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

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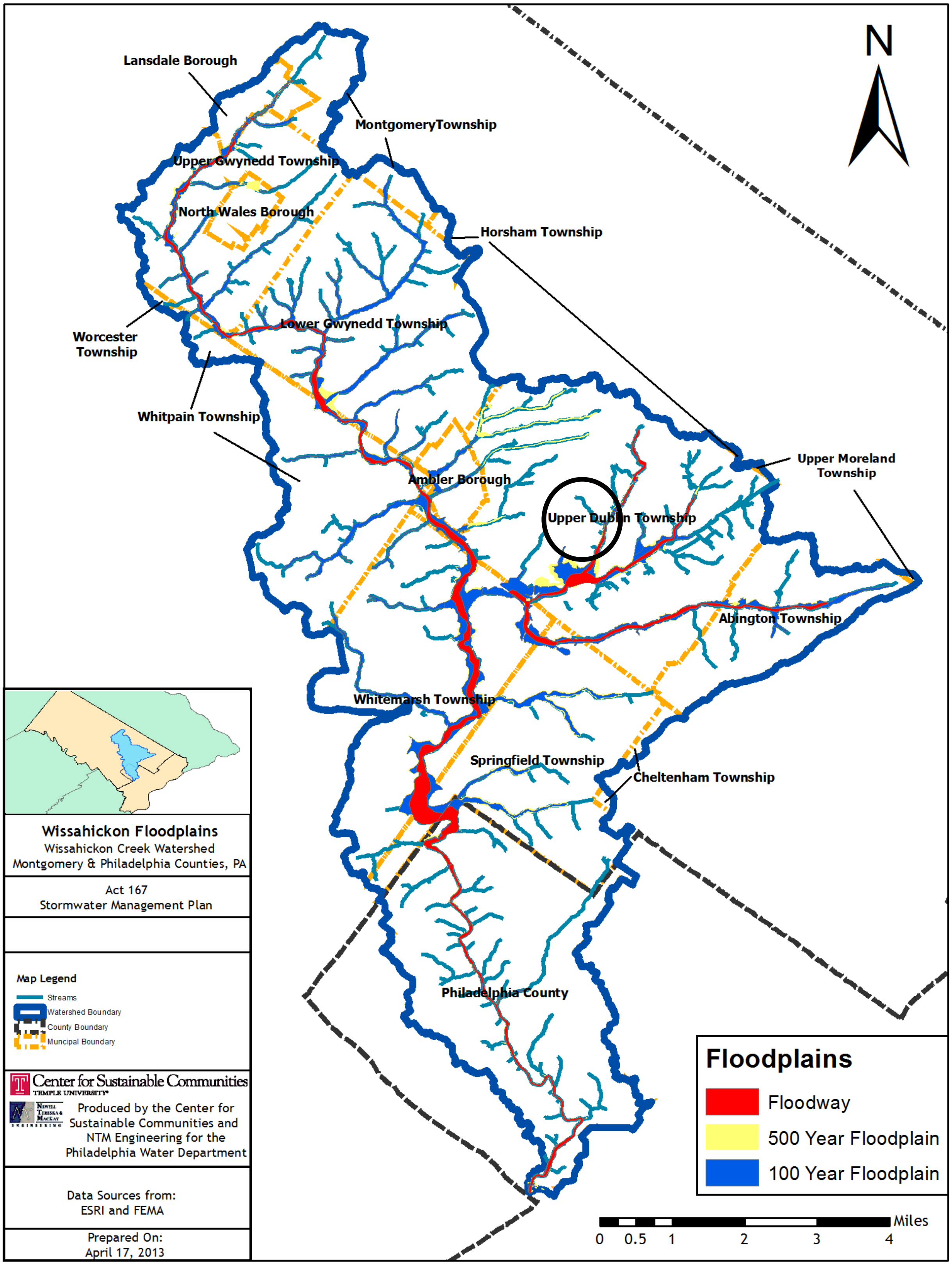
[1] *Philadelphia Water Department, Comprehensive Characterization Report for the Wissahickon Watershed, 2007.*
[2] *DeBarry, Paul. 2004. Watersheds: Processes, Assessment, and Management. New Jersey: John Wiley & Sons.*
[3] *The Temple News Web Site, http://www.temple-news.com, accessed on August 5,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



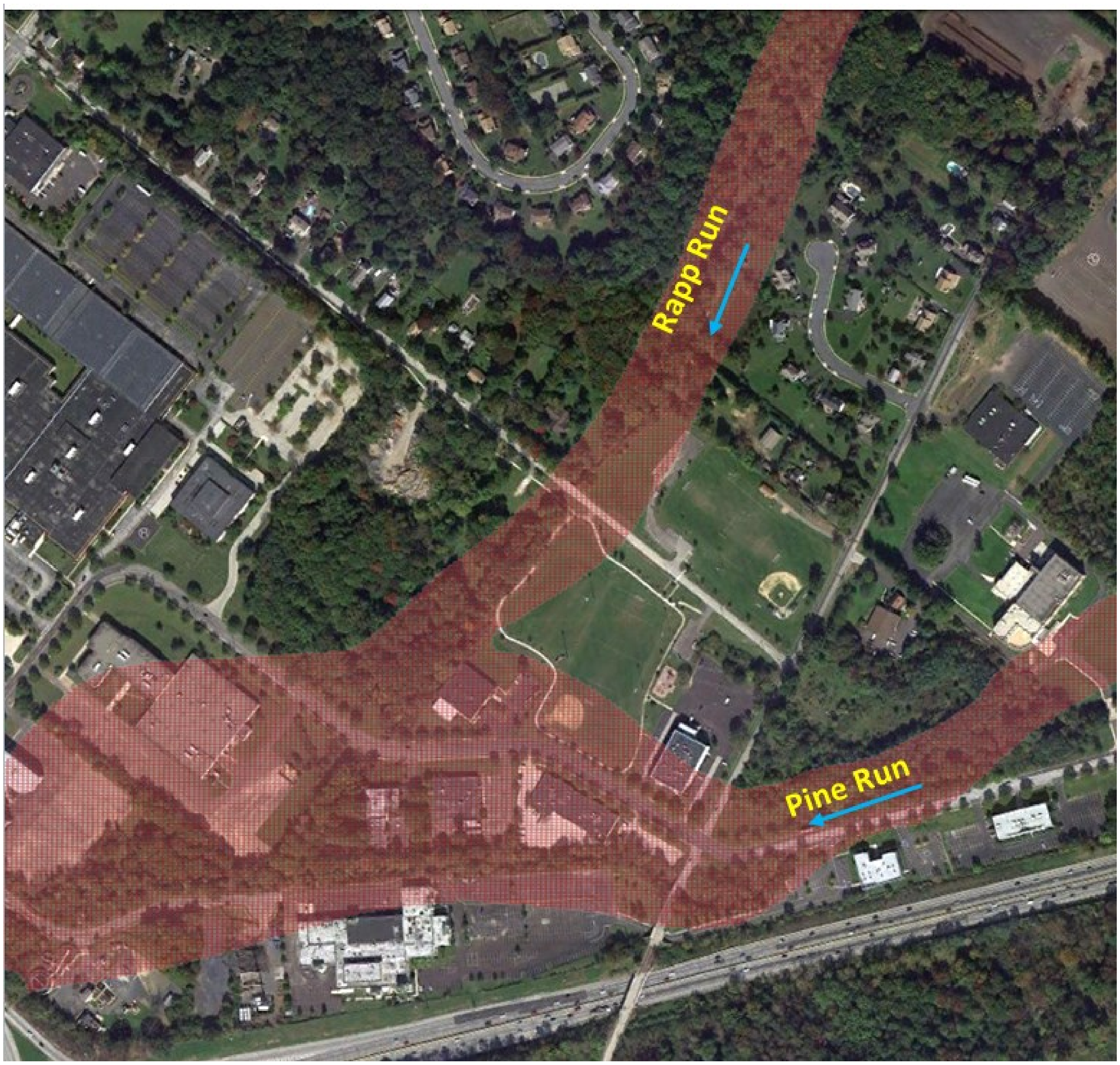


Figure 3.1.B 100-Year Floodplain – Pine Run and Rapp Run showing Flooding of Virginia Drive – Upper Dublin Township, Montgomery Co., PA

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

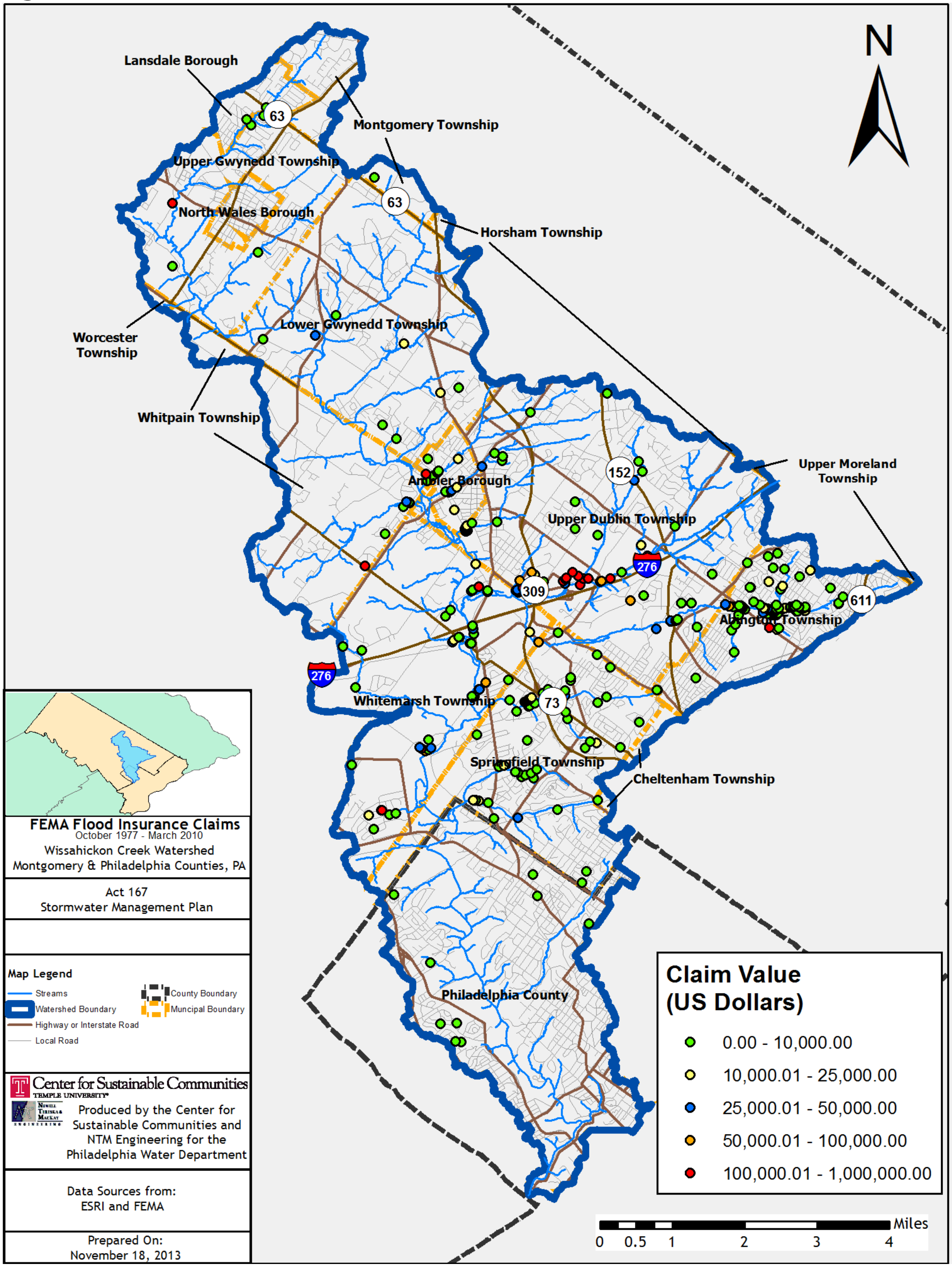
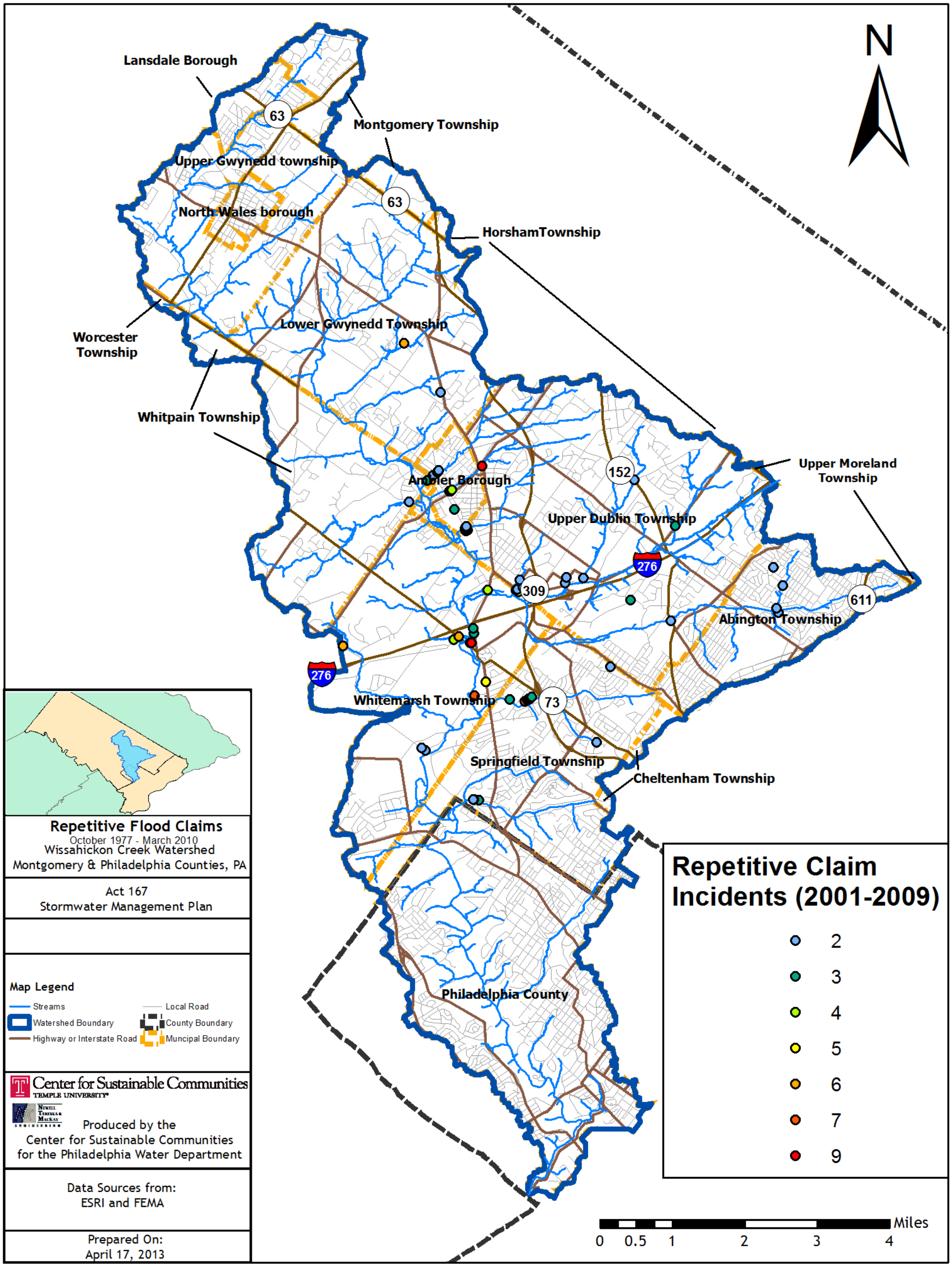


Figure 3.1.D Repetitive Flood Insurance Claims

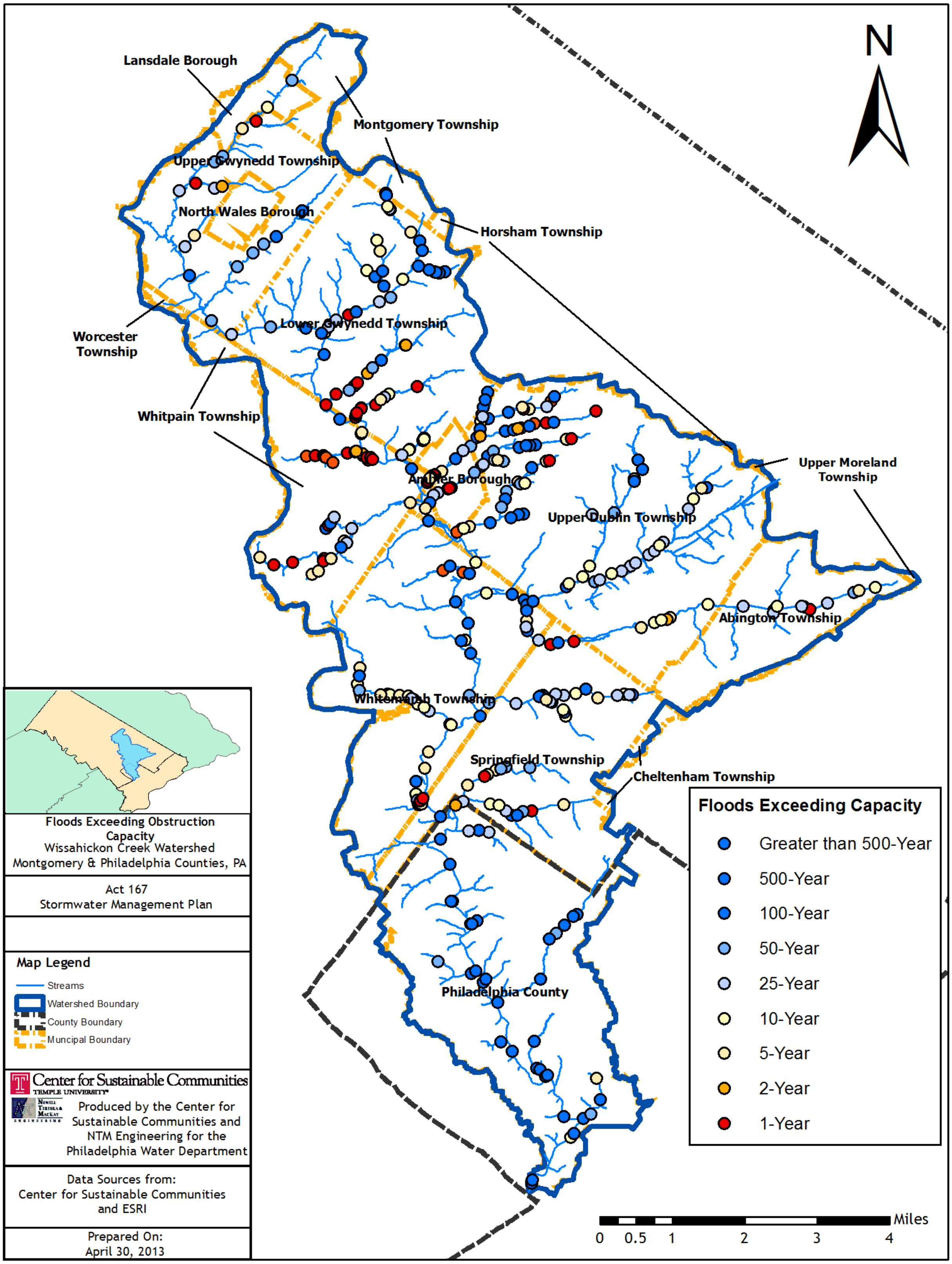


Flooding problems can also occur at bridges and culverts. These structures can change the flow characteristics of waterways by restricting flow during flood events, temporarily raising the upstream water surface elevation. Hazards associated with this include upstream flooding, bridge deck overtopping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

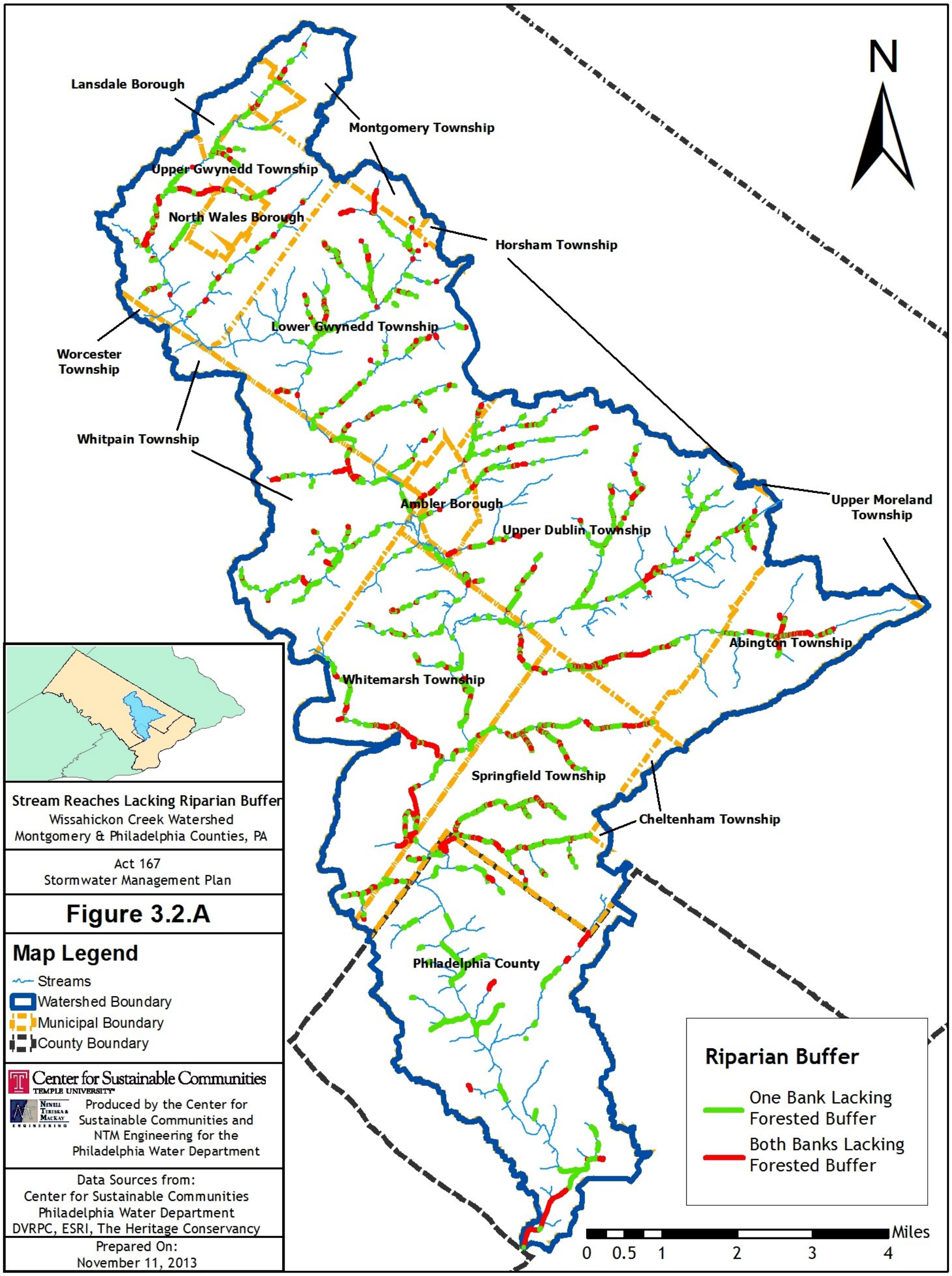


Figure 3.2.B Municipal Problem Areas

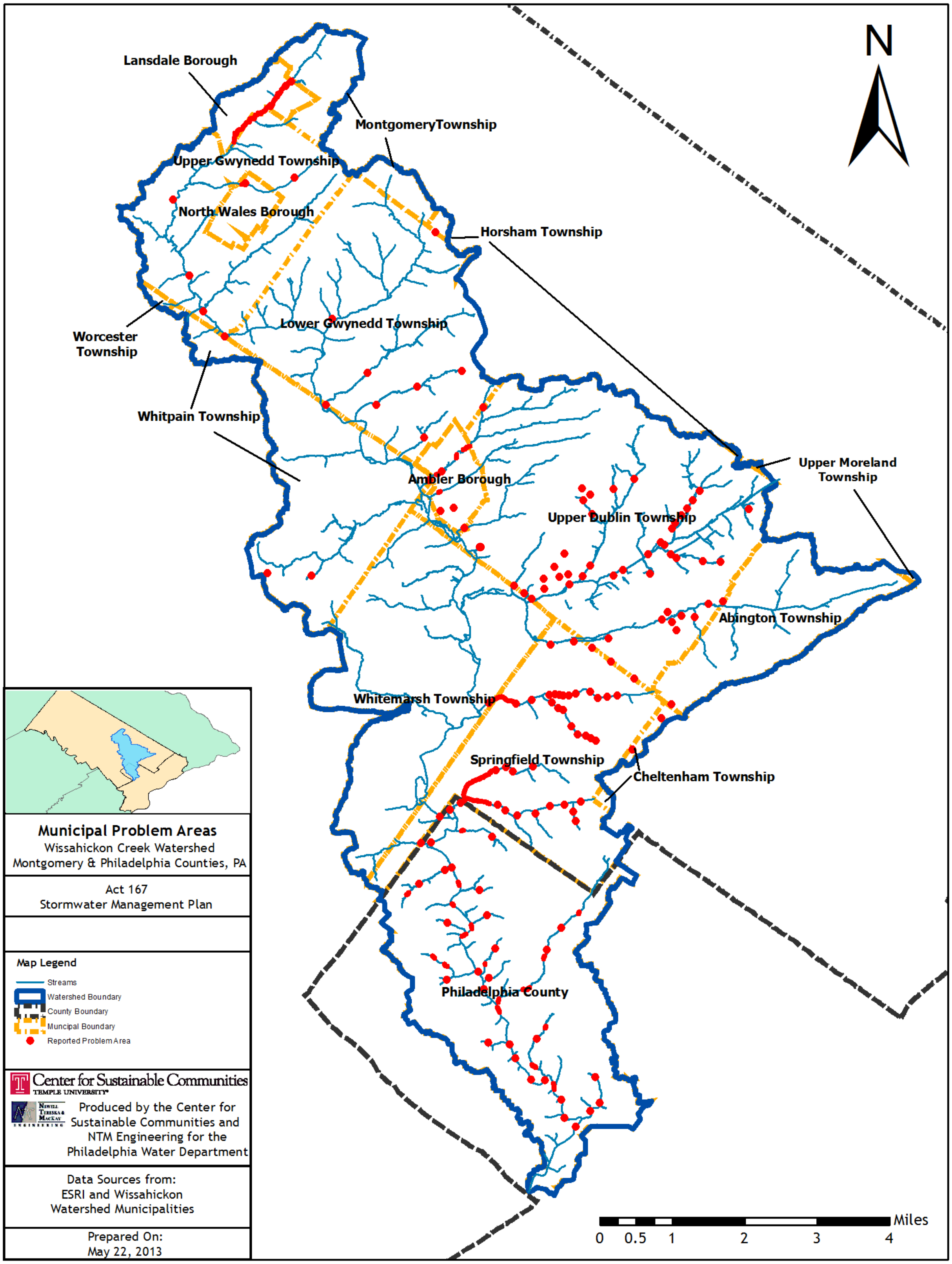
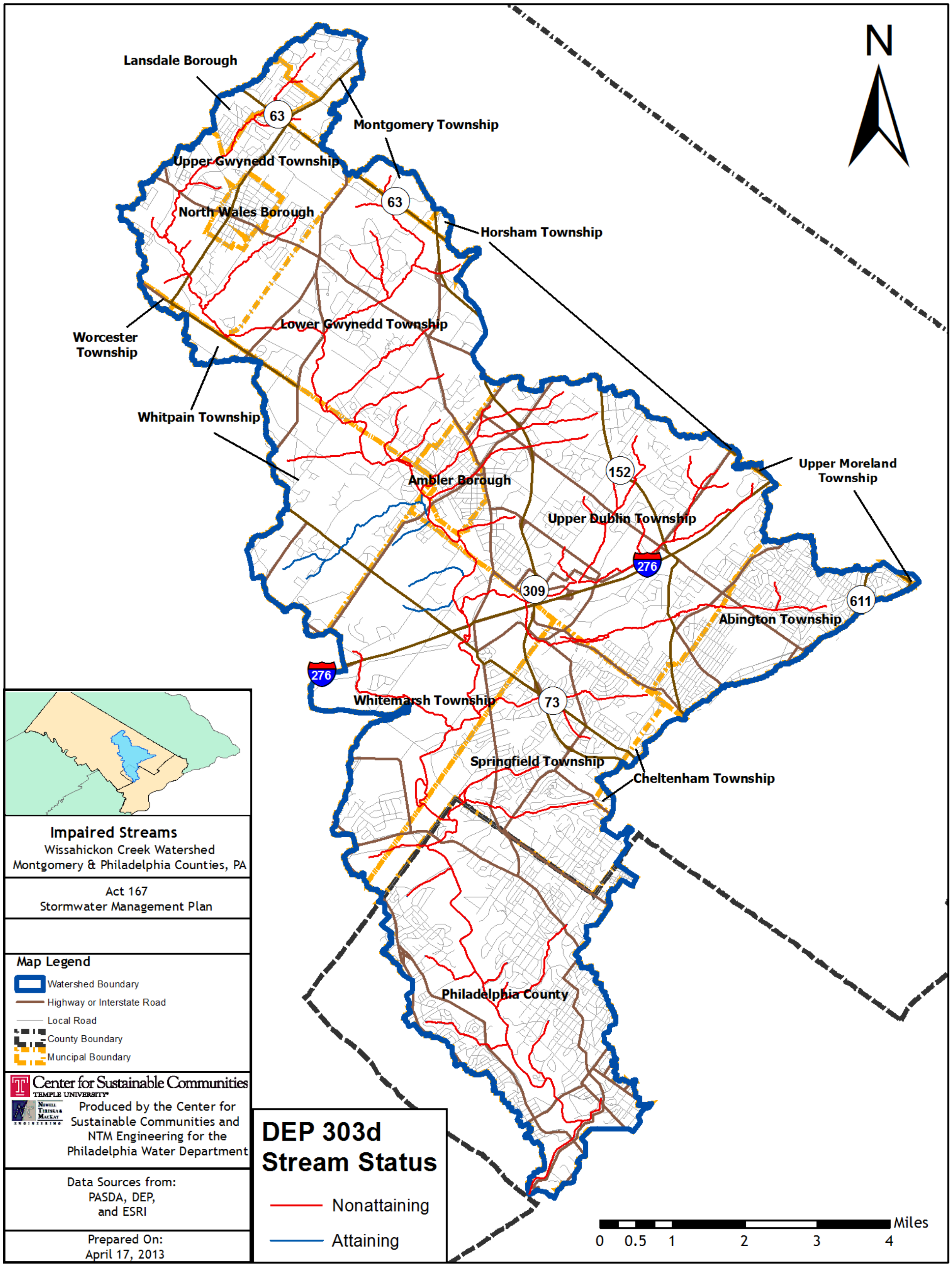


Figure 3.2.C   Example of streambank erosion and bank undercutting on Paper Milll Run (a tributary to Wissahickon Creek), Springfield Township, Montgomery County, PA

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.

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[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.