information associated with the person(s) responsible for operations and maintenance,

3. The name of the project site, the name and address of the owner of the property, and the name of the individual or firm preparing the plan, and

4. A statement, signed by the landowner, acknowledging that the stormwater facilities and BMPs are fixtures that cannot be altered or removed without prior approval by the Municipality.

D. The O&M Plan for the project site shall establish responsibilities for the continuing O&M of all stormwater facilities and BMPs, as follows:

1. If a plan includes structures or lots that are to be separately owned and in which streets, sewers, and other public improvements are to be dedicated to the Municipality, associated stormwater controls and BMPs also may be dedicated to and maintained by the Municipality;

2. If a plan includes operation and maintenance by a single ownership or if sewers and other public improvements are to be privately owned and maintained, the O&M of stormwater controls and BMPs, and inspections required by permits, shall be the responsibility of the owner.

E. The Municipality will make the final determination on the continuing operation and maintenance responsibilities prior to final approval of the Stormwater Management Site Plan. The Municipality reserves the right to accept or reject the O&M responsibility for any or all portions of the stormwater controls and BMPs.

F. The O&M Plan shall be recorded as a restrictive deed covenant that runs with the land.

G. The municipality may take enforcement actions against an owner for any failure to satisfy the provisions of this Article and this Ordinance.

Philadelphia County Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Section 702 through existing provisions of the Charter, Code and Regulations, as set forth in the Table below.

Paragraph In Section 702	Corresponding Provisions of the Charter, Code and Regulations
A	PWD Regulations, §§ 600.11(a) &600.13(a)
B	Charter, Article V, Ch. 10, §5-1002(e) Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 3, §A-302.9 & Ch. 5, §A-504 & §A-505 Code, Title 13, Ch. 13-600, §13-603(4) Code, Title 14, Ch. 14-300, §14-306(1)(d)&(e) PWD Regulations, §600.10(c) & §600.16(d)
C	PWD Regulations, §600.6(b), §600.8(b)&(c) see also the Manual
D	PWD Regulations, §600.11; See also Manual at section 4.4.3
E	PWD Regulations, §600.11(a)-(d)
F	PWD Regulations, §600.13
G	Charter, Article V, Ch. 10, §5-1002(a)&(e) Code, Title 13, Ch. 13-600, §13-603(4) Code, Title 14, Ch. 14-300,§14-306

Section 703. Municipal Review of an O&M Plan

Montgomery County Portion of the Watershed

A. O&M plans shall be consistent with the requirements of this Ordinance.

B. The Municipality will notify Applicants in writing whether or not O&M plans are approved.

C. The Municipality's approval letter will indicate whether or not "record drawings" of all stormwater controls and BMPs are required, including a final "as-built" O&M Plan.

Philadelphia County Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Section 703 through existing provisions of the Code and Regulations, as set forth in the Table below.

Paragraph In Section 703	Corresponding Provisions of the Code and Regulations
A	PWD Regulations, §600.11(a)
B	Code, Title 14, Ch. 14-700, §14-704(3)(b) PWD Regulations, §600.11(a)
C	PWD Regulations, §600.10(d)&(e)

Section 704. Operation and Maintenance (O&M) Agreement for Privately Owned Stormwater Controls and BMPs

Montgomery County Portion of the Watershed

A. The owner shall sign an O&M agreement with the Municipality covering all stormwater facilities and BMPs that are to be privately owned. The O&M agreement shall be transferred with transfer of ownership.

B. Other items may be included in the agreement where determined necessary to guarantee the satisfactory operation and maintenance of all stormwater facilities and BMPs. The O&M Agreement shall be subject to the review and approval of the Municipality.

C. The owner is responsible for O&M of the SWM BMPs. If the owner fails to adhere to the O&M Agreement, the Municipality may perform the services required and charge the owner appropriate fees. Nonpayment of fees may result in a lien against the property.

Philadelphia County Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Section 704 through existing provisions of the Code and Regulations, as set forth in the Table below.

Paragraph In Section 704	Corresponding Provisions of the Code and Regulations
A	PWD Regulations, §600.11
B	PWD Regulations, §600.11
C	Code, Title 4, Ch. 4-200.0, Subcode A, §A-503.2 Code, Title 13, Ch. 13-600, §13-603(5)(b)-(e)

Section 705. Stormwater Management Easements

Montgomery County Portion of the Watershed

A. The owner must obtain all necessary real estate rights to install, operate, and maintain all stormwater facilities in the SWM Site Plan and the O&M Plan.

B. The owner must provide the municipal easements, or other appropriate real estate rights, to perform inspections and maintenance or the preservation of stormwater runoff conveyance, infiltration, and detention areas.

Philadelphia County Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Section 705 through existing provisions of its Regulations, as set forth in the Table below.

Paragraph In Section 704	Corresponding Provisions of the Regulations
A	PWD Regulations, §600.12
B	PWD Regulations, §600.12

ARTICLE VIII-PROHIBITIONS

Section 801. Prohibited Discharges and Connections

Montgomery County Portion of the Watershed

A. Any drain or conveyance, whether on the surface or subsurface, that allows any non-stormwater discharge, including sewage, process wastewater, or wash water to enter the separate storm sewer system, or otherwise to enter the waters of the Commonwealth is prohibited. Any connections to the storm drain system from indoor drains and sinks also are prohibited.

B. No person shall allow, or cause to allow, discharges into surface waters of the Commonwealth which are not composed entirely of stormwater, except (1) as provided in subsection C below, and (2) discharges allowed under a state or federal permit.

C. The following discharges are authorized unless they are determined to be significant contributors to pollution to the waters of the Commonwealth:

- Discharges from fire fighting activities	- Flows from riparian habitats and wetlands
- Potable water sources including water line flushing	- Uncontaminated water from foundations or from footing drains
- Irrigation drainage	- Lawn watering
- Air conditioning condensate	- Dechlorinated swimming pool discharges
- Springs	- Uncontaminated groundwater
- Water from crawl space pumps	- Water from individual residential car washing
- Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spill material has been removed) and where detergents are not used	- Routine external building wash down (which does not use detergents or other compounds)

D. In the event that the Municipality or DEP determines that any of the discharges identified in Subsection C significantly contribute to pollution of the waters of the Commonwealth, the Municipality or DEP will notify the responsible person(s) to cease the discharge.

Philadelphia County Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Section 801 through existing provisions of the Code and Regulations, as set forth in the Table below.

Paragraph In Section801	Corresponding Provisions of the Code and Regulations
A	Code, Title 4, Ch.4-200.0, Subcode P, §§ 901.1, 901.2, 901,3, 1203,2 & 1401.1 Code, Title 4, Ch 4-200.0, Subcode PM, Ch. 4, §405.3.3 Code, Title 4, Ch.4-200.0, Subcode PM, Ch. 5, §504.3.3 Code, Title 13, Ch. 13-600, §13-603(3)(a)
B	Code, Title 4, Ch.4-200.0, Subcode P, §§ 901.1, 901.2, 901,3, 1203,2 & 1401.1 Code, Title 4, Ch. 4-200.0, Subcode PM, Ch. 4, §405.3.3 Code, Title 4, Ch. 4-200.0, Subcode PM, Ch. 5, §504.3.3 Code, Title 13, Ch. 13-600, §13-603(3)(b)
C	Code, Title 13, Ch. 13-600, §13-603(3)(c)
D	Code, Title 13, Ch. 13-600, §13-603(5)(b) PWD Regulations, §600.14(b)

Section 802. Roof Drains

Montgomery County Portion of the Watershed

In Montgomery County, roof drains shall not be connected to streets, sanitary or storm sewers, or roadside ditches, and shall discharge to infiltration areas or vegetative BMPs to the maximum extent practicable, except for already existing developed sites where the onsite stormwater system already is designed and equipped to accomplish stormwater rate, quality, and quantity mitigation. The applicant shall, in these cases, submit documentation on the existing stormwater system to the municipal engineer, who shall determine if the stormwater system accomplishes comparable stormwater rate, quality, and quantity mitigation.

In the event that an existing developed site is to be redeveloped, existing roof drains that discharge to an existing stormwater system that is designed and equipped to accomplish stormwater rate, quality, and quantity mitigation, those existing roof drains may remain, provided the applicant submits documentation on the existing stormwater system to the municipal engineer, who shall determine if the stormwater system accomplishes comparable stormwater rate, quality, and quantity mitigation.

Philadelphia County of the Watershed

In Philadelphia County, roof drains must comply with the provisions of the Code and Regulations, as set forth in the Table below.

Section 802	Corresponding Provisions of the Code and Regulations
	Code, Title 4, Ch 4-200.0, Subcode P, §1001.1 PWD Regulations, § 600.6(a)

Section 803. Alteration of BMPs

Montgomery County Portion of the Watershed

A. No person shall modify, remove, fill, landscape, or alter any existing stormwater facility or BMP unless it is part of an approved maintenance program and written approval of the Municipality has been obtained.

B. No person shall place any structure, fill, landscaping, or vegetation into a stormwater control or BMP or within a drainage easement which would limit or alter the functioning of the stormwater control or BMP without the written approval of the Municipality.

Philadelphia County Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Section 803 through existing provisions of its Regulations, as set forth in the Table below.

Paragraph In Section 803	Corresponding Provisions of the Code and Regulations
A	PWD Regulations, §600.11
B	PWD Regulations 600.11(c)&(d)

ARTICLE IX - ENFORCEMENT AND PENALTIES

Section 901. Right-of-Entry

Montgomery County Portion of the Watershed

The Municipality, or its authorized agents and employees, will provide forty-eight (48) hours written notice when appropriate, at its sole discretion, and may then enter upon any part of the property within the Municipality to inspect and determine the compliance of the implementation, condition, or operation and maintenance (O&M) of the stormwater facilities or Best Management Practices (BMPs) in regard to any aspect governed by this Ordinance. Inspection includes monitoring and sampling to determine proper operation of stormwater facilities and BMPs. The Municipality shall have the right to temporarily locate on any stormwater control or BMP in the Municipality such devices as are necessary to conduct monitoring and/or sampling of the discharges from such stormwater control or BMP.

Philadelphia County Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Section 901 through existing provisions of the Charter, Code and Regulations, as set forth in the Table below.

Section 901	Corresponding Provisions of the Charter, Code and Regulations
	Charter, Article V, Ch. 10, §5-1001(b), §5-1002(c) & (f), &§5-1004 Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 4, § A-401 Code, Title 13, Ch. 13-600, §13-603(4) Code, Title 14, Ch. 14-300, §14-306(1)(a) PWD Regulations, § 600.10(a)&(e)&§ 600.11(e)

Section 902. Inspection

Montgomery County Portion of the Watershed

BMPs should be inspected for proper operation by the landowner, or the owner's designee (including the municipality for dedicated and owned facilities), according to the following list of minimum frequencies:

1. Annually for the first 5 years.

2. Once every 3 years thereafter.

3. During or immediately after the cessation of a 10-year, 24-hour, or greater storm event.

4. As specified in the O&M agreement

Philadelphia Count Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department has implemented the provisions of Section 902 through the Operation and Maintenance Agreements required under Section 600.11 of its Regulations. Section 7 of the Manual sets forth recommended inspection frequencies which vary depending on the particular type of stormwater management practice.

Section 903. Enforcement

Montgomery County Portion of the Watershed

All inspections regarding compliance with the Stormwater Management (SWM) Site Plan and this Ordinance shall be the responsibility of the Municipality.

A. Whenever the Municipality finds that a person has violated a prohibition or failed to meet a requirement of this Ordinance, the Municipality may order compliance by notifying the responsible person. Such notice may include 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;

   6. Payments to reimburse administrative and remediation costs;

   7. Implementation of stormwater controls and BMPs; and

   8. O&M of stormwater facilities and BMPs.

B. Such notification shall set forth the nature of the violation(s) and establish a time limit for correction of those violations(s). If the violator fails to take the required action within the established deadline, the work may be done by the Municipality and the expenses may be charged to the violator.

C. Failure to comply within the time specified may subject a violator to the penalty provisions of this Ordinance. All such penalties shall be deemed cumulative and shall not prevent the Municipality from pursuing other remedies available in law or equity.

Philadelphia County Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Section 903 through existing provisions of the Charter and Code, as set forth in the Table below.

Paragraph In Section 903	Corresponding Provisions of the Charter and Code
A	Charter, Article V, Ch. 10, §5-1002 Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 3, § A-302.9.1 Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 5, §§ 502, 503, 504 & 505 Code, Title 13, Ch. 13-600, §13-603(5)(b) Code, Title 14, Ch. 14-300, § 14-306 PWD Regulations, §600.16(a)
B	Charter, Article V, Ch. 10, §5-1002 Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 3, § A-302.9.1 Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 5, §§ 502 & 503 Code, Title 13, Ch. 13-600, §13-603(5)(c) Code, Title 14, Ch. 14-300, § 14-306 PWD Regulations, §600.16(b)
C	Code, Title 1, Ch.1-100, § 1-109 Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 6, §§A-601.1 &A-604.1 Code, Title 13, Ch. 13-600, §13-603(5)(a)& (g) Code, Title 14, Ch. 14-300, § 14-306 PWD Regulations, § 600.16(c)

Section 904. Suspension and Revocation

Montgomery County Portion of the Watershed

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 SWM Site Plan or O&M 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.

D. If a violation causes no immediate danger to life, public health or safety, or property, at its sole discretion, the municipality may provide a limited time period for the owner to correct the violation. In these cases, the municipality will provide the owner, or the owner's designee, with a written notice of the violation and the time period allowed for the owner to correct the violation. If the owner does not correct the violation within the allowed time period, the municipality may revoke or suspend any, or all, applicable approvals and permits pertaining to any provision of this Ordinance.

Philadelphia County Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Section 904 through existing provisions of the Charter, Code and Regulations, as set forth in the Table below.

Paragraph In Section 904	Corresponding Provisions of the Charter and Code
A	Charter, Article V, Ch. 10, §5-1002(e) Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 3, §A-302.9 Code, Title 4, Ch. 4-200.0, Subcode "A,", Ch. 5, §§A-503, A-504 & A-505 Code, Title 14, Ch. 14-300, §14-306(1)(d)&(e) PWD Regulations, §600.10(c) & §600.16(d)
B	Code, Title 4, Ch. 4-200.0, Subcode "A,", Ch. 5, §A-503 Code, Title 14, Ch. 14-300, §14-306(1)(d)
C	Code, Title 4, Ch. 4-200.0, Subcode "A,", Ch. 5, §§A-302.9, A-504.6 & A-505.7 Code, Title 14, Ch. 14-300, §14-306(1)(d)
D	Code, Title 4, Ch. 4-200.0, Subcode "A", Ch. 5, §§ A-502 & §A-503

Section 905. Penalties

Montgomery County Portion of the Watershed

A. Anyone violating the provisions of this Ordinance shall be guilty of a summary offense, and upon conviction, shall be subject to a fine of not more than $_____ for each violation, recoverable with costs. Each day that the violation continues shall be a separate offense and penalties shall 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 shall have the right to issue restraining orders, temporary or permanent injunctions, mandamus, or other appropriate forms of remedy or relief.

Philadelphia Portion of the Watershed

In Philadelphia County, the Philadelphia Water Department anticipates implementing the provisions of Section 905 through existing provisions of the Charter and Code and the Water Department's Regulations, as set forth in the Table below.

Paragraph In Section 905	Corresponding Provisions of the Code
A	Charter, Article 1, §1-100 Code, Title 1, Ch.1-100, §1-109 Code, Title 4, Ch. 4-200.0, Subcode "A," Ch. 5, §A-504.8 & Ch. 6 §A-601 Code, Title 13, Ch. 13-600, §13-603(5)(a)&(g) PWD Regulations, § 600.16(c)
B	Code, Title 4, Ch. 4-200.0, Subcode "A," Ch. 5, §A-504.8 & Ch. 6 §A-604.1 Code, Title 13, Ch. 13-600, §13-603(5)(f) & (g)

Section 906. Appeals

Montgomery County Portion of the Watershed

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.

Philadelphia County Portion of the Watershed

In Philadelphia, appeals are governed by the following sections of the Charter and Code:

A. The Charter, at Article V, Chapter 10, Section 5-1005, requires the Board of License and Inspection Review to provide an appeal procedure whereby any person aggrieved by the issuance, transfer, renewal, refusal, suspension, revocation or cancellation of any City license or by any notice, order or other action as a result of any City inspection, affecting the person directly, shall upon request be furnished with a written statement of the reasons for the action taken and afforded a hearing in which the Board will hear any evidence which the aggrieved party or the City may desire to offer. The Board must make findings and render a decision in writing. The Board may affirm, modify, reverse, vacate or revoke the action from which the appeal was taken to it. Appeals form decisions of the Board may be taken to the Court of Common Pleas in the time and manger provided by law.

B. The Code, at Article 4, Chapter 4-200, Subcode A, Chapter 8, Section A-801 through A-804 establishes procedures for technical and non-technical appeals arising out of matters addressed under certain provisions of the Administrative Code, Plumbing Code, Property Maintenance Code and Zoning Code.

Montgomery County Portion of the Watershed

ENACTED and ORDAINED at a regular meeting of the _____ _____ on the _____ of _____, 20__. This Ordinance shall take effect immediately.

_____
[Name]

_____
[Title]

_____
[Name]

_____
[Title]

_____
[Name]

_____
[Title]

_____
[Name]

_____
[Title]

_____
[Name]

_____
[Title]

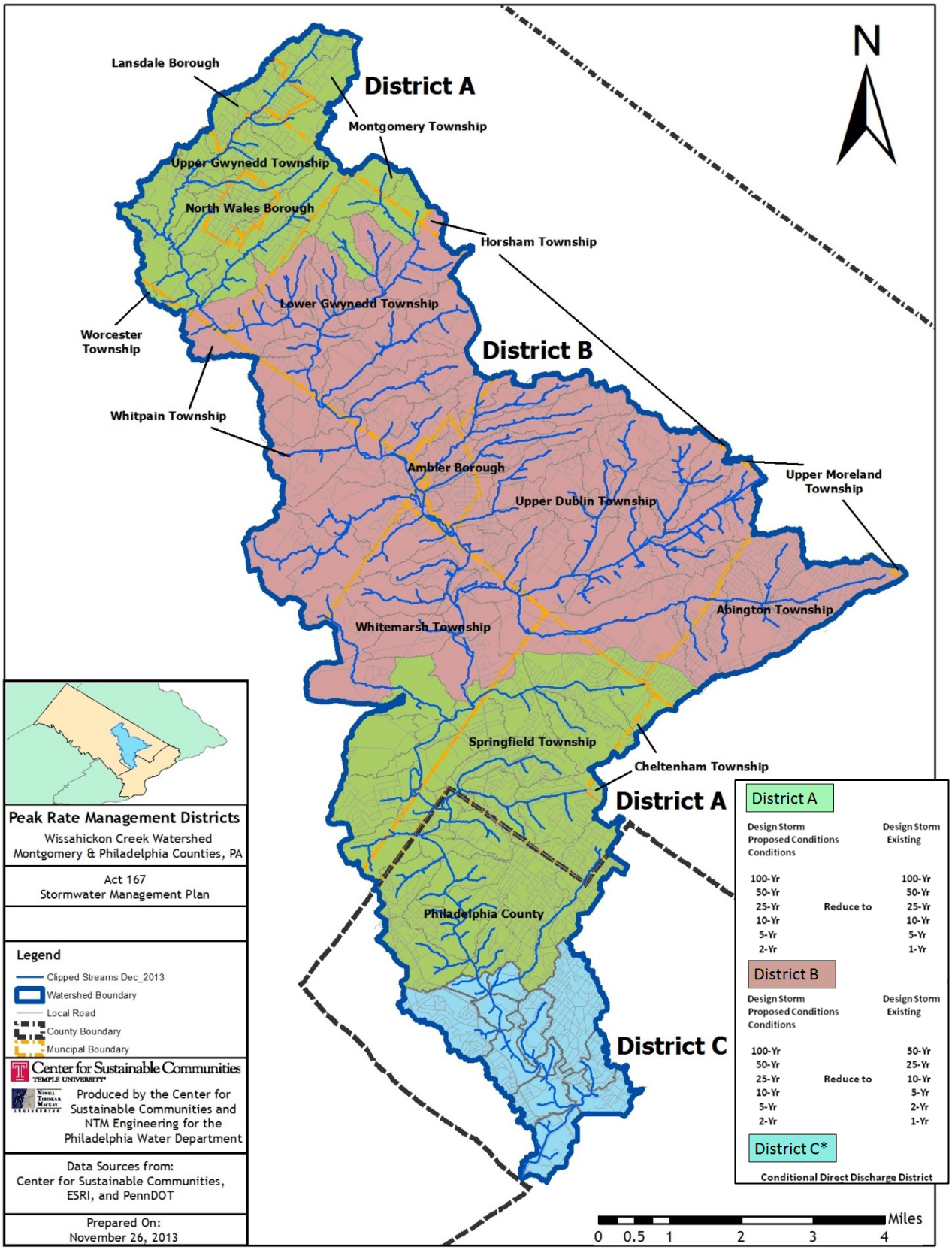
ATTEST:

_____
Secretary

I hereby certify that the foregoing Ordinance was advertised in the _____ on _____, 20__, a newspaper of general circulation in the Municipality and was duly enacted and approved as set forth at a regular meeting of the Municipality's Governing Body held on _____, 20__.

_____
Secretary

ORDINANCE APPENDIX A
STORMWATER MANAGEMENT DISTRICT WATERSHED MAP



ORDINANCE APPENDIX B
SMALL PROJECT STORMWATER MANAGEMENT (SWM)
SITE PLAN FOR RESIDENTIAL DEVELOPMENT

Small Project Stormwater Management Site Plan

This Small Project SWM Site Plan is included as an option for municipalities to adopt to give small regulated activities the opportunity to submit a non-engineered stormwater management plan. The requirements of this site plan alternative are consistent with the volume control requirements of the *Wissahickon Creek Watershed Stormwater Management Plan (SMP)*. This small project site plan is only permitted for projects identified in Table 106.1.

A. What is an applicant required to submit?

A brief description of the proposed stormwater facilities, including types of materials to be used, total square footage of proposed impervious areas, volume calculations, and a simple sketch plan showing the following information:

- Location of proposed structures, driveways, or other paved areas with approximate surface area in square feet.
- Location of any existing or proposed onsite septic system and/or potable water wells showing proximity to infiltration facilities.
- Montgomery County Conservation District erosion and sediment control "Adequacy" letter as required by Municipal, County or State regulations.

B. Determination of Required Volume Control and Sizing Stormwater Facilities

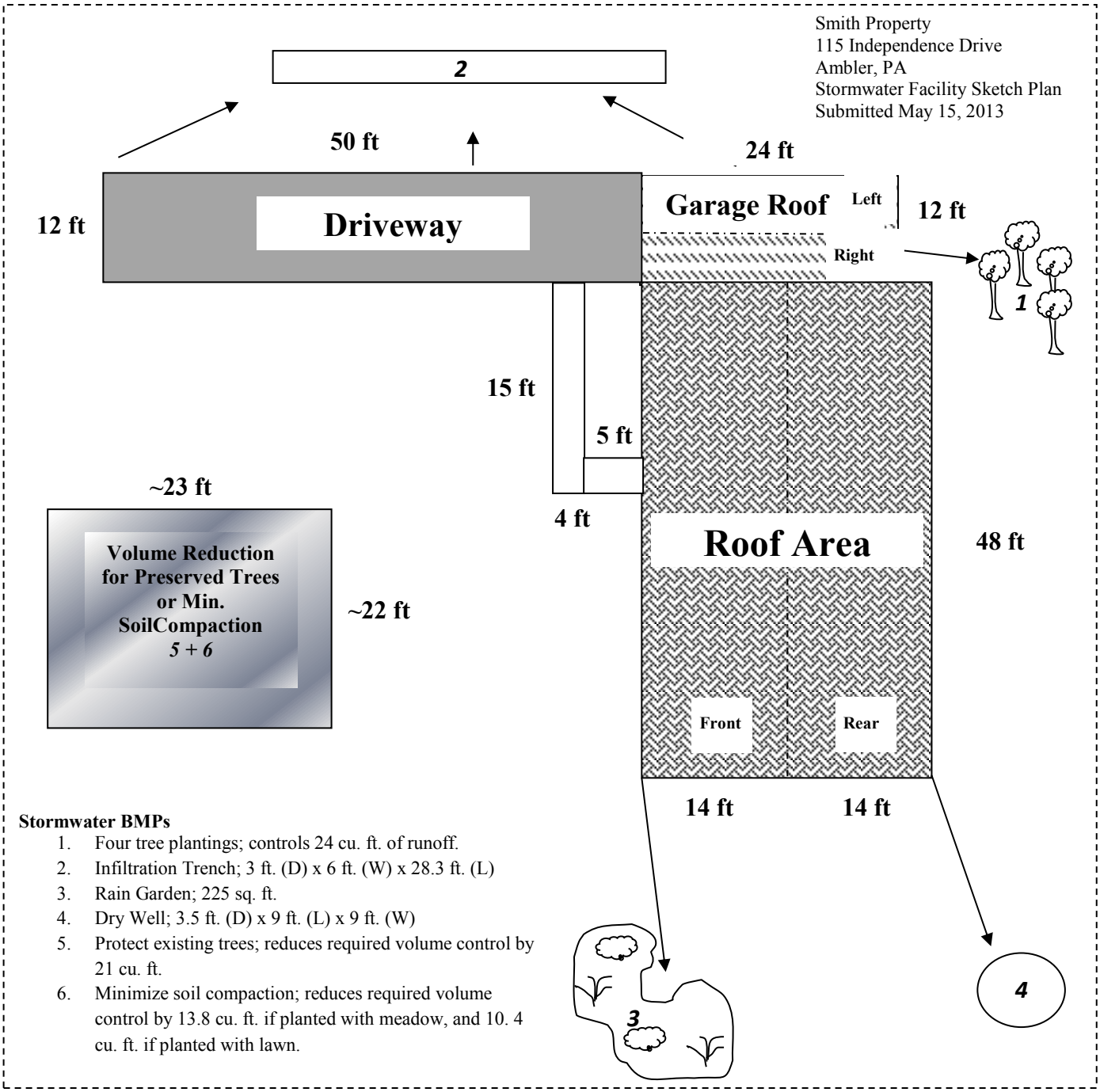
By following the simple steps outlined below in the provided example, an applicant can determine the runoff volume that is required to be controlled and how to choose the appropriate stormwater facility to permanently remove the runoff volume from the site. Impervious area calculations must include all areas on the lot proposed to be covered by roof area or pavement which would prevent rain from naturally percolating into the ground, including impervious surfaces such as sidewalks, driveways, parking areas, patios or swimming pools. Sidewalks, driveways or patios that are designed and constructed to allow for infiltration are not included in this calculation.

Site Plan Example: Controlling runoff volume from a proposed home site
Step 1: Determine Total Impervious Surfaces

Impervious Surface			Area (sq. ft.)
House Roof (Front)	14 ft. x 48 ft.	=	672 sq. ft.
House Roof (Rear)	14 ft. x 48 ft.	=	672 sq. ft.
Garage Roof (Left)	6ft. x 24 ft.	=	144 sq. ft.
Garage Roof (Right)	6 ft. x 24 ft.	=	144 sq. ft.
Driveway	12 ft. x 50 ft.	=	1,000 sq. ft.
Walkway	4 ft. x 20 ft.	=	80 sq. ft.

	Total Impervious		3,000 sqft
	Total Earth Disturbance		6,000 sqft

Figure 1: Sample Site Sketch Plan



Stormwater BMPs

1. Four tree plantings; controls 24 cu. ft. of runoff.
2. Infiltration Trench; 3 ft. (D) x 6 ft. (W) x 28.3 ft. (L)
3. Rain Garden; 225 sq. ft.
4. Dry Well; 3.5 ft. (D) x 9 ft. (L) x 9 ft. (W)
5. Protect existing trees; reduces required volume control by 21 cu. ft.
6. Minimize soil compaction; reduces required volume control by 13.8 cu. ft. if planted with meadow, and 10. 4 cu. ft. if planted with lawn.

Step 2: Determine Required Volume Control (cubic feet) using the following equation:

Volume (cu. ft.) = (Total impervious area in square feet x 2 inches of runoff) /12 inches

(3,000 sq. ft. x 2 inches of runoff) /12 inches = 500 cu. ft.

Step 3: Sizing the Selected Volume Control BMP

Several Best Management Practices (BMPs), as described below, are suitable for small stormwater management projects. However, their application depends on the volume required to be controlled, how much land is available, and the site constraints. Proposed residential development activities can apply both non-structural and structural BMPs to control the volume of runoff from the site. A number of different volume control BMPs are described below. Note that Figure 1 is an example of how these BMPs can be utilized in conjunction to control the total required volume on one site.

Structural BMPs

1. Infiltration Trench

An Infiltration Trench is a linear stormwater BMP consisting of a continuously perforated pipe at a minimum slope in a stone-filled trench. During small storm events, infiltration trenches can significantly reduce volume and serve in the removal of fine sediments and pollutants. Runoff is stored between the stones and infiltrates through the bottom of the facility and into the soil matrix. Runoff should be pretreated using vegetative buffer strips or swales to limit the amount of coarse sediment entering the trench which can clog and render the trench ineffective. In all cases, an infiltration trench should be designed with a positive overflow.

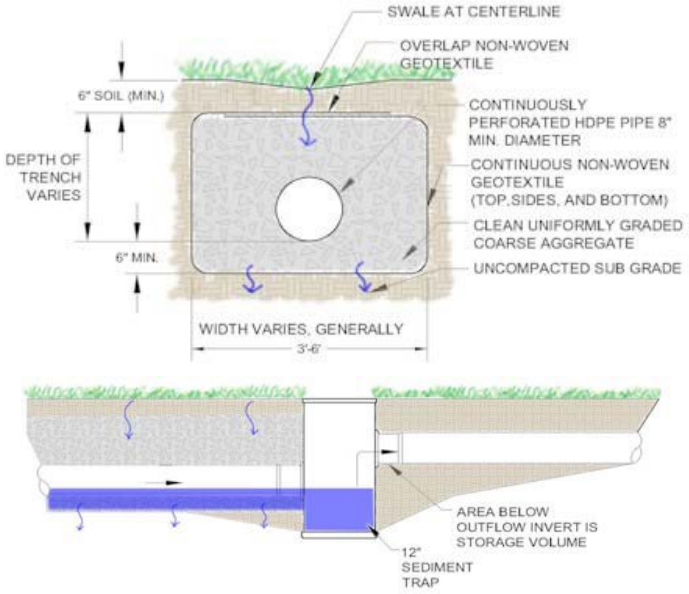
Design Considerations:

- Although the width and depth can vary, it is recommended that Infiltration Trenches be limited in depth to not more than six (6) feet of stone.
- Trench is wrapped in nonwoven geotextile (top, sides, and bottom).
- Trench needs to be placed on uncompacted soils.
- Slope of the Trench bottom should be level or with a slope no greater than 1%.
- A minimum of 6" of topsoil is placed over trench and vegetated.
- The discharge or overflow from the Infiltration Trench should be properly designed for anticipated flows.
- Cleanouts or inlets should be installed at both ends of the Infiltration Trench and at appropriate intervals to allow access to the perforated pipe.
- Volume of facility = Depth x Width x Length x Void Space of the gravel bed (assume 40%).

Maintenance:

- Catch basins and inlets should be inspected and cleaned at least two times a year.
- The vegetation along the surface of the infiltration trench should be maintained in good condition and any bare spots should be re-vegetated as soon as possible.
- Vehicles should not be parked or driven on the trench and care should be taken to avoid soil compaction by lawn mowers.

Figure 2: Infiltration Trench Diagram



Source: PA BMP Guidance Manual, Chapter 6, page 42.

Figure 3: Example of Infiltration Trench Installation

Source: PA BMP Guidance Manual, Chapter 6, Page 46.

Sizing Example for Infiltration Trench

1. Determine Total Impervious Surface to drain to Infiltration Trench:

Garage Roof (Left)	6 ft. x 24 ft.	=	144 sqft
Driveway	12 ft. x 50 ft.	=	1000 sqft
Walkway	4 ft. x 20 ft.	=	80 sqft

2. Determine the required infiltration volume:

   (1224 sq. ft. x 2 inches of runoff)/12 ft. = 204 cu. ft. / 0.4* = 510 cu. ft.
   (*0.4 assumes 40% void ratio in gravel bed)

3. Sizing the infiltration trench facility:

   Volume of Facility = Depth x Width x Length

   Set Depth to 3 feet and determine required surface area of trench.

   510 cu. ft / 3 ft = 170sqft.

   The width of the trench should be greater than 2 times its depth (2 x D), therefore in this example the trench width of 6 feet selected.

   Determine trench length: L = 170 sq. ft. / 6 ft. = 28.3 ft.

   Final infiltration trench dimensions: 3 ft. (D) x 6 ft. (W) x 28.3 ft. (L)

2. Rain Garden

A Rain Garden is a planted shallow depression designed to catch and filter rainfall runoff. The garden captures rain from a downspout or a paved surface. The water sinks into the ground, aided by deep rooted plants that like both wet and dry conditions. The ideal location for a rain garden is between the source of runoff (roofs and driveways) and the runoff destination (drains, stream, low spots, etc).

Design Considerations:

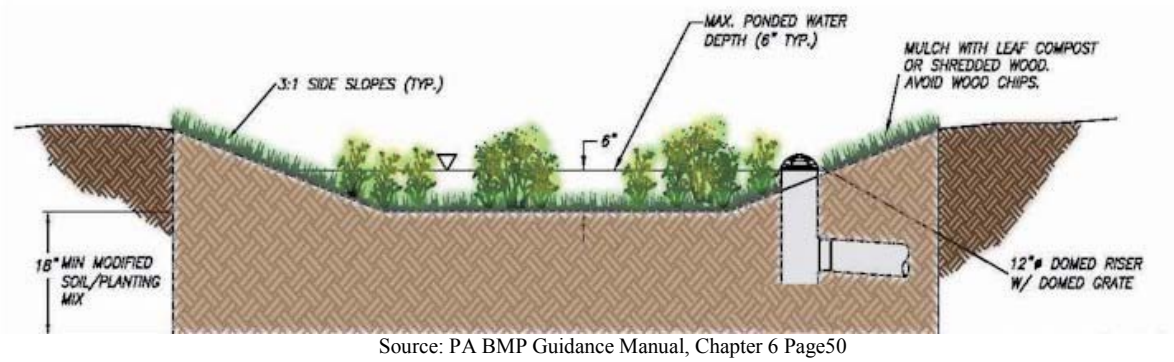
- A maximum of 3:1 side slope is recommended.
- The depth of a rain garden can range from 6 - 8 inches. Ponded water should not exceed 6 inches.
- The rain garden should drain within 72 hours.
- The garden should be at least 10-20 feet from a building's foundation and 25 feet from septic system drainfields and wellheads.
- If the site has clay soils, soil should be amended with compost or organic material.
- Choose native plants. See http://pa.audubon.org/habitat/PDFs/RGBrochure_complete.pdf for a native plant list. To find native plant sources go to www.pawildflower.org.

- At the rain garden location, the water table should be at least 2' below the soil level. If water stands in an area for more than one day after a heavy rain you can assume it has a higher water table and is not a good choice for a rain garden.

Maintenance:

- Water plants regularly until they become established.
- Inspect twice a year for sediment buildup, erosion and vegetative conditions.
- Mulch with hardwood when erosion is evident and replenish annually.
- Prune and remove dead vegetation in the spring season.
- Weed as you would any garden.
- Move plants around if some plants would grow better in the drier or wetter parts of the garden.

Figure 4: Rain Garden Diagram



Source: PA BMP Guidance Manual, Chapter 6 Page50

Sizing Example for Rain Garden

1. Pick a site for the rain garden between the source of runoff and between a low lying area, a.k.a., a drainage area.

2. Perform an infiltration test to determine the depth of the rain garden:
   - Dig a hole 8″ x 8″
   - Fill with water and put a popsicle stick at the top of the water level.
   - Measure how far it drains down after a few hours (ideally 4).
   - Calculate the depth of water that will drain out over 24 hours.

3. Determine total impervious surface area to drain to rain garden:

House Roof (Front)	14 ft. x 48 ft.	=	672 sqft

4. Sizing the rain garden:

   For this example the infiltration test determined 6″ of water drained out of a hole in 24 hours. The depth of the rain garden should be set to the results of the infiltration test so 6″ is the depth of the rain garden. The sizing calculation below is based on controlling 1″ of runoff. First divide the impervious surface by the depth of the rain garden.

   (672 sqft / 6 ft.) = 112 sq. ft.

   In order to control 2″ of runoff volume, the rain garden area needs to be multiplied by 2.

   112 sq. ft. * 2 = 224 sq. ft.

   The rain garden should be about 225 sq. ft. in size and 6"deep.

3. Dry Well (a.k.a., Seepage Pit)

A Dry Well, sometimes called a Seepage Pit, is a subsurface storage facility that temporarily stores and infiltrates stormwater runoff from the roofs of structures. By capturing runoff at the source, Dry Wells can dramatically reduce the increased volume of stormwater generated by the roofs of structures. Roof leaders connect directly into the Dry Well, which may be either an excavated pit filled with uniformly graded aggregate wrapped in geotextile, or a prefabricated storage chamber or pipe segment. Dry Wells discharge the stored runoff via infiltration into the surrounding soils. In the event that the Dry Well is overwhelmed in an intense storm event, an overflow mechanism (surcharge pipe, connection to a larger infiltration are, etc.) will ensure that additional runoff is safely conveyed downstream.

Design Considerations:

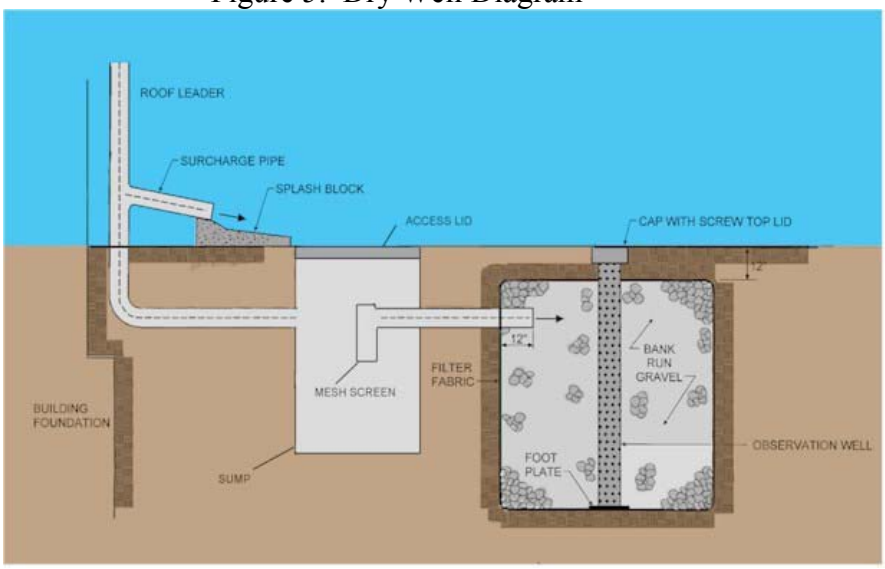
- Dry Wells typically consist of 18 to 48 inches of clean washed, uniformly graded aggregate with 40% void capacity (AASHTO No. 3, or similar). “Clean” gravel fill should average one and one-half to three (1.5 – 3.0) inches in diameter.
- Dry Wells are not recommended when their installation would create a significant risk for basement seepage or flooding. In general, 10 - 20 feet of separation is recommended between Dry Wells and building foundations.
- The facility may be either a structural prefabricated chamber or an excavated pit filled with aggregate.
- Depth of dry wells in excess of three-and-a-half (3.5) feet should be avoided unless warranted by soil conditions.
- Stormwater dry wells must never be combined with existing, rehabilitated, or new septic system seepage pits. Discharge of sewage to stormwater dry wells is strictly prohibited.

Maintenance:

- Dry wells should be inspected at least four (4) times annually as well as after large storm events.
- Remove sediment, debris/trash, and any other waste material from a dry well.
- Regularly clean out gutters and ensure proper connections to the dry well.

- Replace the filter screen that intercepts the roof runoff as necessary.

Figure 5: Dry Well Diagram



Source: PA BMP Guidance Manual, Chapter 6, Page 65.

Sizing Example for Dry Wells:

1. Determine contributing impervious surface area:

House Roof (Rear)	14 ft. x 48 ft.	=	672 sq. ft.

2. Determine required volume control:

   (672 sq. ft. * 2 inches of runoff) / 12 inches = 112 cu. ft.

   112 cu ft / 0.4 = 280 cu. ft. (assuming the 40% void ratio in the gravel bed)

3. Sizing the dry well:

   Set depth to 3.5 ft; Set width equal to length for a square chamber.

   280 cu. ft. = 3.5 ft. x L x L; L = 9 ft.

   Dimensions = 3.5 ft. (D) x 9 ft. (L) x 9 ft. (W)

Non-Structural BMPs

1. Tree Plantings and Preservation

Trees and forests reduce stormwater runoff by capturing and storing rainfall in the canopy and releasing water into the atmosphere through evapotranspiration. Tree roots and leaf litter also create soil conditions that promote the infiltration of rainwater into the soil. In addition, trees and forests reduce pollutants by taking up nutrients and other pollutants from soils and water through their root systems. A development site can reduce runoff volume by planting new trees or by preserving trees which existed on the site prior to development. The volume reduction calculations either determine the cubic feet to be directed to the area under the tree canopy for infiltration or determine a volume reduction credit which can be used to reduce the size of any one of the planned structural BMPs on the site.

Tree Considerations**:**

- Existing trees must have at least a 4″trunk caliper or larger.
- Existing tree canopy must be within 100 ft. of impervious surfaces.
- A tree canopy is classified as the continuous cover of branches and foliage formed by a single tree or collectively by the crowns of adjacent trees.
- New tree plantings must be at least 6 ft. in height and have a 2″trunk caliper.
- All existing and newly planted trees must be native to Pennsylvania. See http://www.dcnr.state.pa.us/forestry/commontr/commontrees.pdf for a guide book titled *Common Trees of Pennsylvania* for a native tree list.
- When using trees as volume control BMPs, runoff from impervious areas should be directed to drain under the tree canopy.

Determining the required number of planted trees to reduce the runoff volume:

1. Determine contributing impervious surface area:

Garage Roof (Right)	6 ft. x 24 ft.	=	144ft

2. Calculate the required control volume:

   (144 sq. ft. x 2 inches of runoff) / 12 inches = 24 cu. ft.

3. Determine the number of tree plantings:

   - A newly planted deciduous tree can reduce runoff volume by 6 cu. ft.
   - A newly planted evergreen tree can reduce runoff volume by 10 cu. ft.

   24 cu. ft./6 cu. ft. = 4 Deciduous Trees

Determining the volume reduction for preserving existing trees:

1. Calculate approximate area of the existing tree canopy:

~22 sq. ft. x ~23 sq. ft = 500 sq. ft.

2. Measure distance from impervious surface to tree canopy: 35 ft.

3. Calculate the volume reduction credit by preserving existing trees:

   - For Trees within 20 feet of impervious cover:
     Volume Reduction cu. ft. = (Existing Tree Canopy sq. ft. x 1 inch) / 12
   - For Trees beyond 20 feet but not farther than 100 feet from impervious cover:
     Volume Reduction cu. ft. = (Existing Tree Canopy sq. ft. x 0.5 inch) / 12

   (500 sq. ft. x 0.5 inches) / 12 = 21 cu. ft.

   This volume credit can be utilized in reducing the size of any one of the structural BMPs planned on the site. For example, the 21 cu. ft. could be subtracted from the required infiltration volume when sizing the infiltration trench;

   510 cu. ft – 21 cu. ft. = 489 cu. ft.

   489 cu. ft. / 3 ft (Depth) = 163 / 6 ft. (Width) = 27.1 ft (Length)

   Using the existing trees for a volume credit would decrease the length of the infiltration trench to 27.1 ft. instead of 28.3 ft.

2. Minimize Soil Compaction and Replant with Lawn or Meadow

When soil is overly compacted during construction it can cause a drastic reduction in the permeability of the soil and rarely is the soil profile completely restored. Runoff from vegetative areas with highly compacted soils similarly resembles runoff from an impervious surface. Minimizing soil compaction and re-planting with a vegetative cover like meadow or lawn, not only increases the infiltration on the site, but also creates a friendly habitat for a variety of wildlife species.

Design Considerations:

- Area shall not be stripped of topsoil.
- Vehicle movement, storage, or equipment/material lay down shall not be permitted in areas preserved for minimum soil compaction.
- The use of soil amendments and additional topsoil is permitted.
- Meadow should be planted with native grasses. Refer to *Meadows and Prairies: Wildlife-Friendly Alternatives to Lawn* at http://pubs.cas.psu.edu/FreePubs/pdfs/UH128.pdf for reference on how to properly plant the meadow and for a list of native species.

Determining the volume reduction by minimizing soil compaction and planting a meadow:

1. Calculate approximate area of preserved meadow:

   ~22 sq. ft. x ~23 sq. ft = 500 sq. ft.

2. Calculate the volume reduction credit by minimizing the soil compaction and planting a lawn/meadow:

   - For Meadow Areas: Volume Reduction (cu. ft.) = (Area of Min. Soil Compaction (sq. ft.) x 1/3 inch of runoff) / 12

     (500 sq. ft. x 1/3 inch of runoff) / 12 = 13.8 cu. ft.

   - For Lawn Areas: Volume Reduction (cu. ft.) = (Area of Min. Soil Compaction (sq. ft.) x 1/4 inch of runoff) / 12

     (500 sq. ft. x 1/4 inch of runoff) / 12 = 10.4 cu. ft.

This volume credit can be used to reduce the size of any one of the structural BMPs on the site. See explanation under the volume credit for preserving existing trees for details.

Alternative BMP to Capture and Reuse Stormwater

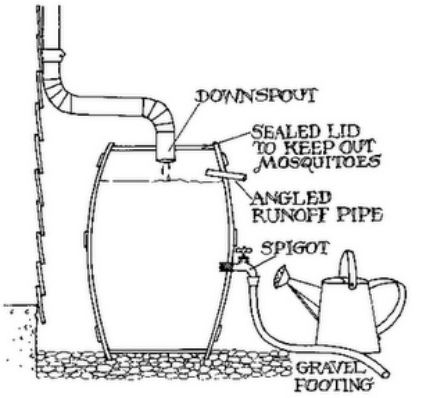
Rain Barrels

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. It is not recommended for rain barrels to be used as a volume control BMP because infiltration is not guaranteed after each storm event. For this reason, a rain barrel is not utilized in the site plan example. However, the information is included to provide an alternative for a homeowner to utilize when considering capture and reuse stormwater methods.

Design Considerations:

- Rain barrels should be directly connected to the roof gutter/spout.
- There must be a means to release the water stored between storm events to provide the necessary storage volume for the next storm.
- When calculating rain barrel size, rain barrels are typically assumed to be 25% full because they are not always emptied before the next storm.
- Use screens to filter debris and cover lids to prevent mosquitoes.
- An overflow outlet should be placed a few inches below the top with an overflow pipe to divert flow away from structures.
- It is possible to use a number of rain barrels jointly for an area.
- Are requirements for 15-foot access easements waived?

Figure 6: Rain Barrel Diagram and Examples



Sources: (top picture) http://www.citywindsor.ca/DisplayAttach.asp?AttachID=12348
(bottom picture on left) http://repurposinglife.blogspot.com/2009/05/rainwater-harvesting.html
(bottom picture on right) http://www.floridata.com/tracks/transplantedgardener/Rainbarrels.cfm

Sizing Example for a Rain Barrel

1. Determine contributing impervious surface area:

Garage Roof (Right)	6 ft. x 24 ft.	=	144 sqft

2. Determine the amount of rainfall to be captured by the Rain Barrel. A smaller storm, no more than 2″, is recommended to calculate the runoff to be captured. This example chose the 1″ storm event.

3. Calculate the volume to be captured and reused:

   (144 sq. ft. x 1 inch of runoff) / 12 inches = 12 cu. ft.

4. Size the rain barrel:

   1 cu. ft. = 7. 48 gallons

   12 cu. ft. x 7.48 = 90 gallons
   90 gallons x (0.25*) = 22.5 gallons (*assuming that the rain barrel is always at least 25% full)

   90 gallons + 22.5 gallons = 112 gallons

   The rain barrel or barrels should be large enough to hold at least 112 gallons of water.

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ORDINANCE APPENDIX C
NONSTRUCTURAL PROJECT DESIGN CHECKLIST

The goal of this checklist is to minimize the increases in stormwater runoff and impacts to water quality resulting from the proposed regulated activity:

1. Prepare an Existing Resource and Site Analysis Map (ERSAM, see Section 301.B.)
2. Establish a stream buffer according to Section 407.
3. Prepare a draft project layout avoiding sensitive areas identified in Section 301.
4. Identify site-specific existing conditions drainage areas, discharge points, recharge areas, and hydrologic soil groups A and B (areas conducive to infiltration).
5. Evaluate nonstructural stormwater management alternatives (Section 404):
    a) Minimize earth disturbance.
    b) Minimize clearing operations (vegetation removal)
    c) Minimize impervious surfaces.
    d) Break up large impervious surfaces.
6. Satisfy the groundwater recharge (infiltration) objective (Section 405) and provide for stormwater pretreatment prior to infiltration.
7. Provide for water quality protection in accordance with Section 406 water volume control requirements.
8. Provide stream bank erosion protection in accordance with Section 407 stream bank erosion requirements.
9. Determine into what management district the site falls (Section 408) and conduct an existing conditions runoff analysis.
10. 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.
11. Conduct a proposed conditions runoff analysis based on the final design that meets the management district requirements (Section 408).
12. Manage any remaining runoff prior to discharge through detention, bioretention, direct discharge, or other structural control.

ORDINANCE APPENDIX D
RIPARIAN BUFFER TRAIL GUIDELINES

[Note to Municipality: The following riparian buffer trail guidelines may be modified provided that the buffer meets all minimum width and vegetation requirements detailed in Section 407 of the ordinance as well as all federal, state and local, stormwater, floodplain, and other requirements and regulations.]

Introduction

Riparian buffers are used as non-structural best management practices (BMPs) for protecting and enhancing water quality. Depending on their size, location, and design, riparian buffers often supply additional environmental, economic, aesthetic, and recreational value. Passive recreational trails can be a compatible use within riparian buffers if the trails are sized and placed appropriately. The trail guidelines below are meant to supplement Section 406, Water Volume Control Requirements, and do not alter or modify the regulations set forth in Section 401, General Requirements. All other applicable rules and requirements should be followed, including all federal, state, permitting, and local stormwater and floodplain ordinances.

Installing a trail does not relieve a developer or municipality of the minimum buffer and vegetation requirements described in Section 407, or infiltration and peak rate controls in Sections 405 and 408.Effort shall be made to mitigate water quality and peak rate adjacent the trail structure to avoid collecting runoff in a large facility and creating a point discharge. This can be accomplished by trail-side stone filtration trenches, vegetative filter strips, small bio-retention facilities, and other mechanisms subject to site constraints and municipal engineer approval. See Figure 1. In situations where site constraints negate the feasibility of trail-side mitigation methods, effort shall be made to collect runoff in multiple stormwater facilities for segmented portions of the trail, in place of detaining stormwater in one large facility. Level spreaders shall be constructed at facility outlets to decrease point-source discharges.

As with all trails, adequate land acquisition, easements, and/or landowner permission should be obtained in advance of any trail placement. Care should be given when designing and installing trails so as not to compromise the buffer's ability to protect water quality. Many factors such as slope, vegetation, and soil type will determine the type, size, and placement of the trail within the riparian buffer. Heavily used trails and trails with wide impervious surfaces should be set back farther from the stream edge to help mitigate the effects of any associated increase in runoff. Note: failure to comply with these guidelines (Installing a trail with inadequate setback from the stream bank) could result in increased stormwater runoff, decreased water quality, stream bank degradation, and damage to the buffer or trail.

Trail Recommendations

Location, Size, and Orientation

All trails should be a reasonable width appropriate for the site conditions. It is not recommended that the width of any paved trail exceed twenty five (25) percent of the total buffer width. All trail designs and specifications are subject to approval by the Municipality.

Natural vegetation must be present throughout the buffer as described in Section 306 of the ordinance. Grassy areas should be managed as meadows or be reforested and should not be mowed as lawn in any part of the buffer. Where existing vegetation is insufficient to protect water quality, additional native species should be planted to enhance the buffer.

Paved trails, if appropriate to the site, are permitted and must be located at least twenty-five (25) feet from the top of the stream bank. In limited instances, paved trails be placed closer to a stream due to topography, or in order to accommodate passive educational and recreational activities, but must always be at least ten (10) feet from the top of the stream bank. Although this can be achieved by diverting the entire trail closer to the stream, more conservative methods should be considered, such as smaller spur trails or loop trails. These smaller trails provide access to the stream, but reduce the total traffic along the sensitive stream bank.

In rare instances where the buffer width is reduced due to zoning setback or geographical constraints, the municipality should strongly consider whether the benefits of a trail outweigh the benefits of a wider buffer.

Signage

The installation of interpretive and educational signage is strongly encouraged along the trail. Signs should point out local natural resources and educate the public on how riparian buffers protect the watershed. There should be minimum disturbance in the vegetated buffer between the trail and the stream. Therefore, all appurtenances (e.g. benches, educational signs, kiosks, fountains, etc.) should be installed on the landward side of the trail, if possible. All appurtenances shall be installed in compliance with federal, state, local, stormwater, floodplain, and other regulations and permitting requirements (e.g. anchoring, etc.)

Parking Areas

New trailheads and trail parking areas shall meet all the infiltration, rate control, and minimum setback requirements of this ordinance. Every effort should be made to coordinate trail access with existing parking areas. Any new parking areas and trailhead clearings should not encroach on the riparian buffer in any way.

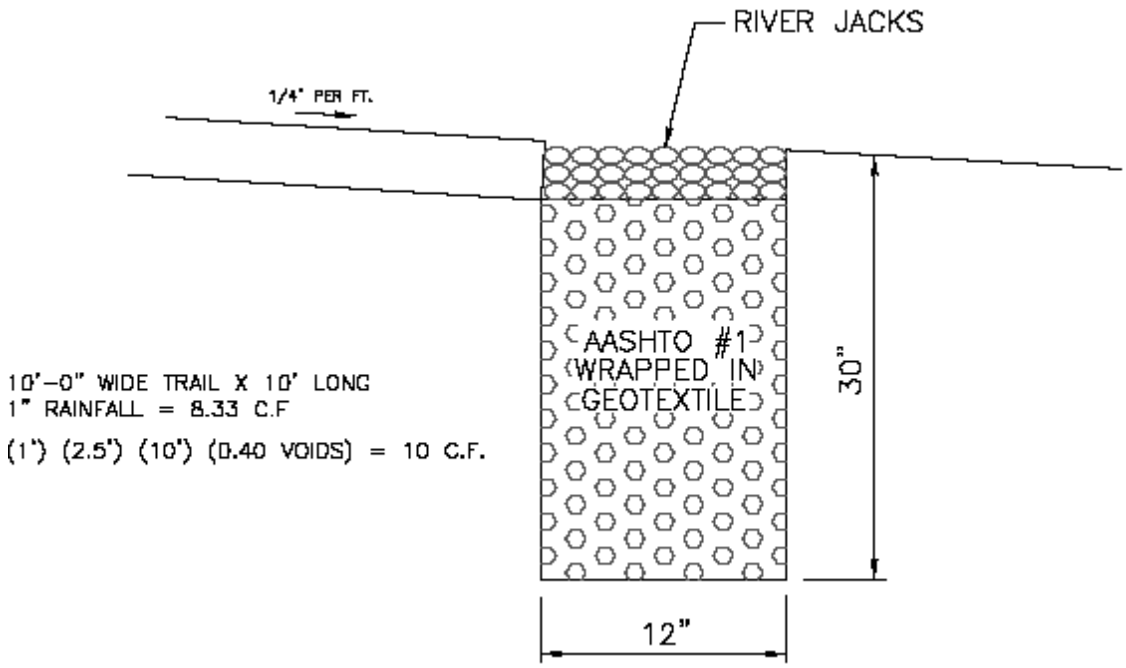
Trail Maintenance

The installation and maintenance of all trails should be performed in a manner that minimizes site disturbance and prevents runoff and erosion. Soil disturbance should be avoided if possible. The

removal of native trees and other native vegetation should also be kept to a minimum. If large or heavy equipment is required for trail installation, special care should be given not to damage existing trees and tree roots.

FIGURE 1.

EXAMPLE DESIGN OF A TRAIL-SIDE STONE FILTRATION TRENCH



Source:
James MacCombie, H*erbert E. MacCombie Jr. P.E. Consulting Engineers & Surveyors Inc.*

ORDINANCE APPENDIX E
OPERATION AND MAINTENANCE (O&M) AGREEMENT

OPERATION AND MAINTENANCE (O&M) AGREEMENT STORMWATER MANAGEMENT BEST MANAGEMENT PRACTICES (SWM BMPs)

THIS AGREEMENT, made and entered into this _____ day of _____, 20___, by and between _____, (hereinafter the "Landowner"), and _____,_____ County, 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").

WHEREAS, the Landowner is proceeding to build and develop the Property; and

WHEREAS, the SWM Site Plan approved by the Municipality (hereinafter referred to as the "Plan") for the property identified herein, which is attached hereto as Appendix E and made part hereof, as approved by the Municipality, provides for management of stormwater within the confines of the Property through the use of BMPs; 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 SWM BMPs be constructed and maintained on the Property; and

WHEREAS, the Municipality requires, through the implementation of the SWM Site Plan, that stormwater BMPs as required by said 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 shall construct the BMPs in accordance with the plans and specifications identified in the SWM Site Plan.
2. The Landowner shall operate and maintain the BMPs as shown on the Plan in good working order in accordance with the specific maintenance requirements noted on the approved SWM Site 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 BMPs whenever necessary. Whenever possible, the Municipality shall notify the Landowner prior to entering the property.
4. In the event the Landowner fails to operate and maintain the BMPs per paragraph 2, the Municipality or its representatives may enter upon the Property and take whatever action is deemed necessary to maintain said BMP(s). 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 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 10 days of receipt of invoice from the Municipality.

6. The intent and purpose of this Agreement is to ensure the proper maintenance of the onsite BMPs 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, and other successors in interests, shall 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 BMP(s) by the Landowner or Municipality.
8. The Municipality shall inspect the BMPs at a minimum of once every three years to ensure their continued functioning.

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:

_____

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 _____, 20_____.

_____ __ _____

NOTARY PUBLIC **(SEAL)**

Wissahickon Creek Watershed
Act 167 Plan

Prepared by

Center for Sustainable Communities
TEMPLE UNIVERSITY®

And

NEWELL TERESKA & MACKAY
ENGINEERING

Edited by Richard Fromuth, P.E., Research Fellow,
Center for Sustainable Communities, Temple University
April 2014 (revised November 2014)

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Appendix E: *Final Report: Inventory of Existing Stormwater Management Facilities with Retrofit Potential Within the Wissahickon Creek Watershed*, Philadelphia Water Department, 2008
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Introduction

This plan has been developed for the Wissahickon Creek Watershed in Montgomery, and Philadelphia counties, Pennsylvania, to comply with the requirements of the Pennsylvania Stormwater Management Act of 1978, also known as Act 167. The Act requires Pennsylvania counties to prepare and adopt stormwater management plans for each watershed located in the county, as designated by the Pennsylvania Department of Environmental Protection (DEP). It also requires municipalities to implement a stormwater management ordinance limiting stormwater runoff from new development and redevelopment.

The main objective of the plan is to control stormwater runoff on a watershed basis rather than on a site-by-site basis, taking into account how development and land cover in one part of the watershed will affect stormwater runoff in all other parts of the watershed. Consistent with Act 167, the plan 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 ground water and ground water recharge areas.

The plan also seeks to address serious water quality problems that are noted in Section 3. The vast majority of the watershed's streams are considered impaired according to water quality reports prepared by the Department of Environmental Protection. Through implementation of the stormwater improvements recommended in Section 6 and Appendix C, the plan will simultaneously reduce flooding, erosion and sedimentation, and improve water quality.

The final plan offers a highly analytical approach to the Act 167 planning process that incorporates detailed watershed scale hydrologic modeling. While all study elements required for an Act 167 study were completed as listed in Table 1.1, the study team expanded the analytical work to include the evaluation of alternative stormwater improvements to determine their effectiveness in reducing runoff and improving water quality. They are listed in Section 6. As this watershed is highly urban and largely "built-out," we concentrated much of our research on identifying opportunities for retrofitting existing stormwater facilities and finding locations for new Stormwater Control Measures , or SCMs, in areas that are not currently served by stormwater facilities. Restoration of riparian stream buffers is recommended as an opportunity to address the goal of preserving and restoring flood carrying capacity of streams. We strongly endorse the use of stormwater SCMs as the preferred means to achieve improved water quality, groundwater recharge and retention, stream bank protection, and volume control. The implementation of these retrofits and new SCMs in conjunction with regulation of new development and redevelopment through new stormwater ordinances will reduce stormwater problems in the Wissahickon Creek Watershed. The plan encourages municipalities to construct the stormwater improvements over a ten-year period. The various improvements are assigned a priority according to their cost-effectiveness and capture potential, and municipalities can use this ranking as a basis for funding projects.

The final plan presents criteria and standards for new development and redevelopment in Section 5 and a model ordinance in Appendix A. 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 the municipalities adopt the model ordinance in its entirety as part of its zoning regulations. If the municipality lies in more than one watershed, the applicable criteria and standards should be identified for the different watersheds.

The Wissahickon Act 167 Stormwater Management Plan includes the Sandy Run Watershed as a component of the plan. A draft Act 167 plan for the Sandy Run Watershed was completed in 2010, but not adopted by Montgomery County or the Pennsylvania Department of Environmental Protection. The draft plan was evaluated by the research team as part of the planning process. The Wissahickon Plan updates the modeling and engineering for the Sandy Run Watershed and this new information and recommendations are included in this plan.

The Wissahickon Plan was prepared by Temple University's Center for Sustainable Communities (CSC) and NTM Engineering, Inc. The plan was funded by the Philadelphia Water Department and prepared in consultation with municipalities located in the watershed, working through a Watershed Plan Advisory Committee (WPAC) comprised of municipal officials and other interested parties. The plan provides uniform technical standards and criteria throughout the watershed for the management of stormwater runoff from new land development and redevelopment sites.

The plan consists of seven sections and four appendices:

Section 1:	Wissahickon Watershed Location
Section 2:	Watershed Characteristics and Runoff
Section 3:	Stormwater Problems
Section 4:	Model Development and Application
Section 5:	Criteria and Standards for New Development
Section 6:	Stormwater Improvements
Section 7:	Plan Implementation
Appendix A:	Model Ordinance
Appendix B:	Hydrologic Model Parameters and Release Rates
Appendix C:	Recommended Improvements
Appendix D:	Wissahickon Watershed Culverts

The Project Team and members of the Water Plan Advisory Committee follow. The team expresses its appreciation to Joanne Dahme, Marc Cammarata, and Sue Patterson of the Philadelphia Water Department for their oversight and technical support, and to Paul Racette of the Pennsylvania Environmental Council for his coordination of the work of the WPAC.

Project Team

Project Directors

Jeffrey Featherstone, Ph.D., Director, Center for Sustainable Communities, and Professor, Department of Community and Regional Planning

Paul DeBarry, PE, D.WRE, Project Manager, Water Resources, NTM Engineering, Inc.

Temple Faculty, Research Fellows, and Staff

Manahel Awda, Ph.D., Adjunct Professor, Department of Civil and Environmental Engineering:
Hydrologic and Hydraulic Modeling
Richard Fromuth, P.E., C.R.P., Research Fellow, Center for Sustainable Communities:
Editing, Modeling Supervision, Stormwater Assessment
Md Mahbubur R. Meenar, Ph.D., Center for Sustainable Communities:
GIS and Mapping
Susan Spinella, M.S., Center for Sustainable Communities:
Budgeting and Administration

NTM Engineering

Bethany Kavulich, PE, Engineer
Jeff McKay, PE, Principal
Tamara Monaghen, Accounting Manager
Dylan Shannon, PE, Engineer
John Yamashita, PE, Engineer

Graduate Student Assistants

Christopher Basse, Andrew Pennington, Thomas Spokas, David Swedkowski

Water Plan Advisory Committee Members

Drew Gilchrist, DCNR-SE PA
Allison Hastings, Delaware Valley Regional Planning Commission
Maggie Allio, Philadelphia Water Department
Amy Montgomery, B & J Engineers
Bob Baker, Montgomery Township EAC
Kaitlyn Bendik, Environmental Protection Agency
Bryan Havir, Cheltenham Township
Bruce Jones, Ambler Borough
Barry Lewis, Greentreks
Robert Adams, Wissahickon Valley Watershed Association
Bob Harries, Friends of Wissahickon
Chuck Bailey, Springfield Township
David Burke, PA Dept. of Environmental Protection
Donald Berger, Springfield Township
David Dodies, Upper Moreland Township
Dennis Pennington, Wissahickon Valley Watershed Association

Dulcie Flaharty, Montgomery County Lands Trust
Desiree Henning-Dudley, Pennsylvania Dept. of Environmental Protection
Bruce Shoupe, Montgomery Township
David Mrochko, Whitpain Township
Douglas Blazey, Elliot, Greenleaf & Siedzikowski
Drew Shaw, Montgomery County Planning Commission
Dan Shinskie, Lansdale Borough
Jennifer Sherwood, Abington Township EAC
E.J. Lee, Whitemarsh Township
Jeffrey Featherstone, Temple Center for Sustainable Communities
Frank Browne, Fxbrowne
Greg Klucharach, Whitpain Township
Bob Gutowski, Morris Arboretum
James Blanch, Whitpain Township
John Interrante, Environmental Engineering & Management Association
Jon Lesher, Montgomery County Planning Commission
Joanne Dahme, Philadelphia Water Department
John Nystedt, Delaware River Keeper Network
Deborah Shreero, Whitemarsh Township EAB
Krista, Heinrich, T & M Associates
Timi Kirchner, Lansdale Borough
Larry Comunale, Lower Gwynedd Township
Tiffany Ledesma Groll, Philadelphia Water Department
Lawrence Gregan, Montgomery Township
Lonnie Manai, Montgomery Township
Leonard. Perrone, Upper Gwynedd Township
Michele Fountain, CKS Engineers
Mary Aversa, Ambler Borough
Lee Mangan, Worcester Township
Maura McCarthy, Friends of the Wissahickon
Susan McDowell, EPA
Sister Mary Elizabeth Clark, Chestnut Hill College Earth Center
Mahbubur Meenar, Temple Center for Sustainable Communities
Mark Hintenlang, Upper Dublin Township
Mark Hudson, Horsham Township
Mike Weilbacher, Schuylkill Center for Environmental Education
Michael Lefevre, Abington Township
Nathan Walker, AMEC
Nathan Dysard, North Wales Borough
Liz Ottinger, Environmental Protection Agency
Paul DeBarry, NTM Engineering
Goetz Phillips, Philadelphia University School of Architecture
Paul Leonard, Upper Dublin Township
Paul Racette, Pennsylvania Environmental Council

Patrick Starr, Pennsylvania Environmental Council
Richard Breitenstein, Pennsylvania Dept. of Environmental Protection
Richard Fromuth, Temple Center for Sustainable Communities
Richard Mellor, Whitemarsh Township
Robert Cavett, Merck & Company, Inc.
Robert Leber, Abington Township
Ronald Ayres, Wissahickon Restoration Volunteers
Roman Pronczak, Whitpain Township
Stacy Crandell, Montgomery Township
Susan Harris, Montgomery County Conservation District
Stanley Ropski, Upper Dublin Township EPAB
Scott Marlin, Abington Township
Stephen Brown, Dow Chemical Company
Susan Johnsson, Ambler EAC
Susannah Beckett, Wissahickon Restoration Volunteers
Susan Curry, Ambler Borough EAC
Tracy Beerley, Morris Arboretum
Thomas Spokas, Temple Center for Sustainable Communities
Mr. William Witmer, Philadelphia Parks & Recreation
William Walker, Horsham Township

Table i.1 Required Contents of Watershed Storm Water Plans Under Sections 5(b) and 5(c) of Act 167

Required Elements Under Section 5(b)	Location in Wissahickon Plan
(1) A survey of existing runoff characteristics in small as well as large storms, including the impact of soils, slopes, vegetation and existing development;	Section 2
(2) A survey of existing significant obstructions and their capacities;	Section 3, Appendix D
(3) An assessment of projected and alternative land development patterns in the watershed, and the potential impact of runoff quantity, velocity and quality;	Section 2
(4) An analysis of present and projected development in flood hazard areas, and its sensitivity to damages from future flooding or increased runoff;	Section 2, Section 3
(5) A survey of existing drainage problems and proposed solutions;	Section 3, Section 6, Appendix C
(6) A review of existing and proposed storm water collection systems and their impacts;	Section 2
(7) An assessment of alternative runoff control techniques and their efficiency in the particular watershed;	Section 6, Appendix C
(8) An identification of existing and proposed State, Federal and local flood control projects located in the watershed and their design capacities;	Section 4, Section 6, Appendix C
(9) A designation of those areas to be served by storm water collection and control facilities within a ten>year period, an estimate of the design capacity and costs of such facilities, a schedule and proposed methods of financing the development, construction and operation of such facilities, and an identification of the existing or proposed institutional arrangements to implement and operate the facilities;	Section 6, Section 7, Appendix C
(10) An identification of flood plains within the watershed;	Section 3
(11) Criteria and standards for the control of storm water runoff from existing and new development which are necessary to minimize dangers to property and life and carry out the purposes of this act;	Section 5, Appendix A
(12) Priorities for implementation of action within each plan; and	Section 6, Section 7
(13) Provisions for periodically reviewing, revising and updating the plan.	Section 7

Table i.1 Continued

Required Elements Under Section 5(c)	Location in Wissahickon Plan
(1) contain such provisions as are reasonably necessary to manage storm water such that development or activities in each municipality within the watershed do not adversely affect health, safety and property in other municipalities within the watershed and in basins to which the watershed is tributary; and	Section 5, Appendix A
(2) consider and be consistent with other existing municipal, county, regional and State environmental and land use plans.	Section 5, Section 7, Appendix A

Section 1: Watershed Location and Setting

The Wissahickon Creek Watershed is located in southeastern Pennsylvania. It covers 64 square miles and includes a population of approximately 221,000 people (2010 Census). The watershed includes the 1,400 acre Wissahickon Valley Park, part of the Fairmont Park system within the City of Philadelphia; Fort Washington State Park in Montgomery County; 1,200 acres of protected land and 21 miles of trails in Montgomery County protected under stewardship of the Wissahickon Valley Watershed Association; as well as many smaller municipal parks and preserves.

The watershed lies within the lower Delaware River Basin and discharges to the Schuylkill River in the City of Philadelphia. Most of the watershed is located in Montgomery County, with approximately 16 percent located in Philadelphia County (Figure 1.A). A total of 16 municipalities lie either all or partially within the watershed. The population of those municipalities is provided in Table 1.A, along with the percentage of the watershed draining each municipality.

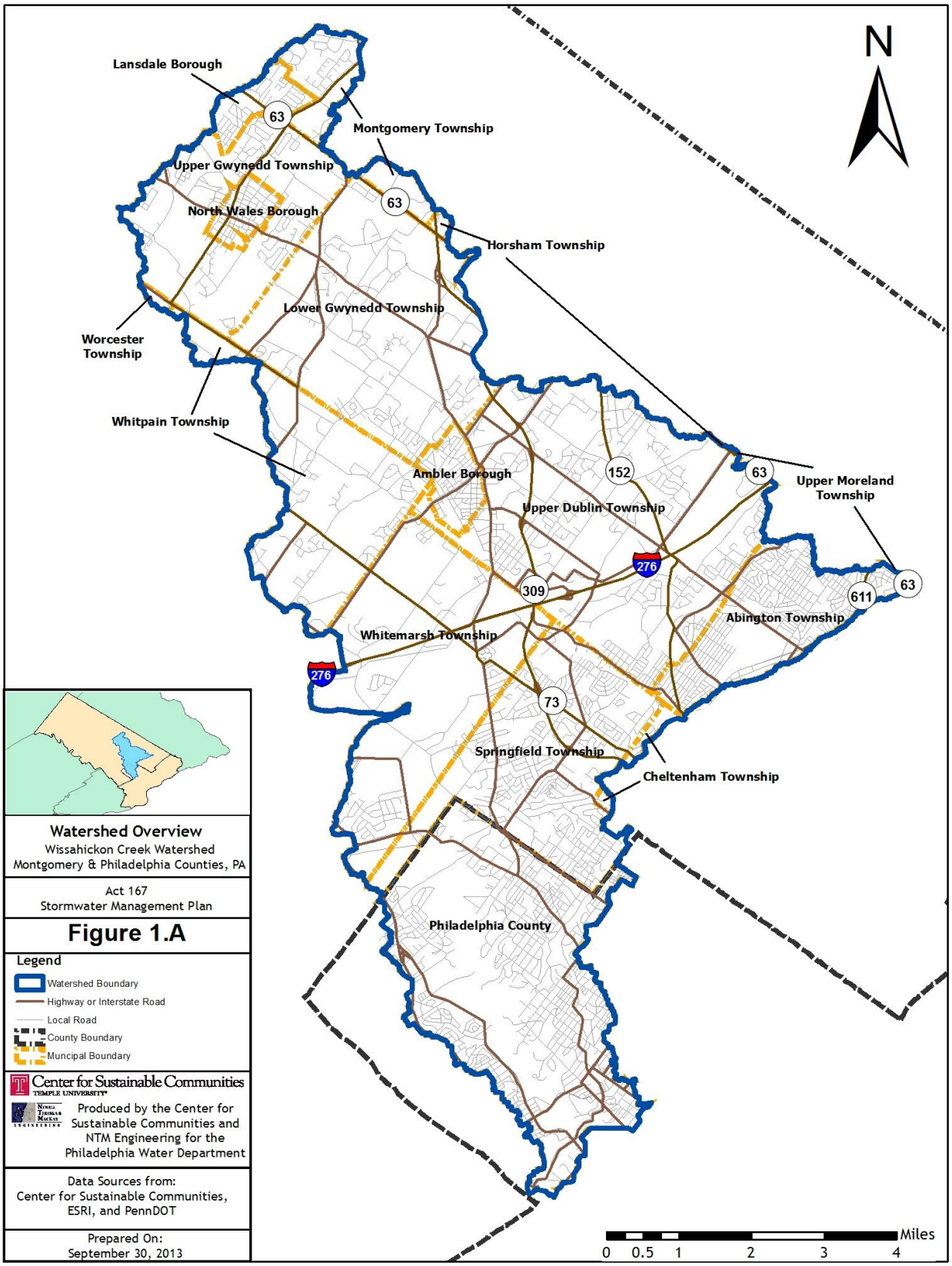
Table 1.A Population by Municipality

2010 Population by Municipality			
Municipality	2010 Census	Municipality % in Watershed	2010 Population in Watershed
Abington Township	55,310	22.94%	12,687
Ambler Borough	6,417	100.00%	6,417
Cheltenham Township	36,793	1.39%	514
Horsham Township	26,147	0.56%	147
Lansdale Borough	16,269	23.65%	3,848
Lower Gwynedd Township	11,405	88.29%	10,069
Montgomery Township	24,790	14.01%	3,473
North Wales Borough	3,229	100.00%	3,229
Philadelphia County	1,526,006	7.34%	112,075
Springfield Township	19,418	94.57%	18,364
Upper Dublin Township	25,569	90.30%	23,090
Upper Gwynedd Township	15,552	61.86%	9,622
Upper Moreland Township	24,015	0.29%	70
Whitemarsh Township	17,349	56.38%	9,782
Whitpain Township	18,875	41.68%	7,868
Worcester Township	9,750	0.64%	63

The Wissahickon Creek watershed contains approximately 115 miles of defined streams and tributaries.[1] Figure 1.B shows the main stem and major tributaries within the watershed. The flow regimen and the interrelationships between surface and groundwater are affected by geology, land cover, topography, and climate. They are also a product of development and other human activities within the basin. The bedrock geology is highly diverse and the watershed is underlain by 14 different rock formations.[2] More than half of the watershed, generally the area north of the Pennsylvania Turnpike, is composed of sedimentary rocks of the Lockatong and Stockton shales. Within the City of Philadelphia, the Wissahickon formation is the dominant geology, and is a combination of sedimentary and igneous rocks. Each of the numerous rock formations has a different set of physical characteristics including texture, mineral composition, hardness, and permeability, which affect the way in which they weather and decompose, and the differences in the soils and terrains that develop over them. These factors combine with human induced changes in land cover and water management to influence the ways in which water enters and moves through the stream network. Consequently, the hydrologic regimen of the Wissahickon Creek and its tributaries varies greatly within the larger watershed.

[1] *Wissahickon Creek Watershed Comprehensive Characterization Report, City of Philadelphia Water Department, 2007*

[2] *Pennsylvania Bureau of Topographic and Geologic Survey, Pennsylvania Department of Conservation and Natural Resources, 2001.*


N
Lansdale Borough
63
Montgomery Township
Upper Gwynedd Township
North Wales Borough
63
Horsham Township
Lower Gwynedd Township
Worcester Township
Whitpain Township
Ambler Borough
152
63
Upper Moreland Township
Upper Dublin Township
276
309
611
63
Abington Township
Whitemarsh Township
276
73
Springfield Township
Cheltenham Township
Philadelphia County
Watershed Overview
Wissahickon Creek Watershed
Montgomery & Philadelphia Counties, PA
Act 167
Stormwater Management Plan
Figure 1.A
Legend
Watershed Boundary
Highway or Interstate Road
Local Road
County Boundary
Muncipal Boundary
Center for Sustainable Communities
TEMPLE UNIVERSITY
Produced by the Center for Sustainable Communities and NTM Engineering for the Philadelphia Water Department
Data Sources from:
Center for Sustainable Communities, ESRI, and PennDOT
Prepared On:
September 30, 2013
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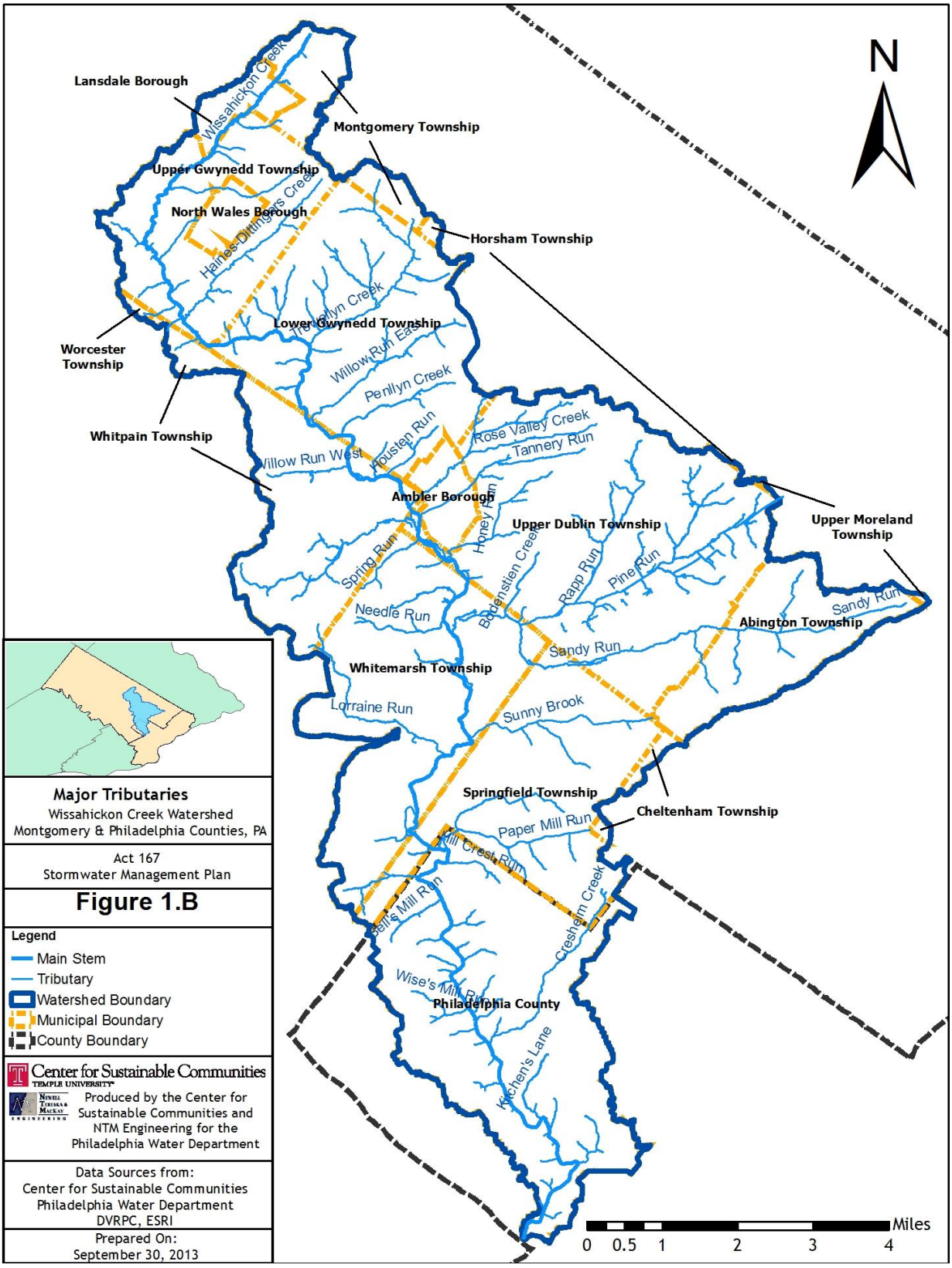

Major Tributaries
Wissahickon Creek Watershed
Montgomery & Philadelphia Counties, PA

Act 167
Stormwater Management Plan

Figure 1.B

Legend
- Main Stem
- Tributary
- Watershed Boundary
- Municipal Boundary
- County Boundary

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Newell Tiriska & MacKay ENGINEERING
Produced by the Center for Sustainable Communities and NTM Engineering for the Philadelphia Water Department

Data Sources from:
Center for Sustainable Communities
Philadelphia Water Department
DVRPC, ESRI

Prepared On:
September 30, 2013

Section 2: Watershed Characteristics and Runoff

The hydrology of the Wissahickon Creek and its tributaries varies greatly from place to place within the larger watershed. Stormwater management planning must take numerous surface features into account, including topography, soils, land use, and impervious cover, as well as existing stormwater collection and discharge. This section describes the primary factors defining the storm runoff in the watershed. In addition, because of the close linkage between land cover and runoff, an analysis of land development alternatives to meet projected future growth is provided.

2.1 Precipitation

For the 30 year period from 1981 to 2010, precipitation at the National Weather Service (NWS) rain gage at Springhouse, PA, in the north-central portion of the Wissahickon Watershed averaged 47.4 inches.[1] Similar annual totals were recorded for NWS stations near the watershed at Norristown (48.4 inches) and Conshohocken (48.7 inches). Additionally, a water budget analysis performed by the U.S. Geological Survey for the period 1987-1998 reported an average annual total for the watershed of 47.2 inches.[2] This annual total, however, is not uniformly distributed over time, and extreme events can produce 8 inches of rain or more in a single day. Flood events occur at any time of year, and may be caused by different types of weather events including severe thunderstorms, tropical storms, or even colder weather events when heavy rains can combine with snowmelt. Rainfall during individual storms is generally not distributed evenly across the watershed, and rarely occurs at a constant rate. Because of its location immediately northwest of the Coastal Plain, the watershed is vulnerable to heavy rainfall from tropical weather events. Damaging tropical storms in recent years have included Floyd (1999), Allison (2001), Ivan (2004), Irene (2011), and Lee (2011).

Table 2.1.A lists design rainfall totals that have been applied to the hydrologic analyses in this study. The design events are based on the PennDOT Intensity-Duration-Frequency (IDF) data for regions in Pennsylvania. This data was developed from the latest NOAA Atlas 14 precipitation frequency data. The precipitation totals for the various design events are weighted averages because the Wissahickon Watershed is situated at the boundary of PennDOT IDF Regions 4 and 5. Approximately 40% of the Wissahickon Watershed is in Region 4 and 60% in Region 5.

In terms of probability, the meaning of design storm frequency is as follows: a 5-year event would have a 20 percent chance of occurring in a given year; a 10-year event would have a 10 percent chance of occurring in a given year, etc. The rainfall totals in the table provide a means of predicting the magnitude of storms for planning and design purposes. They are a statistical product based on the population of events that have occurred in the past. They are not predictive of the timing or sequence of individual storm events or their rainfall distribution in the watershed. For example, the extreme precipitation events caused by tropical storms Floyd and Allison occurred less than two years apart.

In addition to total rainfall, the timing of rain during an event affects peak runoff rates. The design storms applied in this study include a period of heavy rain in the middle of the event. This is done

[1] NOAA, National Climatic Data Center, 1981-2010 Normals Data Access, http://www.ncdc.noaa.gov/land-based-station-data/climate-normals/1981-2010-normals-data.

[2] Sloto, R. A., and Buxton, D. E., Scientific Investigations Report 2005-5113, U.S. Geological Survey, 2005.

to mimic the flashy runoff conditions that are usually a part of flood events in watersheds the size of the Wissahickon and its tributaries. Additionally, the same rainfall total and timing of rain is applied to the entire watershed simultaneously in the modeling. While this does not replicate any single historic event, it provides a means of evaluating the watershed under a range of runoff conditions and gives a measure of the effectiveness of potential stormwater improvements.

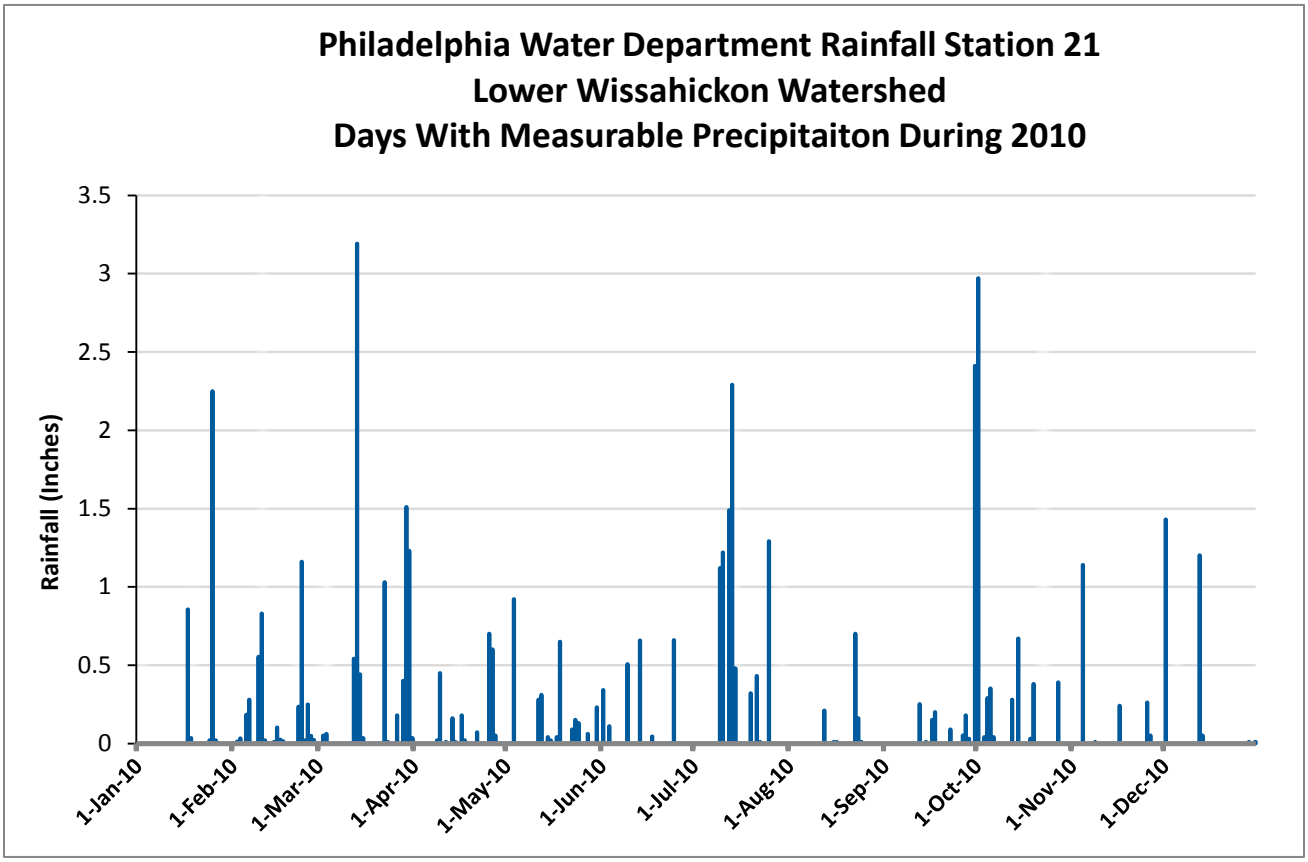
Although extreme storm events trigger the most damaging flooding in the Wissahickon Watershed, most storms produce less than one inch of rainfall. These smaller storms produce a significant portion of annual runoff. For this reason, stormwater management measures designed for infiltration or extended detention of these smaller runoff events are effective in reducing non-point pollution loadings and stream erosion. Daily precipitation data for 2010 at the Philadelphia Water Department's rain gage No. 21 in the lower portion of the Wissahickon Watershed is presented in Figure 2.1.A. Of the 69 days when more than 0.1 inch of precipitation occurred, only 16 (23 percent) produced total rainfall exceeding one inch.

Table 2.1.A Rainfall Totals for 24-Hour Design Storms

Based on PennDOT Intensity-Duration-Frequency (IDF) data for Regions 4 and 5 in Pennsylvania.

Storm Frequency	Total Precipitation (in)
1-Yr	2.75
2-Yr	3.30
5-Yr	4.10
10-Yr	4.80
25-Yr	5.90
50-Yr	6.91
100-Yr	8.11
500-Yr	11.83

Figure 2.1.A Precipitation Events in the Wissahickon Watershed



2.2 Surface Features

The Wissahickon Watershed is characterized by gently rolling terrain in the headwaters, a moderately sloping valley in the central part of the watershed, and the relatively steep terrain of Wissahickon Valley Park in the lower watershed. The elevations over the watershed range from 12 feet at the mouth of Wissahickon Creek in Philadelphia to 488 feet in Montgomery and Upper Gwynedd Townships. Portions of Roxboro and Chestnut Hill in Philadelphia have elevations of over 400 feet, as well as sections of Cheltenham, Montgomery, and Springfield Townships and North Wales and Lansdale Boroughs.

Figure 2.2.A provides a graphical presentation of elevation from a Digital Elevation Model or DEM. The DEM was created from 2008 LIDAR flown for the PAMAP program of the Pennsylvania Department of Conservation and Natural Resources, and was downloaded from the Pennsylvania Spatial Data Access website.[3] It includes high resolution, high quality data with two-foot contours.

Based on their runoff characteristics, soils of the U.S. are classified by the Natural Resource Conservation Service (NRCS) into four hydrologic groups A, B, C, D. Group A soils have low runoff potential with high infiltration rates, while Group D soils have high runoff with very slow infiltration

[3] Pennsylvania State Data Access, Penn State Institutes of Energy and the Environment, Penn State University

rates. The other two groups are in between. Runoff characteristics of various land uses vary with the underlying hydrologic soil group designation, and information on the location of hydrologic soils groups was used in the hydrologic modeling for this study. As noted on Figure 2.2.B, hydrologic soils in the Wissahickon Watershed are predominately groups B and C with some D soils.

Group B soils have moderate infiltration rates even when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well drained to well drained soils with moderately fine to moderately coarse textures.

Group C soils have slow infiltration rates even when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures.

Group D soils have the slowest infiltration rates of the four groups. Movement of water through this soil type is highly restricted due to the soil composition which generally more than 40 percent clay. All soils with a water table within 2 feet of the surface are included in Group D.[4]

Soil erodibility in the Wissahickon Watershed is depicted in Figure 2.2.C. Soil erodibility in the watershed ranges from slight in most upland areas to severe in riparian areas along the lower main stem of the Wissahickon Creek in the City of Philadelphia.

Current land use in the Wissahickon Watershed is shown in Figure 2.2.D. The watershed has been heavily developed with residential use, and includes areas of commercial and manufacturing use along with highway and rail corridors. Despite the high degree of development, lands in Wissahickon Valley Park in Philadelphia and lands preserved through efforts of the Wissahickon Valley Watershed Association have preserved long reaches of the main stem stream corridor as open space. Had these lands been developed to the degree of many other riparian stream reaches in urban areas, the flood damage potential would be much higher.

As of 2005, approximately 46 percent of the Wissahickon Watershed was in single-family residential use, with an additional 5 percent used for multi-family residences. Commercial and industrial use comprised 3 percent and 1 percent of the watershed, respectively. Parking to support commercial, residential and community activities comprised an additional 3 percent of the land use. Woodland covered 17 percent of the watershed, agriculture covered 7 percent , and recreational space occupied an additional 8 percent. The remaining land use (10 percent) was comprised of transportation, community services, water, utility operations, and vacant properties. A detailed analysis of alternative land use scenarios to meet projected future growth in the Wissahickon watershed is provided in Section 2.3. A summary of a hydrologic model evaluation of the two scenarios is presented in Section 4.

Taken together, the surface features of the Wissahickon Watershed, along with antecedent soil moisture conditions, define how it responds to rainfall. In order to provide more precise information about potential for flash flooding in small watersheds, the National Weather Services' Mount Holly Weather Forecast Office has conducted a GIS-based analysis of flash flood potential for its forecast area. The product of the analysis is the map shown in Figure 2.2.E, which shows

[4] U.S. Department of Agriculture, Natural Resources Conservation Service, National Engineering Handbook, Part 630 – Hydrology, Chapter 7, pp. 7-2-7-3.

relative flash flood potential in the Wissahickon Watershed based on digital data available for soils, slope, forest density, and land use. The map shows an index of the combined potential for these land-based parameters to generate flash flooding, with the highest index numbers representing the areas of highest flood potential. Comparison of this map with Figure 2.2.D shows the close agreement with flash flood potential and land uses associated with impervious cover. The map provides a good picture of the areas in the watershed that would be expected to generate the largest runoff volumes, and is consistent with the representation of surface conditions by the hydrologic model described in Section 4.

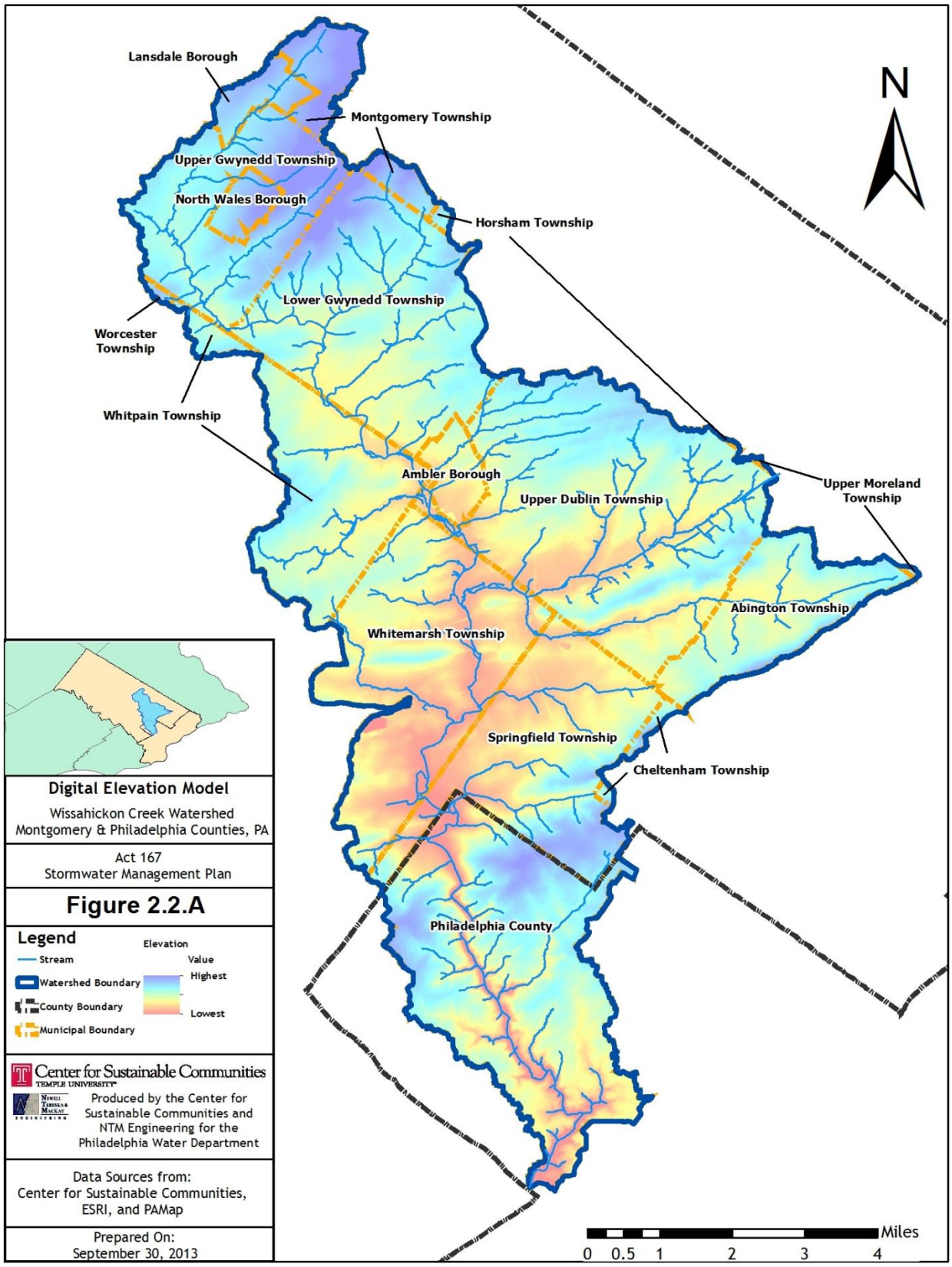
Once runoff occurs, constructed surface storage that intercepts and holds the runoff can delay flow and lower flood peaks. For this study, the Philadelphia Water Department provided an inventory with 185 existing detention basins in the watershed. This was supplemented by data collected by the CSC during field inspections of additional detention facilities and ponds. Figure 2.2.F shows the distribution of these facilities in the watershed. The majority are located in the upper half of the watershed where there has been more development subsequent to the implementation of stormwater management regulations. The storage provided by these facilities was estimated and totals for each modeled subbasin were included in the hydrologic model. The estimated total storage of all existing facilities is approximately 380 acre-feet. Most are local facilities designed to control site runoff from specific development sites. If spread over the entire area of the Wissahickon Watershed, this storage total amounts to the equivalent of 0.11 inches of runoff. Many existing facilities are not designed for extended detention, and runoff from smaller storms passes directly through the facility. These structures represent opportunities for retrofitting to provide additional storage and extended detention.

Stormwater collection, piping, and discharge through outfalls affect the pathway and timing of runoff in developed watersheds such as the Wissahickon. Stormwater collection systems are located in each of the municipalities in the Wissahickon Watershed. The collection systems are located primarily in the residential, commercial, and industrial areas served by curbed streets, and along arterial and secondary roadways. Although a detailed survey of stormwater piping was not conducted as part of this study, estimates of the extent of coverage were made based on field observations, orthophotography, land use data, and outfall and drainage shed data provided by the Philadelphia Water Department. Based on this information, it is estimated that stormwater collection systems of various capacities have been installed in approximately 60 percent of the Wissahickon Watershed.

The single largest land use category in the Wissahickon Watershed is single-family residential. In most residential areas, only a portion of the water falling on roofs and properties enters the street, and subsequently the storm inlets, depending on the slope of the property and gutter drainage onto the property. The remainder of roof and property drainage infiltrates into the soil, and as the soil becomes saturated, runoff flows at an increasing rate to the street or to other drainage basins offsite. As housing density increases, a larger proportion of each property's drainage enters storm inlets. In the developed sections of the watershed with curbed roadways, the roadways channel runoff to the storm inlets during smaller storm events, and become stormwater channels once runoff exceeds the capacity of the inlets and/or pipe capacities. Development alters the local runoff pathway, particularly for smaller storms, and the runoff to stream channels is often controlled by the location of stormwater inlets, piping, detention basins, and outfalls. This situation is depicted in Figure 2.2.G. For the portion of the watershed within the Philadelphia city limits, stormwater shed boundaries were used to delineate subareas for modeling, due to the modification of drainage

caused by streets, inlets and piping. The watershed boundaries and outfall locations also were used as guidance in delineating subareas outside of the City limits. A map showing outfall locations in the watershed is shown in Figure 2.2.H. In addition, an example of a municipal stormwater system map, with stormwater piping, inlet and outlet locations provided by Upper Dublin Township, is shown in Figure 2.2.I.

Based on the analysis of future land use presented in Section 2.3, and as shown on Figure 2.3.A, scattered areas of new residential and non-residential development are projected in each of the watershed's municipalities. Future stormwater collection modifications or expansions would be most likely in these areas.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Upper Gwynedd Township
North Wales Borough
Horsham Township
Lower Gwynedd Township
Worcester Township
Whitpain Township
Ambler Borough
Upper Dublin Township
Upper Moreland Township
Abington Township
Whitemarsh Township
Springfield Township
Cheltenham Township
Philadelphia County
N
Digital Elevation Model
Wissahickon Creek Watershed
Montgomery & Philadelphia Counties, PA
Act 167
Stormwater Management Plan
Figure 2.2.A
Legend
Stream
Watershed Boundary
County Boundary
Municipal Boundary
Elevation
Value
Highest
Lowest
Center for Sustainable Communities
TEMPLE UNIVERSITY
Produced by the Center for Sustainable Communities and NTM Engineering for the Philadelphia Water Department
Data Sources from:
Center for Sustainable Communities, ESRI, and PAMap
Prepared On:
September 30, 2013
Miles
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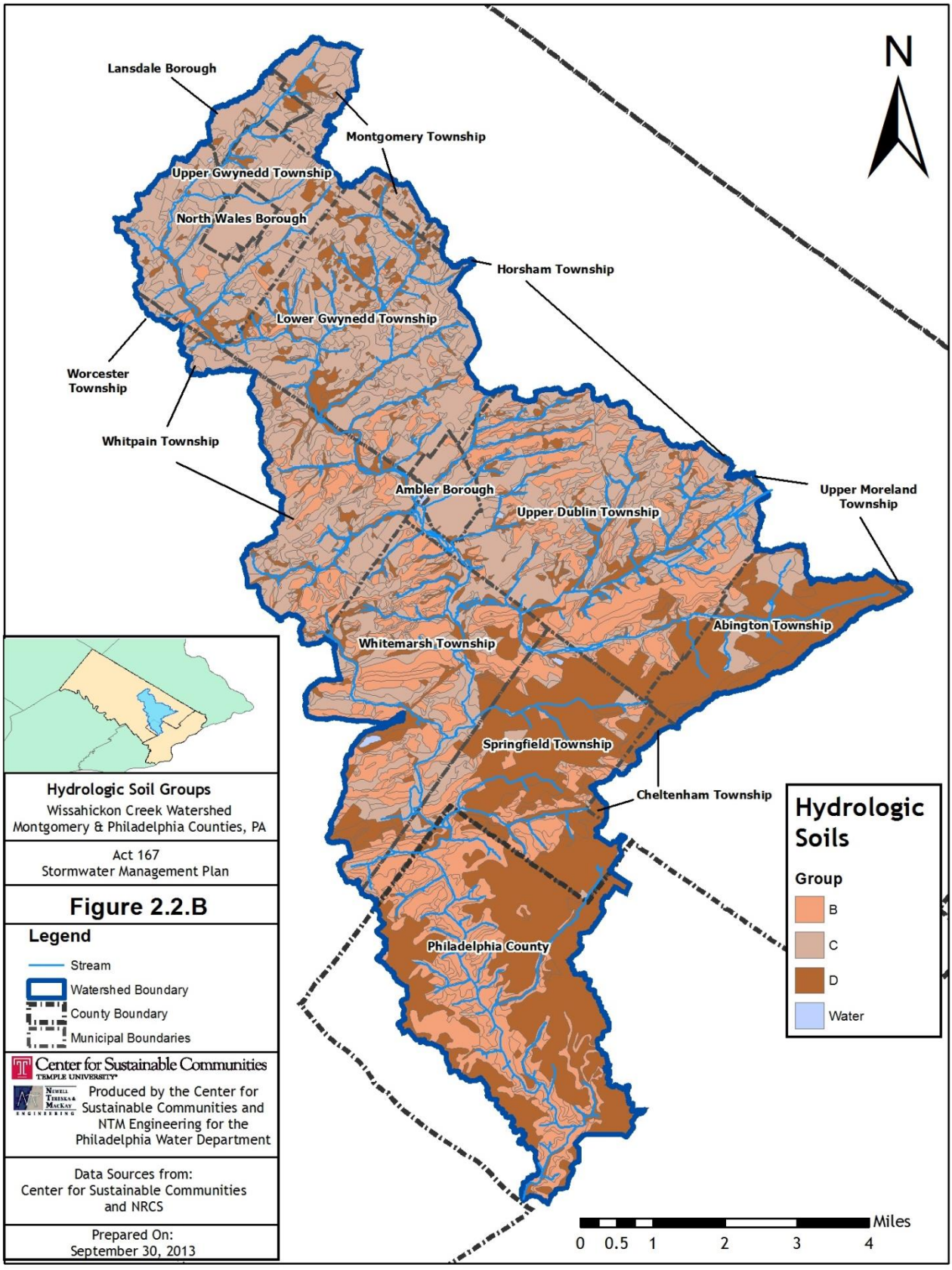
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Cheltenham Township
Philadelphia County
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Hydrologic Soil Groups
Wissahickon Creek Watershed
Montgomery & Philadelphia Counties, PA
Act 167
Stormwater Management Plan
Figure 2.2.B
Legend
Stream
Watershed Boundary
County Boundary
Municipal Boundaries
Center for Sustainable Communities
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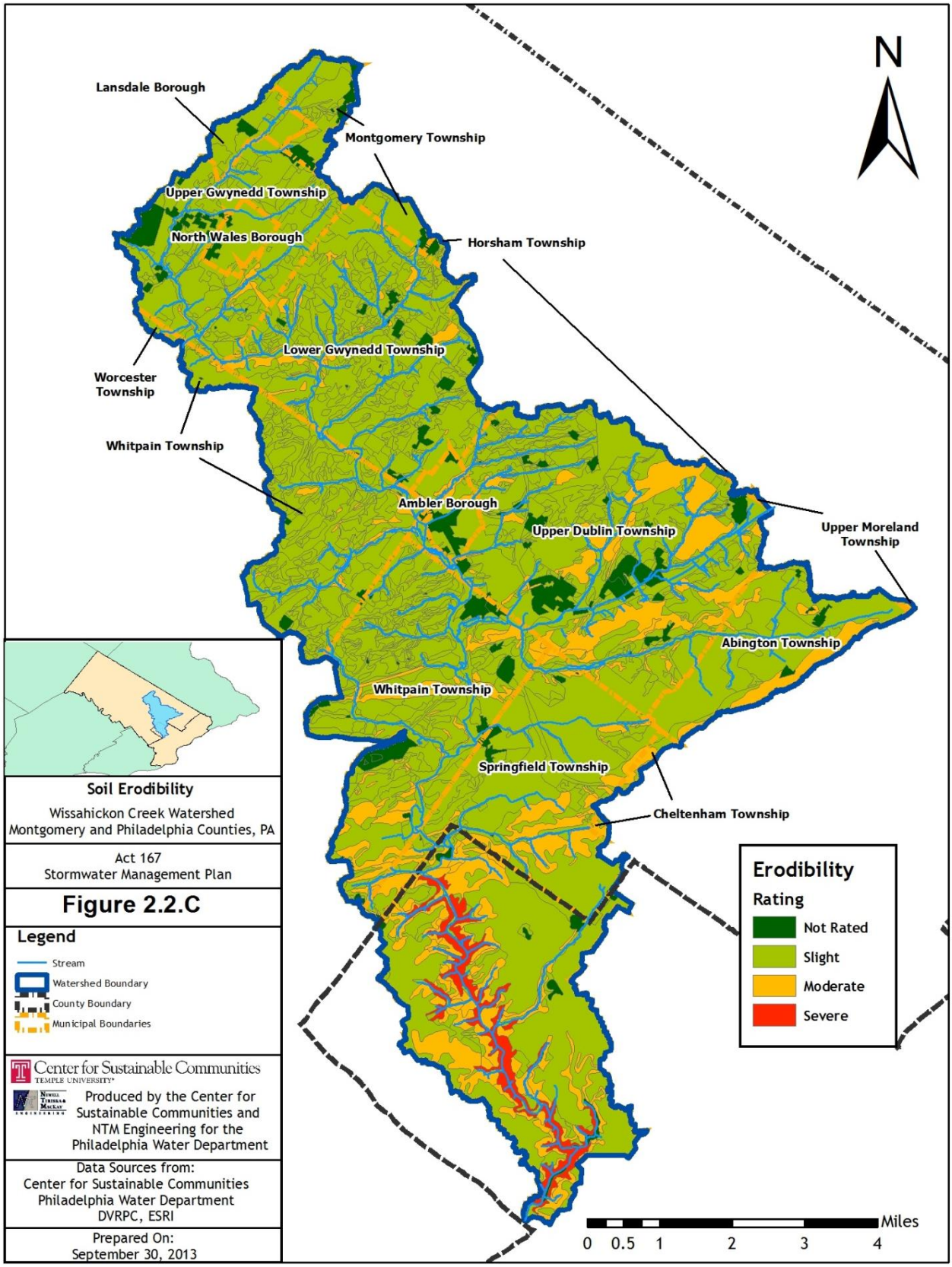
Produced by the Center for Sustainable Communities and NTM Engineering for the Philadelphia Water Department
Data Sources from:
Center for Sustainable Communities and NRCS
Prepared On:
September 30, 2013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Soil Erodibility
Wissahickon Creek Watershed
Montgomery and Philadelphia Counties, PA
Act 167
Stormwater Management Plan
Figure 2.2.C
Legend
Stream
Watershed Boundary
County Boundary
Municipal Boundaries
Center for Sustainable Communities
TEMPLE UNIVERSITY
Produced by the Center for Sustainable Communities and NTM Engineering for the Philadelphia Water Department
Data Sources from:
Center for Sustainable Communities
Philadelphia Water Department
DVRPC, ESRI
Prepared On:
September 30, 2013
Erodibility
Rating
Not Rated
Slight
Moderate
Severe
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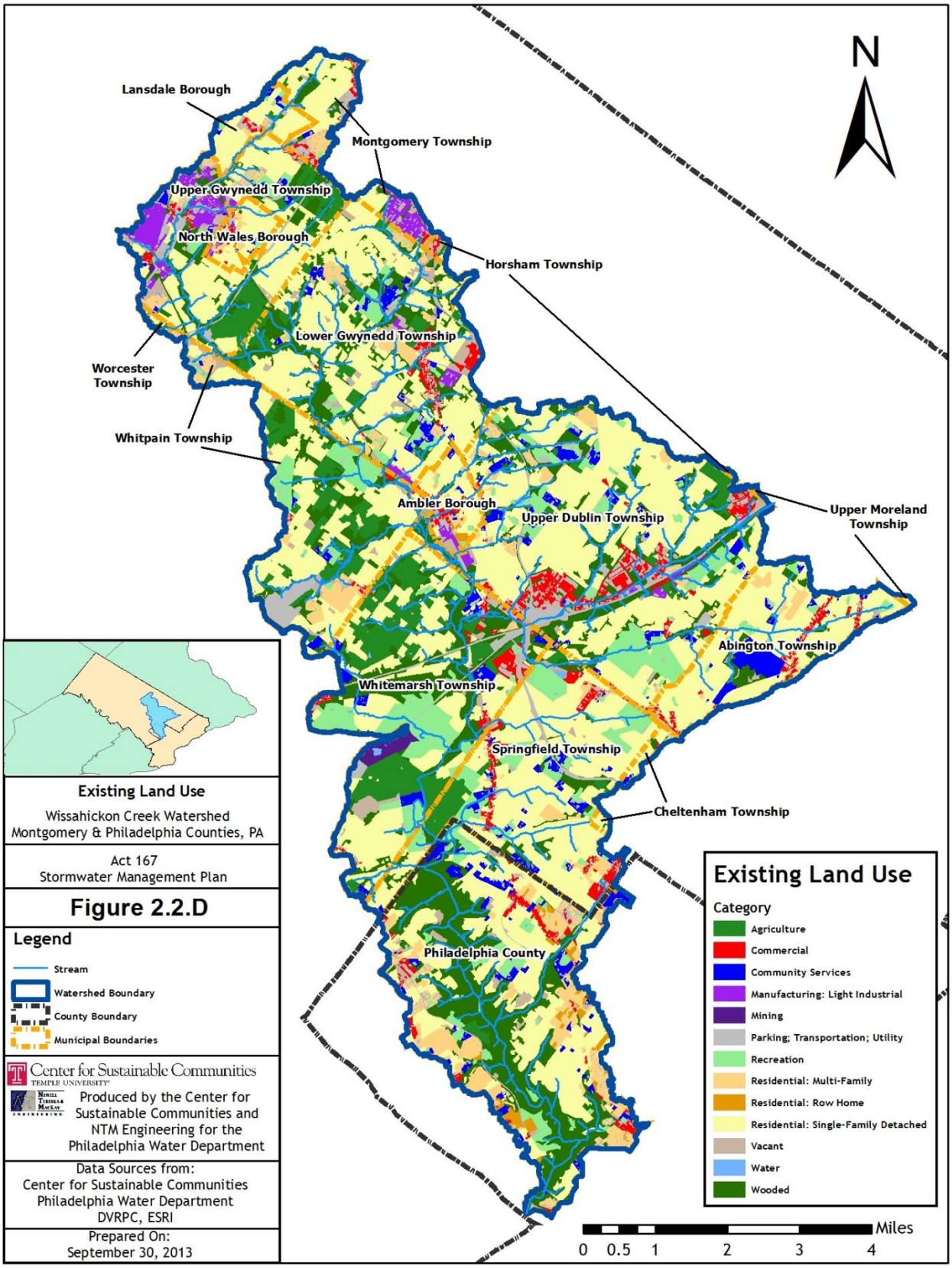
Miles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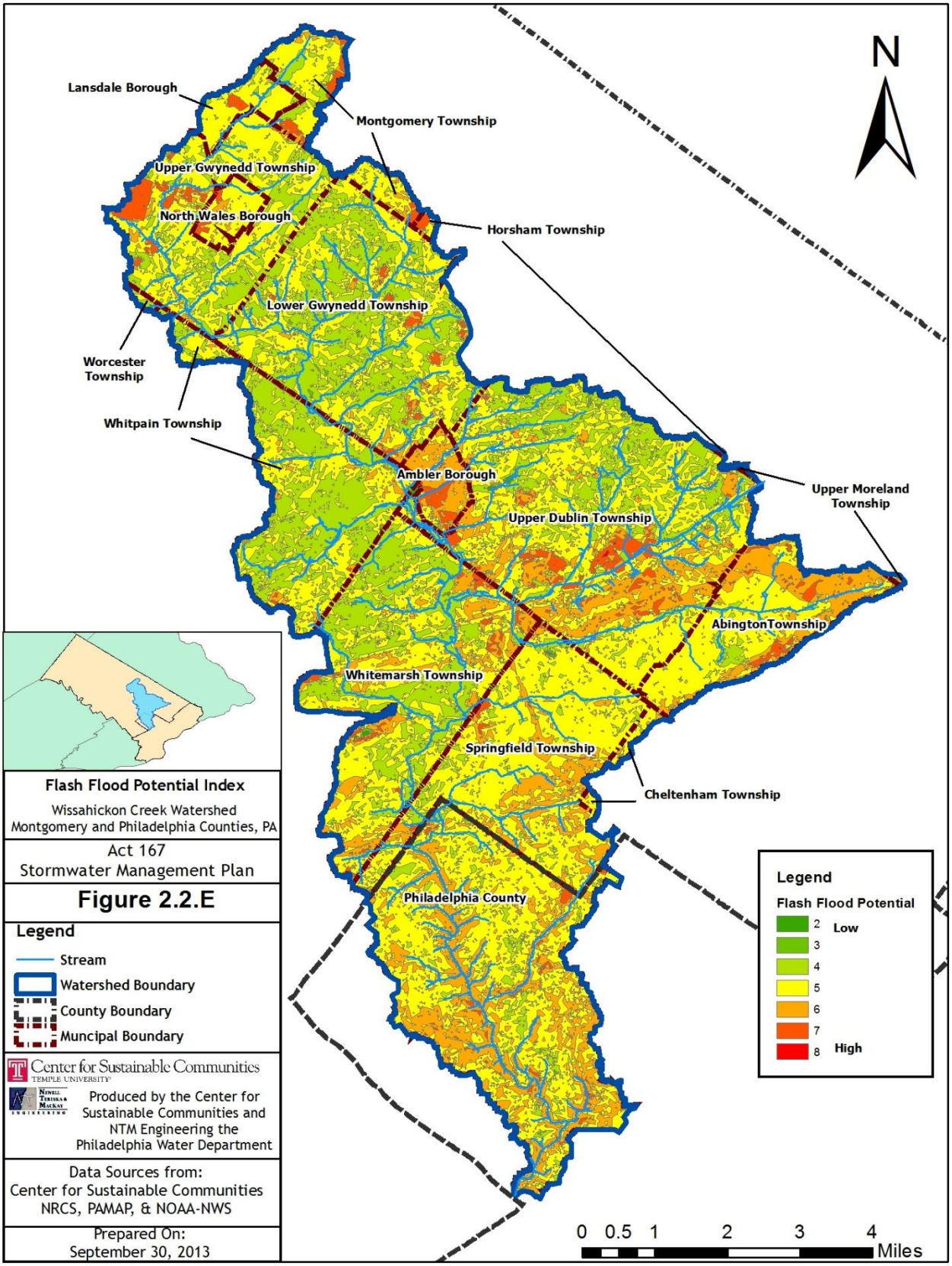
Whitpain Township
Ambler Borough
Upper Dublin Township
Upper Moreland Township
Abington Township
Whitemarsh Township
Springfield Township
Cheltenham Township
Philadelphia County
Existing Land Use
Wissahickon Creek Watershed
Montgomery & Philadelphia Counties, PA
Act 167
Stormwater Management Plan
Figure 2.2.D
Legend
Stream
Watershed Boundary
County Boundary
Municipal Boundaries
Center for Sustainable Communities
TEMPLE UNIVERSITY
Produced by the Center for Sustainable Communities and NTM Engineering for the Philadelphia Water Department
Data Sources from:
Center for Sustainable Communities
Philadelphia Water Department
DVRPC, ESRI
Prepared On:
September 30, 2013
Existing Land Use
Category
Agriculture
Commercial
Community Services
Manufacturing: Light Industrial
Mining
Parking; Transportation; Utility
Recreation
Residential: Multi-Family
Residential: Row Home
Residential: Single-Family Detached
Vacant
Water
Wooded
Miles
0 0.5 1 2 3 4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Horsham Township
Lower Gwynedd Township
Worcester Township
Whitpain Township
Ambler Borough
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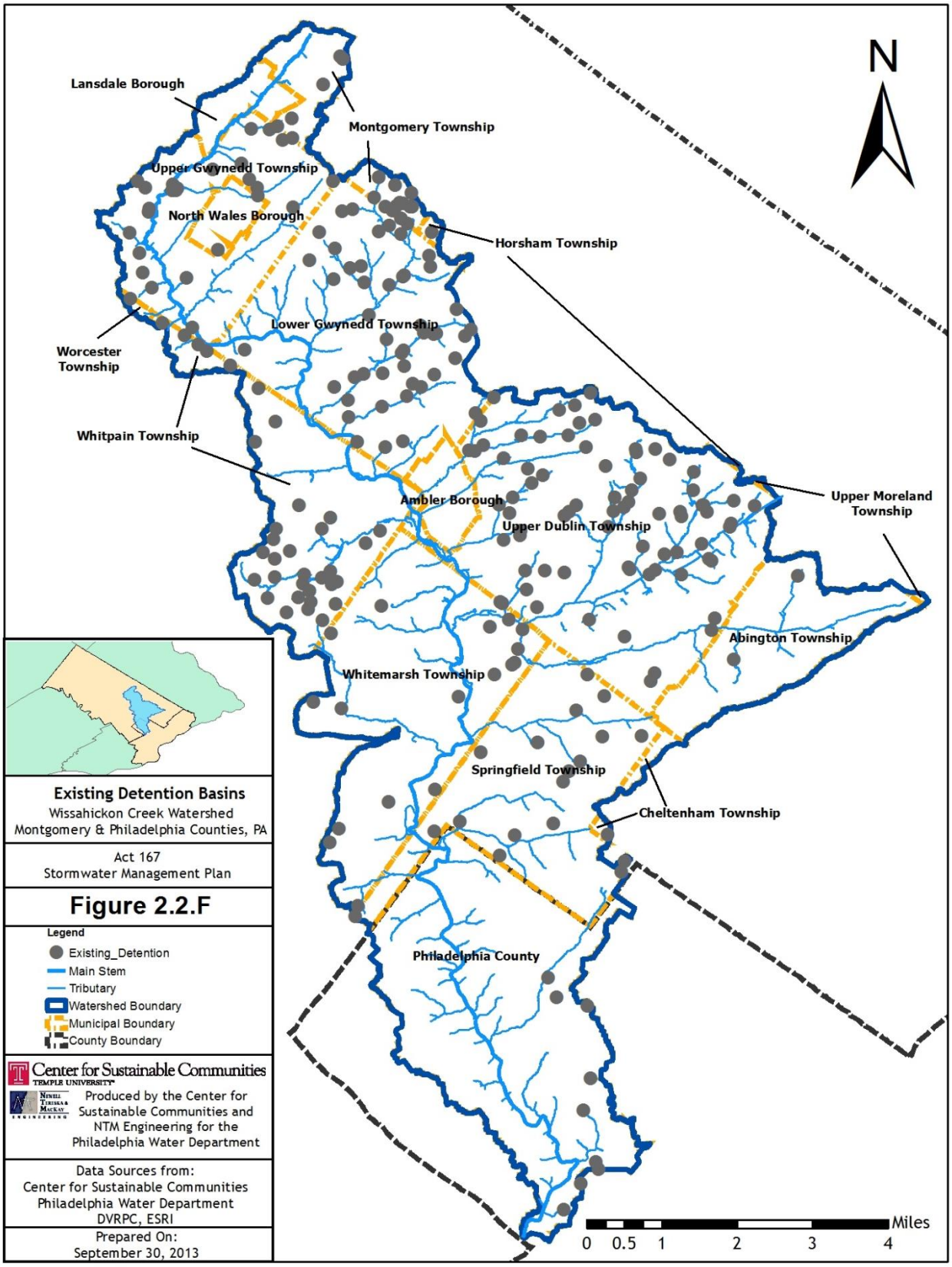
AbingtonTownship
Whitemarsh Township
Springfield Township
Cheltenham Township
Philadelphia County
Legend
Flash Flood Potential
2 Low
3
4
5
6
7
8 High
0 0.5 1 2 3 4 Miles
Flash Flood Potential Index
Wissahickon Creek Watershed
Montgomery and Philadelphia Counties, PA
Act 167
Stormwater Management Plan
Figure 2.2.E
Legend
Stream
Watershed Boundary
County Boundary
Muncipal Boundary
Center for Sustainable Communities
TEMPLE UNIVERSITY
Produced by the Center for Sustainable Communities and NTM Engineering the Philadelphia Water Department
Data Sources from:
Center for Sustainable Communities
NRCS, PAMAP, & NOAA-NWS
Prepared On:
September 30, 2013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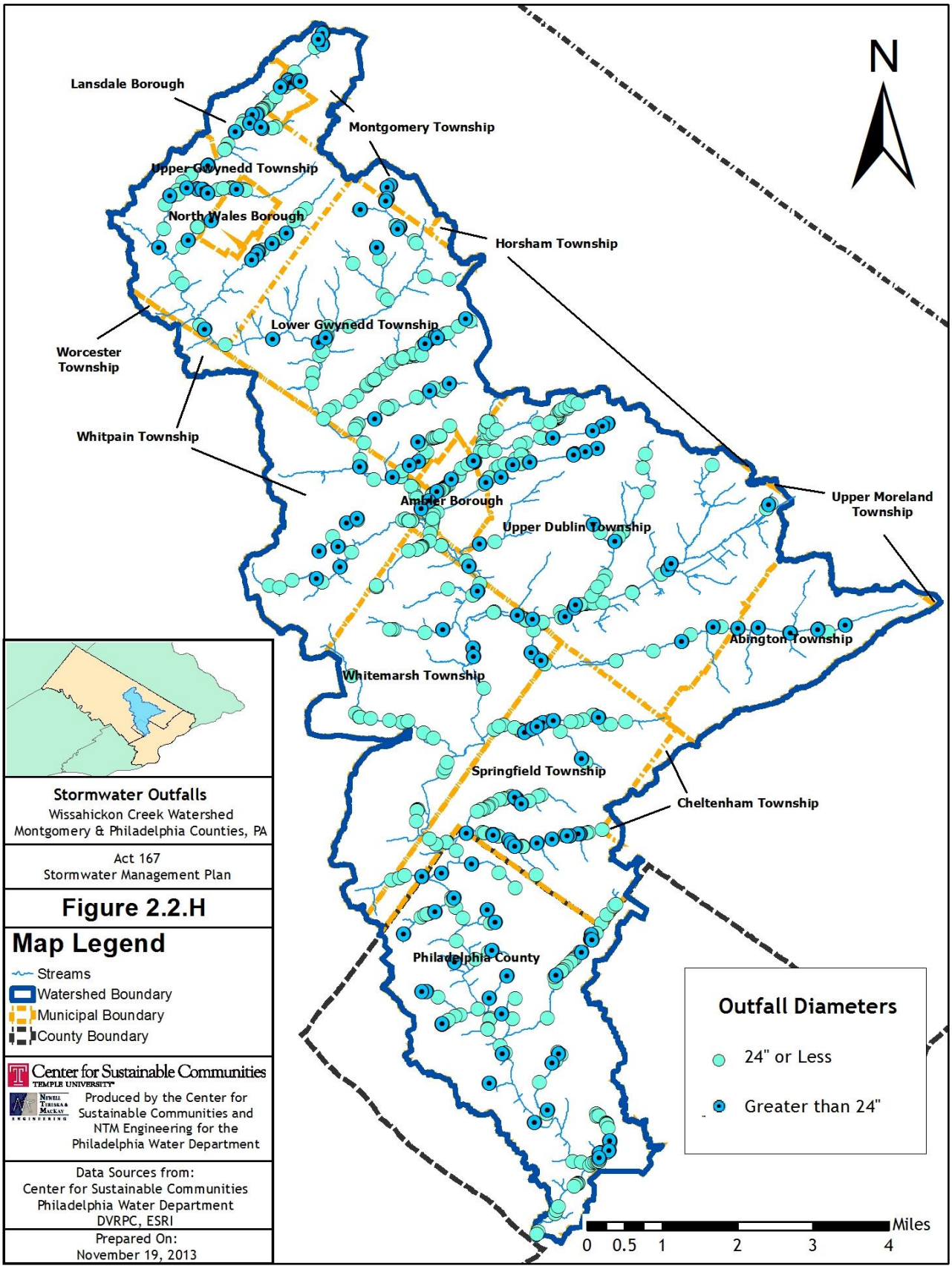
Ambler Borough
Upper Dublin Township
Abington Township
Whitemarsh Township
Springfield Township
Cheltenham Township
Philadelphia County
Existing Detention Basins
Wissahickon Creek Watershed
Montgomery & Philadelphia Counties, PA
Act 167
Stormwater Management Plan
Figure 2.2.F
Legend
Existing_Detention
Main Stem
Tributary
Watershed Boundary
Municipal Boundary
County Boundary
Center for Sustainable Communities
TEMPLE UNIVERSITY
Produced by the Center for Sustainable Communities and NTM Engineering for the Philadelphia Water Department
Data Sources from:
Center for Sustainable Communities
Philadelphia Water Department
DVRPC, ESRI
Prepared On:
September 30, 2013
0 0.5 1 2 3 4
Miles

Figure 2.2.G Stormwater Collection and Outfalls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North Wales Borough
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Ambler Borough
Upper Dublin Township
Abington Township
Whitemarsh Township
Springfield Township
Cheltenham Township
Philadelphia County
Stormwater Outfalls
Wissahickon Creek Watershed
Montgomery & Philadelphia Counties, PA
Act 167
Stormwater Management Plan
Figure 2.2.H
Map Legend
Streams
Watershed Boundary
Municipal Boundary
County Boundary
Center for Sustainable Communities
TEMPLE UNIVERSITY
Newell Turuka & MacKay ENGINEERING
Produced by the Center for Sustainable Communities and NTM Engineering for the Philadelphia Water Department
Data Sources from:
Center for Sustainable Communities
Philadelphia Water Department
DVRPC, ESRI
Prepared On:
November 19, 2013
Outfall Diameters
24" or Less
Greater than 24"
Miles
0 0.5 1 2 3 4

Figure 2.2.I Stormwater Collection System for a Portion of Upper Dublin Township, Montgomery County, PA

Section 2.3 Projected Growth and Land Use Projections

The project team evaluated the potential impacts of projected land use changes on stormwater runoff. Specifically, this study developed and compared two projected future land use scenarios in the Wissahickon Watershed. The projected "trend" scenario considered the continuation of current land use practices throughout the watershed. The alternate scenario was a "green" scenario, incorporating a wide variety of sustainable planning and development practices. This land use projection analysis looked only at the effects of land use change at the watershed scale in order to isolate the impact that land use decisions alone can have on watershed hydrology. The combined effect of potential stormwater control measures and sustainable development practices on future conditions is presented in Section 4.

Population forecasts were used to generate future land use demand for the watershed. The most recent official population forecasts were obtained from the Delaware Valley Regional Planning Commission (DVRPC), the designated regional and metropolitan planning organization covering the WCW area. The official population forecasts are used by DVRPC for transportation planning and modeling, and serve as an objective source of population forecasts. The study team used projections for the year 2040 that were developed in 2012.

The population forecasts for each of the 16 municipalities, either partially or completely located with the Wissahickon Watershed, were used to determine the proportion of the housing and population growth needs for those portions of the municipalities within the boundaries of the watershed. Using the land use and demographic data, the project team determined how much of a municipality's population and land area were within the Wissahickon Watershed's boundary using the area weighted-average technique. These percentages were used to apportion future population growth targets to the appropriate watershed. For example, if a weighted average of 30 percent of a municipality's land area was within the watershed, then 30 percent of the forecasted population growth rates were apportioned to future growth within the WCW. One of the difficulties in watershed planning and land use forecasting within smaller watersheds in Pennsylvania is that fundamental land use decisions are made by municipalities and the boundaries of municipalities do not conform to watershed boundaries. Municipalities are generally required to make adequate provision in their zoning for their projected population growth, but predicting into which watershed the growth will be directed is difficult.

Table 2.3.A presents the projected population growth for Wissahickon Watershed municipalities, representing only the future growth assigned to areas within the Wissahickon Watershed. The fifth column represents the population growth estimates for 2040 for each municipality. U.S. Census data was used to project the additional housing that will be associated with the population growth. First, the population of each municipality was divided by the total number of households in each municipality in order to calculate occupancy rates. Occupancy rates are listed in column 2. Within the municipalities in the Wissahickon watershed, the average household size is 2.56 persons per household, ranging from a low of 2.42 persons per household in Upper Moreland Township to a high of 2.74 persons per household in Worcester Township. Housing unit needs were also adjusted to account for each municipality's vacancy rate. The vacancy rates in column 3 were calculated by dividing the number of vacant housing units by the total number of housing units.

The last column of Table 2.3.A presents the number of housing units, which would need to be constructed during the planning horizon to maintain the same household size for the increase of

population. These figures were determined by dividing the expected population increase inside the watershed by the current occupancy rate plus the vacancy rate.

Overall, the results of the demographic analysis forecast a slow growth rate in the Wissahickon Watershed. The suburban watershed's population is expected to grow from approximately 109,200 in 2010 to slightly over 116,900 by the year 2040, a total increase of 7.0 percent. A similar increase is forecast for the City of Philadelphia. A total of 5,826 new housing units in a 30-year time period would be needed to accommodate the overall population growth, with about half of the units located within Philadelphia. The amount of undeveloped land used to provide for new housing demand was different in the "trend" and "green" scenarios evaluated for this study.

Table 2.3.A Population Growth and Housing Needs in the Wissahickon Watershed

Municipality	2010 Census Occupancy Rate (Persons per Occupied Housing Unit)	Vacancy Rate (Vacant units per Total Units)	Occupancy Rate + Vacancy Rate (Persons per unit)	Change in Population in Watershed 2010 to 2040	**2040 Housing Units Needed**
Abington Township	2.5868	0.0441	2.6309	281	**107**
Ambler Borough	2.4643	0.0589	2.5232	556	**221**
Cheltenham Township	2.5431	0.0611	2.6041	14	**6**
Horsham Township	2.7325	0.0481	2.7806	31	**12**
Lansdale Borough	2.4446	0.0701	2.5148	482	**192**
Lower Gwynedd Township	2.4307	0.0436	2.4744	851	**344**
Montgomery Township	2.6925	0.0275	2.7200	346	**128**
North Wales Borough	2.5031	0.0430	2.5461	112	**44**
Philadelphia County	2.5445	0.1051	2.6496	7,680	**2,899**
Springfield Township	2.5719	0.0347	2.6066	539	**207**
Upper Dublin Township	2.7210	0.0261	2.7471	1,975	**719**
Upper Gwynedd Township	2.4935	0.0385	2.5320	768	**304**
Upper Moreland Township	2.4175	0.0603	2.4778	3	**2**
Whitemarsh Township	2.5725	0.0508	2.6233	1,092	**417**
Whitpain Township	2.5295	0.0598	2.5893	591	**229**
Worcester Township	2.7411	0.0575	2.7986	18	**7**

Scenario 1: Trend Development

Table 2.3.B represents the land use analysis associated with Scenario 1: Trend Development. In this scenario, each new housing unit was assumed to consume the same amount of land as the existing year 2010 average housing unit land consumption, for each municipality. That is, in this scenario current densities (reflecting current zoning and current development practices) were assumed to predict future densities. This assumption is still somewhat conservative in terms of land consumption, because newer housing units generally are produced at densities lower than existing average densities.

Table 2.3.B Land Consumption Rates: Trend Development Scenario

Municipality	2040 Residential Need	2040 Non-Residential Need	2040 Acreage Need
Montgomery County			
Abington Township	29.6	12.9	42.5
Ambler Borough	26.9	25.5	52.4
Cheltenham Township	1.4	0.6	2.0
Horsham Township	4.7	1.4	6.1
Lansdale Borough	29.1	22.1	51.2
Lower Gwynedd Township	220.5	39.1	259.6
Montgomery Township	45.6	15.9	61.5
North Wales Borough	9.1	5.1	14.2
Springfield Township	71.1	24.8	95.9
Upper Dublin Township	361.6	90.7	452.3
Upper Gwynedd Township	114.3	35.3	149.6
Upper Moreland Township	0.5	0.1	0.6
Whitemarsh Township	195.5	50.1	245.6
Whitpain Township	120.2	27.1	147.3
Worcester Township	6.7	0.8	7.5
Philadelphia County	157.6	352.6	510.2
TOTAL	**1394.4**	**704.1**	**2098.5**

Note: all figures expressed in acres

Using the high-resolution digital land data in this study, the project team determined gross residential housing unit densities, defined for each municipality as number of housing units divided by land classified as in residential use. Thus, the estimate of gross residential housing unit densities was a good estimate of the amount of land consumed per housing unit. Using the figures from 2010, aggregate residential land use consumption was projected in Table 2.3.B, shown in column 1. Development densities across the suburban portion of the Wissahickon Watershed ranged from a low of 1.05 housing units per acre in Worcester Township to a high of 8.2 housing units per acre in Ambler Borough. Philadelphia had the highest density of residential housing density with 18.4 units per acre.

Estimates of the amount of land needed for non-residential development (including commercial, industrial, office, utility, and transportation land use needs) can be estimated with detailed employment growth forecasts to convert employment needs into space requirements. In this case, per capita demand projected for non-residential land under the trend development scenario was approximately 2000 square feet. The analysis in Table 2.3.B indicates that, at current trend densities, the Wissahickon Watershed would see a total of 2,098 additional acres converted to urban development between now and 2040, of which almost 1394 acres (66 percent) would be residential, while 704 acres would be non-residential.

For this scenario, in order to apportion future land use growth in, the suitability and capability of current land uses was analyzed to accommodate future land development, redevelopment, and growth. The first step was to create a GIS layer that included all land uses identified as not

"potentially developable." This included known permanently-preserved open space and conservation land (state, county and municipal parks, riparian corridors, etc.). The project team restricted areas within the Wissahickon Creek floodway, the 100-year floodplain, and an additional 50-foot buffer around the creek and its tributaries. Finally, wetland areas were also deemed not suitable for development. All remaining land is considered "potentially developable."

Within the land classified as potentially developable, four criteria were applied to identify the areas most suitable for development. The first criterion was the derived slope of the land, calculated in 100 square feet cells. Slope values over 25% were given a score of 0, while values from 15% to 25% were given a score of 4, and values under 15% were given a perfect score of 10. Accordingly, for the trend scenario, steep slope areas were scored lower than flat areas, but development was not prohibited in these areas except in special cases.

The second and third criteria used were proximity to major roads and schools. For each of these, a half-mile buffer was added around major arterial roads and highways, and public and private schools in the watershed. Areas within the half-mile buffer for roads and schools received a score of 10, while areas outside the school buffer area scored a 7 and areas outside the road buffer area scored a 5, on the grounds that developers are more likely to prefer proximity to arterial roads than schools for their development, be it residential or non-residential.

The final criterion accounted for the land use currently in place across the watershed. Agricultural and wooded areas were given scores of 10, based on an analysis of land use from 1990 to 2005 across the watershed, showing that agriculture and wooded lands decreased in coverage across the watershed, suggesting that these areas were most attractive to developers. Vacant areas were given a score of 3, balancing the availability of land for development with the general willingness of developers to use "virgin" land over previously developed areas for their projects. All current residential and commercial areas were given a score of 2, while all other land uses (including industrial, parking, community services, recreation, military, and utility) were given a score of 0, reflecting that it is still technically possible to use these areas for new development or redevelopment, but they should not be preferred.

Each criterion was combined to create a single raw score for all areas deemed "potentially developable", with a perfect score being 10. This layer with the raw score is then subdivided into municipalities within the watershed for purposes of analysis and assigning development areas. These subdivided layers were assigned to have "residential" or "non-residential" development based on the combined suitability score as well as the acreage of the continuous area receiving the same score; larger areas were given preference over smaller areas. Needed residential acreage was assigned to the high-scoring parcels first, followed by non-residential acreage. Areas were chosen to add up to the required acreage for each municipality, but overrun was permitted if the result would mean concentrating development in fewer areas. Area selection using the trend scenario ended up exceeding the projected need by 1.62 acres across the entire watershed, or 0.07% of the projected need.

Out of the 2,100 acres assigned for development, 1591 acres (76%) is in areas that received a perfect score of 10, meaning that the area has a slope of under 15%, is within a half-mile of a major arterial road and a school, and is currently classified as agriculture or wooded. Another 22% of the needed land was chosen from areas that scored a 9, and a further 2% of the needed land scored an 8. Overall, 73% of the land chosen for development in the trend scenario is currently

agriculture or wooded areas. Thus, one of the planning challenges facing the watershed is balancing the growth needs with preserving agricultural and forested landscapes. Even if an area in this analysis is classified as potentially suitable for development, it does not mean that development of these landscapes is the most appropriate policy choice. See Table 2.3.C below for a chart of how land was allocated to the individual municipalities based on suitability score.

Table 2.3.C Trend Scenario Land Allocation

Municipality	NEED - Trend Scenario Residential (Acres)	NEED - Trend Scenario Non-Residential (Acres)	NEED - Trend Scenario Total (Acres)	Trend Scenario Land Allocation Scores (AC)			Total Allocated	Difference from Need
				10	9	8		
Abington Township	29.62	12.90	42.53	42.55	0.00	0.00	42.55	-0.02
Ambler Borough	26.94	25.53	52.47	3.24	8.71	40.53	52.48	-0.01
Cheltenham Township	1.42	0.64	2.06	3.19			3.19	-1.13
Horsham Township	4.68	1.42	6.10		6.11		6.11	-0.01
Lansdale Borough	29.07	22.13	51.20	34.80	4.63	12.10	51.53	-0.33
Lower Gwynedd Township	220.52	39.07	259.60	201.38	58.22		259.60	0.00
Montgomery Township	45.56	15.89	61.45	19.98	41.52		61.50	-0.05
North Wales Borough	9.15	5.14	14.29	14.32			14.32	-0.03
Philadelphia County	157.60	352.62	510.22	491.12	19.10		510.22	0.00
Springfield Township	71.14	24.75	95.89	95.89			95.89	0.00
Upper Dublin Township	361.58	90.68	452.26	287.68	164.59		452.27	-0.01
Upper Gwynedd Township	114.29	35.26	149.55	106.61	42.94		149.55	0.00
Upper Moreland Township	0.52	0.14	0.66	0.63			0.63	0.03
Whitemarsh Township	195.47	50.14	245.61	134.42	111.19		245.61	0.00
Whitpain Township	120.18	27.13	147.31	147.38			147.38	-0.07
Worcester Township	6.68	0.83	7.50	7.49			7.49	0.01
TOTALS	1394.43	704.27	2098.70	1590.68	457.01	52.63	2100.32	-1.62
				75.74%	21.76%	2.51%		

In this scenario, each municipality accommodates its own projected land development needs and there is no sharing of uses among municipalities. In many ways, this represents the trend in Pennsylvania land use planning by municipalities, as each municipality is under an affirmative obligation to "accommodate reasonable overall community growth, including population and employment growth" (cf. 53 P.S. § 10604 [5]) absent a shared land-use agreement within a multi-municipal plan.

Figure 2.3.A shows the projected land use in 2040 under the Trend Development scenario. Much of the undeveloped land near the various streams of the watershed is protected in this scenario from development because of their environmental constraints. Most of the land conversion under this scenario occurs in the currently less developed townships in the northern portion of the watershed.

Scenario 2: "Green" Development

In this land use future scenario, municipalities accommodated their forecasted population growth needs, but accommodated the residential portion of that population growth at significantly higher gross residential housing unit densities and the non-residential portion of that development at slightly increased intensities. In order to illustrate this scenario, the project team chose to simulate new residential development in the less dense municipalities as occurring at densities of six units per gross residential acre. Existing densities were maintained in those municipalities where the current density is higher than six units per acre.

Depending on the planning decisions of these municipalities in accommodating growth at higher densities in terms of housing mix and design standards (e.g. cluster subdivisions), some of these housing units could be townhouses and others would be cluster houses on smaller lots (<8,000 square feet). Further, in this scenario, we assumed only 1,500 square feet of non-residential land per new resident, in that commercial and other uses are developed at higher intensities. The results are shown in Table 2.3.D below. The last column of Table 2.3.D indicates that, in comparison with the trend development scenario illustrated in Table 2.3.B, the total area of land required for new residential and non-residential development under the green scenario is 936 acres (45 percent) less.

Table 2.3.D Land Consumption Rates: Green Development Scenario

Municipality	2040 Residential Need	2040 Non-Residential Need	2040 Acreage Need	Acreage Saved vs. Trend
Montgomery County				
Abington Township	17.8	9.7	27.5	15.0
Ambler Borough	26.9	19.2	46.1	6.4
Cheltenham Township	1.0	0.5	1.5	0.6
Horsham Township	2.0	1.1	3.1	3.0
Lansdale Borough	29.1	16.6	45.7	5.5
Lower Gwynedd Township	57.3	29.3	86.6	173.0
Montgomery Township	21.3	11.9	33.2	28.2
North Wales Borough	7.3	3.9	11.2	3.1
Springfield Township	34.5	18.6	53.1	42.8
Upper Dublin Township	119.8	68.0	187.8	264.4
Upper Gwynedd Township	50.7	26.4	77.1	72.4
Upper Moreland Township	0.3	0.1	0.4	0.2
Whitemarsh Township	69.5	37.6	107.1	138.5
Whitpain Township	38.2	20.4	58.6	88.8
Worcester Township	1.2	0.6	1.8	5.7
Philadelphia County	157.6	264.5	422.1	88.2
TOTAL	**634.6**	**528.2**	**1162.8**	**935.9**

Note: all figures expressed in acres

The factors that were used to craft the green scenario suitability score were developed by the Center for Sustainable Communities with assistance from a survey of Environmental Advisory Committee members and other officials from municipalities in the Pennypack watershed. The Pennypack and Wissahickon watersheds have experienced similar land use development, so it is reasonable to apply the Pennypack survey results to the Wissahickon. After combining survey input with CSC decisions, the final decisions on scoring for land use types are as follows (scores out of 10):

- Agriculture: 3
- Commercial: 8
- Community Services: 5
- Light Industrial: 4
- Military: 10
- Mobile Home Residential: 3
- Multi-Family Residential: 6
- Parking: 8
- Recreation: 2
- Row Home Residential: 6
- Single Family Residential: 8
- Transportation: 6
- Utility: 5
- Vacant: 10
- Water: 0
- Wooded: 1

In addition to existing land use type, suitability of land in the green scenario was scored based on additional physical characteristics and proximity factors.

Scores based on proximity to train stations, bus routes, open space and institutions were based one-quarter mile distances. For example, areas within a quarter-mile of a train station were given a score of 10. Areas that were between a quarter-mile and a half-mile of a train station were given a score of 9 and so on. Slope values over 25% were given a score of 0, while values from 15% to 25% were given a score of 4, and values under 15% were given a perfect score of 10. Areas that contain wetlands, were in the floodway, or within a 60-foot buffer of the stream or its tributaries were restricted. Areas within the 100-year flood plain were given a score of 0. Areas within the 500-year flood plain were given a score of 5. The relative weightings for all criteria, including land use type was as follows:

- 17%: Water (areas outside of floodplain, wetlands, ponds, streams)
- 15%: Current Land Use
- 15%: Slope

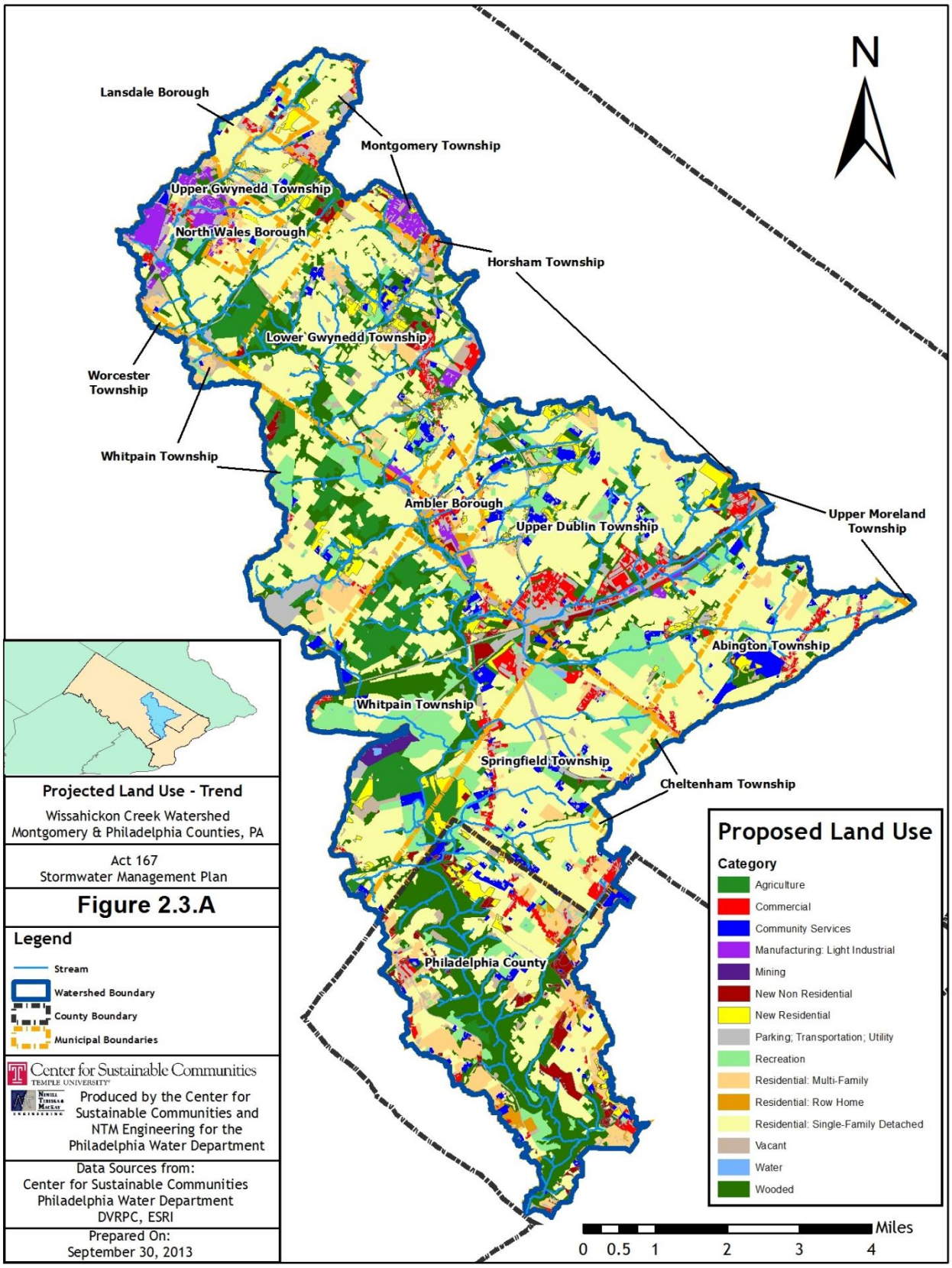
  Proximity to:
- 12%: Bus Routes
- 12%: Rail Stations
- 12%: Institutions (schools, hospitals, employment centers, religious sites)
- 17%: Open Space (includes trails)

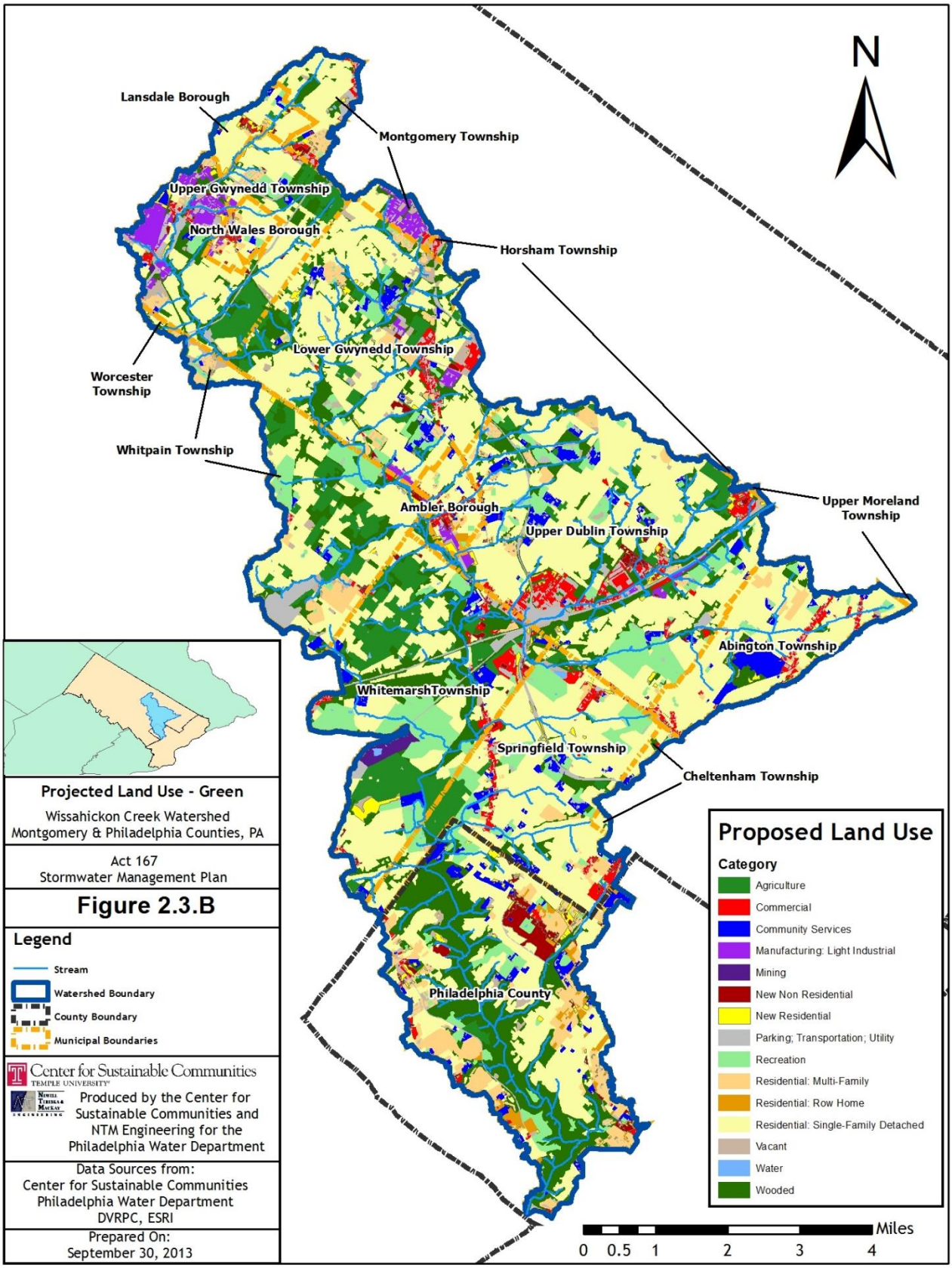
The scoring factors and relative weightings were combined with the maximum suitability score being 10. Table 2.3.E shows how the development required for each municipality was allocated to land in accordance with suitability scores.

Table 2.3.E Green Scenario Land Allocation

Municipality	NEED - Green Scenario Residential	NEED - Green Scenario Non-Residential	NEED - Green Scenario Total (Acres)	Green Scenario Land Allocation Scores (AC)			Total Allocated	Difference from Need
				9	8	7		
Abington Township	17.83	9.68	27.51	1.72	25.75		27.47	0.04
Ambler Borough	26.94	19.15	46.09		46.21		46.21	-0.12
Cheltenham Township	1.00	0.48	1.48		1.55		1.55	-0.07
Horsham Township	2.00	1.07	3.07		0.02	3.14	3.16	-0.09
Lansdale Borough	29.07	16.60	45.67		45.83		45.83	-0.16
Lower Gwynedd Township	57.33	29.30	86.64	0.45	86.30		86.75	-0.11
Montgomery Township	21.33	11.91	33.25		33.37		33.37	-0.12
North Wales Borough	7.33	3.86	11.19		11.22		11.22	-0.03
Philadelphia County	157.60	264.46	422.07	1.97	420.55		422.52	-0.45
Springfield Township	34.50	18.56	53.06	5.22	47.91		53.13	-0.07
Upper Dublin Township	119.83	68.01	187.84	11.32	176.57		187.89	-0.05
Upper Gwynedd Township	50.67	26.45	77.11	0.15	77.03		77.18	-0.07
Upper Moreland Township	0.33	0.10	0.44		0.47		0.47	-0.03
Whitemarsh Township	69.50	37.60	107.10	10.64	96.47		107.11	-0.01
Whitpain Township	38.17	20.35	58.52		58.52		58.52	0.00
Worcester Township	1.17	0.62	1.79			1.85	1.85	-0.06
TOTALS	634.61	528.20	1,162.82	31.47	1,127.77	4.99	1,164.23	-1.41
				2.70%	96.87%	0.43%		

Figure 2.3.B shows the projected land use futures for 2040 under the green scenario.
The green scenario is a concept which allows for the use of developed land to accommodate additional growth. Many of the areas designated as new residential or non-residential development are already developed in some fashion, as the suitability decision was driven by many factors, not just existing land use. For most of these areas, including already existing commercial, community services, manufacturing, parking, utility, and transportation land uses, it may be possible to "stack" land uses through mixed-use development by adding another floor (or multiple floors) to existing buildings. In this way, a 2 acre commercial area could accommodate an additional 2 acres of residential development if, for example, apartments were added on top of stores or in parking areas. This would require changes in how land is developed, especially in the suburban municipalities, but it would result in a reduced requirement for the development of open land.


N
Lansdale Borough
Montgomery Township
Upper Gwynedd Township
North Wales Borough
Horsham Township
Lower Gwynedd Township
Worcester Township
Whitpain Township
Ambler Borough
Upper Dublin Township
Upper Moreland Township
Abington Township
Whitpain Township
Springfield Township
Cheltenham Township
Philadelphia County
Proposed Land Use
Category
Agriculture
Commercial
Community Services
Manufacturing: Light Industrial
Mining
New Non Residential
New Residential
Parking; Transportation; Utility
Recreation
Residential: Multi-Family
Residential: Row Home
Residential: Single-Family Detached
Vacant
Water
Wooded
Miles
0 0.5 1 2 3 4
Projected Land Use - Trend
Wissahickon Creek Watershed
Montgomery & Philadelphia Counties, PA
Act 167
Stormwater Management Plan
Figure 2.3.A
Legend
Stream
Watershed Boundary
County Boundary
Municipal Boundaries
Center for Sustainable Communities
TEMPLE UNIVERSITY
Produced by the Center for Sustainable Communities and NTM Engineering for the Philadelphia Water Department
Data Sources from:
Center for Sustainable Communities
Philadelphia Water Department
DVRPC, ESRI
Prepared On:
September 30, 2013


N
Lansdale Borough
Montgomery Township
Upper Gwynedd Township
North Wales Borough
Horsham Township
Lower Gwynedd Township
Worcester Township
Whitpain Township
Ambler Borough
Upper Dublin Township
Upper Moreland Township
Abington Township
Whitemarsh Township
Springfield Township
Cheltenham Township
Philadelphia County
Projected Land Use - Green
Wissahickon Creek Watershed
Montgomery & Philadelphia Counties, PA
Act 167
Stormwater Management Plan
Figure 2.3.B
Legend
Stream
Watershed Boundary
County Boundary
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New Non Residential
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Parking; Transportation; Utility
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Residential: Multi-Family
Residential: Row Home
Residential: Single-Family Detached
Vacant
Water
Wooded
Miles
0 0.5 1 2 3 4

Section 3: Stormwater Problems

The Wissahickon Creek Watershed has undergone major development and urbanization. Much of the watershed area was developed as a part of the "inner ring suburbs" of Philadelphia in the 1950s through the 1980s. The pattern of growth has resulted in the densest development being located in the center third of the watershed, with riparian areas along much of the lower and central main stem and portions of the northwestern headwaters preserved as parks and preserves.

In the Wissahickon Watershed, the conversion of land cover to less permeable surfaces has increased volume and frequency of runoff and led to a number of problems, including increased incidence of flooding, impaired water quality, and ecological degradation. The impaired water quality and ecological degradation are documented in detail in the Comprehensive Characterization Report for the Wissahickon Watershed completed by the Philadelphia Water Department (PWD) in 2007.[1]

Of paramount concern is the increase in the amount of impervious cover (i.e., roads, rooftops, turf grass), which has contributed to the escalation of runoff and flood levels. Approximately 29%[1] of the Wissahickon Watershed is covered by impervious surfaces. Increased volumes of runoff are not only the result of increases in impervious surfaces, but also from the substantial areas of natural landscape converted to lawns or playing fields on highly compacted soil. Furthermore, stormwater runoff is subject to many pollutants such as nutrients (in fertilizers), pesticides, and bacteria that it encounters as it makes its way to the nearest water body.

Development in many of the watershed municipalities took place long before stormwater management plans and ordinances were adopted. As with many of the largely developed suburbs surrounding Philadelphia, ordinances that were in place during the suburban growth period did not adequately manage the increased volume of stormwater runoff resulting from the increase in impervious cover. It was not until the 1970s that municipalities began to recognize the need to get involved with this type of regulatory oversight. Impacts of uncontrolled urban runoff include: (1) faster timing of runoff, (2) non-point source pollution, (3) decreased groundwater recharge, and (4) increased stream temperatures, which result in increased flooding, increased streambank erosion, impaired water quality, and decreased aquatic diversity.[2]

3.1 Flooding

While flooding is a natural process and occurs in both developed and undeveloped watersheds, land conversion to less permeable surfaces in the absence of stormwater controls leads to higher flood peaks, flood volumes and frequency of flooding. This is the case for large storm events, and in particular for smaller more frequent storms.

Communities have faced devastating effects from large flood events, and have faced millions of dollars worth of damage as well as loss of life. During a 2006 summer storm, two persons were trapped in their basement and drowned near Sandy Run.[3] Thirteen nearby homes were

[1] *Philadelphia Water Department, Comprehensive Characterization Report for the Wissahickon Watershed, 2007.*
[2] *DeBarry, Paul. 2004. Watersheds: Processes, Assessment, and Management. New Jersey: John Wiley & Sons.*
[3] *The Temple News Web Site, http://www.temple-news.com, accessed on August 5, 2005.*

subsequently removed and two were elevated above the 100-year floodplain. Flooding along Pine Run affects several buildings in the Fort Washington Business Center. In 2001, a SEPTA train bridge was badly damaged by flooding. Virginia Drive and other access roads to the business park become flooded and impassable during large flood events.

Figure 3.1.A shows the floodway and the 100-year and 500-year floodplains for Wissahickon Watershed streams. The circled area along Pine Run in Upper Dublin Township is shown on an expanded map in Figure 3.1.B. This shows the extent of the floodplain versus the adjacent buildings and roadway. For the suburban communities, the floodplains shown are based on the Federal Emergency Management Agency (FEMA) digital Flood Insurance Rate Maps (dFIRM). The number of buildings located within the 100-year floodway, 100-year floodplain, and 500-year floodplain is provided in Table 3.1.A, based on an overlay of orthophotography and floodplain maps. The absence of buildings in Fairmount Park in Philadelphia and in other preserved areas along the main stem and tributaries have helped limit the number of flood-prone structures.

Figure 3.1.A FEMA Floodplains

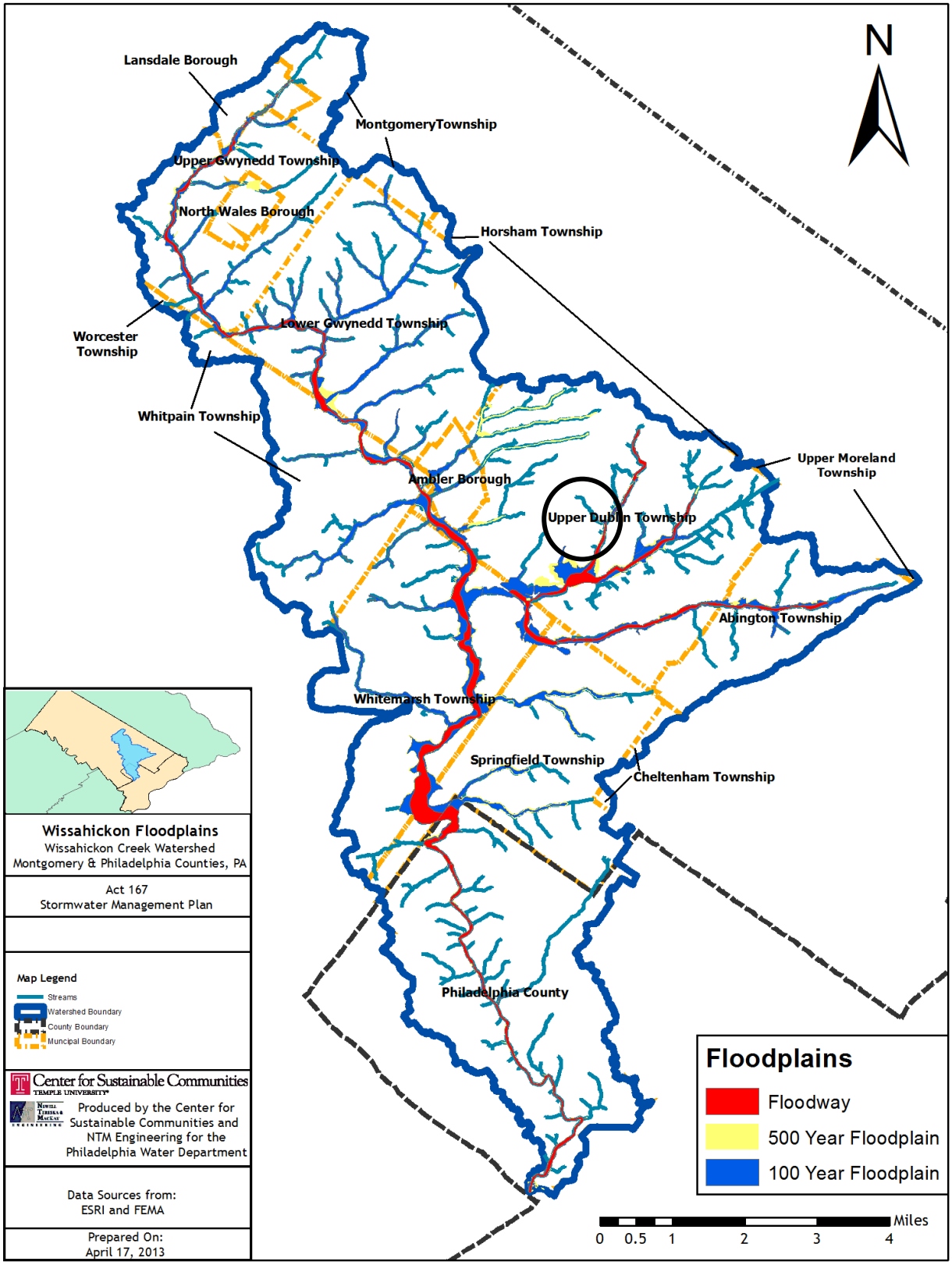


Figure 3.1.B 100-Year Floodplain – Pine Run and Rapp Run showing Flooding of Virginia Drive – Upper Dublin Township, Montgomery Co., PA

Table 3.1.A Buildings affected by Floodways and 100- and 500-Year Floodplains

Municipality	Building Footprints in Floodplain		
	Floodway	**100 Year**	**500 Year***
Abington	82	319	398
Ambler	0	130	130
Cheltenham	0	0	0
Horsham	0	0	0
Lansdale	6	25	32
Lower Gwynedd	1	46	50
Montgomery	0	0	0
North Wales	0	85	98
Philadelphia	2	5	16
Springfield	6	234	545
Upper Dublin	19	127	265
Upper Gwynedd	5	68	78
Upper Moreland	0	0	0
Whitemarsh	15	77	113
Whitpain	1	41	43
Worcester	0	0	0
Total	**137**	**1157**	**1768**

Source: FEMA, PAMAP, PWD
*Includes buildings within 100-yr floodplain

Flood insurance claims paid under FEMA's federal flood insurance program provide a partial measure of flood damage that has occurred since the late 1970s. This information can be used to indicate areas where flood damages are clustered, and also where repetitive flood claims have been filed. Figure 3.1.C shows the distribution of all flood insurance claims and dollars paid in the Wissahickon Watershed for the period October 1977 thru March 2010. As of March 2010, a total of 601 claims had been paid with a total payout of $26 million. The dollar amount is not adjusted for inflation and is only a fraction of the actual damage that has occurred as the result of flooding. Damages to uninsured property, disaster assistance, and damage to public property is not included. Locations of repetitive flood claims (structures that claimed more than once) are shown in Figure 3.1.D, along with the number of repetitive claims at the site.

Figure 3.1.C FEMA Flood Insurance Claims

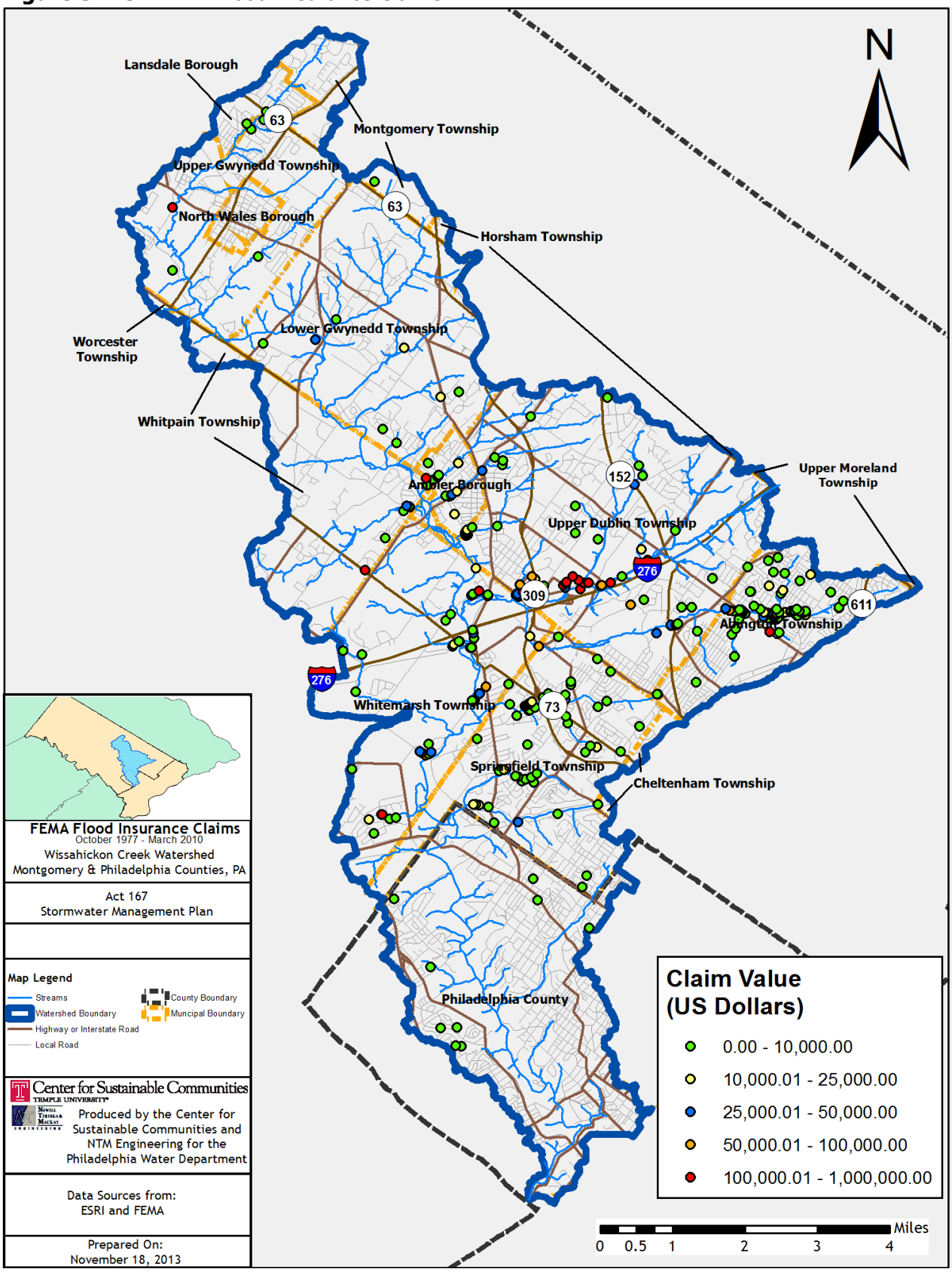
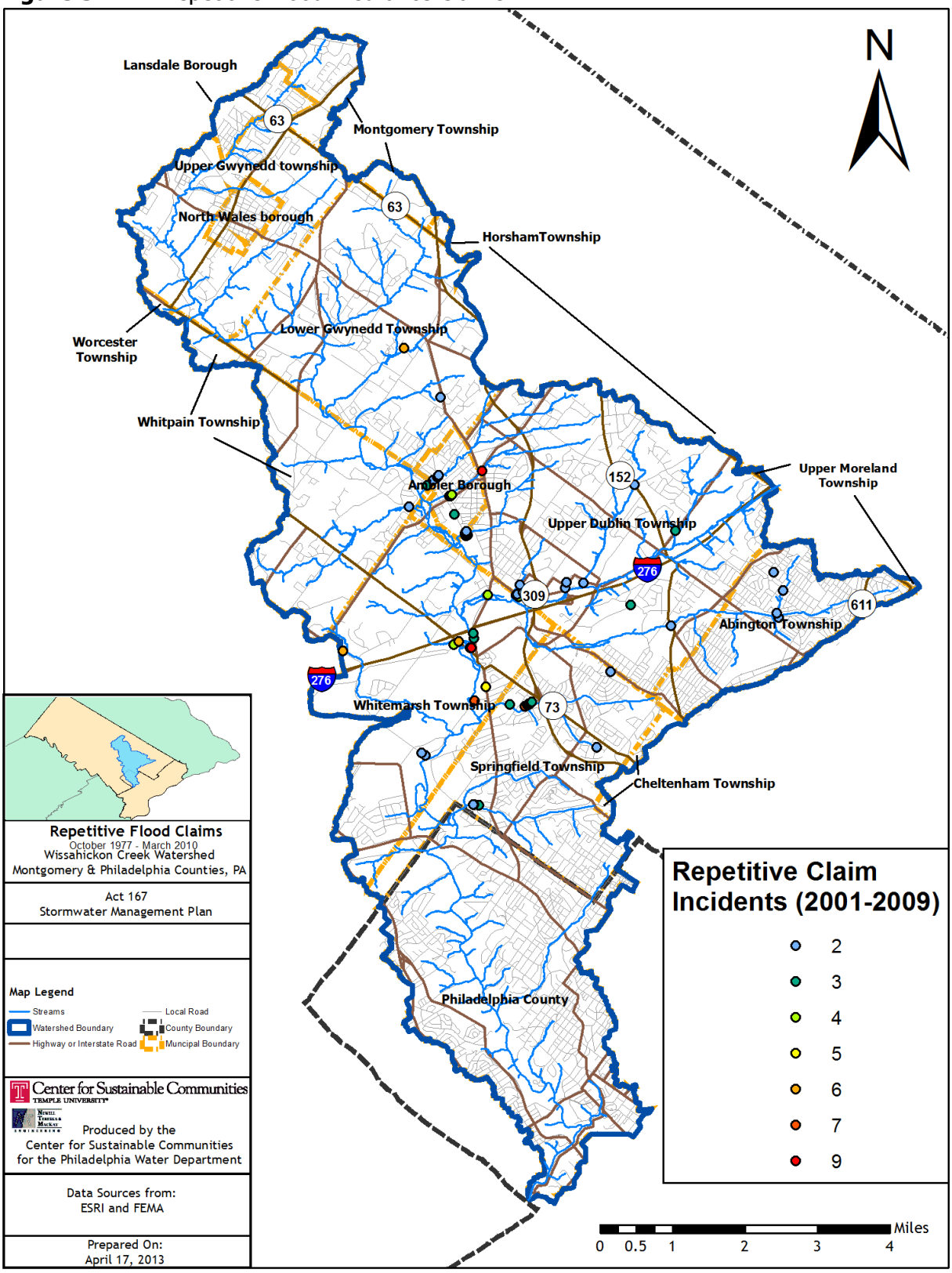


Figure 3.1.D Repetitive Flood Insurance Claims

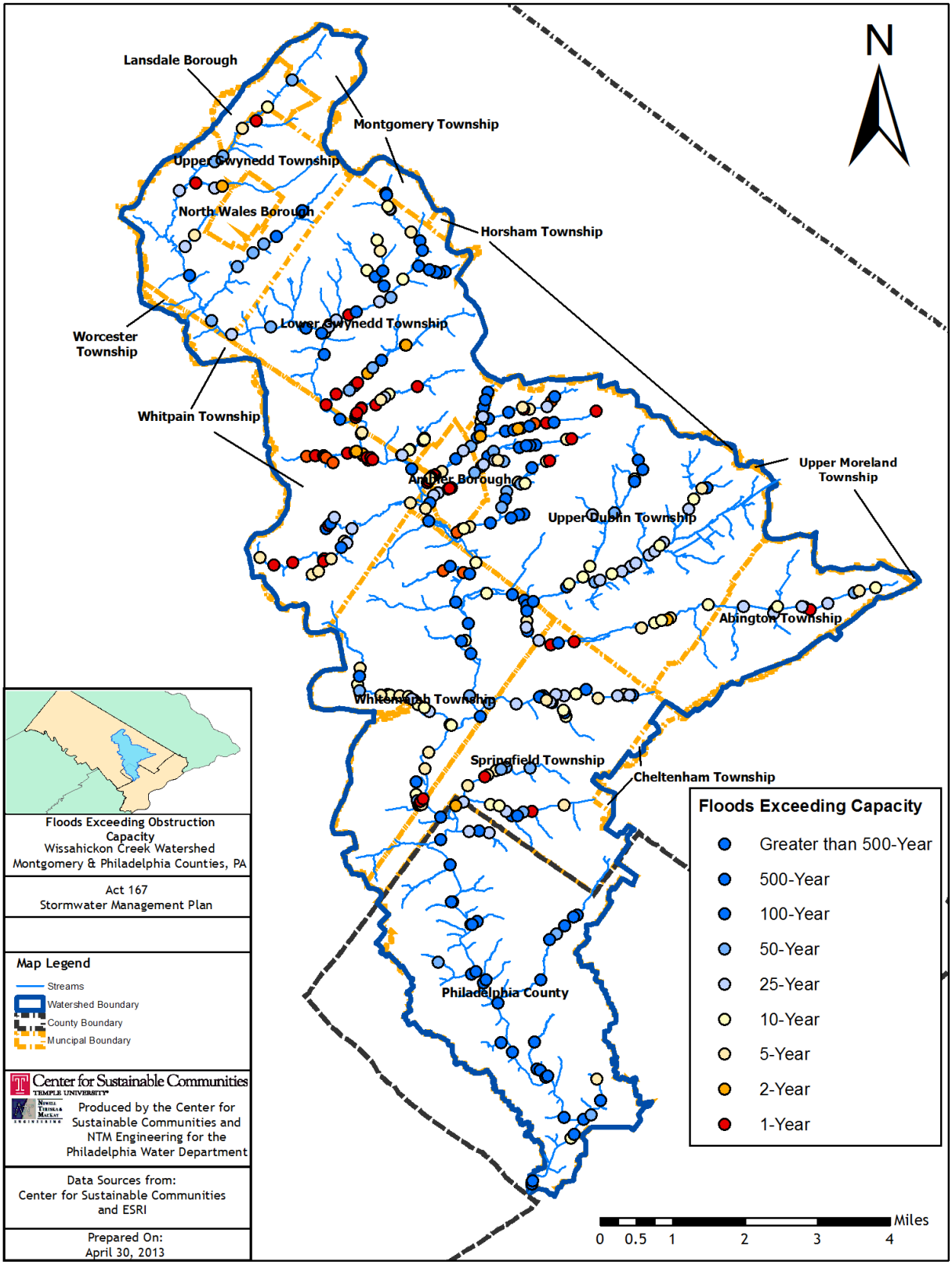


Flooding problems can also occur at bridges and culverts. These structures can change the flow characteristics of waterways by restricting flow during flood events, temporarily raising the upstream water surface elevation. Hazards associated with this include upstream flooding, bridge deck overtopping and flooding of low-lying approach roadways.

The PWD provided a comprehensive survey of 370 bridges and culverts considered to be significant obstructions to flow. These structures were re-measured by both the PWD and the study team to obtain current dimensions. The obstructions were then evaluated using the hydrologic model to determine flood events that would exceed their flow capacity. The results are shown in Figure 3.1.E. The analysis identified 34 structures where capacity would be exceeded by the 1-Yr design storm. These results are based on a watershed scale model, and problem culverts and bridges should be verified by the municipality based on the experience with historic flooding at the structure. A list of the structures shown in Figure 3.1.E is provided in Appendix D and GIS files that can be used for mapping the structures are available in digital format accompanying this report. Profiles from the existing flood insurance study for the Wissahickon Creek in Montgomery County and the City of Philadelphia indicated that the major roadway bridges were not vulnerable to overtopping by smaller events.

Section 6 recommends projects that will reduce peak flows and volumes at downstream culverts and bridges. As a general approach, the project team recommends the construction of stormwater improvements to increase storage and reduce stormwater flows and volumes as the first consideration in addressing drainage problems. For cases where increased culvert capacity is the only viable means for solving a drainage problem, an evaluation of potential increases in downstream flood peaks should be performed to prevent adverse flooding or stream channel impacts. In addition, such actions might require municipalities to modify their flood insurance rate maps to outline additional areas subject to inundation during more extreme flood events. The provision of upstream storage through extended detention, infiltration, riparian buffer restoration, or other stormwater control measures can help offset the impacts of increasing the capacities of culverts located downstream.

Figure 3.1.E Floods Exceeding Obstruction Capacity



3.2 Stream Impairment

Surface water quality can become impaired from a lack of stormwater runoff management and inadequate non-point source pollution control.[4] Runoff from parking lots or other types of impervious surfaces increases stream temperatures and contributes to non-point source pollution. Pollutants come from automobile emissions, lawn and garden chemicals, and litter.[5]

Increasing urbanization in the Wissahickon Watershed has also led to the destruction of riparian buffers, which has created additional pollution problems stemming from overland runoff into the watershed's streams, both the main stem Wissahickon Creek and its tributaries. The destruction of riparian buffers also has increased erosion and sediment loadings by exposing the stream bank soils to the velocity of the streams. It has led to the widespread loss of habitat for both aquatic and terrestrial species, as well as propagation of invasive plant species. A map of stream reaches in the watershed lacking adequate riparian buffer is shown in Figure 3.2.A. This information is based on an updated inventory prepared in 2010 by the Heritage Conservancy.

A survey of municipalities located in the watershed conducted during this study identified numerous locations in the suburban portion of the watershed where flooding, erosion, and sedimentation were occurring. These locations are shown in Figure 3.2.B as red lines along stream segments. An example of streambank undercutting in Paper Mill Run, a tributary to Wissahickon Creek in Springfield Township, is shown in Figure 3.2.C.

[4] *DeBarry, Paul. 2004. Watersheds: Processes, Assessment, and Management. New Jersey: John Wiley & Sons.*
[5] *Ibid.*

Figure 3.2.A Stream Reaches Lacking Sufficient Riparian Buffer

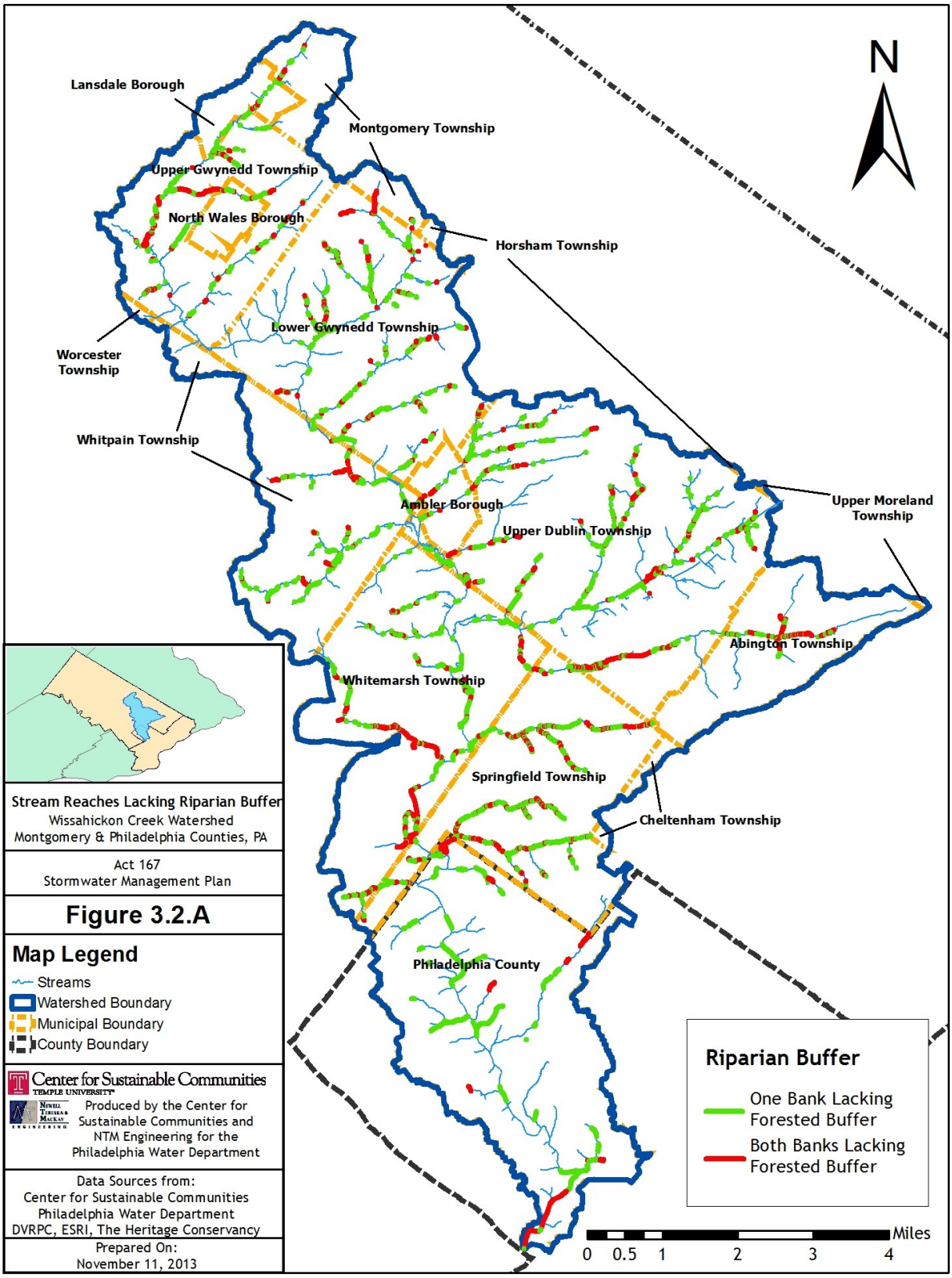


Figure 3.2.B Municipal Problem Areas

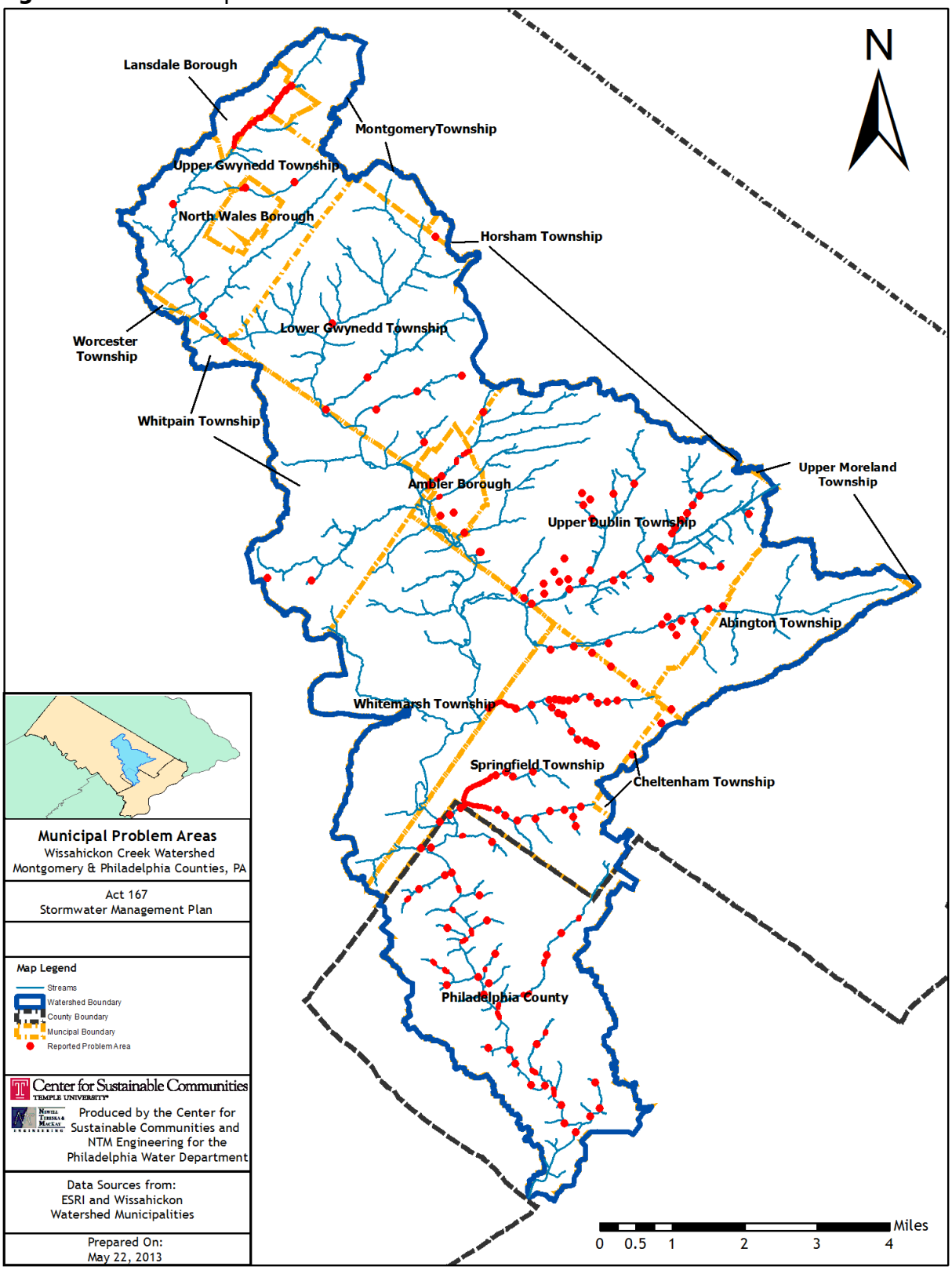
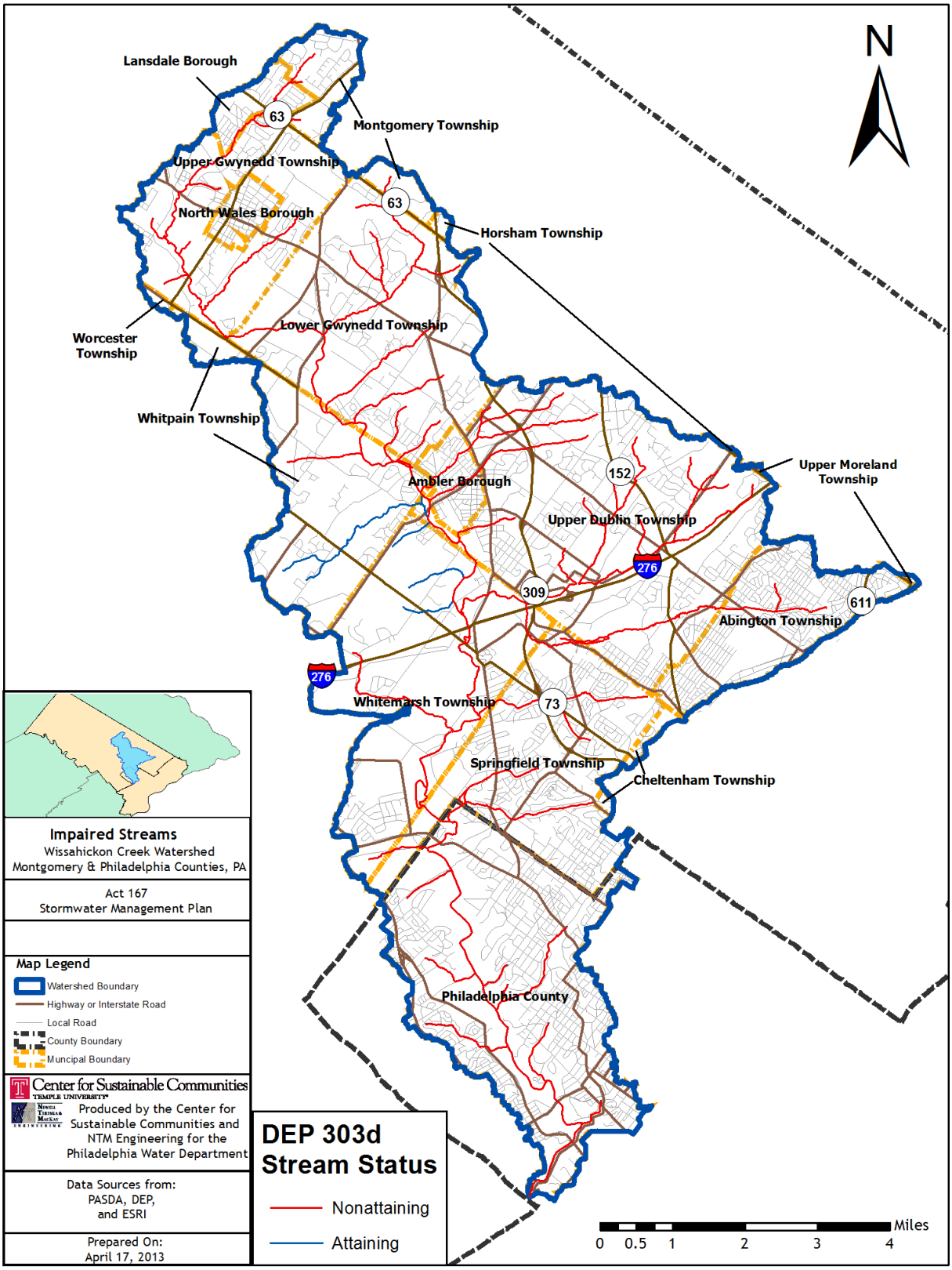


Figure 3.2.C Example of streambank erosion and bank undercutting on Paper Milll Run (a tributary to Wissahickon Creek), Springfield Township, Montgomery County, PA

The Pennsylvania Department of Environmental Protection (DEP) and Philadelphia Water Department have conducted several water quality studies and biological assessments in the Wissahickon Creek Watershed. Monitoring conducted by DEP has determined that about 83 percent of the Wissahickon Creek Watershed's stream miles are impaired for designated uses and have subsequently been listed on the Pennsylvania 303(d) list of impaired waters. The current designated use of the Wissahickon Creek is Trout Stocked Fishery. The impaired reaches are shown in Figure 3.2.D. The 303d list indicates that the majority of impairment is due to urban stormwater run-off, water flow variability, and flow and habitat alterations. Recent studies of the creek and watershed also identify stormwater runoff as a primary challenge to protecting and restoring the stream's ecosystem. Urban runoff is listed as the primary cause of impairment in 57 percent of the designated streams.[6] Given the state of the watershed and widespread impacts of stormwater, a major part of this study focused on measures to improve control of existing runoff, in addition to criteria for future development.

[6] *Pennsylvania 303d Non-attaining Streams List*

Figure 3.2.D Impaired Streams



In 2003 the Environmental Protection Agency approved the Wissahickon Creek Total Maximum Daily Load (TMDL) to address the water quality impairments from point sources, in particular violations of standards for sediment and nutrients[7]. The TMDL sets waste load allocations (WLAs) for point sources for these contaminants. The TMDL established for sediment (2,823,095 lbs/year) was allocated among the fifteen municipalities in the following manner:

Table 3.2.A Municipal Sediment Waste Load Allocations

Sediment TMDL	Sediment Loads (lbs/yr)
Ambler	42,189.97
Cheltenham	5,961.13
Horsham	3,555.71
Lansdale	52,332.43
Lowe Gwynedd	437,360.30
Montgomery	111,128.30
North Wales	42,331.55
Philadelphia	380,861.30
Springfield	190,165.00
Upper Dublin	464,607.60
Upper Gwynedd	550,584.30
Upper Moreland	861.57
Whitemarsh	239,532.40
Whitpain	291,273.30
Worcester	10350.07

The stormwater improvements recommended in Section 6 and Appendix C would contribute toward mitigation of the impairments identified in the TMDLs. This is discussed in Section 7.

3.3 Municipal Problem Area Survey

Problem areas were determined by collecting data from a number of sources, as shown in Table 3.3.A. Information on drainage problems and proposed solutions was solicited from each municipality within the Wissahickon Creek Watershed by providing forms for each Watershed Plan Advisory Committee (WPAC) member early in the Watershed Plan study. One hundred sixty-three (163) problem areas were identified by the municipalities. The distribution of these problem areas is shown on Figure 3.2.B, and the problems are categorized by type and municipality in Table 3.3.B.

[7] *TMDL for Sediment and Nutrients Wissahickon Creek Watershed*

TABLE 3.3.A
Wissahickon Watershed Problem Identification

Types of Problems	Source	# of Problems
Flooding	Ambler Borough	1
	Cheltenham Township	1
	Horsham Township	1
	Lansdale Borough	3
	Lower Gwynedd Township	8
	North Wales Borough	1
	Springfield Township	24
	Upper Dublin Township	47
	Upper Gwynedd Township	4
	Whitpain Township	3
	Bing, PASDA (Floodplains), Flood Insurance Claims	77 Areas 697 Buildings
Erosion Sites	Ambler Borough	1
	Cheltenham Township	2
	Lansdale Borough	3
	North Wales Borough	1
	PWD	46
	Springfield Township	38
	Upper Dublin Township	0
	Upper Gwynedd Township	1
	Whitpain Township	1
Sedimentation Sites	Lower Gwynedd Township	1
	PWD	46
	Springfield Township	39
	Upper Dublin Township	0
Groundwater	Cheltenham Township	1
FIS Bridge Backwater Data	FEMA FIS Profiles	61
Non-Attaining Streams	PaDEP 303d List -PASDA	101.5 Miles Impaired 3 Non-Attaining Uses
Obstructions	PWD and Temple	369

TABLE 3.3.B

Problems Reported by Municipalities

Municipality	**Type of Problems** (A)
Abington Township	N/A
Ambler Borough	1,2
Cheltenham Township	1,2,5
Horsham Township	1
Lansdale Borough	1,2
Lower Gwynedd Township	1,3
Montgomery Township	N/A
North Wales Borough	1,2
City of Philadelphia	2,3
Springfield Township	1,2,3
Upper Dublin	1
Upper Gwynedd Township	1,2
Upper Moreland Township	N/A
Whitemarsh Township	N/A
Whitpain Township	1,2
Worcester Township	N/A

N/A No problem areas reported
* No Data Collection Forms Received

Types of Problems

1. Flooding
2. Accelerated Erosion
3. Sedimentation
4. Landslide
5. Groundwater
6. Water Pollution

3.4 Drainage and Stormwater Collection Systems

Section 2.2 includes a discussion of the role of stormwater collection systems and outfalls in defining hydrologic characteristics. It is estimated that approximately 60 percent of the Wissahickon Watershed includes stormwater collection. These systems are located in portions of each municipality in the watershed. Specific problems with piping and inlets for stormwater collection systems were not specifically identified in the municipal survey results for this study.

Stormwater collection system surcharge due to limited capacity occurs in locations throughout the Wissahickon watershed. This is particularly true in highly developed areas with older infrastructure.

The obstruction of flow by bridges and culverts was a significant component of this study as discussed in Section 3.1. Using the language from Act 167, these obstructions represent "drainage" problem areas. Section 6 addresses these problems through an approach that focuses on the provision of upstream stormwater control measures such as extended detention, infiltration, and riparian buffer restoration. Measures that increase infiltration also reduce surface runoff to existing storm sewer inlets.

Section 4: Model Development and Application

The hydrologic model for the Wissahickon Act 167 study was built using GIS layers of land use, hydrologic soil groups, terrain and orthophotography. Within the Sandy Run watershed, model sub-watershed boundaries match those used for the hydrologic and hydraulic modeling completed for the recent flood insurance study of the suburban Sandy Run Watershed. The modeling for this portion of the watershed was coordinated with an updated flood insurance study and the hydrology has been approved by the Federal Emergency Management Agency (FEMA). The model has been calibrated against two U.S. Geological Survey stream gaging stations located on the Wissahickon Creek at Fort Washington and at Philadelphia.

4.1 Development of the Act 167 Hydrologic Model

The objectives of the Act 167 hydrologic modeling were: to determine peak rate controls for stormwater management; to assess the hydrologic impact of potential land use change; to obtain flows at obstructions, and to evaluate the potential impacts of stormwater improvements.

Subbasin delineations were chosen primarily at stream confluence points and boundary delineations were based on several sources. These included a digital elevation model (DEM) and 2-foot contour interval data obtained by the Center for Sustainable Communities (CSC), 2-foot contour data provided by PWD, and, particularly within the city limits of Philadelphia, storm sewer shed delineations provided by PWD. The Wissahickon Watershed was subdivided into 137 subbasins as shown in Figure 4.1.A.

The outer boundary shown with the modeling results in this report is slightly different from that shown for the informational maps in Sections 2 and 3 and the peak rate management district maps in Section 5 (Figure 5.3.A) and the Ordinance (Appendix A). The reason for this is that the model boundary was set up to precisely match with previous flood insurance study modeling of the Sandy Run portion of the watershed. Because the outer boundary in Figure 5.3.A and the Ordinance conforms more closely with the neighboring Pennypack watershed boundary and with boundaries in use by the Philadelphia Water Department and PADEP, it is recommended that it be used as a guide for the purpose of peak rate management. The difference does not affect the peak rate district modeling results. The precise determination of the applicable peak rate district for individual projects near the boundary would be determined form site plans as specified in Section 408.C of the Ordinance.

Land Use Data for 2005 from the Delaware Valley Regional Planning Commission (DVRPC) and NRCS data for Hydrologic Soil Groupings were used to generate NRCS runoff Curve Numbers for each of the 137 subbasins. Figure 4.1.B shows the distribution of runoff Curve Numbers calculated for the Wissahickon Watershed. These are composite Curve Number values that include the effect of impervious cover, such as roof and parking areas, as well as pervious areas.

In addition to the volume of precipitation that runs off the land surface, the shape and slope of each subbasin affect the timing of the runoff and the peak flow. For this study, these factors are represented by the subbasin time of concentration (Tc), which was calculated as the sum of sheet flow time, shallow concentrated flow time, and channel flow time for the longest flow path to the subbasin outlet. Orthophotography, elevation contours and digital elevation models (DEMs) were

used to estimate slope and the length of each flow path. The maximum length of sheet flow was limited to 100 feet.[1]

The Act 167 hydrologic model also includes 87 stream reaches to convey flow from the subbasin outlets through the tributaries and main stem of the Wissahickon Creek. Flow rates through reaches are influenced by storage defined by the shape of the channel and over banks and by the friction generated. This relationship was used to apply Muskingum-Cunge routing to the stream reaches in the model. This method represents the reach using channel length, an average cross section, and Manning's roughness coefficients. Figure 4.1.C shows a sample schematization of stream reaches. A Type II rainfall distribution developed for interior portions of the continental United States was used for modeling the storm events.

The Act 167 model parameters for subbasins and reaches are provided in Appendix B.

[1] *Merkel, References on Time of Concentration with Respect to Sheet Flow, National Water and Climate Center, 2001.*

Figure 4.1.A Subwatershed Delineation for the Wissahickon Watershed Showing 137 Subbasins.

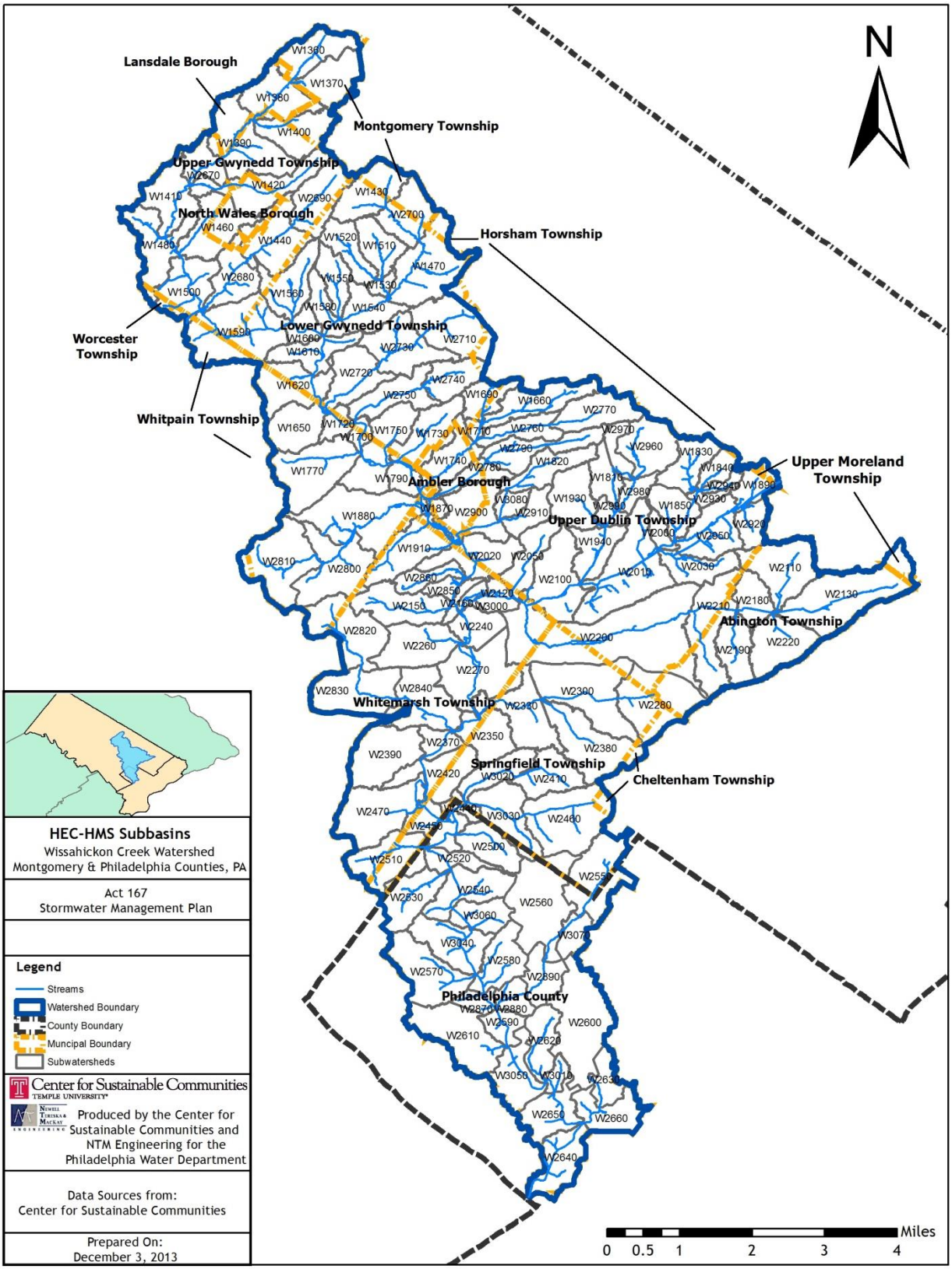


Figure 4.1.B NRCS Runoff Curve Numbers for Each of the 137 Subbasins

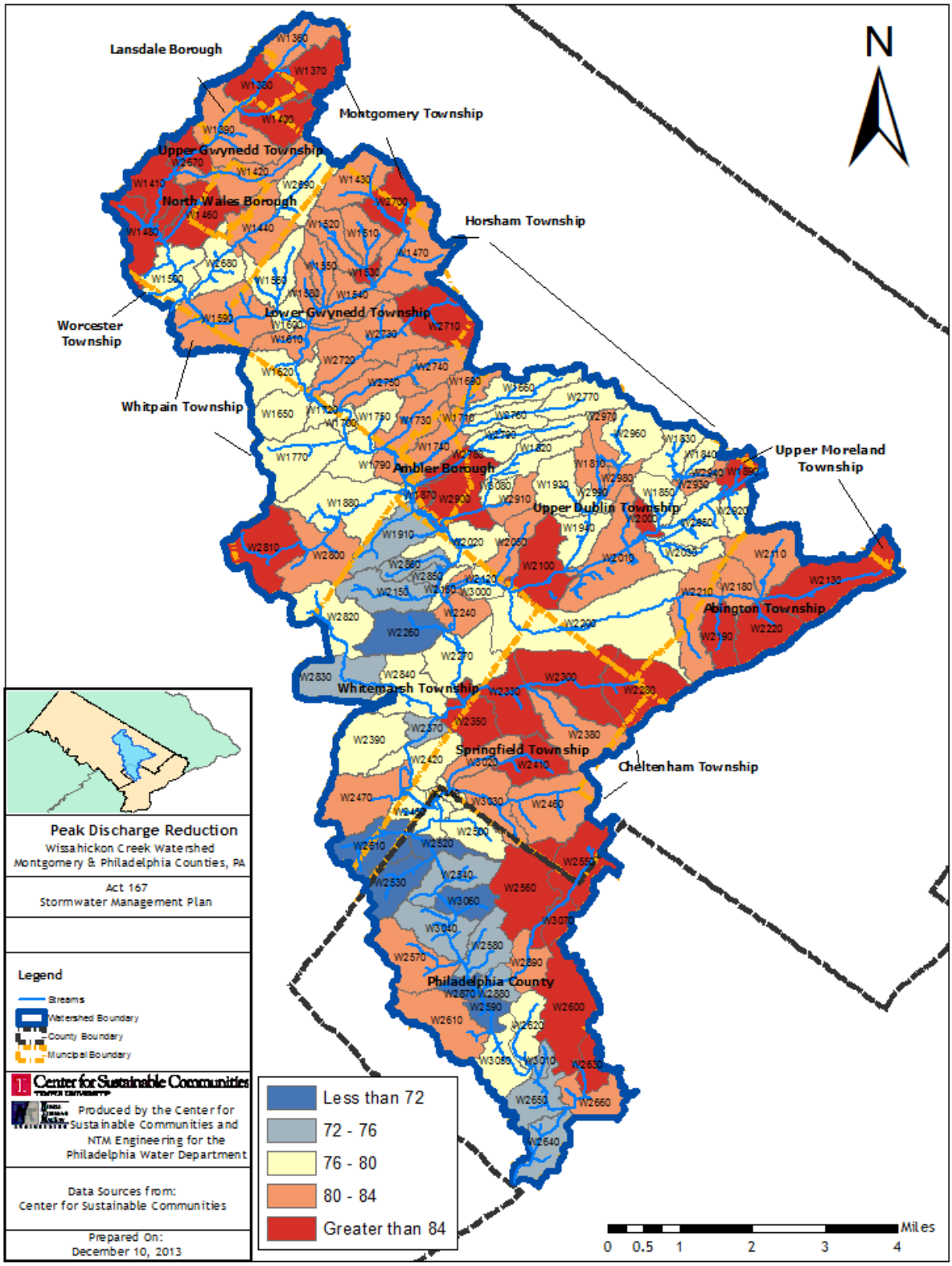
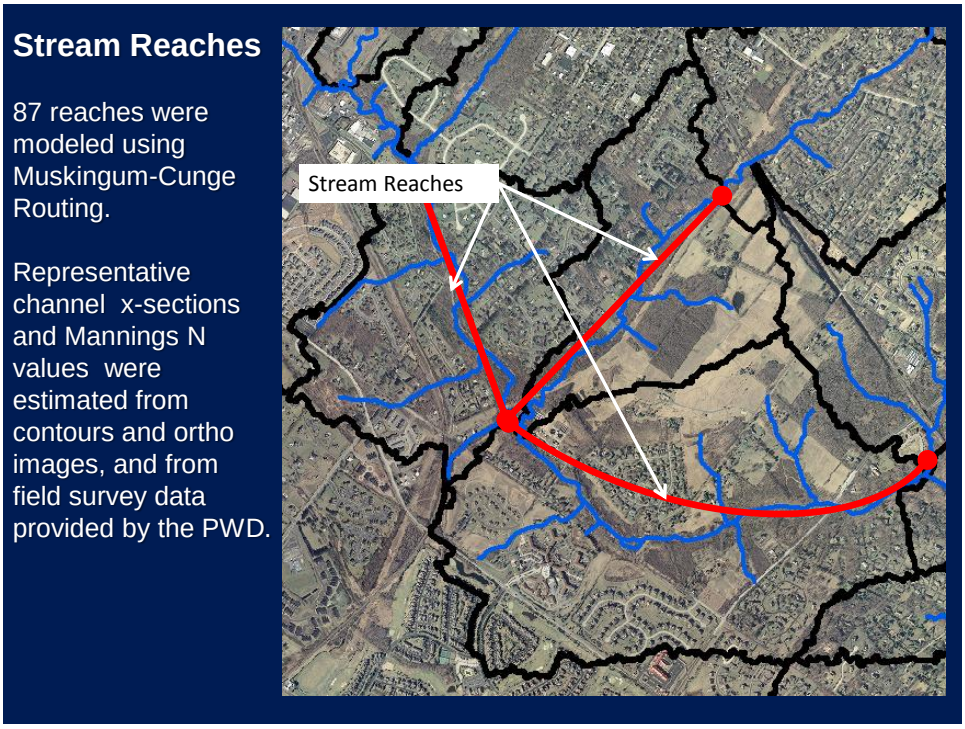


Figure 4.1.C Sample Stream Reach Schematization



4.2 Modeling Assumptions

Assumptions included in the hydrologic modeling affect the representation of the rainfall-runoff process and the potential applications of the model. The key modeling assumptions include:

- Subbasin properties are averaged for each subbasin area. Subbasin areas ranged from 0.06 to 2.11 square miles and averaged 0.46 square miles.
- The hydrologic impact of stormwater piping is not included in the modeling. The Tc for the subbasins was calculated based on surface features.
- For the design events, the same total volume and temporal distribution of rainfall is applied over each of the subbasins.
- Design storm precipitation totals were obtained from PennDOT's PDT-IDF curves based on NOAA Atlas 14.
- Design storm precipitation timing was assigned a Type II distribution, which concentrates most of the rainfall during the middle portion of the storm event.
- The maximum distance for sheet flow was assumed to be 100 feet.
- Curve Numbers for each subbasin were calculated so that the impervious cover associated with each land use type was included.
- Facilities with storage volumes larger than 5 Acre-Feet were modeled as reservoirs. For smaller facilities, the aggregate total of detention storage in each subbasin was considered additional potential storage. The Curve Number for each subbasin was adjusted downward to account for this using the NRCS Curve Number equation.
- Tc was calculated as the sum of sheet flow, shallow concentrated flow and channel flow. Subbasin lag was calculated as 0.6*Tc.

It is important to note that the scale of the model, while considered adequate for purposes of the Act 167 study, is not suitable for site level analysis or design.

4.3 Model Calibration

The hydrologic model developed for the Act 167 Plan included 137 subbasins for the 64-square mile Wissahickon Watershed. A schematic diagram of the model is shown in Figure 4.3.A. The model was based on Natural Resource Conservation Service (NRCS) Curve Number and Unit Hydrograph procedures available within the HEC-HMS modeling software and was developed by Temple University's Center for Sustainable Communities and calibrated by NTM Engineering following the general procedure outlined in Figure 4.3.B and detailed in the calibration report which is available upon request.

Figure 4.3.A Diagram of Wissahickon 137-Subbasin Hydrologic Model

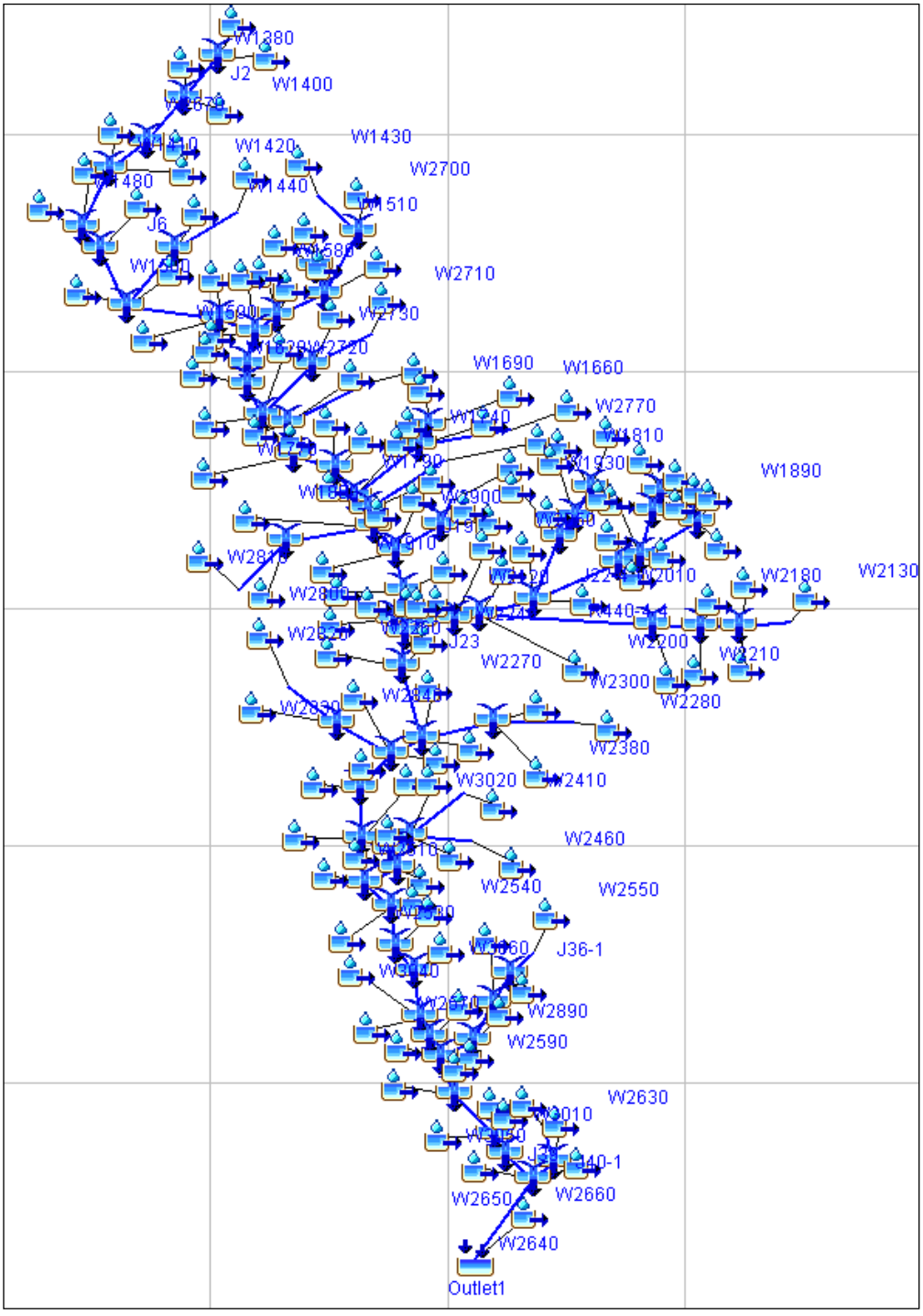
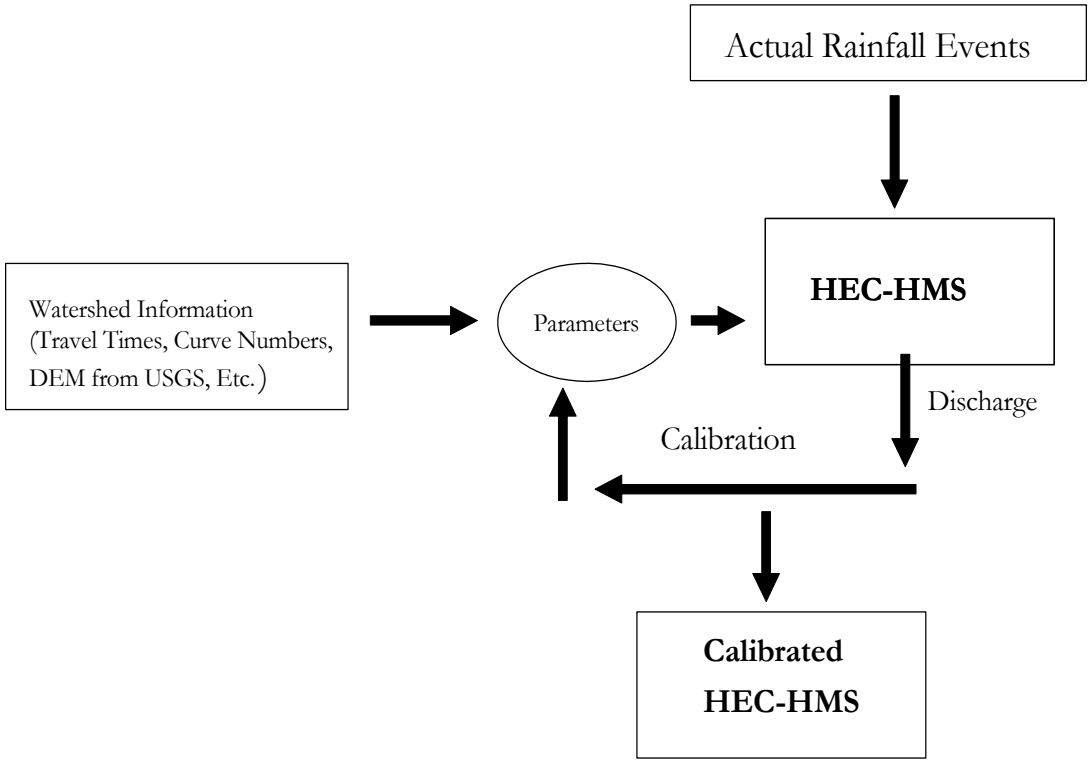


Figure 4.3.B Development and Calibration of the 137-Subbasin Hydrologic Model



4.4 Model Applications

The hydrologic model was applied to several components of the study. Each of the applications is summarized in this section.

- Evaluation of hydrologic impacts of land use change
- Determination of peak flow rates for identifying frequently flooded bridges and culverts
- Determination of peak rate control management districts included in the model ordinance
- Evaluation of runoff impacts of improved stormwater control through BMP applications

Evaluation of the Hydrologic Impacts of Future Land Use Change

Details of the two land use scenarios developed for this study are presented in Section 2.3. For each scenario, the projected land use was used to calculate revised curve numbers for each model subbasin. The new curve numbers were then used in the model to determine runoff volume and peak flow rates. The results were compared to existing conditions to determine the magnitude of the changes. A summary of the results is provided below.

Trend Scenario

This scenario projects that land use demand from Year 2040 projected population growth will be met under primarily through the use of available, non-restricted open space with suitable terrain.

The method used for this projection is described in Section 2.3. The purpose of the model run was to determine the additional runoff volume due to projected land use change only, in the absence of stormwater controls. While this model run does not include the stormwater measures that would normally be required for new development, it provides a measure of the runoff volume increase that could be expected in the Wissahickon Watershed in the absence of sustainable land use practices. For this scenario, runoff volume for the Wissahickon Creek at the mouth in Philadelphia increases by 1 percent during the 1-Yr storm event and increases by between 0.4 and 0.7 percent for larger storm events as shown in Figure 4.4.B. This small increase in volume reflects the slow rate of growth projected for the watershed as a whole. Subbasin runoff increases during the 1-Yr storm event are shown in Figure 4.4.A. Comparison with projected land use in Figure 2.3.A shows that the subbasins with the largest runoff volume increases are located on areas where significant new residential or non-residential land use is projected.

Green Scenario

The Green Scenario assumes that Year 2040 population growth can be met using higher density residential and non-residential development, with a focus on redevelopment and use of "stacked" or cluster and mixed land uses. The details of the assumptions for meeting land use demand are presented in Section 2.3. The purpose of the model run was to determine the reductions in runoff that this approach could offer versus the Trend Scenario. As with the Trend Scenario, the model run was performed without stormwater control measures in order to isolate the impact of the land use approach. The analysis showed that under the assumptions applied, runoff curve numbers were actually reduced slightly for a number of subbasins due to the use of developed land (already with a high curve number) to accommodate growth. Figure 4.4.B compares the aggregate runoff impact of the Green Scenario versus the Trend Scenario and Existing Condition. The results show that at the mouth of the Wissahickon Watershed runoff volume is reduced by 2 percent over the Trend Scenario and 1 percent over existing conditions. While these differences are small, the result supports the concept that land use management based on suitability criteria offers a means of control for future runoff volume that supplements the use of extended detention and other BMPs. In practice, site-by-site analysis of development or re-development is required to fully evaluate runoff impacts.

Future Conditions Evaluation

This study also included a model analysis of "Future Conditions" to evaluate the runoff impacts of potential stormwater control measures such as detention basin retrofits, infiltration, and restoration of riparian buffer areas. The Green Scenario was used to represent the future land use condition for this evaluation. This was done to account for changes in land use practices toward mixed use and clustering to accommodate new demand, given the highly developed status of the Wissahickon Watershed and the potential application of more sustainable land use practices. The results of the Future Conditions modeling are summarized at the end of this section.

Figure 4.4.A Volume Increase for 1-Yr Storm – Trend Scenario

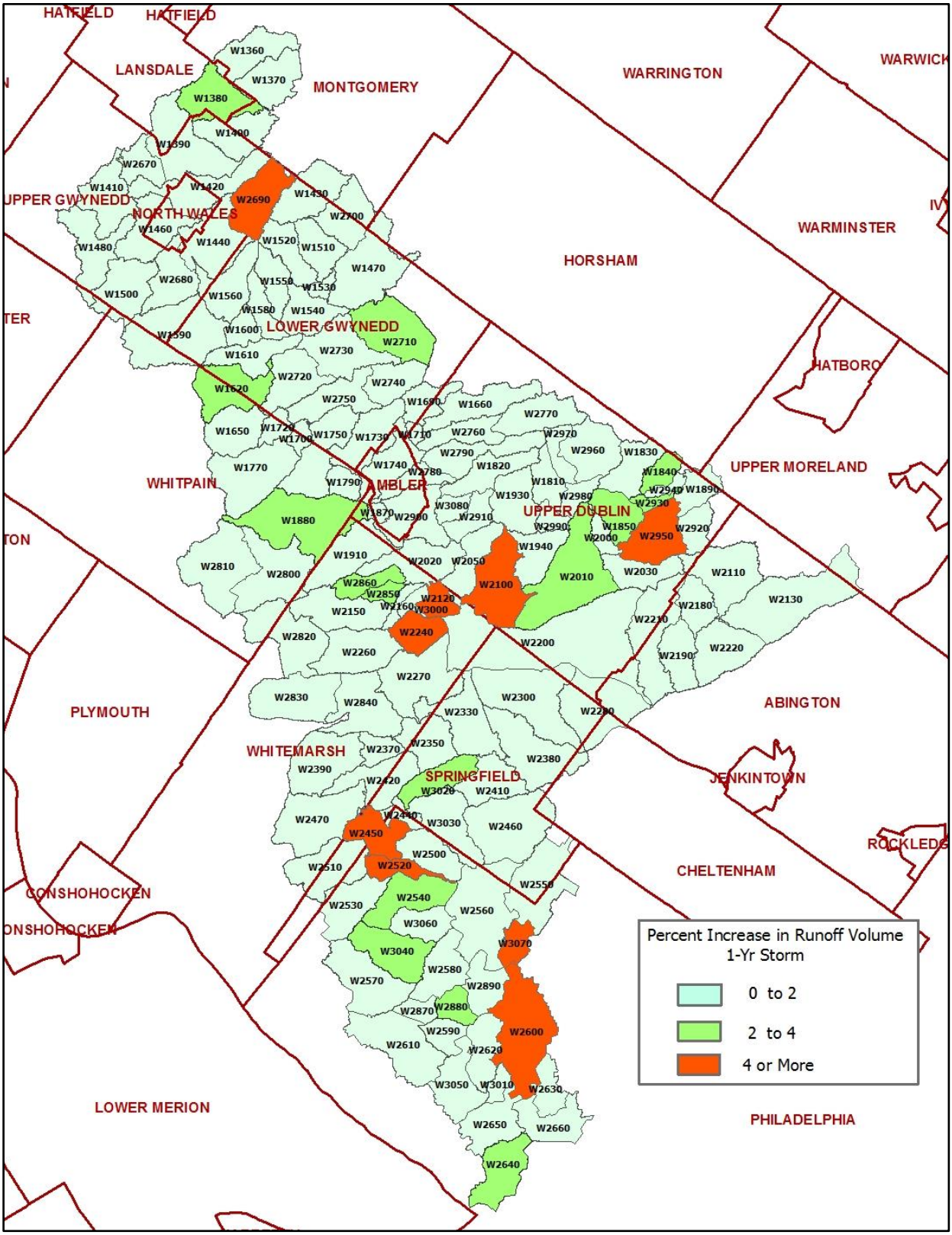
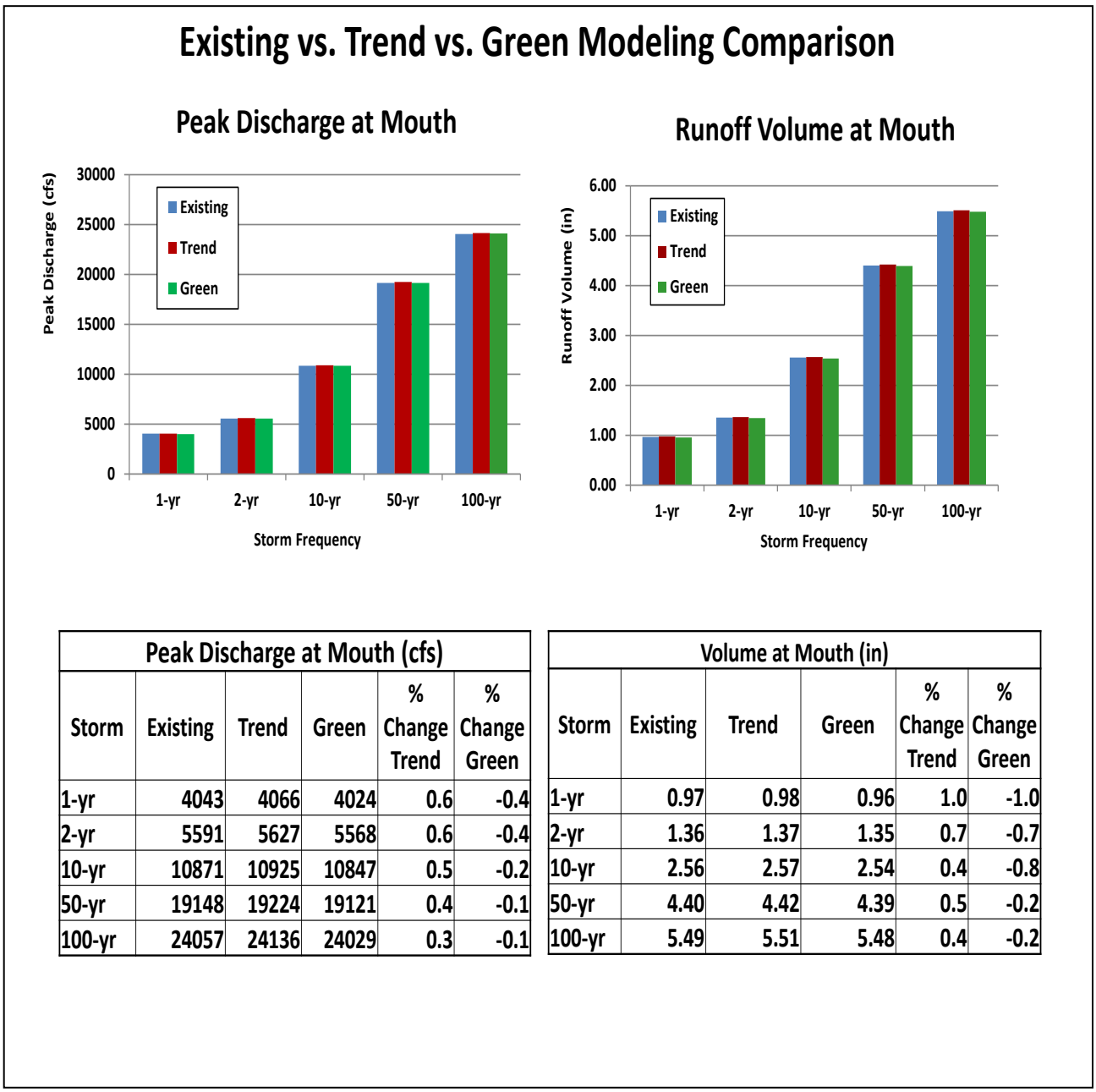


Figure 4.4.B Hydrologic Impact of Projections for Wissahickon Creek at Mouth



Peak Discharge at Mouth (cfs)					
Storm	Existing	Trend	Green	% Change Trend	% Change Green
1-yr	4043	4066	4024	0.6	-0.4
2-yr	5591	5627	5568	0.6	-0.4
10-yr	10871	10925	10847	0.5	-0.2
50-yr	19148	19224	19121	0.4	-0.1
100-yr	24057	24136	24029	0.3	-0.1

Volume at Mouth (in)					
Storm	Existing	Trend	Green	% Change Trend	% Change Green
1-yr	0.97	0.98	0.96	1.0	-1.0
2-yr	1.36	1.37	1.35	0.7	-0.7
10-yr	2.56	2.57	2.54	0.4	-0.8
50-yr	4.40	4.42	4.39	0.5	-0.2
100-yr	5.49	5.51	5.48	0.4	-0.2

Determination of Peak Flow Rates for Identifying Flood-Prone Bridges and Culverts

The hydrologic model was applied to determine obstructions (bridges and culverts) where capacities are most likely to be exceeded by flooding. PWD provided the CSC and NTM Engineering with a GIS shape file including 370 bridges and culverts located in the Wissahickon Watershed, that were identified as significant obstructions to flow. The PWD and the CSC preformed field measurements to update the dimensions of these structures. The study team then calculated the full flow capacity of most of these structures, accounting for the potential headwater upstream of the structure. The hydrologic model was used to calculate peak discharges at each obstruction for the 1-year, 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events. The discharges were then compared to the calculated capacity of each obstruction. The results of the comparison were presented in Figure 3.1.E as part of the description of flood problems in the watershed. The method applied does not take debris blockage or potential downstream submergence into account, but provides a screening tool to identify structures where the free flow capacity to convey flooding is most limited.

Determination of Peak Rate Control Management Districts Included in the Model Ordinance

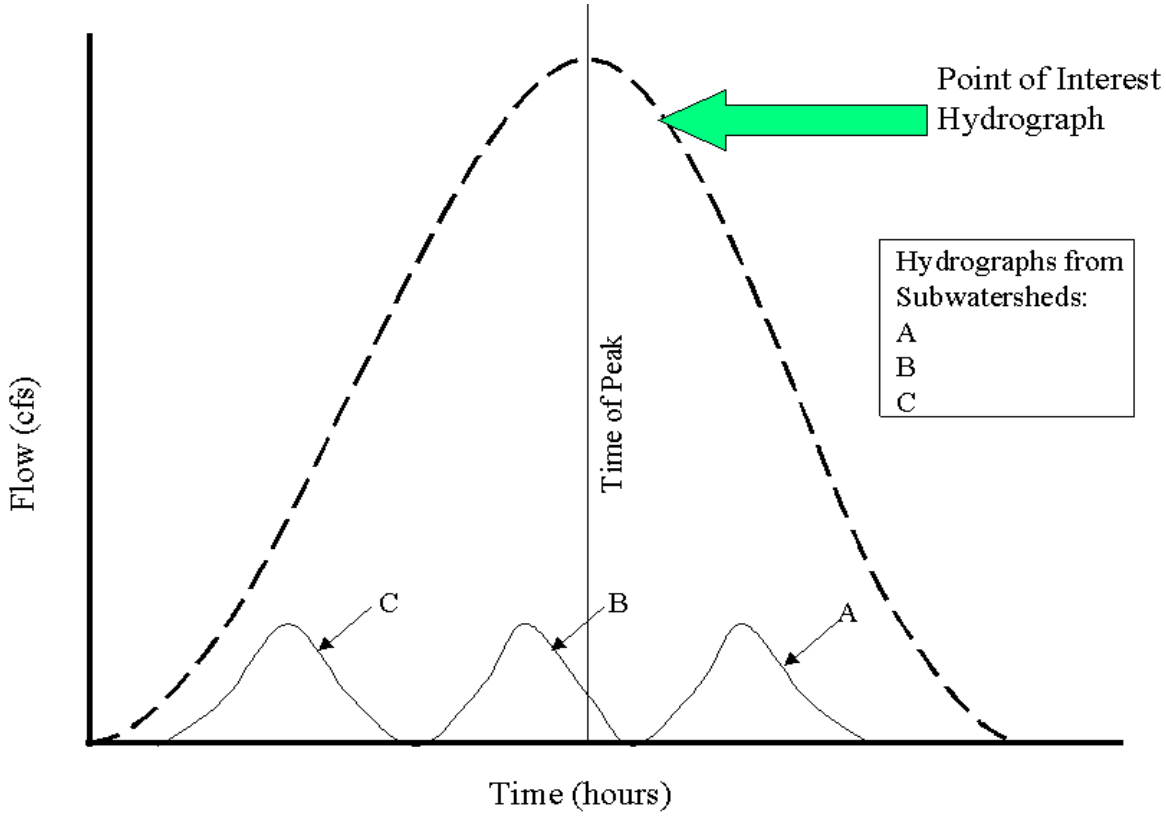
Stormwater management criteria include peak rate control in order to prevent post development flood discharge from exceeding pre-development discharge and worsening downstream flooding. Because detention basins used to control increased peak flows and runoff volumes from development also slow the timing of outflow, an understanding of runoff timing throughout the watershed is needed to establish peak rate criteria. Under some conditions, delaying runoff at a site can cause the peak from the site to better coincide with the peak from other parts of the watershed at downstream locations. This may occur even when the detention basin limits outflow so that there is no increase in the runoff rate from the site after development. This can worsen downstream flooding and increase erosion for a given storm. Because it accounts for the timing of flow through the subbasins and stream reaches, a hydrologic model is useful for defining post-development runoff rates that will prevent this situation from occurring.

The objective of modeling for peak rate control is to determine the flow contribution of different subareas in the watershed (model subbasins) to the peak discharge at various locations downstream, and then determine which subbasins can potentially worsen flooding at the downstream location if runoff is detained. The method follows the procedures presented by DeBarry for establishing stormwater management districts.[2] This analysis establishes "Points of Interest" and evaluates the effect of lagged hydrographs from portions of the watershed upstream to these points of interest as shown in Figure 4.4.C. The 50-year storm event was used in the modeling to determine routing time and flow contributions for a Type II storm event. The time required for discharge from each upstream subbasin to reach a given point of interest was determined on order to "lag" the subbasin hydrograph, and see how it actually contributes to the peak flow at the point of interest as it flows past the location. If the lagged peak flow from the subbasin occurs after the peak flow at the point of interest, then detention in that subbasin would not worsen flooding at that location as shown for Case A in Figure 4.4.C If it occurs before the peak, particularly as in Case B, detention can worsen flooding and a peak rate control is necessary to protect the point of interest. In general, for the Wissahickon Watershed, headwater subbasins

[2] *DeBarry, P.A., Watersheds, Processes, Assessment, and Management, John Wiley & Sons, Inc., 2004, Section 18.5.*

fall into the first category, while subbasins in the middle portions of the watershed fall into the second group.

Figure 4.4.C Points of Interest Method Used for Modeling to Determine Release Rates[3]



For subbasins where detention could worsen flooding, the ratio of the contributing discharge at the time of peak flow at the point of interest, to the peak flow of the subbasin, is taken as the "release rate" and can be expressed as a percentage. For example, a release rate of 70 percent means that the lagged subbasin flow at the time of the peak discharge at the point of interest is 70 percent of the subbasin peak flow. To prevent worsened flooding at the point of interest, detention to control new runoff volume should limit discharge to 70 percent of the pre-development peak. Release rates for all upstream subbasins were calculated for each point of interest shown in Figure 4.4.D, and the minimum release rate for each subbasin was then determined.

The release rates determined using the model were used to establish where rate controls should be applied to prevent detention at new development sites from increasing flood flows. The calculated release rates were then used to establish the stormwater management districts shown in Figure 4.4.E. These management districts are incorporated with the recommended stormwater management criteria in Section 5, and with the Ordinance in Appendix A.

[3] *DeBarry, P.A., Watersheds, Processes, Assessment, and Management, John Wiley & Sons, Inc., 2004, Figure 18.4.*

Figure 4.4.D Points of Interest Used for Modeling to Determine Release Rates

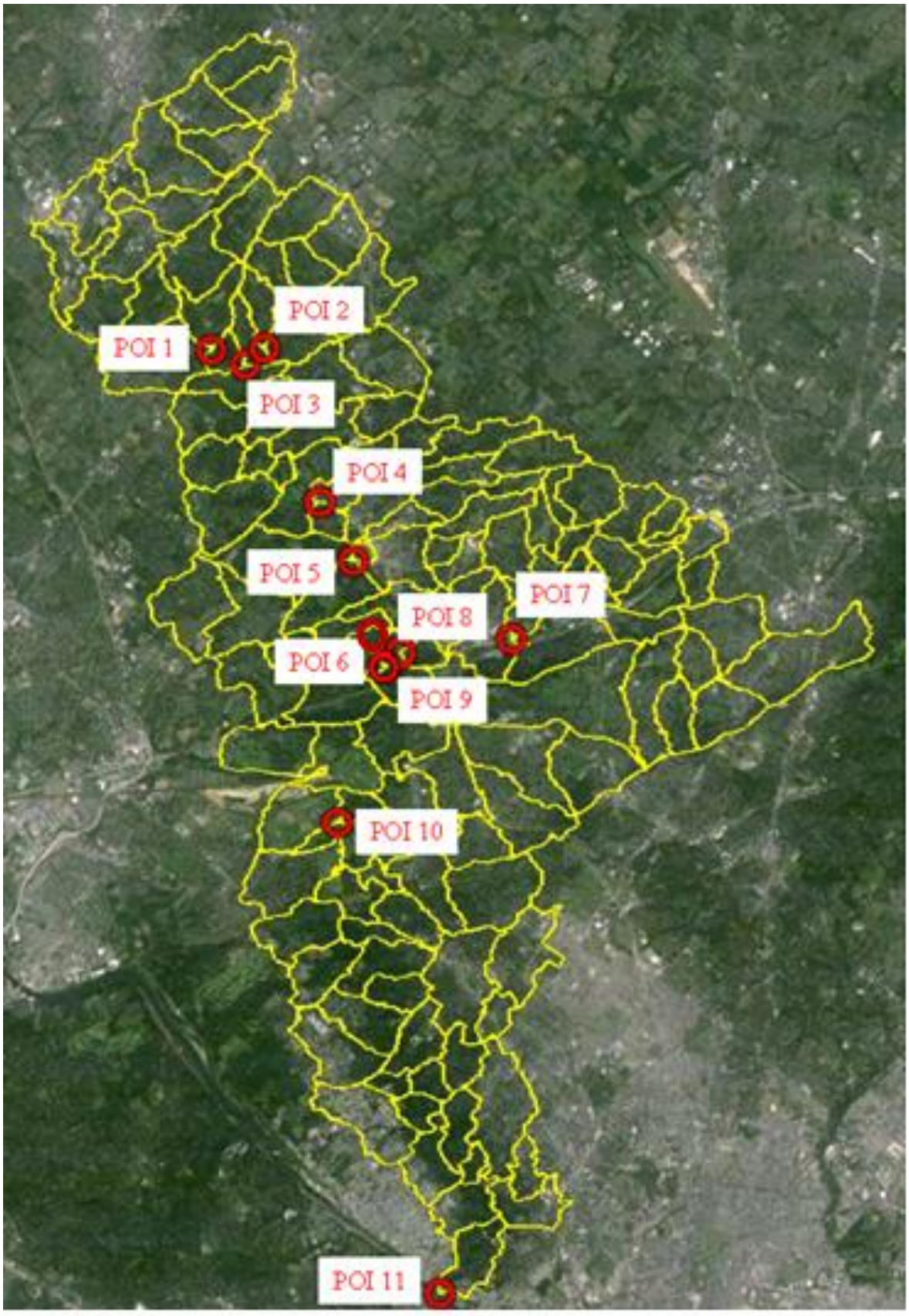
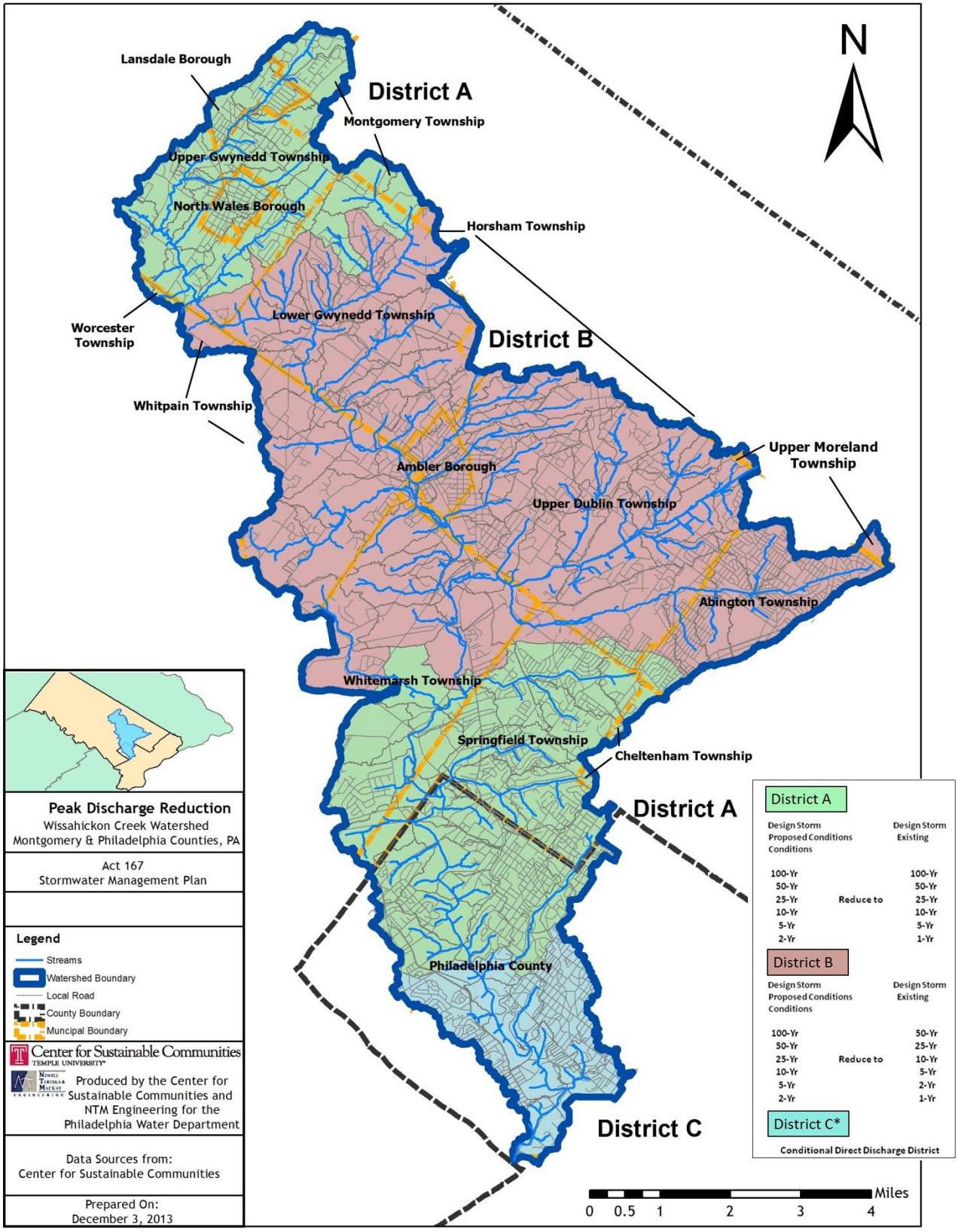


Figure 4.4.E Peak Rate Management District Map for the Wissahickon Watershed



Evaluation of Runoff Impacts of Improved Stormwater Control through BMP Applications

The hydrologic model was applied to a "Future Conditions" analysis to evaluate the hydrologic impact of implementing identified opportunities for installation and/or retrofitting of stormwater BMPs. These potential improvements are presented in Section 6 of this report. Three categories of BMP applications were considered: new or expanded detention, infiltration, and restoration of riparian buffers along stream corridors. For the modeling of potential stormwater improvements, several of the larger facilities were individually modeled in HEC-HMS as reservoirs, as were existing facilities with storage capacity exceeding 5 acre-ft.

Modeling of the proposed facilities included two new flood retarding structures on Rapp Run and Pine Run in the Sandy Run portion of the watershed. Design details for these structures were provided by URS, Inc. at the request of Upper Dublin Township. These on-stream structures are equipped with openings to allow passage of normal stream flows up to near bank-full stage. The structures provide a combined total of 270 acre-ft of flood storage at their spillway crests. These structures operate differently than off-stream extended detention facilities, which are equipped with outlet structures designed to retain runoff from small storms.

For the smaller detention facilities, the total storage was considered additional potential storage available during the course of a given storm event, and the Curve Number for the subbasin was adjusted downward using the NRCS Curve Number equation.[4] The total additional infiltration storage in each subbasin was modeled as initial abstraction, with one inch of storage assumed for most of the site areas. Restored riparian buffer acreage was also assumed to provide one inch of additional storage over the restored acreage and was modeled as initial abstraction. Projected land use for this model run was represented by the "Green Scenario" presented in the land use modeling discussion.

For existing conditions modeling, existing detention facilities were modeled in the same manner as for the future conditions run, with individual modeling of facilities with more than 5 acre-ft of storage capacity.

Details of the proposed improvements and their hydrologic impacts are discussed in Section 6.

The calibrated model developed for this study produces peak flow rates for the Sandy Run watershed that are lower than previous modeling by Temple University for its Fort Washington Area Study in 2008. The 2008 model was developed for the Sandy Run Watershed only and was not calibrated against observed data due to the lack of a stream gage in the watershed. Because the model for this study was developed for the entire Wissahickon Watershed, the calibration process utilized the only available stream gages on the Wissahickon Creek at Fort Washington and Philadelphia. For tributary areas in Sandy Run, the results for this model compare well with peak flow values calculated using Regional Regression equations developed by the U.S. Geological Survey.[5] Flow and precipitation measurement within the Sandy Run and other densely developed watershed would provide a bases for further model testing and frequency analysis.

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[4] *Urban Hydrology for Small Watersheds, TR55, Natural Resources Conservation Service, 1986*

[5] Roland, M.A., and Stuckey, M.H., 2008, Regression equations for estimating flood flows at selected recurrence intervals for ungaged streams in Pennsylvania: U.S. Geological Survey Scientific Investigations Report 2008-5102

Section 5: Criteria and Standards for New Development and Redevelopment in the Wissahickon Creek Watershed

This section provides a summary of the model stormwater management ordinance for the Wissahickon Creek Watershed as presented in Appendix A. The standards and criteria for the model ordinance were developed based on information from the following sources:

- The recently completed ordinance for the Poquessing Creek Watershed
- The approved ordinance for the Pennypack Creek Watershed
- Discussions with representatives from Philadelphia and Montgomery counties
- Hydrologic modeling results used to establish management districts for peak rate control
- Experience and professional judgment of the study team regarding effectiveness of stormwater requirements.

The objective of the model ordinance is to minimize the hydrologic and water quality impacts of future development and redevelopment in the watershed. Twenty one stream segments in the Wissahickon Creek Watershed have been included on Pennsylvania's 303(d) list due to siltation impairments. Most of these impairments can be attributed to urban runoff.[1] While adoption and enforcement of the ordinance would address the impacts of future development and redevelopment, the improvements in Section 6 are also recommended to address the current level of impairment by reducing stormwater flows and runoff volumes.

The municipalities should note that language could be added to the stormwater ordinance when it is adopted that would encourage or permit the municipality to study and collect data on existing components of the stormwater management system, such as detention basins, culverts and bridges, and their impact on stormwater flows. This could be required of a developer for these components of the stormwater management system that are affected by a proposed development. Additional requirements could be added to the ordinance that would enable the municipality to monitor and inspect private stormwater facilities and other constructed portions of the stormwater management system. This information could prove useful in identifying potential impairments and in developing a stormwater management program that reduces runoff and improves water quality.

Funding for such activities is always an issue. The municipality can include language on fees in the stormwater ordinance. This may be desirable, especially if the municipality is considering developing a stormwater authority or user-fee program. The municipalities should consider establishing a stable funding source by the method most suitable to the municipality to provide the funds needed to monitor and improve existing stormwater facilities and other components of the stormwater management system.

[1] *Comprehensive Characterization Report for the Pennypack Creek Watershed –Philadelphia Water Department, 2009.*

5.1 Model Ordinance Summary

The standards and criteria included in the model ordinance apply to regulated activities defined in Article I and vary based on the county of jurisdiction. The standards pertain to the following areas of potential impact as defined in Tables 106.1 of the Ordinance:

- Site Design and Drainage Plan Requirements
- Groundwater Recharge
- Water Volume Control
- Stream Bank Erosion (Channel Protection)
- Peak Rate Control

Article I, Section 103 requires that all legal water quality requirements under state law, including regulations at 25 Pennsylvania Code Chapter 93.4.a requiring protection and maintenance of "existing uses" and maintenance of the level of water quality to support those uses in all streams, and the protection and maintenance of water quality in "special protection" streams, be met.

Applicability and Exemptions (Article I, Sections 105 and 106) for Regulated Activities defined in Section 105 of the Ordinance are based on the area of earth disturbance and the area of impervious cover included in the project. The exemption thresholds vary by county. Exemptions may be denied by municipalities based on identified downstream problem areas, based on High Quality, or Exceptional Value stream designations, or based on known source water protection areas.

Article II, Section 202 of the Ordinance defines terms used in the Ordinance provisions.

Article III specifies stormwater management site plan requirements that must be addressed prior to issuance of land development plans, building or occupancy permits or land disturbance. Plan contents, including stormwater management and erosion and sedimentation plans, and submission requirements are specified.

Article IV contains the stormwater management criteria and provides additional details on the scope of application of these standards to regulated activities. Requirements for determining design storms, for groundwater recharge, water volume control, streambank erosion control, and peak runoff rate control, including acceptable calculation methodologies for determining runoff peaks and volumes, are provided.

Articles V thru IX cover inspections, fees and expenses, maintenance responsibilities, prohibitions, and enforcement and penalties, respectively.

The following two sections highlight the Applicability and Exemptions, and Stormwater Management Criteria provisions of the Ordinance.

5.2 Applicability and Exemptions

The following tables were taken from Section 106 of the ordinance and summarize its applicability to the Montgomery and Philadelphia counties portions of the watershed.

Table 5.2.A Exemptions for the Montgomery County Portion of the Watershed

Article or Section	Type of Project	Proposed New Impervious Cover						
		< 1000 sq. ft.			≥ 1000 to < 5,000 sq. ft.			≥ 5,000 sq. ft.
		Earth Disturbance <5,000 sq. ft.	Earth Disturbance ≥5,000 sq. ft. - 1 acre*	Earth Disturbance > 1 acre	Earth Disturbance <5,000 sq. ft.*	Earth Disturbance ≥5,000 sq. ft. - 1 acre*	Earth Disturbance > 1 acre	All Earth Disturbance Categories
Article III SWM Site Plan Requirements	Development and Redevelopment	Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt
Section 404 Nonstructural Project Design	Development and Redevelopment	Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt
Section 405 Groundwater Recharge	Development and Redevelopment	Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt
Section 406 Water Volume Control Requirements	Development and Redevelopment	Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt
Section 407 Stream Bank Erosion Requirements	Development	Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt	Not Exempt
	Redevelopment		Exempt		Exempt	Exempt		
Section 408 Stormwater Peak Rate Control and Management Districts	Development and Redevelopment	Exempt	Exempt	Not Exempt	Exempt	Exempt	Not Exempt	Not Exempt
Erosion and Sediment Pollution Control Plan	Earth Disturbance	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements
		(Refer to municipal earth disturbance requirements, as applicable)						

Notes:
Exempt – Exempt unless a determination is made by the municipality that the project is subject to Section 106.C.
Not Exempt – Not exempt. All provisions apply.
*Not exempt, but if a municipality has adopted the ordinance for the Small Project SWM Site Plan for Residential Development in Appendix B of the ordinance, such a plan may be submitted in lieu of the SWM Site Plan for residential development.

Table 5.2.B Exemptions for the Philadelphia Portion of the Watershed

Guide to Applicable Stormwater Regulations in Philadelphia Portion of the Watershed		Earth Disturbance Associated with Development			
		0-4,999 sq. ft.	500-14,999 sq. ft.*	15,000 sq. ft.-1 acre	> 1 acre
Section 600.5(a) Water Quality Requirement	New Development	N/A**	Yes	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Yes	Yes
Section 600.5(b) Channel Protection Requirement	New Development	N/A**	Yes	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Exempt	Yes (Alternate Criteria)
Section 600.5(c) Flood Control Requirement	New Development	N/A**	Yes	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Yes (Alternate Criteria)	Yes (Alternate Criteria)
Section 600.6 Nonstructural Project Design Requirement	New Development	N/A**	Yes	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Yes	Yes
Section 600.8 Post-Construction Stormwater Management Plan Requirement	New Development	N/A**	Yes	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Yes	Yes

Yes (Alternate Criteria) – requirements of section may be waived depending on post-development site conditions (See Sections 600.3(a)(3), 600.5(b) and 600.5(c), in addition to Section 14-510 of the Philadelphia Code, for further details).

N/A - Not Applicable, development project is not subject to requirements of indicated Regulations section. Voluntary controls are encouraged.

Any local, state, or federal requirements still apply.

*-Applies to Impervious Ground Coverage Categories 1-4 administered by the Philadelphia City Planning Commission.

**– If the proposed development results in stormwater discharge that exceeds stormwater system capacity, causes a combined sewer overflow, or degrades receiving waters, the design specifications presented in these Regulations may be applied to proposed development activities as warranted to protect public health, safety, or property.

5.3 Stormwater Management Criteria

Article IV, Section 401 of the Ordinance sets forth General Requirements.

Sections 402, 403, and 404, pertain respectively to Permit Requirements of Other Governmental Entities, Erosion and Sediment Control During Regulated Earth Disturbance Activities, and Nonstructural Project Design.

Section 405.A.1 contains minimum requirements for Infiltration Best Management Practices (BMPs), and Section 405.A.2 establishes volume criteria for the infiltration facilities, which are computed differently for Montgomery and Philadelphia counties, as follows:

Montgomery County Portion of the Watershed

Where practicable and appropriate the recharge volume shall be infiltrated on site. The recharge volume shall be equal to one (1.0) inch of runoff (I) over all proposed impervious surfaces.

The Re_v required shall be computed as:

$$\mathbf{Re_v = (1/12) * (I)}$$

Where:
Re_v = Recharge Volume (cubic feet)
I = Impervious Area within the limits of earth disturbance (square feet)

An asterisk (*) in equations denotes multiplication.

Philadelphia County Portion of the Watershed

The recharge volume shall be equal to one (1.0) inch of rainfall over all **DCIA within the limits of Earth Disturbance**.

$$\mathbf{Re_v = (1/12) * (I)}$$

Where:
Re_v = Recharge Volume (cubic feet)
I = DCIA within the limits of earth disturbance (square feet)

An asterisk (*) in equations denotes multiplication.

Section 405.B sets forth the required soils evaluations on project sites to determine the suitability of proposed infiltration facilities.

Section 406 states the Water Volume Control Requirements, which are excerpted from Section 303 of the Pennsylvania Model Stormwater Ordinance [2] *(Note: Montgomery and Philadelphia counties will follow different Water Volume Control requirements.)*

Montgomery County Portion of the Watershed:

The low impact development practices provided in the Pennsylvania BMP Manual shall be utilized for all regulated activities to the maximum extent practicable. Water Volume Controls shall be implemented using the *Design Storm Method* in Subsection A or the *Simplified Method* in Subsection B below. For regulated activity areas equal to or less than one (1) acre that do not require hydrologic routing to design the stormwater facilities, this Ordinance establishes no preference for either methodology; therefore, the applicant may select either methodology on the basis of economic considerations, the intrinsic limitations on applicability of the analytical procedures associated with each methodology, and other factors. All regulated activities greater than one (1) acre must use the Design Storm Method.

A. The *Design Storm Method* (CG-1 in the BMP Manual) is applicable to any size of regulated activity. This method requires detailed modeling or calculations based on site conditions.

   1. The post-development total runoff volume for all storms equal to or less than the 2-year, 24-hour storm event shall not be increased.

   2. For modeling purposes:
      a. Existing (predevelopment) non-forested pervious areas must be considered meadow.
      b. 20% of existing impervious area, when present, shall be considered meadow in the model for existing conditions.

B. The *Simplified Method* (CG-2 in the Pennsylvania BMP Manual) provided below is independent of site conditions and should be used if the *Design Storm Method* is not followed. This method is not applicable to regulated activities greater than one (1) acre, or for projects that require design of stormwater storage facilities. For new impervious surfaces:

   1. Stormwater facilities shall capture at least the first two (2) inches of runoff from all new impervious surfaces. *(Note: An asterisk (*) in equations denotes multiplication.)*

      Volume (cubic feet) = (2/12) * Impervious Surfaces (square feet)

   2. At least the first one (1) inch of runoff from new impervious surfaces shall be permanently removed from the runoff flow-- i.e., it shall not be released into

[2] *Department of Environmental Protection, Bureau of Watershed Management, Document Number 363-03000-003, September 2, 2010.*

the surface waters of the Commonwealth. Removal options include reuse, evaporation, transpiration, and infiltration.

Volume (cubic feet) = (1/12) * Impervious Surfaces (square feet)

3. Wherever possible, infiltration facilities should be designed to accommodate infiltration of the entire permanently removed runoff; however, in all cases at least the first half (0.5) inch of the permanently removed runoff should be infiltrated.

4. Sites that qualify for this method are exempt from the requirements of Section 408, Peak Rate Controls.

Philadelphia County Portion of the Watershed:

The following equation is to be used to determine the Water Volume Control storage requirement in cubic feet for regulated activities within the Wissahickon Creek Watershed in Philadelphia County:

Water Volume Control (cubic feet) = (1/12) * (I)

Where: I = DCIA within the limits of earth disturbance (square feet)

Section 407 sets forth the requirements for the control of Stream Bank Erosion. Montgomery and Philadelphia counties will follow different requirements. If a municipality has adopted a riparian corridor ordinance or regulation, the more restrictive requirement shall apply.

Section 408 sets forth Stormwater Peak Rate Control Standards by Management Districts. The standards are shown Table 5.3.A below. Appendix A of the ordinance includes the map of the management districts as shown in Figure 5.3.A.

Section 409 specifies calculation methodologies that shall be used for the design of stormwater management facilities.

TABLE 5.3.A PEAK RATE CONTROL STANDARDS BY STORMWATER MANAGEMENT DISTRICT IN THE WISSAHICKON CREEK WATERSHED

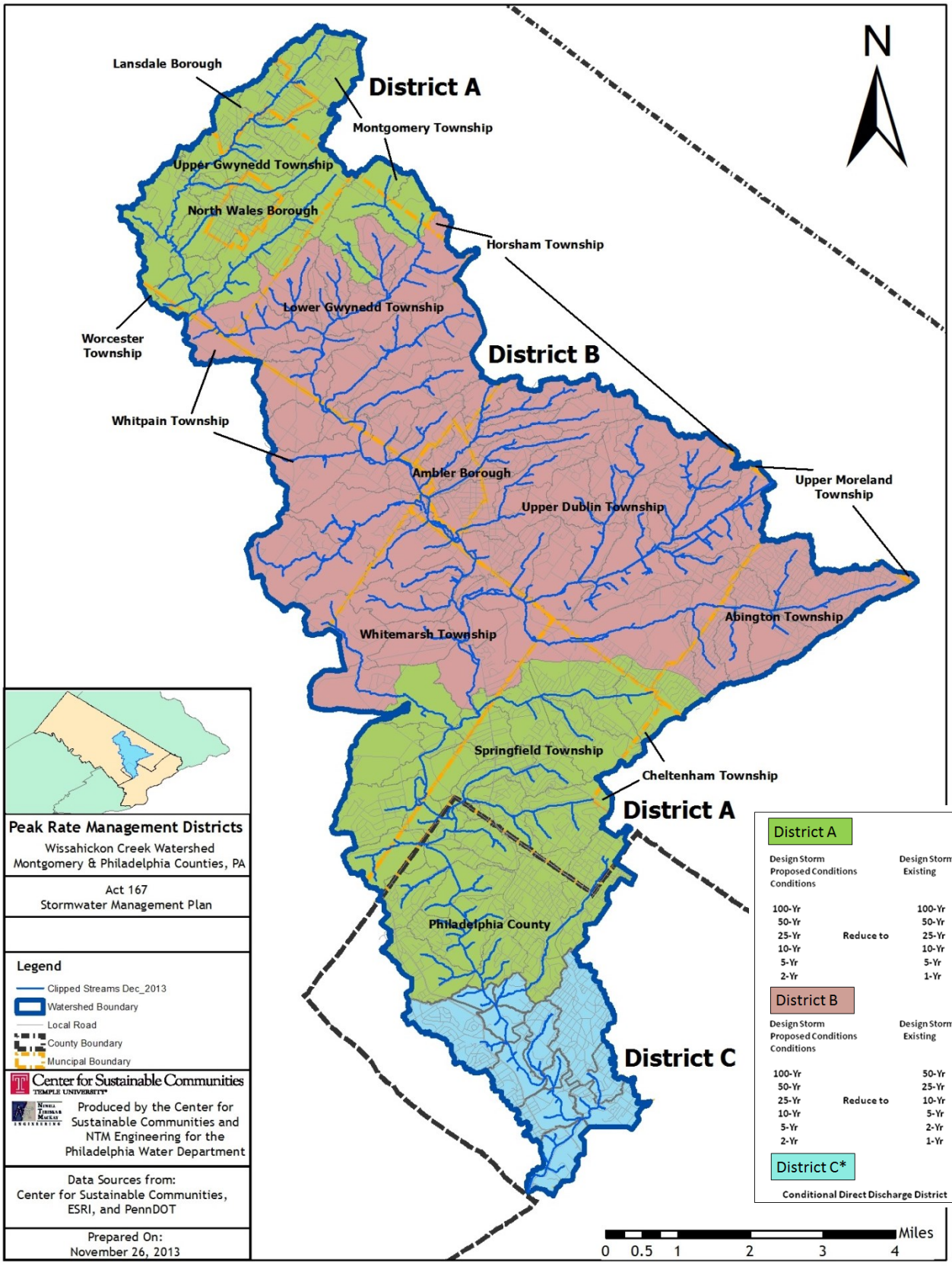
District	Proposed Condition Design Storm		Existing Condition Design Storm
A	2-year	Reduce to	1-year
	5-year		5-year
	10-year		10-year
	25-year		25-year
	50-year		50-year
	100-year		100-year
B	2-year	Reduce to	1-year
	5-year		2-year
	10-year		5-year
	25-year		10-year
	50-year		25-year
	100-year		50-year
C*	Conditional Direct Discharge District		

In District C, development sites that can discharge directly to the Wissahickon Creek Main Channel and to the Schuylkill River main channel without use of City infrastructure may do so without control of proposed conditions peak rate of runoff.

Projects that are required to obtain a NPDES Permit for stormwater discharges associated with construction activities are required to show no increase in peaks from existing conditions.

When adequate capacity in the downstream system does not exist and will not be provided through improvements, the proposed conditions peak rate of runoff must be controlled to the Predevelopment Conditions peak rate as required in District A provisions for the specified Design Storms. The Predevelopment Condition for new development is the existing condition. For redevelopment purposes in Philadelphia County, the Predevelopment Condition shall be determined according to the procedures found in the Philadelphia Stormwater Guidance Manual.

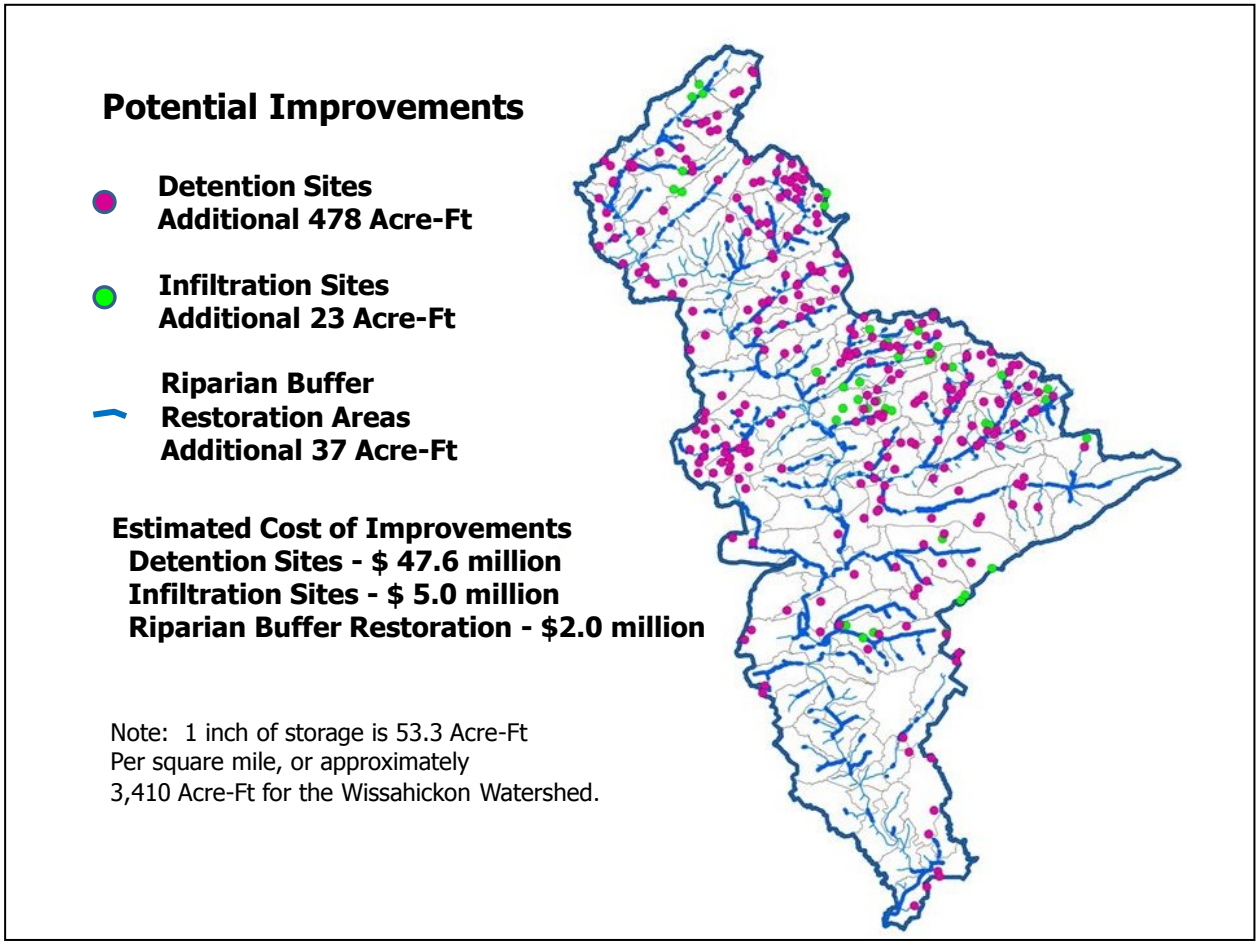
Figure 5.3.A Proposed Peak Rate Control Management Districts



Section 6: Stormwater Improvements

A major objective of this study was to identify opportunities for improvements to address the widespread water quality impairments caused by stormwater runoff in the Wissahickon Creek Watershed. Three classes of sites were evaluated for their potential to provide expanded or new storage. These included new and retro-fit detention basins, potential infiltration sites, and stream reaches for potential restoration of riparian buffers. The distribution of these sites in the watershed is shown in Figure 6.A, along with the aggregate total storage volume and estimated total cost for each category. Appendix C provides the estimated storage and costs for the improvements at the identified facilities. The following sections summarize the evaluation steps and present additional results of hydrologic modeling of the improvements. The facilities were also ranked based on factors including catchment area, cost, and watershed location. The ranking method allows for cross-comparison of all sites.

Figure 6.A Distribution of Potential Improvements in the Wissahickon Watershed



6.1 Detention Storage Facilities

A total of 277 existing and potential detention sites were inventoried. GIS files with the locations and dimensions for 185 of these facilities were provided by the Philadelphia Water Department (PWD). The remaining sites were added by the Center for Sustainable Communities (CSC) based on field inspections as well as review of orthophotography and terrain data. Existing inventoried sites with surface areas greater than a quarter of an acre were field inspected. Factors considered for evaluating potential expansion included:

- Property access
- Drainage or flood risk to nearby properties if berm height were increased
- Water table with respect to the floor of the facility if the floor were lowered
- Availability of adjacent property for expansion

Sites where increased berm height or lowered floors appeared feasible were considered for expansion. For most sites with areas less than a quarter of an acre, a recommendation was made to both increase berm height and lower the basin floor by one foot. In some cases, increased floodplain storage was recommended as a means of providing additional detention, rather than construction of a detention facility in the floodplain. Generally, such areas are recommended as constructed wetlands. A total of 241 sites were recommended for new or expanded detention, including floodplain storage sites. Recommendations were also made to improve outlet structures and revegetate basin floors to increase extended detention. The Detention Spreadsheet in Appendix C lists the existing and potential increased storage at each of the detention sites, and provides estimated costs of the improvements. Cost estimates include 35% for design and contingency, and assumed union labor rates. A ranking based on the catchment area (a measure of the potential for extended detention during small storms), cost, and watershed locations is also included to provide a possible means of prioritizing sites. A GIS shape file is also included for detailed mapping of the improvement location, such as that shown in Figure 6.1.A. The spreadsheet includes the following fields:

- Site ID
- Subbasin
- Municipality
- Cross reference to Site ID used in the Fort Washington Area Study where applicable
- Location or nearby intersection
- Public or Private Ownership
- Current Land Use
- Receiving Watershed
- Existing Depth
- Existing Area
- Existing Volume
- Potential Additional Volume
- Estimated Cost
- Notes regarding the improvement
- Priority ranking assigned to the facility

Figure 6.1.A Sample Detention Basin Site Map

Site UD_139 – Potential Detention/Constructed Wetland in Upper Dublin Township
On Temple University Campus between baseball field and Susquehanna Road
Potential New Storage = 3.2 Acre-Ft Estimated Cost = $320,000

The total of existing storage from detention basins and ponds in the Wissahickon Watershed is estimated at 387 acre-feet. Potential additional storage would provide an additional 478 acre-feet of storage. This total includes 270 acre-feet of storage (to the spillway crest elevation) from the Rapp Run and Pine Run flood retarding structures in Upper Dublin Township which were constructed during the course of this study and are in place as of December 2013.

6.2 Potential Infiltration Sites

Opportunities for additional infiltration were based on field inspections of 41 sites where installation of stone-filled trenches or galleries could provide storage for runoff from large rooftops, parking areas, or athletic fields. Cost estimates were based on the design of infiltration trenches to provide storage for one inch of runoff, or four inches in several cases where infiltration galleries were recommended. The average cost for construction of infiltration facilities is over $4 per acre-ft. of storage, making infiltration more costly than detention or riparian buffer restoration. The total combined area of the identified infiltration sites is 179 acres, and the estimated infiltration volume is 23 acre-feet. The inventory focused on larger sites rather than individual residential properties where the installation of such measures as pervious paving or rain gardens could also increase

infiltration. The Infiltration Spreadsheet in Appendix C lists the infiltration sites and includes the following data fields:

- Site ID
- Municipality
- Cross reference to Site ID used in original Fort Washington Area Study where applicable
- Location/Intersection
- Public or Private Ownership
- Current Land Use
- Watershed receiving largest share of site runoff
- Notes
- Infiltration Area
- Potential Infiltration Volume
- Estimated Cost
- Site Ranking

A GIS file for the infiltration sites is also provided in Appendix C and sample mapping for one of the sites is shown in Figure 6.2.A.

Figure 6.2.A Sample Infiltration Site

Site UD_4B – Potential Infiltration Site in Upper Dublin Township
Student Parking Lot on Temple University Campus
Potential New Storage = 0.67 Acre-Ft Estimated Cost = $128,000

6.3 Riparian Buffer Restoration

An inventory conducted by the Heritage Conservancy in 2000 and updated in 2010 identified stream reaches where riparian stream buffers could be restored on either one or both sides of streams in the Wissahickon watershed. The distribution of these locations is shown in Figure 3.2.A. To estimate the potential additional storage available, the study team assumed an average buffer width of 75 feet for each side of the stream and an average runoff volume reduction of one inch. The estimated acreage and cost of re-establishing the buffers by municipality is presented in Table 6.3.A. The total additional storage volume provided to the watershed would be 37 acre-feet. Riparian buffer restoration has the lowest average cost of the three improvement categories. It should be noted however, that land use conditions have changed in

some areas since the survey was completed in 2000. Actual buffer width would vary significantly from site to site, and buffers may no longer be feasible at some locations. The lack of acceptance by property owners can also limit re-establishing buffers. GIS file with the locations of the identified buffer restoration locations is provided in Appendix C, and a sample site map is shown in Figure 6.3.A.

Table 6.3.A Potential Total Riparian Buffer Restoration Areas by Municipality

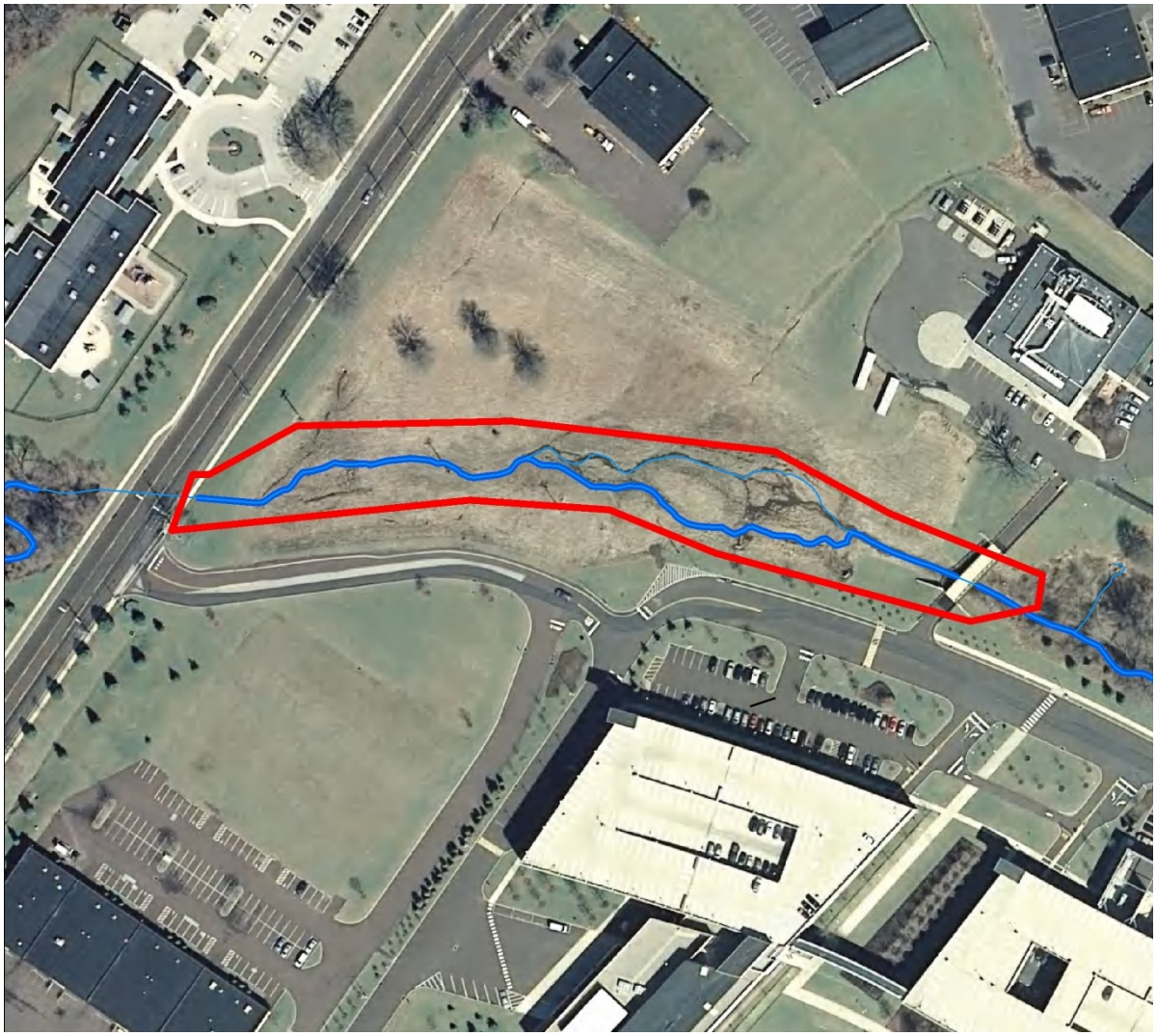
Municipality	*Acreage Requiring Riparian Buffers	**Cost Assuming $4,500 per acre	Rounded-Up Cost	Primary Affected Streams	***Average Volume Reduction per event (Acre-feet)
Abington	23.27	104,723	$105,000	Sandy Run	1.9
Ambler	5.96	26,830	$27,000	Wissahickon Creek, Rose Valley Creek	0.5
Lansdale	6.89	31,020	$32,000	Wissahickon Creek	0.6
Lower Gwynedd	68.12	306,549	$307,000	Wissahickon Creek, Penllyn Creek, Trewellyn Run, Willow Run	5.7
Montgomery	6.79	30,553	$31,000	Wissahickon Creek, Trewellyn Run	0.6
North Wales	2.84	12,797	$13,000	Tributary to Wissahickon Creek	0.2
Philadelphia	88.76	399,422	$400,000	Wissahickon Creek, Cresheim Creek	7.4
Springfield	83.34	375,032	$376,000	Wissahickon Creek, Paper Mill Run, Sunny Brook	6.9
Upper Dublin	106.22	478,008	$479,000	Sandy Run, Pine Run, Rapp Run, Tannery Run, Rose Valley Creek	8.9
Upper Gwynedd	50.40	226,778	$227,000	Wissahickon Creek, Haines Run	4.2
Whitemarsh	103.06	463,761	$464,000	Wissahickon Creek, Sandy Run	8.6
Whitpain	47.47	213,619	$214,000	Wissahickon Creek, Prophecy Creek, Willow Run	4.0

*Updated base data on riparian buffer needs were obtained from the Heritage Conservancy. These data indicate stream lengths requiring a riparian buffer, either on one side or both sides of the stream. The CSC assumed an average buffer width of 75 feet, recognizing that 50 feet may be appropriate for some locations and 100 feet for others. Acreage was derived using GIS analysis.

**Cost assumes 430 three- to four- foot high trees per acre, protective tubes, stakes, and labor, including some replacement in the second year.

*** Average volume reduction is an average value per event and assumed to be an inch of water per acre. The reduction would be the greater in the summer during dry periods, and substantially less in the winter during wet periods.

Figure 6.3.A Sample Riparian Buffer Restoration Site
Tributary to Wissahickon Creek near Dickerson Road in Upper Gwynedd Township
Potential for buffer restoration on both sides of stream



6.4 Hydrologic and Water Quality Impact of the Proposed Improvements

In order to reduce runoff peaks and volumes, a series of improvements to the watershed were evaluated. These improvements included:

- Retrofitting detention basins by rearranging the outlet structure, increasing volume by excavation or increasing berm height, etc.
- Proposing new infiltration sites
- Protecting and restoring riparian buffers to promote infiltration
- Proposing planned residential development with green infrastructure
- Promote LID/cluster development

These improvements were incorporated into a "Future Conditions" HEC-HMS model run.
The modeling approach is summarized in Section 4.4 of this report. The combined potential additional storage provided by the three categories of improvements is estimated at 539 acre-feet, or 180 million gallons (assuming that the Pine Run and Rapp Run facilities are filled to their spillway crest elevations). This volume of storage is equivalent to 0.16 inches of runoff from the 63.5 square mile watershed.

Table 6.4.A shows the modeled percentage change in peak discharge and runoff volume for two locations in the Wissahickon Watershed with the improvements in place. The modeling indicates that cumulative flow and volume reductions would accrue to the watershed, with the largest impacts in the upstream portion of the watershed. In particular, the two large flood reduction facilities currently nearing completion on Rapp Run and Pine Run have a noticeable impact on outflow from the Sandy Run Watershed during large flood events. Table 6.4.B compares the peak flows for the future conditions run at several locations throughout the watershed to the peak flows for existing conditions in addition to peaks for the Green and Trend land use scenarios.

Table 6.4.A Impact of Proposed Improvements on Peak Discharge and Runoff Volume

Upstream of Sandy Run		
Storm	% difference in Peak Discharge	% difference in Runoff Volume
1-yr	-6%	-3%
2-yr	-5%	-3%
10-yr	-4%	-2%
50-yr	-4%	-2%
100-yr	-3%	-1%

Downstream of Sandy Run		
Storm	% difference in Peak Discharge	% difference in Runoff Volume
1-yr	-5%	-4%
2-yr	-4%	-3%
10-yr	-10%	-2%
50-yr	-7%	-2%
100-yr	-5%	-1%

Sandy Run		
Storm	% difference in Peak Discharge	% difference in Runoff Volume
1-yr	-8%	-5%
2-yr	-12%	-4%
10-yr	-23%	-3%
50-yr	-20%	-2%
100-yr	-11%	-2%

At Mouth		
Storm	% difference in Peak Discharge	% difference in Runoff Volume
1-yr	-5%	-4%
2-yr	-4%	-3%
10-yr	-7%	-2%
50-yr	-7%	-2%
100-yr	-5%	-1%

Table 6.4.B Comparison of Existing, Trend, Green, and Future Peak Flows (cfs)

Upstream of Sandy Run				
Storm	Existing	Trend	Green	Future
1-yr	2910.8	2927.3	2896.8	2750.7
2-yr	3914.6	3935.3	3897.5	3735.5
10-yr	7150.7	7162.9	7140.0	6843.4
50-yr	12217.5	12255.1	12212.0	11762.0
100-yr	15276.1	15317.1	15272.0	14797.5

Downstream of Sandy Run				
Storm	Existing	Trend	Green	Future
1-yr	3534.2	3553.8	3520.3	3343.0
2-yr	4967.8	4996.7	4944.7	4788.1
10-yr	10425.8	10475.4	10399.4	9407.4
50-yr	18738.8	18805.1	18720.0	17426.0
100-yr	23678.6	23732.8	23660.4	22528.0

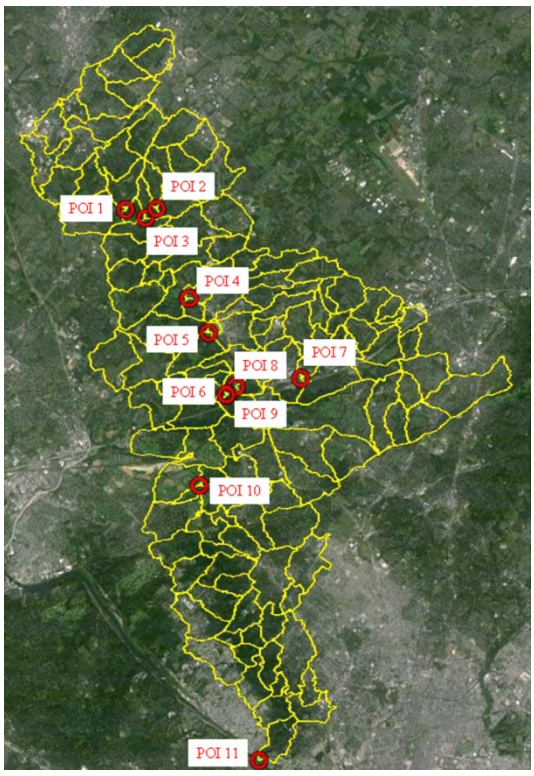
Sandy Run				
Storm	Existing	Trend	Green	Future
1-yr	1294.1	1303.8	1286.0	1196.1
2-yr	2038.2	2057.7	2028.8	1789.3
10-yr	4384.3	4410.3	4372.0	3372.2
50-yr	7657.8	7698.2	7639.9	6115.4
100-yr	9641.7	9662.8	9620.7	8569.2

At Mouth				
Storm	Existing	Trend	Green	Future
1-yr	4042.5	4066.1	4023.7	3850.2
2-yr	5591.4	5627.4	5568.3	5360.5
10-yr	10871.1	10925.4	10846.9	10118.1
50-yr	19148.4	19224.2	19121.4	17853.8
100-yr	24057.3	24135.8	24029.3	22773.0

Peak flow reductions for the 10-year event at additional of points of interest throughout the watershed are provided in Table 6.4.C. These locations are the same as those used in the modeling to determine the peak rate control management districts and are shown in the inset map below**.**

Table 6.4.C Existing and Future Conditions Peak Flows for the 10-year Event

Point of Interest	Existing Peak Flow (cfs)	Future Conditions Peak Flow (cfs)
J8 (POI-1)	3288.1	3189.7
J9-4 (POI-2)	2071.4	1939.3
J9 (POI-3)	3974.3	3923.8
J15 (POI-4)	5585.4	5357.9
J18 (POI-5)	6966.1	6681.2
J21 (POI-6)	7150.7	6843.4
J22-4 (POI-7)	2309.4	1159.6
J22-7 (POI-8)	4384.3	3372.2
J22 (POI-9)	10415.0	9391.3
J26 (POI-10)	10556.7	9663.2
Outlet 1 (POI-11)	10871.1	10118.1



The distribution of the proposed improvements is the most concentrated in the upper half of the watershed, where peak flow and runoff volume reductions would have the most far-reaching effects and benefit the greatest number of stormwater problem areas along the Wissahickon Creek and tributaries.

For existing facilities that were individually modeled, the peak flow and accumulated storage for the 10-Yr design storm are shown in Tables 6.4.D. The results show the significant reductions in peak flow immediately downstream resulting from improvements to these facilities. In some cases, upstream improvements also lower the inflow to a given facility for the future condition. Because the drainage area that is controlled by the off-stream detention facilities is only a small fraction of the watershed area, the peak reduction percentages are diminished for locations further downstream.

Table 6.4.D Inflow, Outflow, and Storage for the 10-year Event before and after Improvements to Existing Facilities

Detention Basin	Existing 10-year Inflow (cfs)	Existing 10-year Outflow (cfs)	Existing Peak 10-year Storage (ac-ft)	With Improvements 10-year Inflow (cfs)	With Improvements 10-year Outflow (cfs)	With Improvements Peak 10-year Storage (ac-ft)
AB_1	139.6	68.2	5.5	124.8	27.4	8.6
LG_10	19.7	2.1	2.9	19.6	1.3	3
LG_11	20.4	14.1	3.0	20.4	2.5	2.7
LG_26	10.6	9.8	0.2	10.6	2.7	1
Loch Alsh	190.7	60.7	22.6	185.8	29.5	24.4
MO_2[a]	110.2	66.6	4.6	109.2	68.9	5.6
St. Mary's Lake	98.2	81.3	8.3	100.5	53.5	11.7
UD_43	17.1	6.2	1.8	17.3	1.9	3
WP_10	6.7	4.9	0.6	6.7	1	1.2
WP_2	27.3	17.6	1.4	27.3	2.0	4.1
WP_3	44.3	23.3	2.6	44.3	4.8	6.1

a) For site MO_2, outflow is slightly higher for the 10-Yr storm in the proposed condition due to modeled outlet improvements that include addition of a 2 square foot high flow outlet to prevent overtopping of the spillway during the 100-Yr storm.

Similar model results for proposed facilities during the 10-Yr storm event are summarized in Table 6.4.E. These facilities include the newly constructed Pine Run (UD_138) and Rapp Run (UD_137) flood retarding structures in Upper Dublin Township. The modeling for this study shows that these structures provide reductions in peak flow rates of hundreds of cubic feet per second once inflowing stream stage exceeds a near bank-full condition. The structures are equipped with large spillways to meet safety requirements during extreme events. Flood reductions are still significant but reduced during events such as the 100-Yr storm because the spillways are overtopped. The structures provide a combined flood storage volume of 270 acre-ft to their spillway crests and 431 acre-ft at full spillway capacity. They are designed as flood control rather than extended detention facilities and convey flows up to near bank-full stage through a 4 foot x 4 foot opening in each structure in order not to impede normal stream flow.

Table 6.4.E Inflow, Outflow, and Storage for the 10-year Event - Proposed Facilities

Detention Basin	Existing 10-year Inflow (cfs)	Existing 10-year Outflow (cfs)	Existing Peak 10-year Storage (ac-ft)	With Improvements 10-year Inflow (cfs)	With Improvements 10-year Outflow (cfs)	With Improvements 10-year Storage (ac-ft
LG_41	N/A	N/A	N/A	1722.9	1678.2	10.2
UD_137	N/A	N/A	N/A	773.1	292.1	56.8
UD_138	N/A	N/A	N/A	840.5	288.25	61.8
UD_140	N/A	N/A	N/A	237.7	231.7	7.1
UD_52	N/A	N/A	N/A	28.6	3.4	2.4
UD_57	N/A	N/A	N/A	44.2	2.3	2.1
UD_69	N/A	N/A	N/A	22.3	0.9	2.2
WP_29	N/A	N/A	N/A	29.8	3.6	2.2

N/A – Existing inflow, outflow, and storage were listed as N/A for proposed new detention basins.

Flow reductions due to the potential stormwater improvements were calculated at each of 370 bridges and culverts inventoried as part of this study. For 31 of these structures, the design storm exceeding the capacity would shift to a less frequent event. This lowered flood frequency would help reduce structural damage to culverts and bridges and reduce instances of hazardous driving conditions at roadway crossings.

Figures 6.4.A and 6.4.B provide maps showing the modeled percent reduction in peak discharge and runoff volume from each subbasin predicted by the hydrologic model with the recommended improvements in place during the 10-year storm. The reduction in peak flows and volumes ranged from 0-40.5% and from 0-31.8%, respectively. The net effect of these reductions at the selected points of interest is shown in Table 6.4.C. Also, Tables 6.4.A and 6.4.B show the combined effects of the improvements at several locations for each of the design storms. There are a few subbasins with small increases in peak flow or volume (noted on the map with a negative reduction percentage). This is due to slightly increased curve numbers for future development, which are not compensated for by greener development practices, riparian buffer restoration, or increased infiltration and detention in the subwatershed. In some locations downstream from potential improvements, the reduction in peak flow rates is sufficient to reduce water surface elevations for smaller storms. Figure 6.4.C shows a reduction of approximately one foot in the water surface profile for the 2-Yr storm along a section of Rose Valley Creek in the Ambler area of Montgomery County.

The reductions in peak flow and volume would help reduce scour and erosion potential along stream reaches, and would be helpful where stream restoration is planned or has been completed. For example, PWD has been working to return streams to their natural state and create stable, healthy waterways able to sustain native vegetation and aquatic life. The year 2011 saw the restoration of Bells Mill—a 5,100-foot tributary to the Wissahickon with grading and rock structures in place that will help stabilize the streambank and reduce erosion as seen in Figure 6.4.D. Elsewhere in the Wissahickon watershed, stormwater wetlands at Cathedral Run and Wises Mill began functioning this year. These wetlands mitigate the impact of stormwater flows, reduce the amount of sediment that ends up in the streams and increase the diversity of aquatic vegetation in those wetland areas. In addition to reducing erosion rates, the facilities recommended by this study would provide for settling and storage of sediment in runoff and reduce sediment loading in the watershed.

Figure 6.4.A Reduction in Subbasin Peak Flow Rates for the 10-year Event With Proposed Improvements in Place

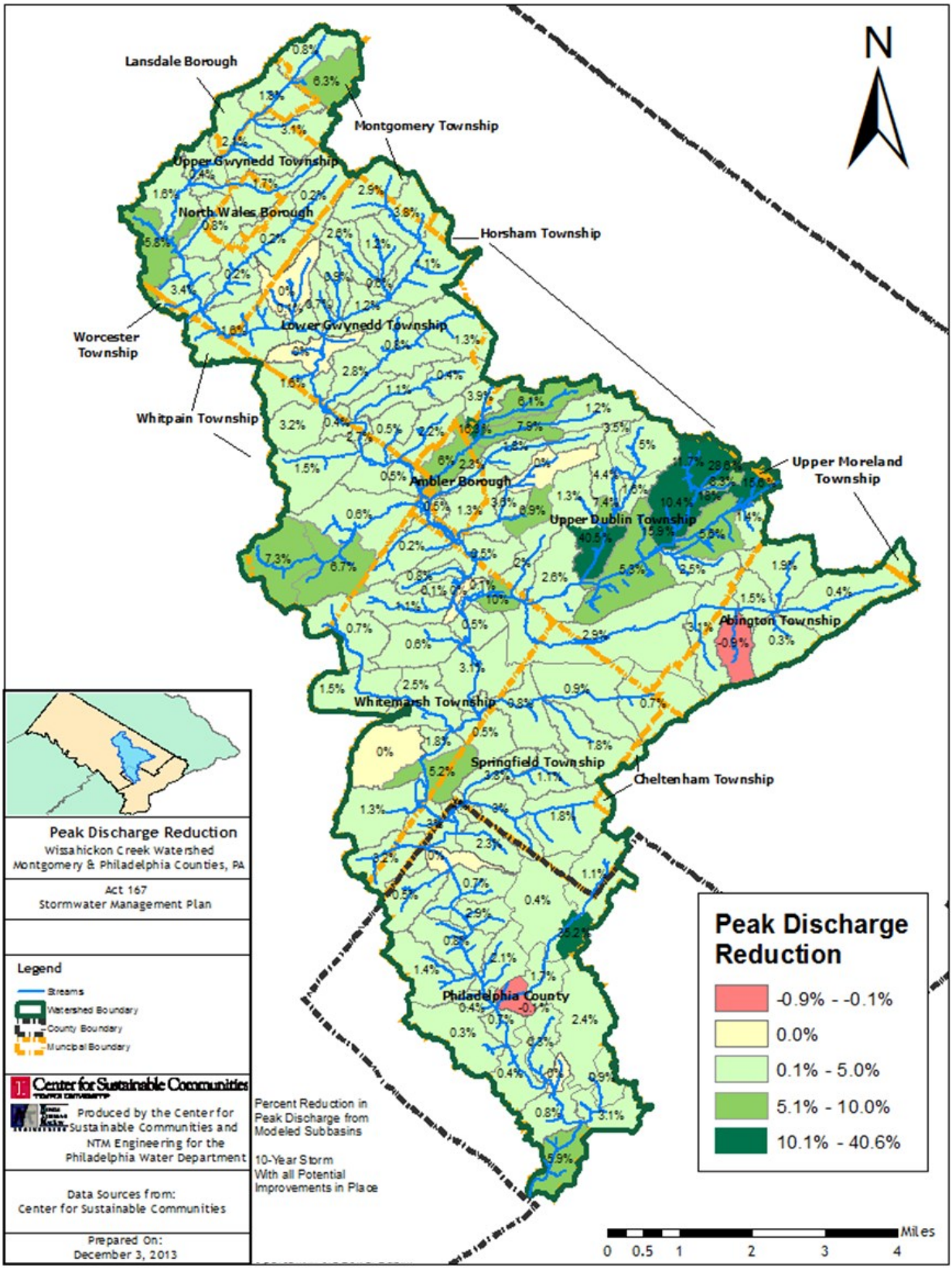


Figure 6.4.B Reduction in Subbasin Flow Volume for the 10-year Event With Proposed Improvements in Place

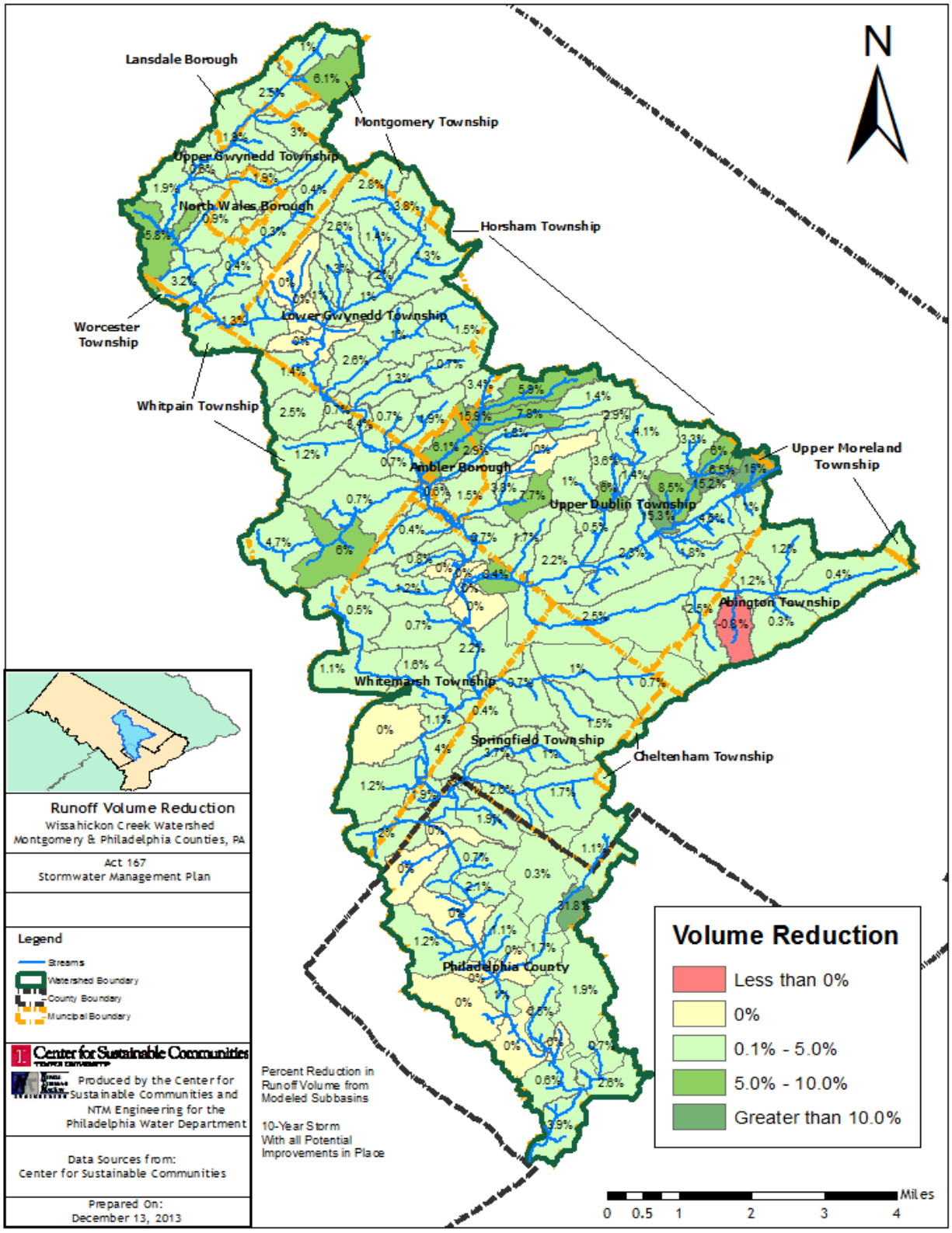


Figure 6.4.C Water Surface Elevation Profiles for 2-Yr Design Storm
Rose Valley Creek in Ambler and West Ambler, Montgomery County

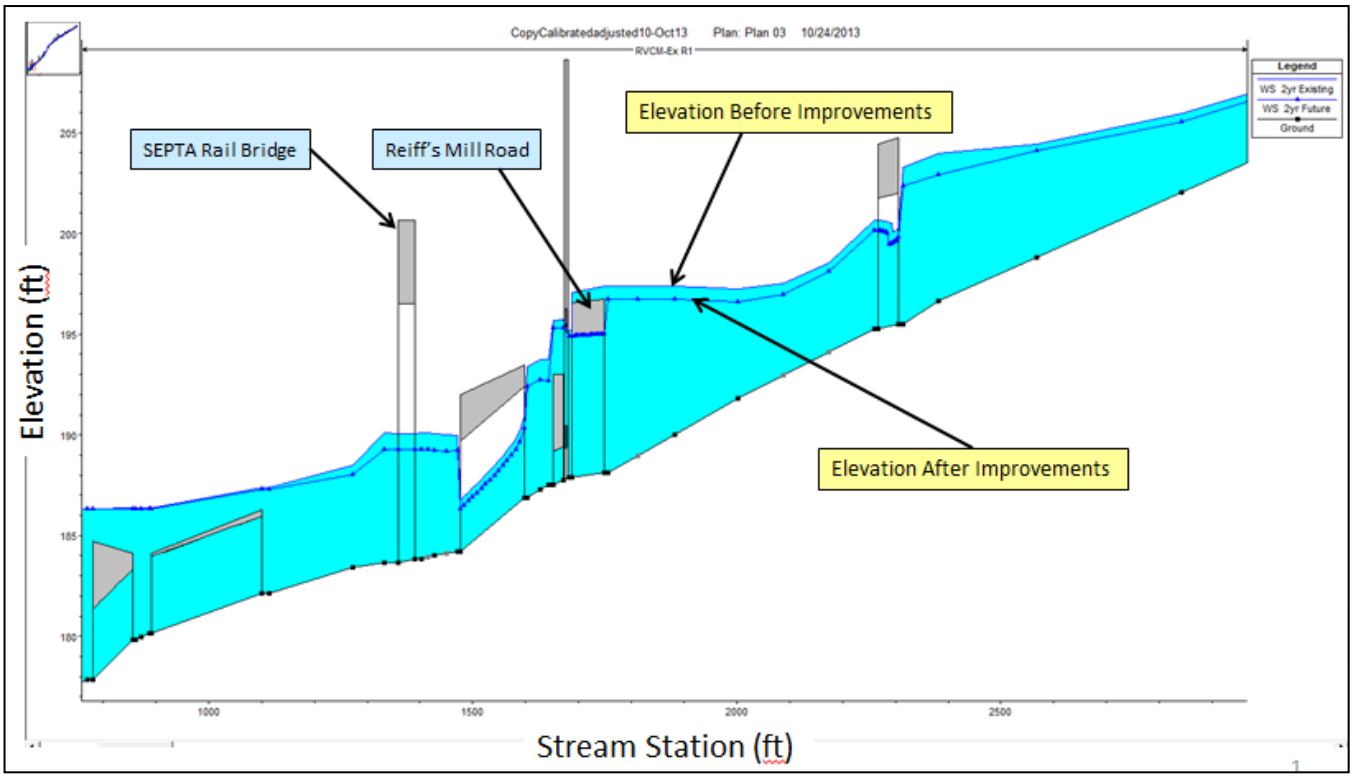


Figure 6.4.D Bells Mill Run Stream Restoration

6.5 Improvement Site Ranking

To provide a means of prioritizing further investigation of the proposed improvements, each site was rated based on three factors:

- Effective use of additional storage during small storms. This was assigned a weight of 50 percent of the total ranking. Storage at infiltration and riparian buffer restoration sites was assumed to be fully used during small storms. Use of detention storage during small storms was assumed to vary based on the ratio of the catchment area to the existing detention volume. Those detention basins where sufficient runoff would be available for additional detention during the 1-year storm received the highest score.
- Cost per acre-foot of storage provided by the site- this was assigned a weight of 25 percent of the total score.
- Location in the watershed, with the upstream portion of the watershed receiving the highest score- this was assigned a weight of 25 percent of the total score.

Figure 6.5.A shows the rankings of the detention and infiltration sites using the criteria described above. Based on this preliminary screening, sites with the higher score should receive first consideration for further site evaluation and funding. Figure 6.5.B shows the location of potential riparian buffer sites identified by the Heritage Conservancy on one or both sides of streams. All riparian restoration sites have a ranking score of 1.5 or higher.

Figure 6.5.A Location and Rank of Proposed Detention and Infiltration Improvements

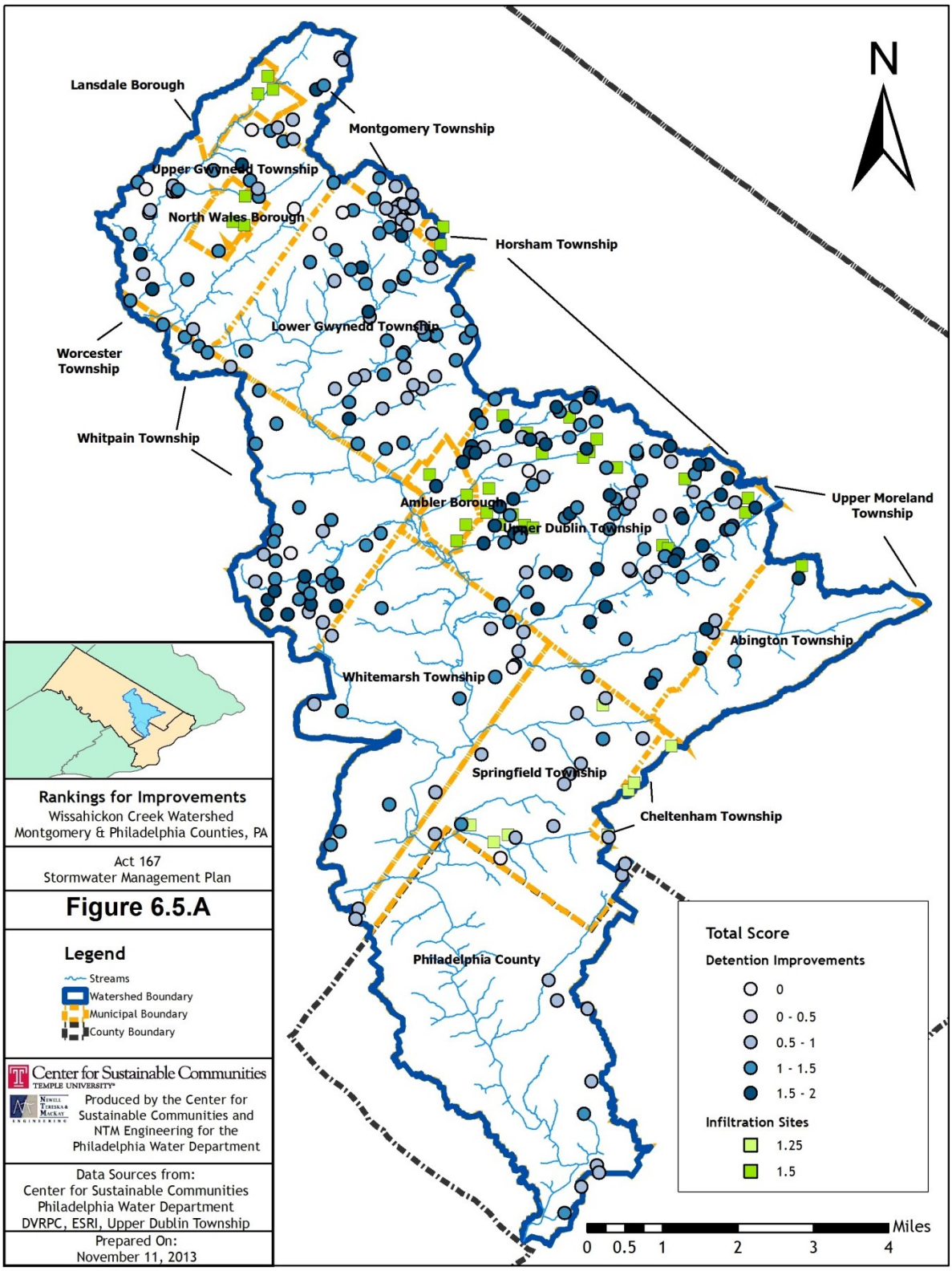
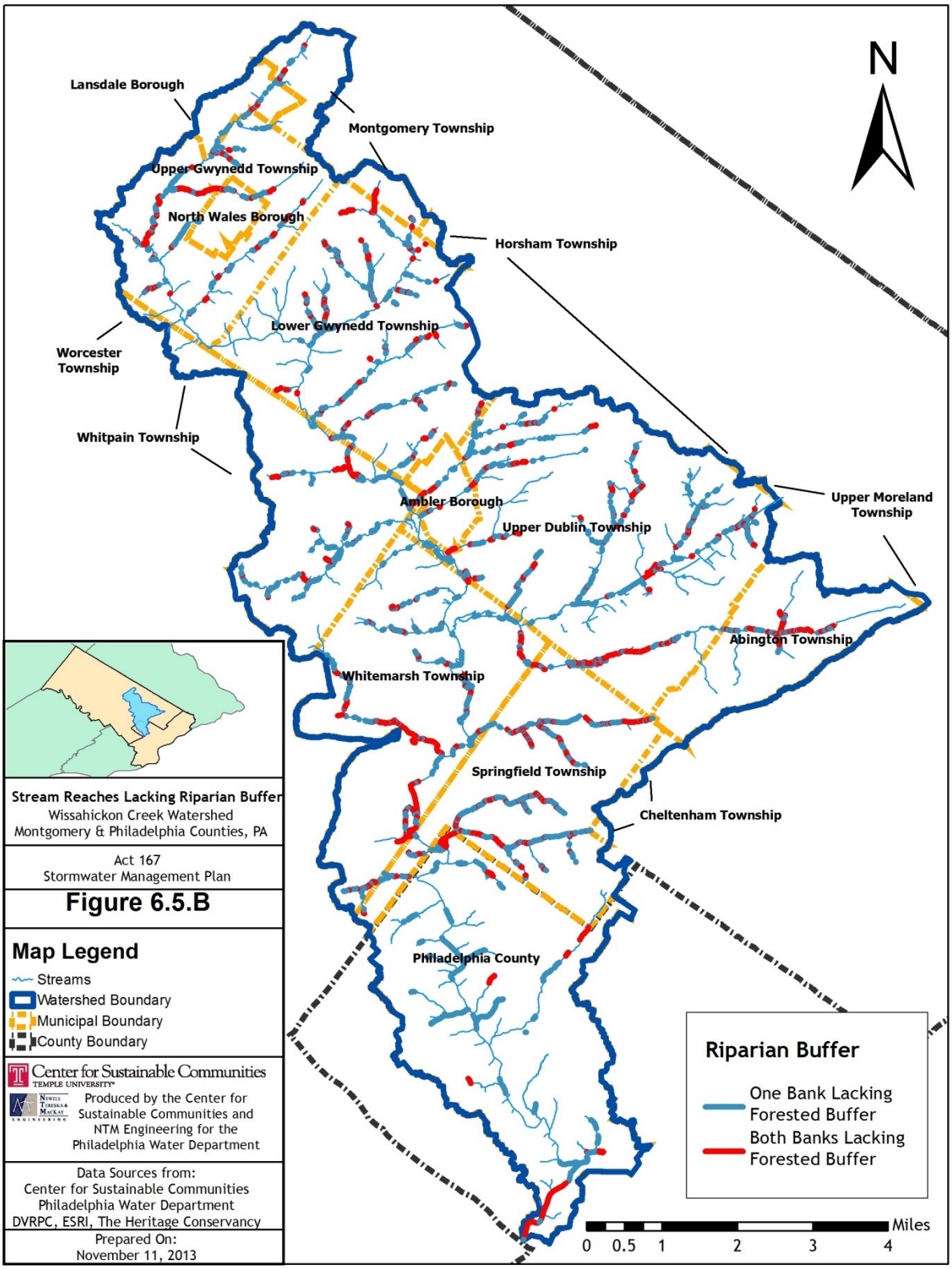


Figure 6.5.B Location of Potential Riparian Buffer Restoration Sites



SECTION 7: Plan Implementation

The existing institutional arrangements for the management of stormwater include state and county governments, as well as the sixteen municipalities within the Wissahickon Creek Watershed. All agencies are required to comply with the standards and criteria set forth in the Plan. This section outlines specific actions to be undertaken by those agencies.

Upon adoption of the Plan by the counties, the Plan will be submitted to the Pennsylvania Department of Environmental Protection (DEP). The DEP review process involves a determination that the Plan is consistent with the policies and requirements of Act 167. The DEP will also review the Plan for consistency with floodplain management requirements and other state programs, including those pertaining to dams, encroachments and other water obstructions.

After DEP approval, the Philadelphia Water Department will publish the Plan and provide copies of the Plan to Montgomery County and the remaining fifteen municipalities.

7.1 Municipal Adoption of Ordinance or Regulations to Implement the Plan

As set forth in Act 167, within six months following the adoption and approval of the Plan by the DEP, each municipality shall adopt or amend, and shall implement such ordinances and regulations, including zoning, subdivision and land development (SALDO), building code, and erosion and sedimentation ordinances, as are necessary to regulate development within the municipality in a manner consistent with the Plan. Table 7.1.A summarizes the status of ordinances for the watershed municipalities as of December 1, 2013.

The project team recommends that the municipalities adopt the model ordinance or regulations in their entirety, or integrate these provisions into existing ordinances or regulations. If the municipality lies in more than one watershed, the applicable release rates should be identified for the different watersheds. An example map showing the Pennypack and Wissahickon watersheds and how municipalities are affected by release rate districts is shown in Figure 7.1.A

Figure 7.1.A Comparison of Wissahickon and Pennypack Watershed Peak Rate Management Districts

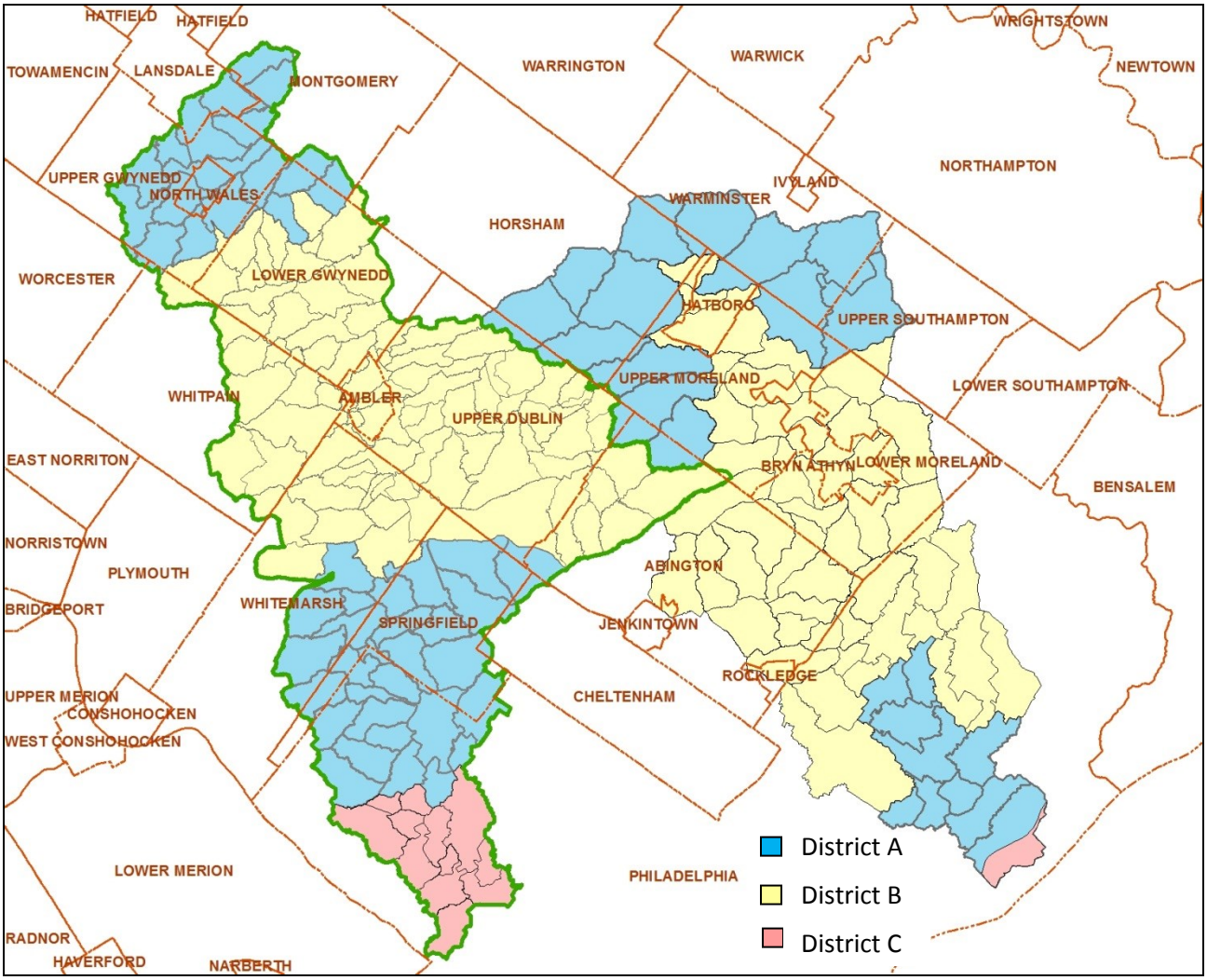


Table 7.1.A Status of Municipal Ordinances

Category	Abington	Ambler Borough	Cheltenham	Horsham Township	Lansdale Borough	Lower Gwynedd Towship	Montgomery Township	North Wales Borough	Springfield Township	Upper Dublin Township	Upper Gwynedd Township	Whitemarsh Township	Whitpain Township	Worcester Township
Ordinance Reviewed	Stormwater Mgmt Ordinance	SALDO, Water (ch 26), Zoning	SALDO, Stormwater Mgmt Ordinance, Ch. 110, 260, & 295	SALDO, Stormwater Mgmt Ordinance Zoning Ordinance	SALDO, Zoning Ordinance	SALDO, Stormwater Mgmt Ordinance, Ch. 1290, Zoning Ordinance	SALDO, Stormwater Mgmt Ordiance	SALDO, Zoning	SALDO, Stormwater Mgmt Ordinance Ch. 13, 28, 95, 111, & 114	SALDO, Stormwater Mgmt Ordinance, Zoning Section	SALDO, Stormwater Mgmt Ordinance	SALDO Ord. 789	Ord. 4-40	SALDO
Riparian Buffer	Yes	Yes, 20 feet	Yes, 5o feet	Yes	NO	Yes, 25 feet Ch. 1298	No	No	Yes, at least 25 feet	Yes, 1 foot above 100 year floodplain or 50 feet from high bank, whichever is greater	No	Yes, 20 feet	NO	No
Wetland Protection	Yes	Yes	Yes	Yes	No, but there was wording about wildlife refuges in ch. 122	Yes	Yes	Yes	Yes	Yes	Yes	Yes	125-27, mention of it, but need more	Yes
Water course, lake, pond protection	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Intermittent Stream protection
Floodplain Regulation	Floodplain Conservation District	Floodplain Conservation District	Floodplain Conservation District	Floodplain Conservation District	Floodplain Conservation District	Floodplain Conservation District, Ch. 1290	Yes	Floodplain Conservation District	Floodplain Conservation District	Floodplain Conservation District, CH. 255	Floodplain District	Floodplain Conservation District	Stormwater Management District Floodplain Conservation District	Floodplain Conservation District
Percent protected for 100-yr floodplain	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100% **	100%*
Limit development on 100-yr floodplain fringe	Yes	Yes	Yes	Yes	Yes	Yes	Yes, 30 feet	Yes	Yes, Detailed in SALDO	Yes		YES	YES **	Yes
Stormwater Ordinance	Yes, Ch. 142	Yes, Ch. 26	Yes, Ch. 290	Yes, Ch. 190	No, but Floodplain Conservation District Ordinance spells out a lot, Ch.122	Yes, Ch. 1241	Yes, Ch. 205	Not a separate one on its own, but included in SALDO (184-15)	Yes, Ch. 88	Yes, ch. 206	Yes, ch. 162	Yes, ch. 58	Yes, ch. 125	Yes, in SALDO
Runoff equals pre and post development	Yes but with exceptions	Yes, ch 26 Appendix A, Attachment #1	Yes	Yes, with strict exceptions, Ch. 198	NO	Yes	Yes	Yes, in SALDO	No, there is no specific language found	No, there is language about controlling post amounts	Yes	Unclear	Yes	Yes
Erosion and sediment control	Yes	Yes	Yes	Yes	NO	Yes	Yes, DEP Regulations	Yes	Yes, DEP Regulations	Yes, DEP Regulations	YES	YES	YES	Yes in BMP
Best Management Practices (BMPs)	Yes	Yes	Yes	Yes	Only in the definitions in Ch. 99	Yes	Yes	Yes	Yes, Ch. 88	Yes	Yes, ch. 162	YES, CH. 58	YES, CH. 125	Yes

**Approximate 100-yr floodway area where no Flood Insurance Stuy has been performed

* The language says it is overflow that covers the 100 year, and is designed for 50 year

7.2 Municipal Implementation of Stormwater Improvements

While not required by Act 167, the municipalities are encouraged to construct the stormwater improvements identified in Section 6 and Appendix C. This can be done by increasing each municipality's capital improvement program funding. The various improvements are assigned a priority according to their location, cost-effectiveness and capture potential, and municipalities can use this ranking as a basis for funding projects over a long-term period, for example ten years. PennVEST funding can be sought to jump start a stormwater improvement program.

With respect to drainage problems, the project team recommends the construction of stormwater improvements to increase storage and reduce stormwater flows and volumes as the first consideration in addressing such problems. For cases where increased culvert capacity is the only viable means for solving a drainage problem, an evaluation of potential increases in downstream flood peaks should be performed to prevent adverse flooding or stream channel impacts. In addition, such actions might require municipalities to modify their flood insurance rate maps to outline additional areas subject to inundation during more extreme flood events.

An alternative approach for funding stormwater improvements and culvert capacity projects is to implement them through existing municipal water or wastewater authorities, which can collect parcel-based stormwater fees similar to those collected by the Philadelphia Water Department as part of its Green City Clean Waters Program. Recent state legislation enables authorities to impose and collect stormwater fees. A recent survey identified 1,112 stormwater utilities located in 38 states and the District of Columbia. The average monthly single family residential fee was $4.12 and the median fee was $3.50. [1] A similar program could be instituted by the municipal authorities in the Wissahickon Creek Watershed.

Municipalities also can consider a pooled watershed approach for constructing stormwater improvements given that improvements vary according to their effectiveness. Section 6 and Appendix C outline 538 acre-feet of additional storage reduction potential in the watershed. Using land area within the basin as baseline criterion, volume reduction targets can be established and used as credits towards achieving this overall reduction amount. Potential volume reduction targets are set forth on Table 7.2.A.

[1] Stormwater Utility Survey 2010. Western Kentucky University, Bowling Green, Kentucky.

Table 7.2.A Reduced Volume Reduction Targets

Municipality	Land Area (sq. miles)	Land Area %	Volume Reduction (acre/feet)
Abington Township	3.58	5.66	30.47
Ambler Borough	0.85	1.34	7.21
Cheltenham Township	0.13	0.21	1.13
Horsham Township	0.01	0.01	0.54
Lansdale Borough	0.71	1.12	6.03
Lower Gwynedd Township	8.29	13.11	70.53
Montgomery Township	1.55	2.45	13.18
North Wales Borough	0.57	0.90	4.84
Philadelphia City	10.49	16.59	89.25
Springfield Township	6.40	10.12	54.45
Upper Dublin Township	12.00	18.98	102.11
Upper Gwynedd Township	5.01	7.92	42.61
Upper Moreland Township	0.03	0.05	0.27
Whitemarsh Township	8.22	13.00	69.94
Whitpain Township	5.29	8.37	45.03
Worcester Township	0.09	0.14	0.75
TOTAL	63.22	100%	538

As noted in Sections 3 and 5, ten stream segments in the Wissahickon Creek Watershed have been included in Pennsylvania's 303(d) list due to nutrient impairments. Twenty one stream segments in the watershed have been included on Pennsylvania's 303(d) list due to siltation impairments. In 2003, the U.S. Environmental Protection Agency (EPA) Region III established TMDLs for nutrients and siltation in the watershed. In 2006, the US EPA initiated a reevaluation of the nutrient TMDL (EPA 2006). The stormwater improvements recommended in Appendix C for the Southampton Creek subwatershed can provide a starting point for addressing the siltation TMDL.

7.3 County-Wide Coordination

The Montgomery County Planning Commission will be available upon request to assist municipalities in the adoption of the model ordinance provisions to fit particular municipal ordinance structures. The primary county level activity will be the establishment of review procedures for evaluating stormwater management proposals for development sites and erosion and sediment control plans, the latter being the responsibility of the county conservation districts.

The counties are the primary local contact for stormwater management programs. County personnel provide the needed linkage between federal and state programs and local implementation. For example, counties can ensure that the requirements of federal wetland regulatory programs have been incorporated into land development decisions. The counties should maintain a database of information to assist the municipalities in their regulation of stormwater.

7.4 Commonwealth of Pennsylvania Actions

As set forth in Act 167: "After adoption and approval of a watershed stormwater plan in accordance with this act, the location, design and construction within the watershed of stormwater management systems, obstructions, flood control projects, subdivisions and major land developments, highways and transportation facilities, facilities for the provision of public utility services and facilities owned or financed in whole or in part by funds from the Commonwealth shall be conducted in a manner consistent with the watershed stormwater plan." Therefore, with the support of the DEP, state agencies constructing roads, highways, buildings and other facilities shall comply with the standards and criteria within the Plan as they pertain to stormwater management.

The PennVEST Act of 1988, as amended, provides low interest loans to governmental entities for the construction, improvement or rehabilitation of stormwater projects including the transport, storage, and infiltration of stormwater, and best management practices to address non-point source pollution associated with stormwater. In order to qualify for a loan under PennVEST, the municipality or county must be located in a watershed in which there is an existing county-adopted and DEP-approved stormwater plan with enacted stormwater ordinances consistent with the plan, or have enacted a stormwater control ordinance consistent with the Stormwater Management Act. With the adoption of the Plan, all local agencies will be eligible for low interest loans through PennVEST.

7.5 Landowners' and Developers' Responsibilities

As noted in Act 167, "Any landowner and any person engaged in the alteration or development of land which may affect stormwater runoff characteristics shall implement such measures consistent with the provisions of the applicable watershed stormwater plan as are reasonably necessary to prevent injury to health, safety or other property. Such measures shall include such actions as are required:

(1) to assure that the maximum rate of stormwater runoff is no greater after development than prior to development activities; or
(2) to manage the quantity, velocity and direction of resulting stormwater runoff in a manner which otherwise adequately protects health and property from possible injury."

7.6 Plan Review

The City of Philadelphia and Montgomery County Planning Commission shall monitor the administration and enforcement of the Plan and meet at least annually to coordinate the results of this monitoring. The Plan should be updated in five years.

7.7 Milestones

Table 7.7.A presents the primary milestones for implementing the Wissahickon Creek Watershed Act 167 Plan.

Table 7.7.A Milestones for Implementing the Wissahickon Watershed Act 167 Plan

Milestone Action	Time Frame	Lead Agency
Conduct Public Hearing	Winter 2014	PWD
Adopt Plan	Spring 2015	Counties, DEP
Adopt and Enforce Ordinances	Six Months after DEP Adoption	Municipalities
Construct Improvements	2014-2019	Municipalities
Monitor Plan and Ordinances	Annual	Counties
Update Plan	2019	Counties