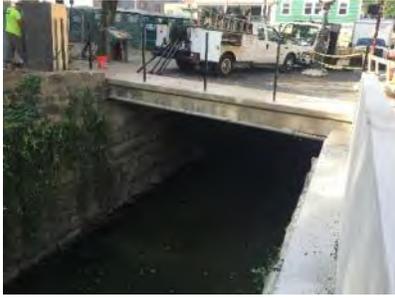


Tiber-Hudson Branch Stream Corridor Assessment 2016



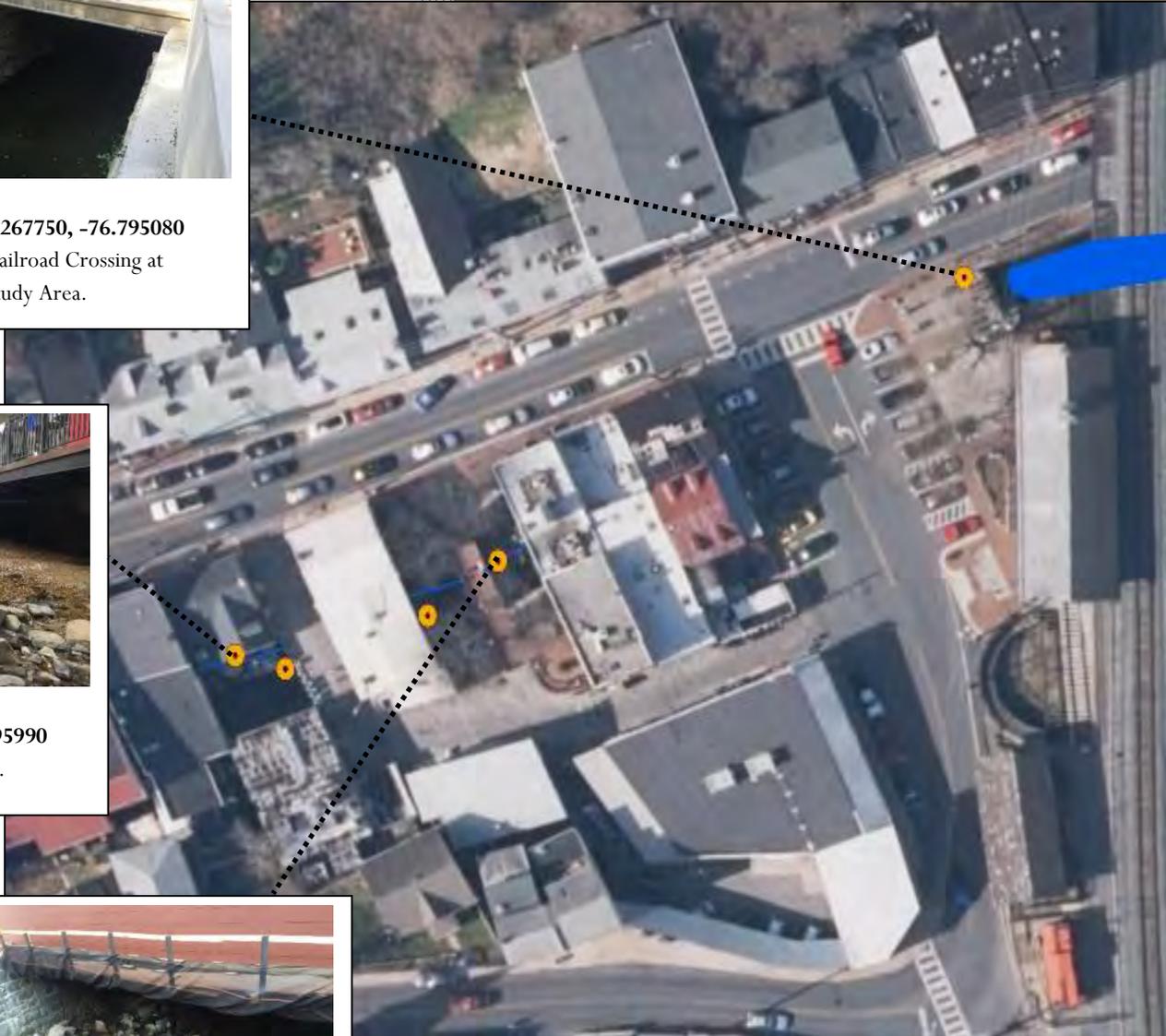
Point # 101
Location: 39.267750, -76.795080
Description: Railroad Crossing at
beginning of Study Area.



Point # 105
Location: 39.267360, -76.795990
Description: Building Crossing.



Point # 102
Location: 39.267410, -76.795680
Description: 8' from debris to lower
cord of bridge/sidewalk.



Tiber-Hudson Branch Stream Corridor Assessment

Smith Planning and Design, LLC.

1/15/2017

Table of Contents

SECTION I	INTRODUCTION	2
1.1	2016 Ellicott City Flood Event	2
1.2	Scope of Assessment	2
1.3	Study Area.....	2
SECTION II	METHODOLOGY	4
2.1	The Stream Corridor Assessment Survey	4
2.2	Data Collection.....	5
2.3	Problem Types	6
SECTION III	RESULTS	7
3.1	Overview	7
3.2	Problem Type Summaries.....	7
3.3	Point Locations and Description - Map Plates.....	17
SECTION IV	RECOMMENDATIONS & CONCLUSIONS	30
4.1	Recommendations	30
4.2	Specific Selected Problem Sites - Potential Mitigation Projects.....	31
4.3	Next Steps	38
APPENDIX A	Point Reference Database	39
APPENDIX B	Federal and State Grant Funding Resources	43

Section I – Introduction

Contents of this Section

- 1.1 2016 Ellicott City Flood Event
- 1.2 Scope of Assessment
- 1.3 Study Area

1.1 2016 Ellicott City Flood Event

On Saturday, July 30, 2016, torrential rains passed through Howard County, Maryland resulting in severe flash flooding through historic downtown Ellicott City. The National Weather Service (NWS) reported that 5.96 inches of rainfall occurred within a two hour period according to the Ellicott City rain gauge (ELYM2); however, 5.48 inches of that rainfall occurred in 90 minutes or less. The total rainfall for the storm event recorded by the rain gauge was 6.60 inches. Due to the city's proximity to waterways, this historic flood event caused extensive property and infrastructure damage and significant erosion.

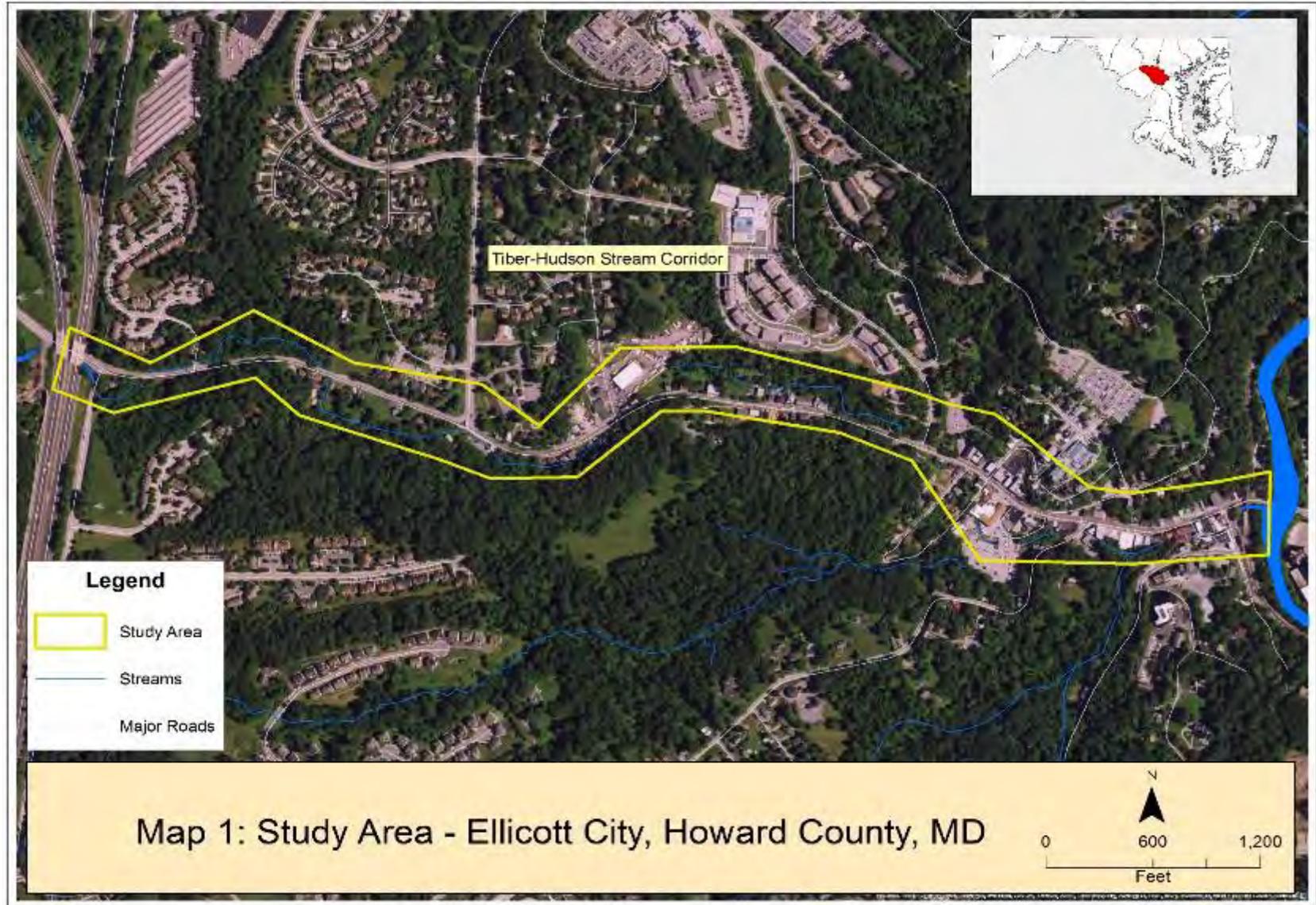
As a counterpart to this report, a Case Study of the referenced flood event has been prepared for the Howard County Office of Emergency Management to document information pertaining to those properties affected by the flood.

1.2 Scope of Assessment

This Stream Corridor Assessment (SCA) was prepared for the Howard County Office of Emergency Management (OEM). The SCA evaluated the Tiber-Hudson Branch stream corridor located in historic downtown Ellicott City and the Hudson Branch contributing corridor to the west along Frederick Road. The scope of the assessment is to perform a visual survey of the stream corridor in order to document specific conditions within the stream system that have the potential to exacerbate flood conditions and/or result in potential threats to property and infrastructure. Specific conditions documented by the assessment include: Road Crossings, Erosion Sites, Debris Blockages, and Channelization. The study will include mapped, written, and photographic documentation of these conditions found within the study area.

1.3 Study Area

The assessment area, as shown in Map 1, is located within the Patapsco River Watershed. The majority of the study area focuses on the Hudson Branch, which falls within the Tiber-Hudson sub-watershed of the Patapsco River. This branch flows through historic downtown Ellicott City, and in many cases it is conveyed directly beneath buildings along Main Street within the City. The study area is approximately 2.1 miles in length; beginning at the Tiber-Hudson Branch confluence with the Patapsco River upstream to the overpass of U.S. Route 29.



Section II – Methodology

Contents of this Section

- 2.1 The Stream Corridor Assessment Survey
- 2.2 Data Collection
- 2.3 Problem Types

2.1 The Stream Corridor Assessment Survey

In order to determine potential problem areas within the study area, a modified Stream Corridor Assessment (SCA) survey was utilized. This survey, developed by the Watershed Restoration Division of the Maryland Department of Natural Resources (DNR), has four primary objectives:

- ❖ To provide a list of observable environmental problems present within a stream system and along its riparian corridor;
- ❖ To provide sufficient information on each problem so that a preliminary determination of both severity and correctability of a problem can be made;
- ❖ To provide sufficient information so that restoration or mitigation efforts can be prioritized; and,
- ❖ To provide a quick assessment of both in- and near-stream habitat conditions so that comparative assessments can be made of the condition of different stream segments.

The SCA survey is not meant to replace more in-depth scientific studies, specifically those relating to chemical, biological or geomorphological surveys, and specific engineering studies. Instead, the SCA provides a quick and simple means of examining a stream reach so that future monitoring, management, mitigation, and/or conservation efforts can be targeted more effectively.

2.2 Data Collection

The SCA survey of the study area was conducted by “walking” the entire stream reach, within the stream channel, and recording potential problem areas/conditions on a field data sheet (Figure 1). Each problem site within the stream corridor was assigned a three digit number (i.e. 101). At each data point, relevant information was recorded either on a data form or in a field notebook. Most of the data was collected visually; however, physical measurements were recorded where appropriate, such as measuring a culvert or bridge opening. Additionally, a TopCon Tesla hand-held GPS unit was utilized to collect coordinate data at each point to be later converted into a shapefile for further utilization in ArcGIS. Pictures were taken at each data point, and along the reach, with either the GPS Unit or a digital camera.

Upon completion of the survey, information from the field data sheets and notebooks was recorded in Microsoft Excel. Furthermore, the point information gathered by the GPS unit was imported into ArcGIS to create the maps presented in the SCA report, as well as a clickable map containing pictures and important information relevant to each point.

STREAM WALK ASSESSMENT DATA FORM					
Date: _____					
Observers: _____					
Road Crossing					Pt. No:
Type:	Bridge	Pipe Culvert	Box Culvert	Arch	Other
Material:	Concrete	Corrugated Metal	Smooth Metal	Round	Elliptical
		Corrugated Plastic	Smooth Plastic		
Number of Cells:	_____				
Pipe Dimension:	_____		Embeddedness:	Yes	No
Fish Blockage?	Yes	No	Notes:		
Erosion Below Outfall	Yes	No			
Erosion Site					Pt. No:
Type:	Downcutting		Lateral		
Cause: _____					
Bank Height:	_____		Length:	_____	
Threat to Infrastructure:	Yes		No		
Severity:	Severe	Moderate	Minor	Notes:	
Correctability:	Limited	Moderate	Easy		
Access:	Limited	Moderate	Easy		
Debris Blockage					Pt. No:
Description: _____					
Extent:	Complete	Half	Minor	Notes:	
Impacts:	Left Bank	Right Bank	Scour	All	
Channelization					Pt. No:
Type/Description: _____					
Bank Affected:	Left	Right	Both	Notes:	
Deposition:	Yes	No			
Vegetation:	Yes	No			
Flood Wall:	Yes	No			
If yes, Condition: _____					

Figure 1

as well as a clickable map containing pictures and important

2.3 Problem Types

For purposes of this assessment, the survey focused on four major problem types: Road Crossings, Erosion Sites, Debris Blockages, and Channelization. The data collection form for each problem type borrowed heavily from the DNR SCA survey methodology; additional details regarding data collected at each problem type are provided below.

Road Crossings

Sites included in this category consisted of bridges (including foot bridges), pipe culverts, box culverts, and arches. Additionally, buildings or houses that completely spanned the channel were also included in this category. The four structural types for road crossings were further defined by their material: 1) concrete, 2) corrugated metal, 3) smooth metal, 4) corrugated plastic, 5) smooth plastic, or 6) stone. The shape of the structure was also taken into consideration and was defined as being either round or elliptical. Other data to be recorded, if applicable, included the number of cells (for culverts), bridge/pipe dimensions, whether the structure was embedded, if a fish blockage existed, and if there was erosion below the structure outfall.

Erosion Sites

Sites included in this category were first defined as either downcutting or lateral erosion. The apparent cause of the erosion at the site was recorded if it could be deduced by the observer. Other data recorded for erosion sites included bank height, length, and whether or not they presented a threat to nearby infrastructure. In keeping in line with typical SCA surveys, each site had its severity, correctability, and accessibility ranked. Severity rating, usually considered to be the most useful rating when comparing one site with another, was measured as being minor, moderate, or severe. The correctability rating, defined as being either limited, moderate, or easy, provides a measurement of how easily a site might be fixed in the future. Finally, the accessibility rating is useful in determining the physical level of difficulty of gaining access to a problem site so that it may be corrected, typically with heavy construction equipment. The accessibility ranking does not factor or account for landowner access permissions, easements, or multiple property owner situations. Accessibility was defined as being limited, moderate, or easy. It should be noted that these ratings represent the overall impressions of the data collection team, for each site, at the time the survey was conducted.

Debris Blockages

A site was considered to be a debris blockage if the observed obstruction was large or accumulative enough to create a significant impediment, or potential impediment, to the flow of water. Sites considered to be debris blockages included, but were not limited to, fallen trees, root masses, branches, material from destroyed man-made objects such as walls or foot bridges, and other human-derived material. For sites defined as debris blockages, the extent was ranked, and the impact was categorized. Extent was ranked as being either complete, half, or minor. Impact categorized the blockages based on their location within the channel and were labeled as affecting the left bank, right bank, scour, or all.

Channelization

While many sites within the study area were channelized, a site was only listed under this category if it was considered to be a failed channelization effort. For example, if the concrete lining of a channel was cracked or eroded, it would be considered to be failed channelization. In addition, failing or crumbling rock or concrete walls were also included in the channelization category. Data recorded for these sites included the bank affected (left, right, or both), deposition (yes or no), presence of vegetation, and whether or not the site includes a flood wall.

Section III – Results

Contents of this Section

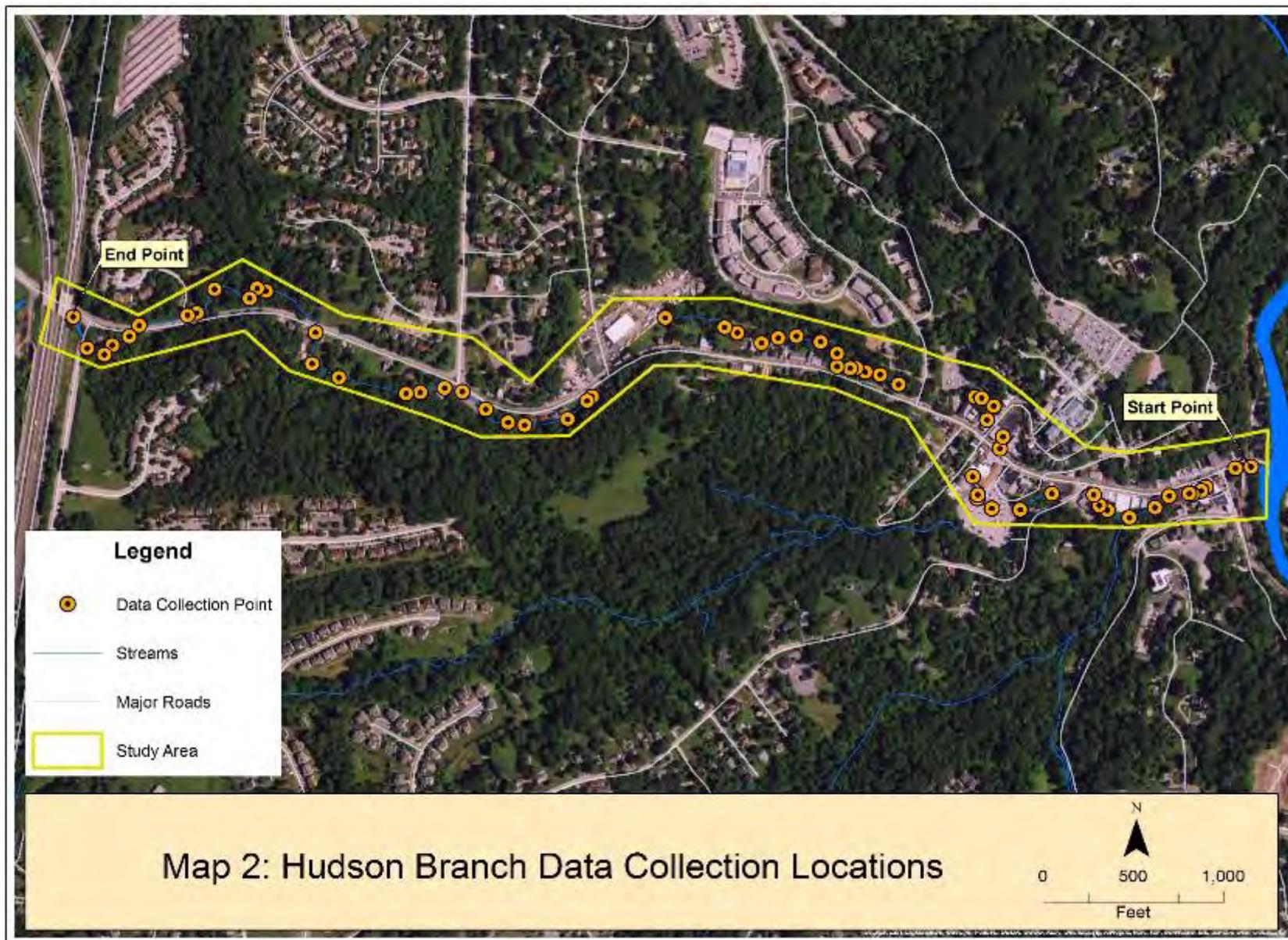
- 3.1 Overview
- 3.2 Problem Type Summaries
- 3.3 Point Locations & Description – Map Plates

3.1 Overview

The Stream Corridor Assessment resulted in data collected for a total of sixty three (63) points. Map 2: Hudson Branch Data Collection Locations provides a visual reference to all of the data collection points located in the Tiber-Hudson Branch corridor. Note that some data points may be categorized as more than one problem type. Therefore, the total number of problem types recorded is actually greater than the number of data points.

3.2 Problem Type Summaries

In total, the survey team recorded thirty (30) Road Crossings, twenty seven (27) Erosion Sites, nine (9) Debris Blockages, and three (3) Channelization sites. The following sections summarize each problem type area and include tables that total the important information gathered for each problem type. Each section also includes a map that shows where each problem type is located. The entirety of the data collected for this survey is available in Appendix A.



Road Crossings

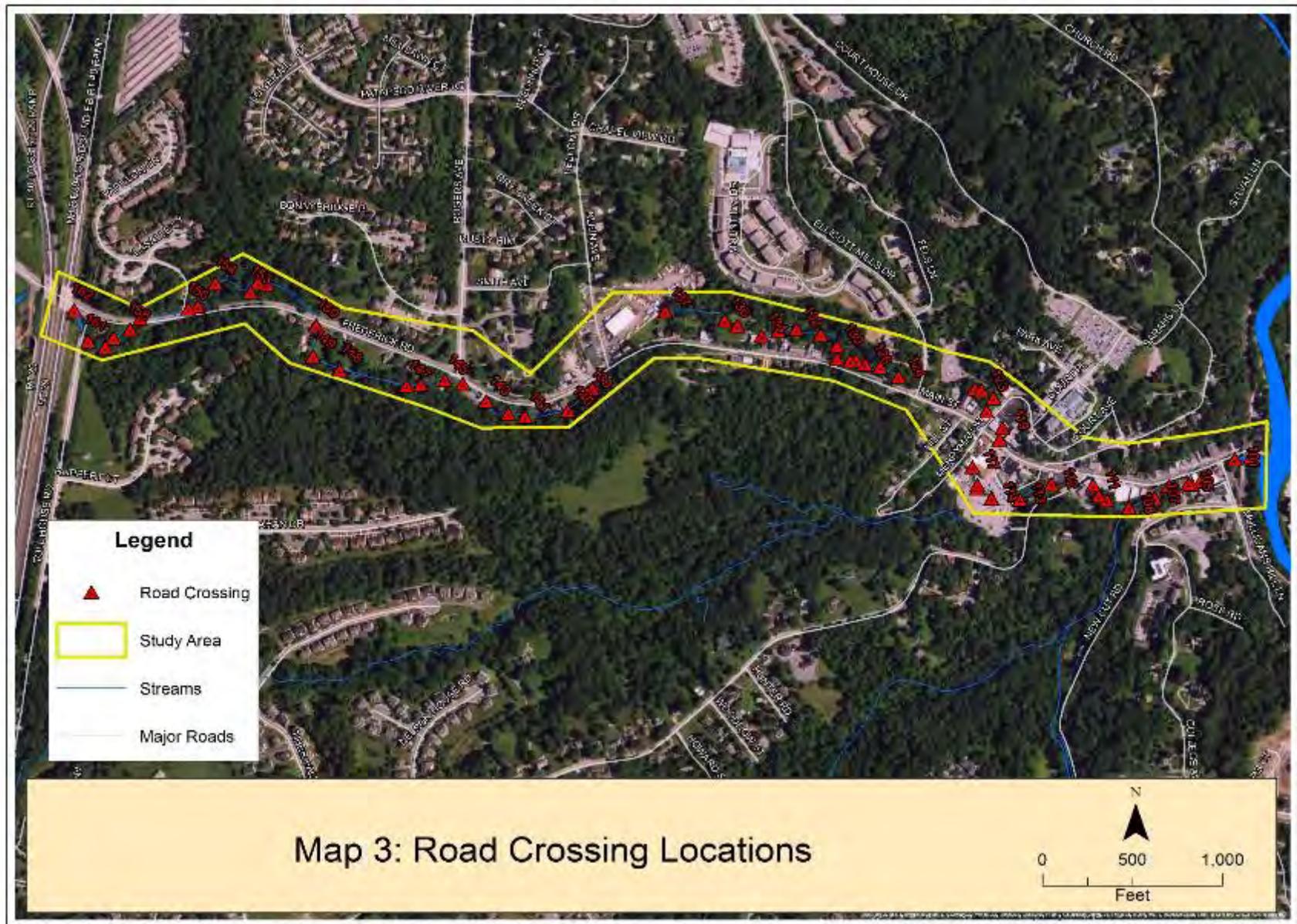


Table 1 – Total Road Crossings: 30				
Type	Bridge	Pipe Culvert	Box Culvert	Arch
Total	14	9	2	1
Material	Concrete	Corrugated Metal	Stone	
Total	8	9	1	
Shape	Round	Elliptical	Arch	
Total	5	3	1	
Number of Cells	One		Two	
Total	20		1	
Fish Blockage	Yes		No	
Total	3		29	
Erosion Below Outfall	Yes		No	
Total	0		29	
Embeddedness	Yes		No	
Total	1		28	

During a high water event, road/stream crossing failure or inundation presents itself as unique hazard to humans. Many of the road crossings atop streams are bridges, which means people will either be driving or walking over them. If a stream is forced out of its banks and over a bridge crossing it may not only prevent passage by emergency personnel, but it could also cause harm to motorists or pedestrians who may be in the path of the moving water.

In total, thirty (30) road crossings were recorded during the stream walk. Of these, fourteen (14) were bridges, eleven (11) were culverts, and (1) was an arch. Of the bridges, two (2) were foot bridges. The majority of road crossings were one-celled culverts made of corrugated metal. It is particularly important that these culverts remain open and free of debris so that during a high rainfall event they will function properly and not cause water to spill over into adjacent land or roadways.

Erosion Sites

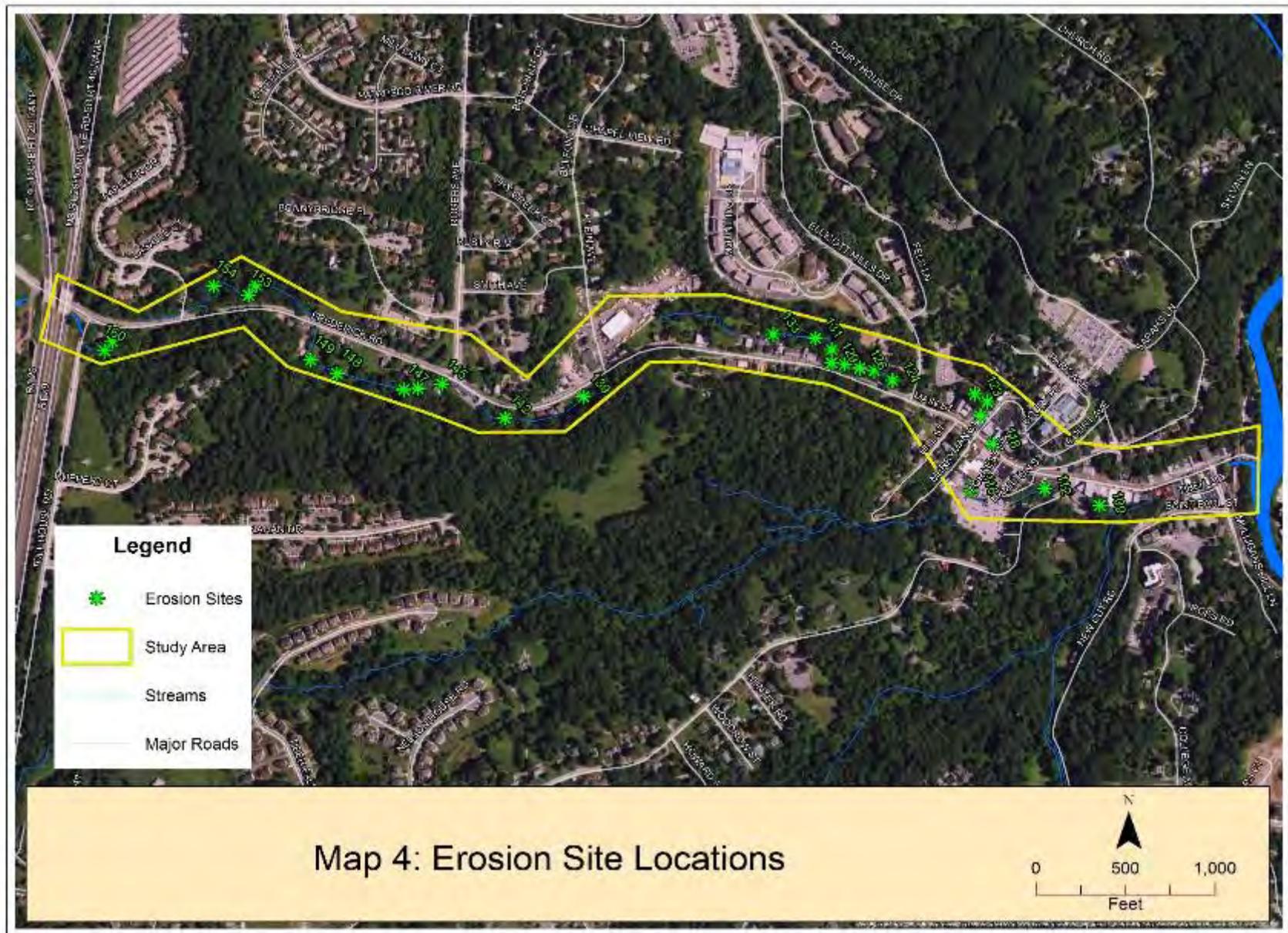
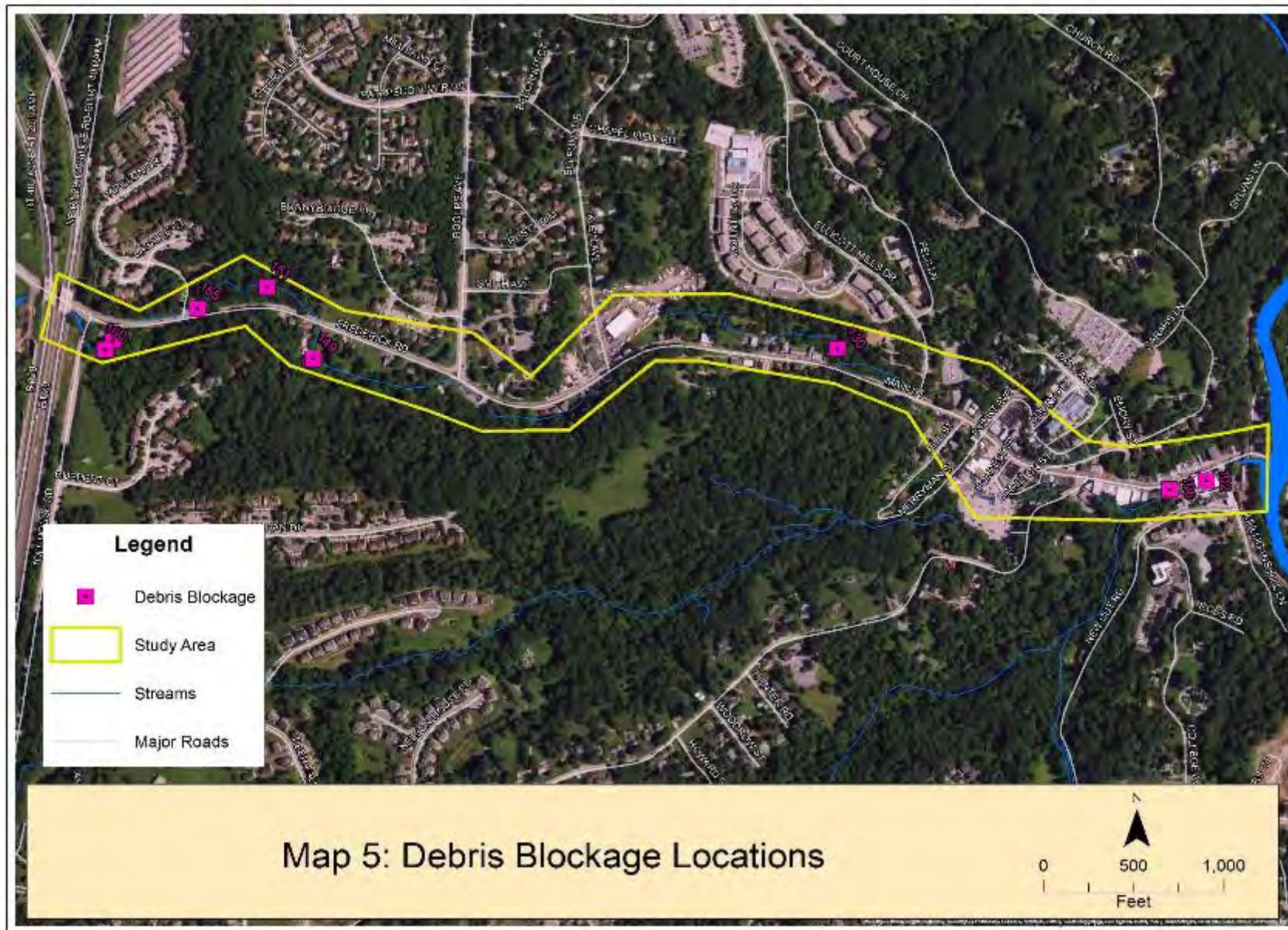


Table 2 – Total Erosion Sites: 27			
Type	Downcutting		Lateral
Total	0		27
Threat to Infrastructure	Yes		No
Total	4		7
Severity	Severe	Moderate	Minor
Total	10	8	4
Correctability	Limited	Moderate	Easy
Total	1	9	11
Access	Limited	Moderate	Easy
Total	2	6	13

Erosion is both natural and necessary to maintain a healthy stream environment, but too much erosion can have undesirable effects. Negative consequences of too much erosion can include the destabilization of stream banks, destruction of in-stream habitat, and significant sediment pollution conditions downstream. These types of problems are largely the result of significant anthropogenic changes in a streams hydrology or sediment supply, which is often related to land use changes within a watershed.

Twenty seven (27) erosion sites were observed within the study area, and of these, four (4) locations were recorded to be a threat to infrastructure. Ten (10) of the sites were categorized as severe. Twelve (12) of the sites were considered to be either moderate (8) or minor (4) in their severity. Furthermore, eleven (11) sites were ranked ‘easy’ for correctability, and thirteen (13) were ranked ‘easy’ for access. This data indicates that approximately half of the erosion sites are moderate or minor in their severity, would take minimal resources to fix these problem areas because they are both relatively easy to correct and are physically accessible. However, addressing the severe erosion sites, if accessible, could provide a greater benefit in terms of both land loss and reducing in-stream sediment supply.

Debris Blockages



Extent	Complete	Half	Minor	
Total	1	3	1	
Impact	Left Bank	Right Bank	Scour	All
Total	4	0	1	0

Debris blockages, especially large blockages caused by fallen trees, can trap smaller debris and create temporary dams which can then lead to flooding of adjacent land. If a debris blockage occurs near a road crossing or culvert inlet during an elevated flow event, flood waters can overtop the road. Once flood waters overtop a road crossing, particularly if the road and stream are somewhat parallel and share the same valley, flood waters will flow down the road until a low point where water will reenter the channel. Therefore, debris available to the stream system, and in close proximity to culverts, can cause unforeseen flooding scenarios that flood models do not anticipate.

In total, nine (9) debris blockages were recorded by the survey team. At each location, both the extent and impact of the blockage was recorded. Of the sites with a measurable extent, one (1) was considered to be “complete”, which means the debris blocked all or most of the channel. Three (3) were considered to be “half” extent and one (1) was considered to be of “minor” extent. The impact of the debris blockages was measured in terms of whether the blockage affected the left or right bank, if it was contributing to scour, or whether it affected all parts of the stream.

Channelization

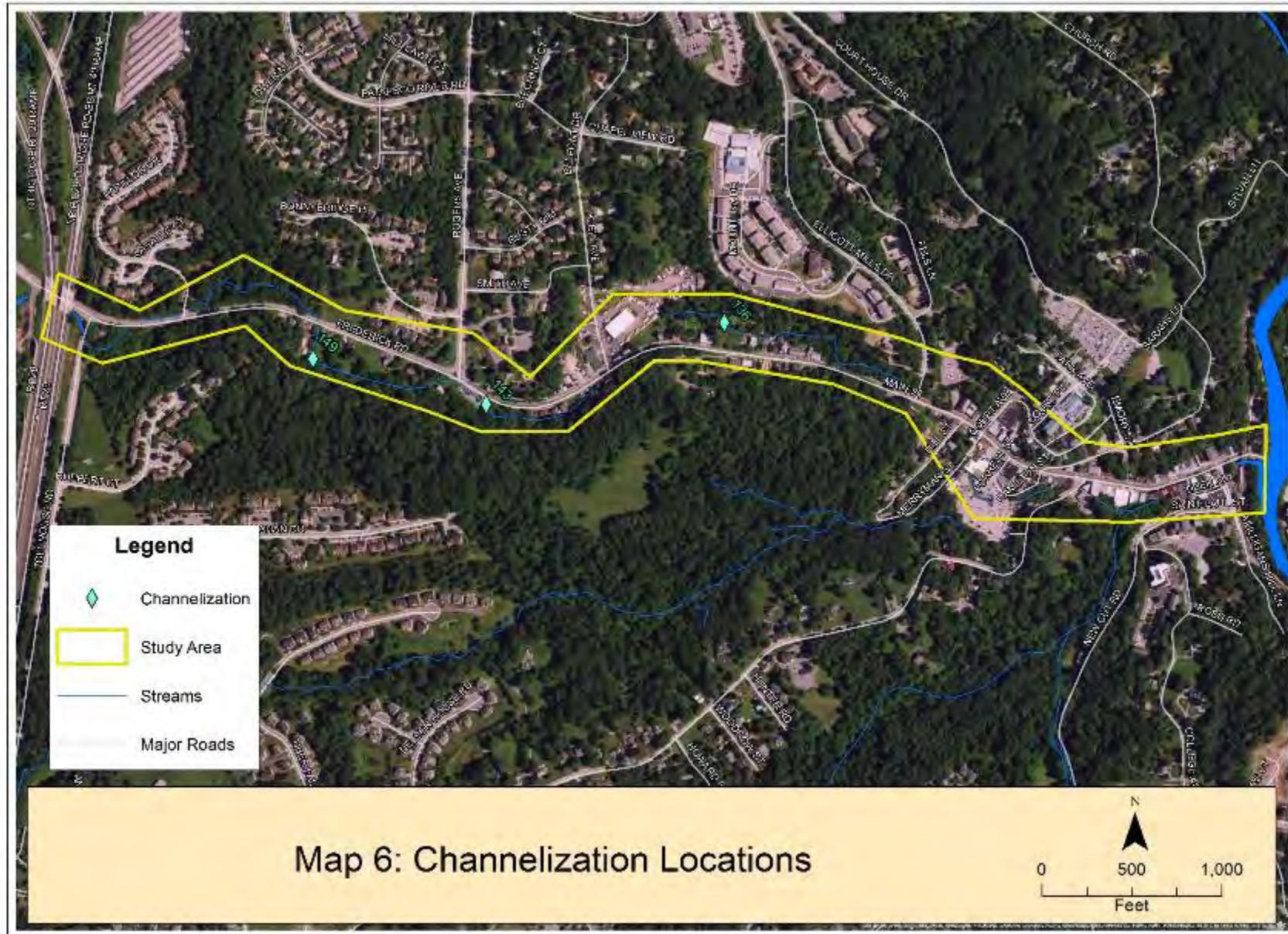
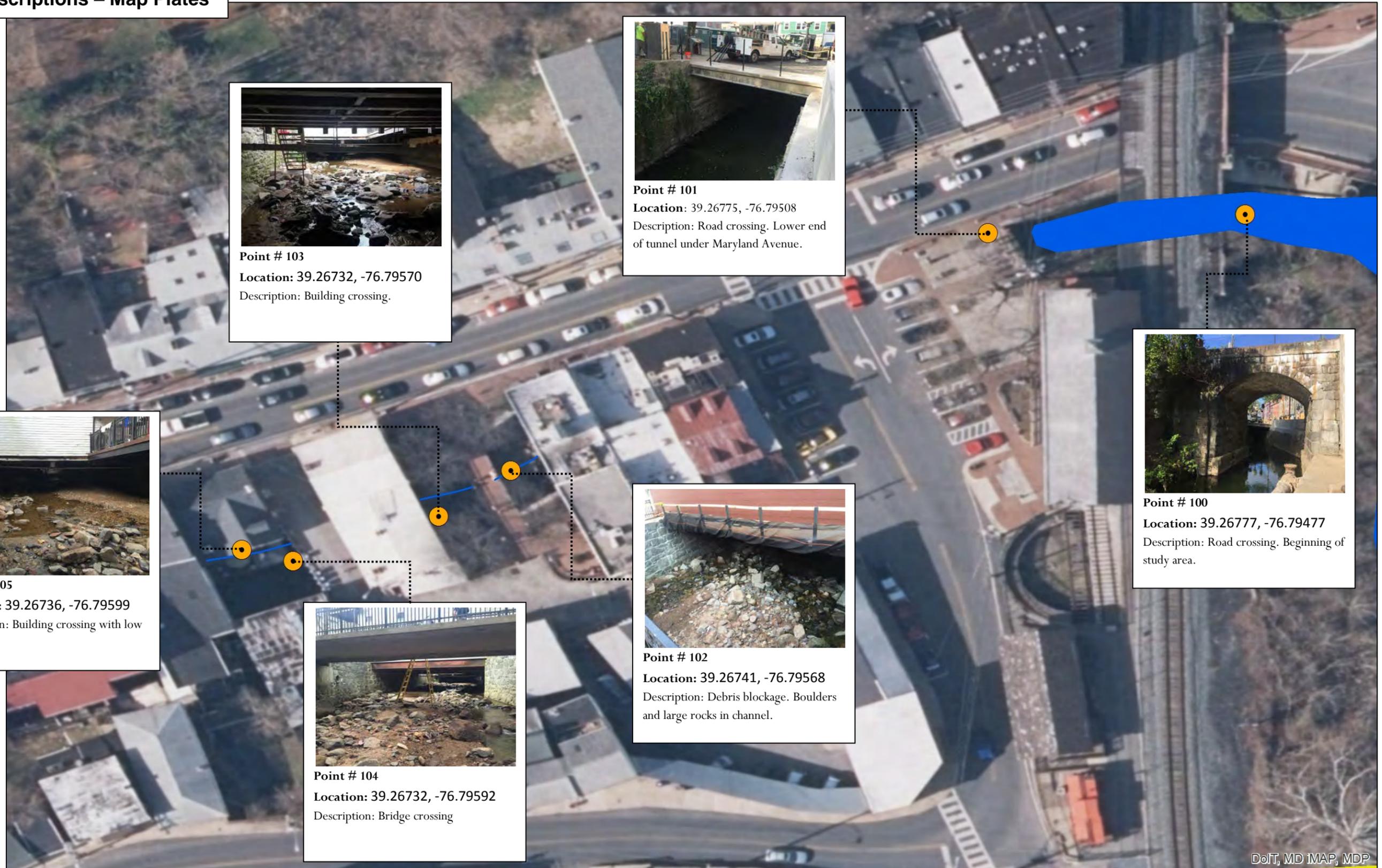


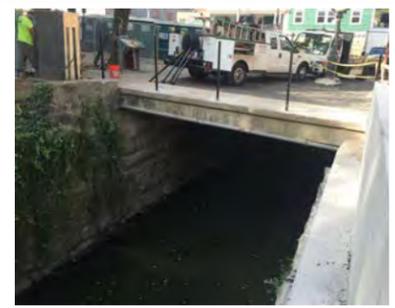
Table 4 – Total Channelization: 3			
Bank Affected	Left	Right	Both
Total	0	1	2
Deposition	Yes		No
Total	3		0
Vegetation	Yes		No
Total	0		2
Flood Wall	Yes		No
Total	2		0

A stream reach is considered channelized when the stream banks and/or channel have been drastically altered from their natural state. Such alterations include replacing the stream bed and/or banks with concrete, installing flood walls, straightening the channel, bank hardening with rocks, and the use of gabion baskets.

3.3 Point Locations & Descriptions – Map Plates



Point # 103
Location: 39.26732, -76.79570
Description: Building crossing.



Point # 101
Location: 39.26775, -76.79508
Description: Road crossing. Lower end of tunnel under Maryland Avenue.



Point # 100
Location: 39.26777, -76.79477
Description: Road crossing. Beginning of study area.



Point # 105
Location: 39.26736, -76.79599
Description: Building crossing with low overhead.

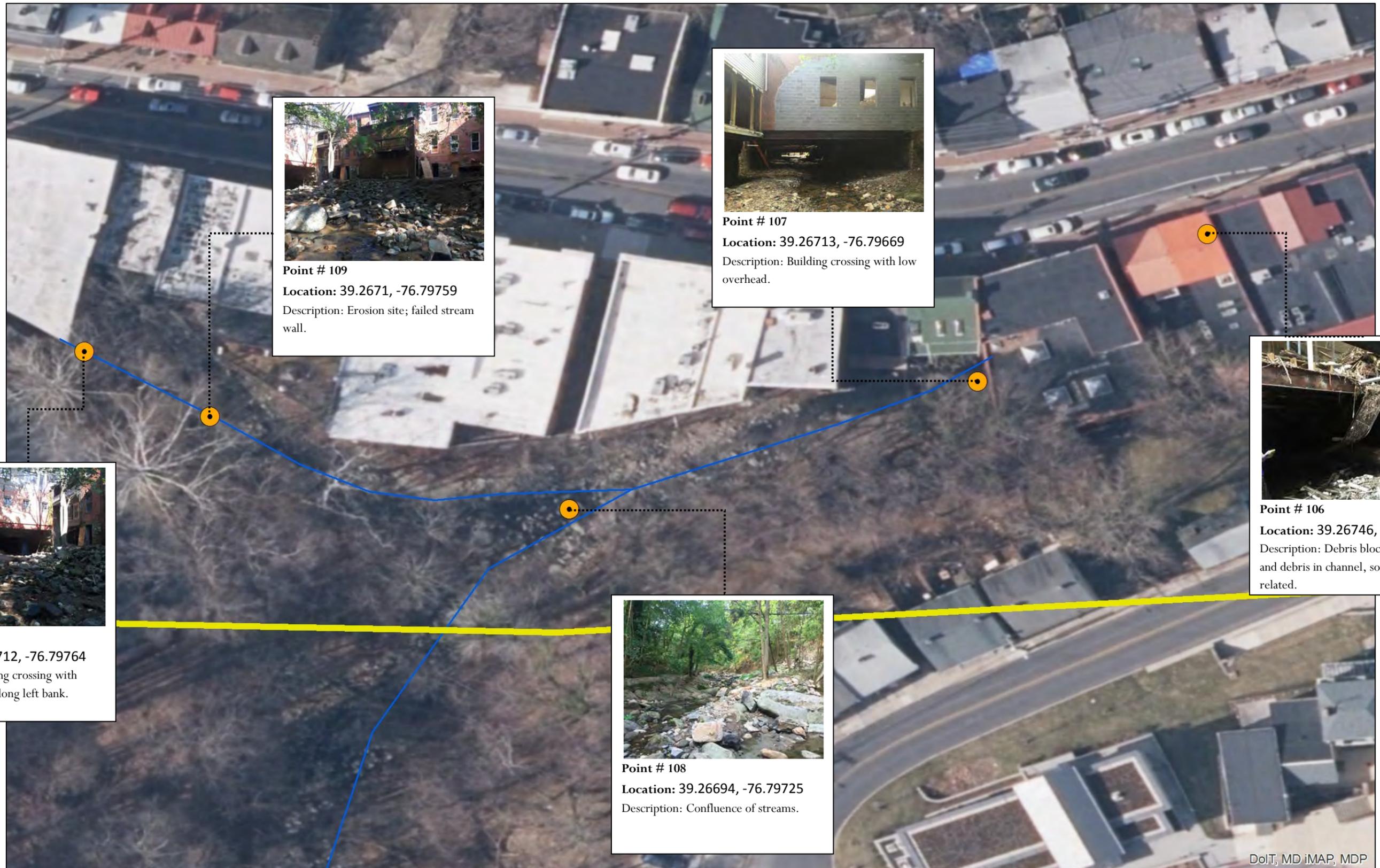


Point # 102
Location: 39.26741, -76.79568
Description: Debris blockage. Boulders and large rocks in channel.



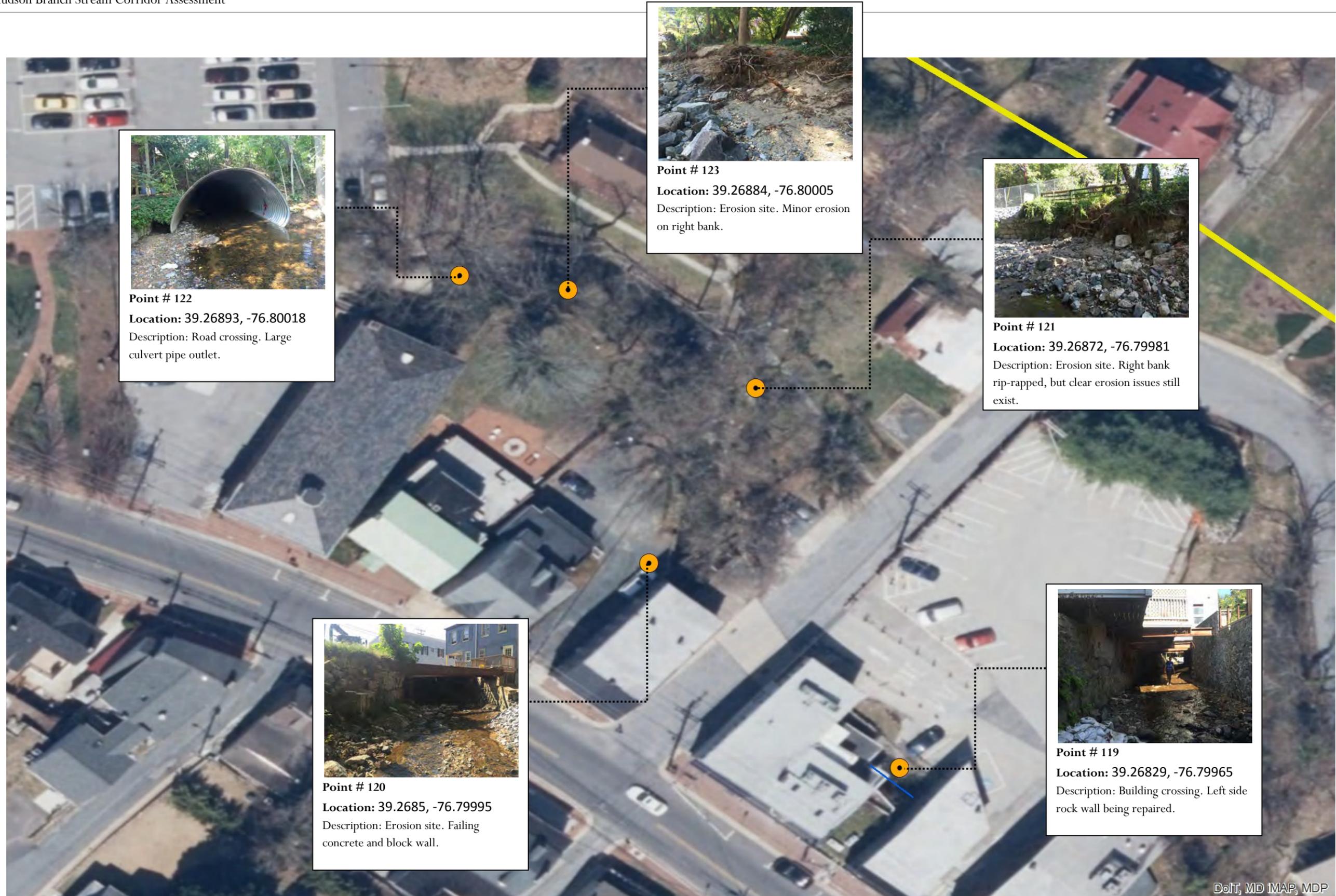
Point # 104
Location: 39.26732, -76.79592
Description: Bridge crossing

DoIT, MD IMAP, MDP

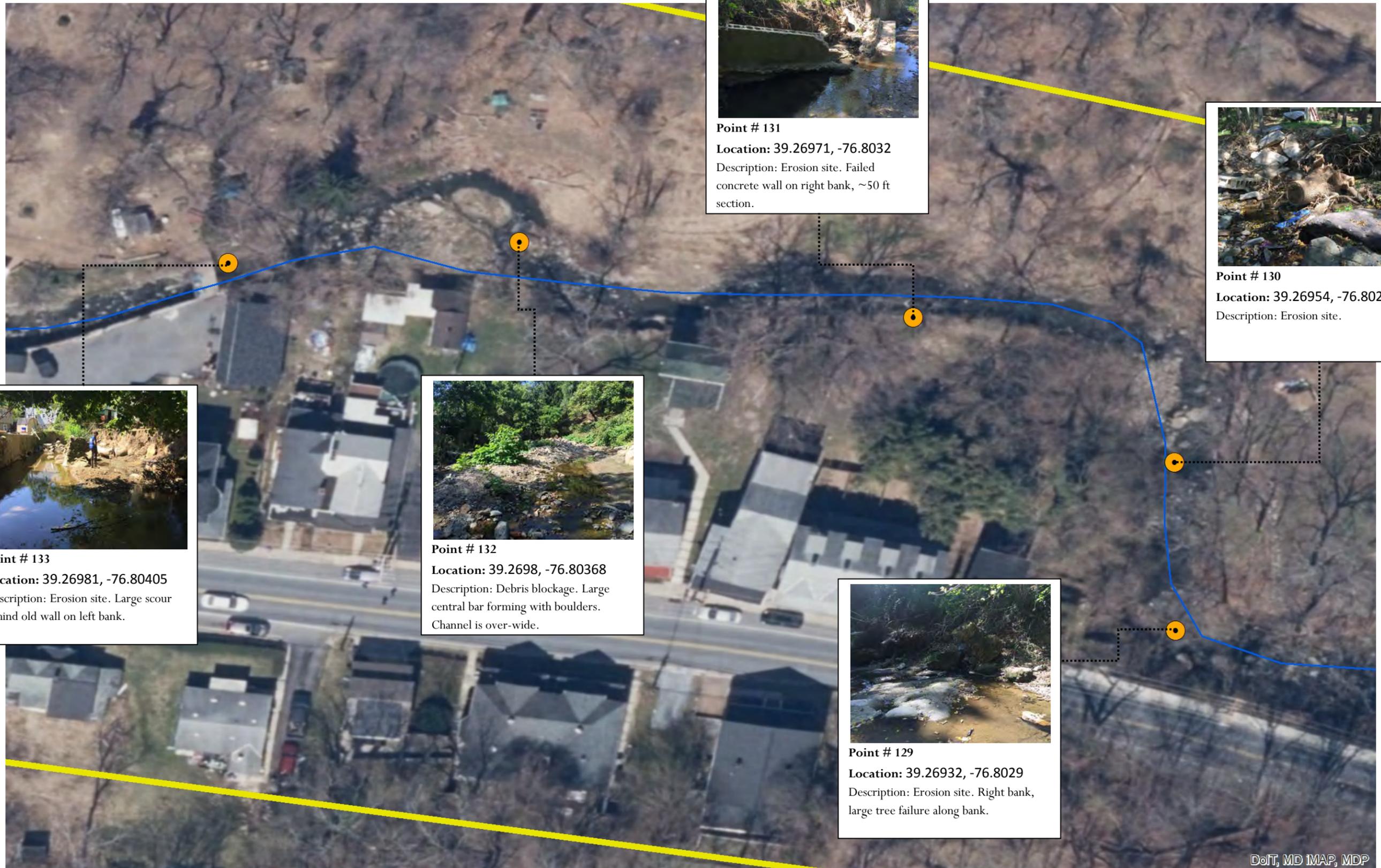












Point # 131
Location: 39.26971, -76.8032
Description: Erosion site. Failed concrete wall on right bank, ~50 ft section.



Point # 130
Location: 39.26954, -76.80288
Description: Erosion site.



Point # 133
Location: 39.26981, -76.80405
Description: Erosion site. Large scour behind old wall on left bank.



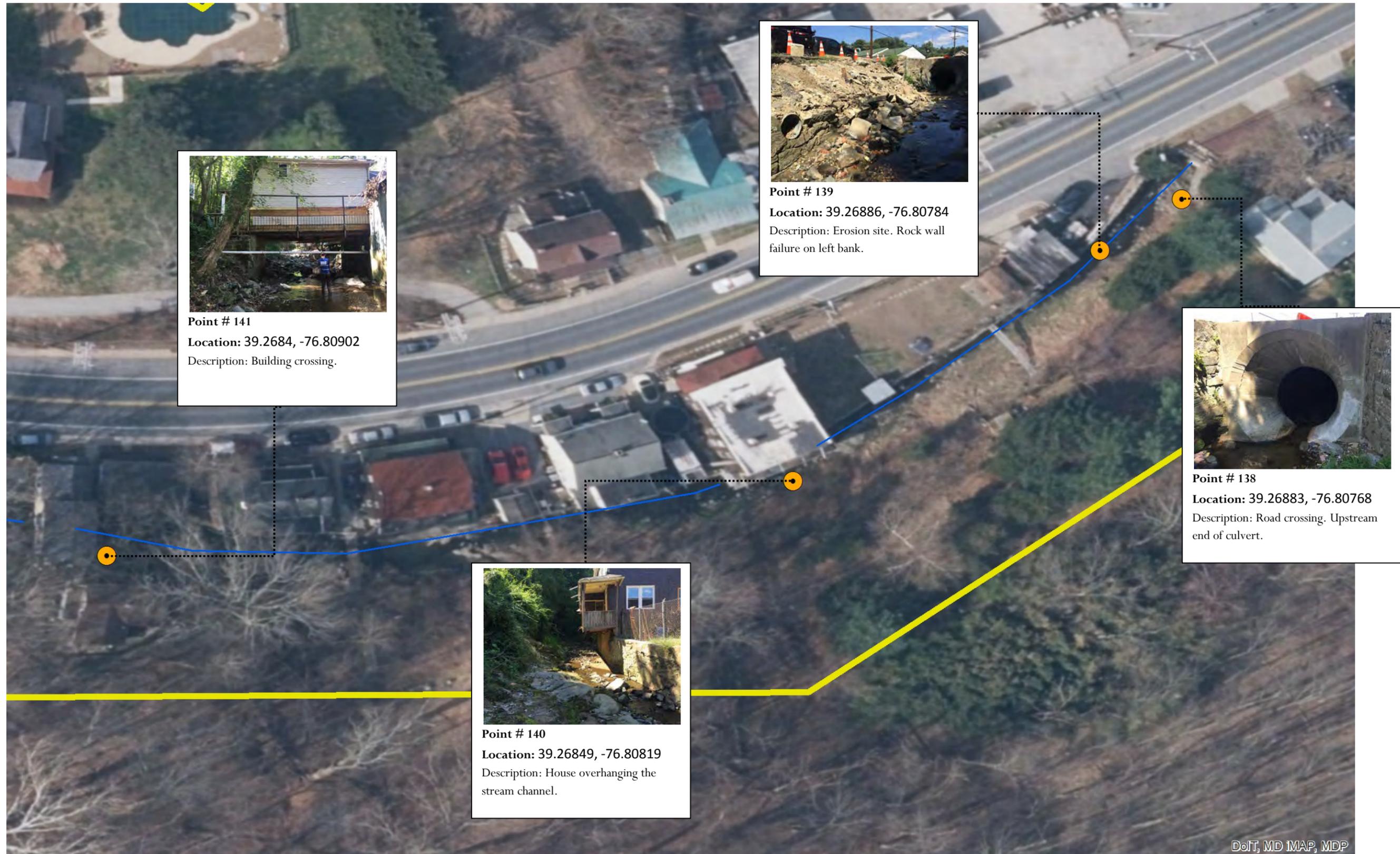
Point # 132
Location: 39.2698, -76.80368
Description: Debris blockage. Large central bar forming with boulders. Channel is over-wide.



Point # 129
Location: 39.26932, -76.8029
Description: Erosion site. Right bank, large tree failure along bank.

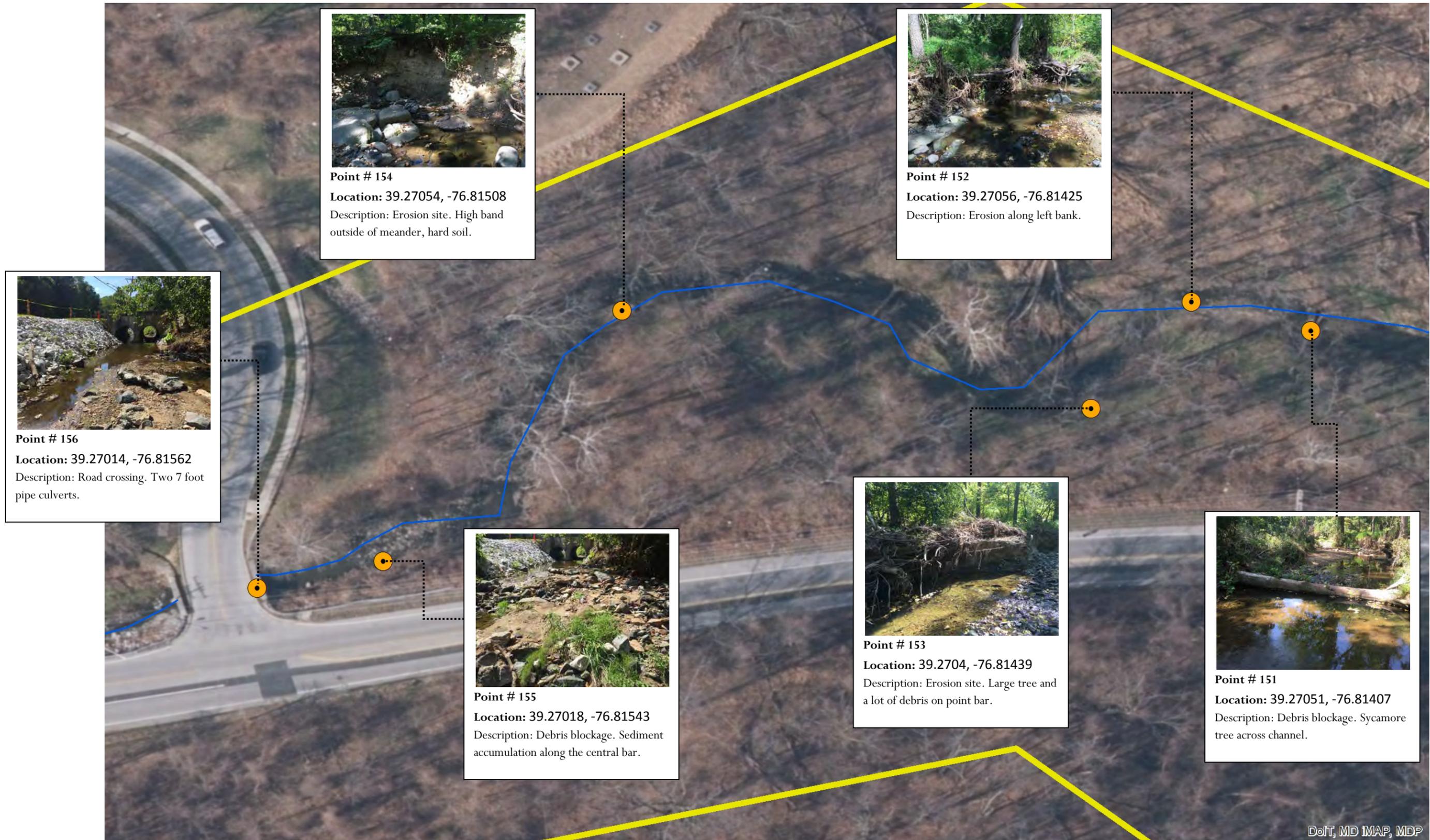
DoIT, MD IMAP, MDP













Section IV – Recommendations and Conclusions

Contents of this Section

- 4.1 Recommendations
- 4.2 Specific Selected Problem Sites – Potential Mitigation Projects
- 4.3 Next Steps

4.1 Recommendations

The Tiber-Hudson Branch stream corridor exhibited many conditions and problems, ranging from minor to severe. This stream corridor, especially in the lower reaches, is almost completely contained within stone flood walls. Additionally, many of the buildings within the historic district are constructed directly over the stream channel. The prevalence of flood walls diminish as one travels upstream; however, there are walled portions of streambank in the upper reaches of the corridor as well. Flood walls can be effective at containing flood conditions within a channel; however, there are limitations and problems associated with walled stream channels. Constructing flood walls on both sides of a channel can result in an enormous amount of shear force on the streambed during high flow events, inducing downcutting, which can eventually undermine and cause the collapse of the floodwalls. Additionally, walled systems typically have buildings and other infrastructure constructed immediately adjacent to the top of the wall, or even across the walls, as is the case in historic downtown Ellicott City. Therefore, a collapsing floodwall with adjacent infrastructure can pose a much greater risk to life and property than the inundation caused by flooding. While flood walls have both benefits and risks, once a town is constructed around and, as is the case of historic Ellicott City, incorporated into, the flood walls, there are not many options for flood mitigation. However, the flood walls should be monitored and evaluated annually to determine if the structural integrity of the wall is being compromised. As problems are identified, repairs can be implemented that will reduce the chances of wall failure. Additionally, hydraulic structures could be designed and implemented within the channel to reduce the shear forces along the walls; however, the construction of these structures would be limited by access to the channel.

Debris blockages and debris accumulation within the stream corridor should be monitored and maintained. During the July 2016 flood event, debris accumulation at the upstream end of culverts and bridges most likely resulted in the flood water “jumping out” of the channel and continuing down Frederick Road or otherwise bypassing the structure. Therefore, a debris maintenance and management plan should be implemented that could minimize the amount of debris that accumulates within the stream channel. However, during any significant storm event within an unstable channel with eroding streambanks, additional debris can be introduced to the stream as banks fail and any woody vegetation along those banks gets introduced into the flood flow.

Stream restoration and bank stabilization techniques can be implemented throughout the watershed to reduce overall bank erosion within the system, thereby reducing the amount of excess sediment as well as large woody material introduced during a flood event due to bank failures. Bank erosion is one of the primary contributing factors to sediment pollution and downstream sedimentation. Additionally, excess sediment within a stream system affects many critical biological and chemical processes as well.

4.2 Specific Selected Problem Sites – Potential Mitigation Projects

The Stream Corridor Assessment (SCA) identifies, maps, and describes the problems observed during the stream walk at the time the assessment was performed. It is important to note that the assessment cannot account for changes within the watershed due to temporal and anthropogenic factors. As such, several priority problem sites are selected and described for further investigation as potential mitigation projects. Appendix B: Federal and State Funding Sources contains a table of various funding sources and grant programs for mitigation projects.

Site 1

Site 1 is identified as Point 102 within the SCA and is located in the historic downtown section of Ellicott City. More specifically, it is located immediately downstream of the footbridge at Tiber Park. It is categorized as a debris blockage and consists primarily of boulder and cobble accumulation within the channel. This accumulation is occurring due to the slope reduction at the Tiber-Hudson nears its confluence with the Patapsco River. A reduction in slope reduces stream competence, or the ability of the stream system to carry its sediment load. This site is identified as a potential problem/mitigation area because the boulder/cobble accumulation is shifting stream flow directly into a corner created by a ninety degree bend in the stone flood wall. Over time, the continued assault of flowing water on the flood wall can compromise the grouting within the walls and eventually result in failure. One recommendation would be to clean out some of the accumulated material and grade the channel such that flow is redirected away from the walls. A hydraulic structure could be incorporated; however, access to the channel is very limited at this location.



Site 2

Site 2 is identified as Point No. 116 within the SCA and is located between two parking lots in the downtown area, immediately upstream of the Tiber Branch/Hudson Branch confluence. Previously, this site consisted of an I-beam supported, timber-decked footbridge that provided pedestrian traffic to flow between the businesses arranged around the parking lots. The cross-sectional area available to flood conveyance through this structure was not sufficient to convey flood flow. If a structure is replaced at this location, it should be designed to accommodate a minimum design storm in accordance with Howard County regulations.



Site 3

Site 3 is identified as Point No. 118 within the SCA and is located near the upper or western end of historic downtown Ellicott City. This site consists of an archway located within the channel beneath Main Street and several businesses. This archway represents a channel constriction that significantly reduces the cross-sectional area of the potential flood conveyance. Once the flow capacity of the archway reaches its limit during a flood event, it will create a backwater condition within the upstream portion of the channel. Additionally, constriction of the channel increases the possibility that debris can get impinged at the opening, thereby exacerbating the backwater condition and potentially resulting in the flood water 'jumping' from the channel into Main Street. It is recommended to have the archway inspected by a structural engineer to evaluate if its removal would jeopardize the structural integrity of the rectangular conveyance or the surrounding buildings built over this location.



Site 4

Site 4 encompasses the stream reach between Point Nos. 131 and 133 within the SCA. This reach experienced significant accelerated bank erosion, losing approximately 10 to 20 feet of streambank laterally in some locations during the flood event. A portion of a block retaining wall failed. A massive central bar is forming within this reach, which results in excessive erosional forces to both streambanks. It is recommended that this reach be evaluated for additional stabilization and restoration alternatives.



Site 5

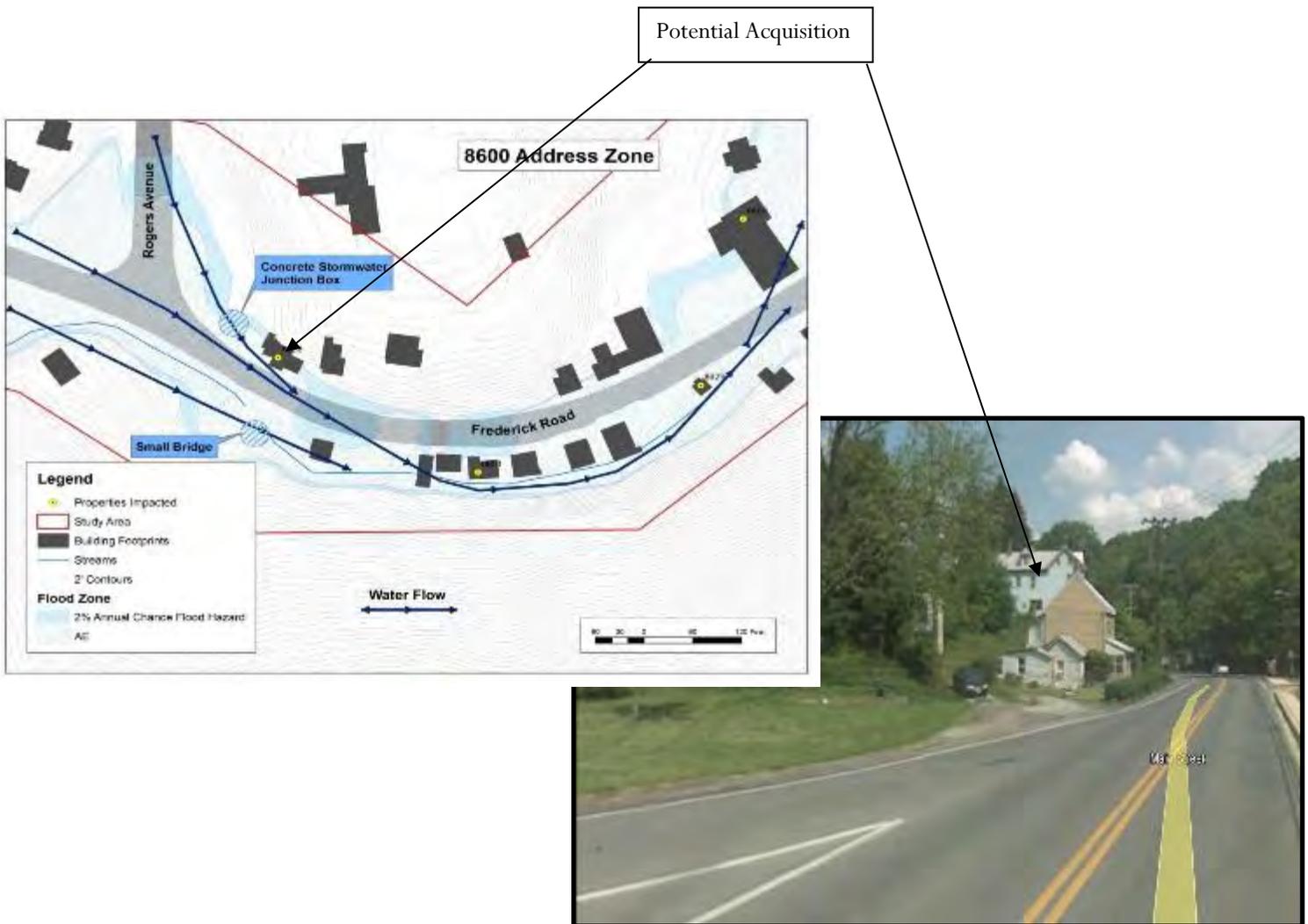
Site 5 is identified as Point No. 149 within the SCA and consists of an erosion site, channelization site, and debris blockage. A concrete bag retaining wall installed to protect the driveway of the adjacent commercial property. It is recommended that this structure be replaced with an appropriate retaining wall. A large accumulation of boulder size material deposited at this location creating a central bar that directed flow into the left bank, resulting in land loss and erosion. Additionally, the left stream bank does not contain vegetation as the floodplain is mowed to the top of bank. A bioengineering plan at this location and agreement with the landowner could reduce the erosion potential at this location.



Site 6

Site 6 consists of a potential flood acquisition project and a stormwater management investigation in the vicinity of the Rogers Avenue and Frederick Road intersection. This area was identified and described within the *Case Study* as the 8600 Address Zone. One structure in particular, located at 8688 Frederick Road, experienced first floor flooding through the windows at the side of the house approximately 3 feet above grade and is recommended as a flood acquisition buyout candidate. Additionally, it was reported that a significant amount of stormwater was flowing down Rogers Avenue to combine with the flows along Frederick Road. A concrete stormwater junction box is located to the northeast of the Rogers Avenue/Frederick Road intersection. Witnesses reported that the manhole access cover was ‘blown off’ the lid of the box. Additionally, they reported that the concrete top was being elevated. This observation would indicate that the junction box and the stormwater pipes leading to it were at capacity, creating sufficient hydraulic pressure to lift the top and remove the manhole cover. With the stormwater system at capacity, excess stormwater would utilize the roadways as the storm conveyance. It is recommended that a stormwater management investigation be conducted to determine the feasibility of installing additional stormwater management facility(s) within this area.

Potential Acquisition



Site 7

Site 7 is located near Point No. 112 within the SCA and consists of an erosion site along the right bank. The erosion has undercut macadam paving where vehicles are routinely parked. In the event of a failure at this location, a car could potentially be introduced into the stream channel at the upstream inlet of a long section of stream that is bridged by buildings. Additionally, these buildings have concrete support columns within the channel that would have a high probability of creating a blockage due to a vehicle introduced to the channel. A stabilization plan at this location and agreement with the landowner could reduce the erosion and failure potential at this location.



4.3 Next Steps

- Develop partnerships between both public and private stakeholders in the form of watershed associations, stream watch groups, or other cooperative agreements.
- Conduct additional investigations within the Tiber-Hudson corridors to assess and develop potential streambank stabilization/restoration projects to reduce bank erosion and land loss. For example, stream corridor assessments within the New Cut and Tiber River corridors could provide additional information and identify problem areas, thereby providing a comprehensive characterization of the watershed. Furthermore, additional mitigation opportunities may be identified within those corridors that could mitigate future flooding.
- Utilizing the watershed/stream partnerships, implement a debris maintenance and management plan.
- Prioritize potential mitigation projects.
- Based on project prioritization, conduct additional studies and investigations into the Potential Mitigation Projects identified herein as Sites 1 through 7 and described in Section 4.2, including:
 - Determine property ownership and identify project specific stakeholders;
 - Develop conceptual designs;
 - Estimate project costs;
 - Determine feasibility of implementation and estimated project timeline;
 - Investigate Public-Private cost sharing options for those projects located on private property; and,
 - Ascertain grant funding options.

APPENDIX A: POINT REFERENCE DATABASE

Tiber-Hudson Branch - Road Crossings												
Point #	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	General Description	Type	Material	Shape	# of Cells	Dimensions	Fish Blockage	Erosion Below Outfall	Embedded	Notes
100	39.267770	-76.794770	RR Crossing, beginning of study area.	Bridge	Concrete/Stone	Arch	1	-	No	No	No	-
101	39.267750	-76.795080	Lower end of tunnel under Maryland Ave.	Bridge	Concrete	-	1	-	No	No	No	-
103	39.267320	-76.795700	Building Crossing	Bridge	-	-	-	-	No	No	No	-
104	39.267320	-76.795920	Bridge Crossing	Bridge	-	-	1	-	No	No	No	-
105	39.267360	-76.795990	Building Crossing	-	-	-	-	-	No	No	No	~5.5' from bed to bottom of beam and ~5' to bottom of septic pipe.
107	39.267130	-76.796690	Building crossing, roughly 9 feet from invert to bottom beam flange.	Bridge	-	-	1	-	No	No	No	-
110	39.267120	-76.797640										
111	39.267340	-76.797860	Building crossing, many boulders and smaller rock debris present.	Bridge	-	-	1	-	No	No	No	-
112	39.267380	-76.798670	Building crossing, pillars and failed wall (being repaired). Chunks of concrete in the channel.	Bridge	-	-	-	-	No	No	No	-
113	39.267140	-76.799250	Bridge with concrete steps, steel pipe.	Bridge	Concrete	-	1	-	Yes	No	No	~5.5 feet clearance
114	39.267110	-76.799840	Upstream end of bridge	Bridge	Concrete	-	1	-	No	No	No	-
117	39.267630	-76.800230	Large tunnel under Main Street and Mexican restaurant.	Box Culvert	Concrete	-	1	-	No	No	No	-
118	39.268060	-76.799690	Upstream end of arch	Arch	-	-	-	-	-	-	-	5.5'X15' @ base
119	39.268290	-76.799650	Beam and building crossing, left rock wall repaired.	-	-	-	-	-	No	No	No	-
122	39.268930	-76.800180	Large culvert pipe outlet	Pipe Culvert	Corrugated Metal	-	1	8'X15'	No	No	No	-
124	39.269080	-76.801760	Upstream end of large culvert, lower lip of culvert curled up.	Pipe Culvert	Corrugated Metal	Elliptical	1	8'X15'	Yes	No	No	-
127	39.269310	-76.802510	Steel foot bridge to house	Bridge	-	-	-	-	No	No	No	-
134	39.269770	-76.804290	Downstream end of culvert	Pipe Culvert	Corrugated Metal	Round	1	8.5'	No	No	No	-
135	39.269860	-76.804840	Upstream end of culvert	Pipe Culvert	Corrugated Metal	Round	1	8.5'	No	No	No	-
137	39.270090	-76.806250	Downstream end of culvert	Pipe Culvert	Corrugated Metal	Round	1	9' @ outlet	Yes	No	No	-
138	39.268830	-76.807680	Upstream end of culvert	Pipe Culvert	Corrugated Metal	Round	1	7'3" @ inlet	Yes	No	No	-
141	39.268400	-76.809020	Building crossing	-	-	-	1	-	No	No	No	-
143	39.268680	-76.809770	-	Bridge	Concrete	-	1	-	No	No	No	-
144	39.268950	-76.810230	Foot bridge to historical school building	Bridge	-	-	1	-	No	No	No	-
150	39.269870	-76.813100	Bridge at Frederick Road.	Bridge	Concrete	-	-	-	No	No	No	-
156	39.270140	-76.815620	Two 7 foot pipes	Pipe Culvert	Corrugated Metal	Round	2	7'	No	No	Yes	-
157	39.269990	-76.816560	Downstream end of culvert at Frederick Road	Pipe Culvert	Corrugated Metal	Elliptical	1	8'X12'	No	No	No	-
158	39.269790	-76.816790	Upstream end of culvert at Frederick Road	Pipe Culvert	Corrugated Metal	Elliptical	1	8'X12'	No	No	No	-
161	39.269640	-76.817550	-	Box Culvert	Concrete	-	1	-	No	No	No	-
162	39.270150	-76.817830	Route 29 overpass, end of study area.	Bridge	-	-	-	-	No	No	No	-

Tiber-Hudson Branch - Erosion Sites											
Point #	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	General Description	Type of Erosion	Cause	Bank Height	Length	Threat to Infrastructure	Severity	Correctability	Access
109	39.267100	-76.797590	-	Lateral	-	5'	50'	-	Severe	Limited	Limited
112	39.267380	-76.798670	Erosion on right bank high up before building with pillars.	Lateral	Failed wall - left bank stone - large pieces missing, being repaired.	-	-	-	-	-	-
116	39.267340	-76.800120	-	Lateral	Former location of foot bridge now gone.	6'	30'	-	Severe	Easy	Easy
118	39.268060	-76.799690	-	Lateral	Large failure	-	-	-	-	-	-
120	39.268500	-76.799950	-	Lateral	Failing concrete and block wall/	8'	50'	-	Severe	Easy	Easy
121	39.268720	-76.799810	Right bank rip-rapped but still has erosion issues and remnant wall.	Lateral	Downstream of stacked stone wall w/ rip-rap on top left bank.	8'	40'	-	Moderate	Easy	Easy
123	39.268840	-76.800050	-	Lateral	Right bank	6'	30'	No	Minor	Easy	Easy
124	39.269080	-76.801760	Large erosion hole behind headwall.	Lateral	Left bank, high up, looks like tree failed.	-	-	-	-	-	-
125	39.269240	-76.802020	-	Lateral	Failing and undercut concrete wall.	8'	-	-	Severe	Moderate	Moderate
126	39.269250	-76.802330	-	Lateral	Portion of rock wall failure.	15'	20'	No	Moderate	Easy	Limited
128	39.269320	-76.802610	-	Lateral	Upstream end of wall near footbridge.	20'	50'	Yes	Severe	Moderate	Moderate
129	39.269320	-76.802900	Right bank	Lateral	Large tree failure along bank.	40'	50'	-	-	-	-
130	39.269540	-76.802880	-	Lateral	-	6'	100'	No	Moderate	Moderate	Moderate
131	39.269710	-76.803200	-	Lateral	Failed concrete wall on right bank, 50' section.	7'	-	No	Severe	Moderate	Easy
133	39.269810	-76.804050	-	Lateral	Large scour behind old wall, left bank.	6'	70'	Yes	Severe	Moderate	Moderate
139	39.268860	-76.807840	Left bank	Lateral	Rock wall failure.	7'	-	Yes	Severe	Easy	Easy
142	39.268480	-76.809340	-	Lateral	Failed wall on left bank, large chunk of wall in creek.	8'	75'	Yes	Severe	Moderate	Easy
145	39.269010	-76.810580	Left bank	Lateral	Failed stone wall.	-	-	-	Moderate	Easy	Easy
146	39.268950	-76.811050	-	Lateral	High eroding slope.	20'	75'	-	Severe	Moderate	Moderate
147	39.268930	-76.811330	-	Lateral	Failed wall along left bank.	-	-	-	Moderate	Easy	Easy
148	39.269180	-76.812650	Right bank. Additionally, 25 foot section along left bank adjacent to lawn.	Lateral	-	5'	100'	No	Minor	Easy	Easy
149	39.269390	-76.813170	-	Lateral	-	4'	100'	-	-	-	-
152	39.270560	-76.814250	Erosion along left bank.	Lateral	-	6'	50'	No	Moderate	Easy	Easy
153	39.270400	-76.814390	Large tree and lots of debris on point bar.	Lateral	S-curve	6'	-	-	Moderate	Moderate	Moderate
154	39.270540	-76.815080	-	Lateral	High bank outside of meander, hard soil resists weathering.	12'	50'	-	Moderate	Moderate	Easy
159	39.269680	-76.817090	-	Lateral	Undercut bank and trees, will lose eventually.	5'	25'	No	Minor	-	-
160	39.269540	-76.817250	-	Lateral	Flow around boulders caused erosion of left bank.	4'	15'	-	Minor	Easy	Easy

Tiber-Hudson Branch - Debris Blockages						
Point #	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	General Description	Description of Debris	Extent	Impact
102	39.267410	-76.795680	-	~8' from debris to lower cord of bridge/sidewalk	-	-
106	39.267460	-76.796490	Under buildings	Large tree and debris in channel - some demolition related.	-	-
130	39.269540	-76.802880	-	Tree root fan, many large boulders, and part of cinder block wall.	Half	Left Bank
132	39.269800	-76.803680	-	Large central bar forming with boulders. Channel is overwide, several feet of deposition.	-	-
149	39.269390	-76.813170	-	Boulder accumulation in center of channel.	Half	Left Bank
151	39.270510	-76.814070	-	Sycamore tree across channel.	Complete	Scour
155	39.270180	-76.815430	-	Sediment accumulation - central bar.	Half	Left Bank
159	39.269680	-76.817090	-	Fallen tree	Minor	Left Bank
160	39.269540	-76.817250	-	Multiple angular boulders in channel.	-	-

Tiber - Hudson Branch - Channelization							
Point #	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Description	Bank Affected	Deposition	Vegetation	Flood Wall
136	39.269340	-76.805090	Rock wall - failing on right bank	Both	Yes	-	Yes
143	39.268680	-76.809770	Concrete lined channel	Both	Yes	No	Yes
149	39.269390	-76.813170	Sandbag/Concrete bag wall	Right	Yes	No	-

APPENDIX B: POTENTIAL FEDERAL & STATE GRANT FUNDING SOURCES

FEDERAL & STATE GRANT FUNDING SOURCES

The following is a list of Federal and State Grants that may assist in implementing mitigation projects. This information is subject to change at any time; contact the federal or state agency for current grant status.

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Continuing Authorities Program (CAP)	USACE Washington DC 20314; 202-761-4561	Initiates a short reconnaissance effort to determine Federal interest in proceeding. If there is interest, a feasibility study is performed.	Federal - 65% Local - 35%	A local sponsor must identify the problem and request assistance. Small flood control projects are also available.	Anytime
Federal Emergency Management Agency, Hazard Mitigation Grant Program (HMGP)	Maryland Emergency Management Agency 5401 Rue Saint Lo Drive Reisterstown, MD 21401	Grants can be used for management costs, information dissemination, planning, technical assistance and mitigation projects.	Federal - 75% Local - 25%	Local governments must be in compliance with the National Flood Insurance Program to be eligible. Projects must be environmentally sound and cost effective.	After a Presidential Disaster Declaration
Federal Emergency Management Agency, Pre Disaster Mitigation Grant Program (PDM)	Maryland Emergency Management Agency 5401 Rue Saint Lo Drive Reisterstown, MD 21401	Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations.	Federal - 75% Non Federal - 25%	PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds.	Annual-Spring/Summer
Federal Emergency Management Agency, Flood Mitigation Assistance Program (FMA)	Maryland Emergency Management Agency 5401 Rue Saint Lo Drive Reisterstown, MD 21401	Assist States and communities to implement measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program.	Federal - 75% Non Federal - 25%	Available once a Flood Mitigation Plan has been developed and approved by FEMA.	Annual-Spring/Summer
Small Business Administration (SBA) Pre-disaster Mitigation Loan Program	Herbert L. Mitchell, Office of Disaster Assistance, Small Business Administration, 409 3rd Street, SW, Washington, DC 20415; 202-205-6734	Activities done for the purpose of protecting real and personal property against disaster related damage.	No information	The mitigation measures must protect property or contents from damage that may be caused by future disasters and must conform to the priorities and goals of the state or local government's mitigation plan.	Anytime

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
National Flood Insurance Program (NFIP)	Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21136	Provides financial protection by enabling persons to purchase insurance against floods, mudslide or flood related erosion.	Varies	Includes Federally backed insurance against flooding, available to individuals and businesses that participate in the NFIP	Anytime
U.S. Economic Development Administration, Economic Adjustment Program	U.S. Department of Commerce Economic Development Administration Curtis Center, 601 Walnut Street, Ste 140 South Philadelphia, PA 19106-3323 215-597-4603	Improvements and reconstruction of public facilities after a disaster or industry closing. Research studies designed to facilitate economic development.	Federal - 50%-70% Local - 30%-50%	Documenting economic distress, job impact and proposing a project that is consistent with a Comprehensive Economic Development Strategy are important funding selection criteria.	Anytime
U.S Economic Development Administration, Public Works and Development Facilities	U.S. Department of Commerce Economic Development Administration Curtis Center, 601 Walnut Street, Ste 140 South Philadelphia, PA 19106-3323 215-597-4603	Water and sewer, Industrial access roads, rail spurs, port improvements technological and related infrastructure	Federal - 50%-70% Local - 30%-50%	Documenting economic distress, job impact and projects that is consistency with a Comprehensive Economic Development Strategy are important funding selection criteria.	Quarterly Basis
Community Development Block Grants / Entitlement Grants	Office of Block Grant Assistance, 451 Seventy Street SW., Washington, DC 20410-7000;202-708-3587	Used for long-term recovery needs, such as: rehabilitation residential and commercial building; homeownership assistance, including down-payment assistance and interest rate subsidies; building new replacement housing; code enforcement; acquiring, construction, or reconstructing public facilities.	No information	Citizen participation procedures must be followed. At least 70 percent of funds must be used for activities that principally benefit persons of low and moderate income. Formula grants to entitlement communities.	After a Presidential Disaster Declaration
Historic Preservation: Repair and Restoration of Disaster-Damaged Historic Properties	Infrastructure Division, Response and Recovery Directorate, FEMA, 500 C Street SW., Washington DC 20024 ; 202-646-4621.	To evaluate the effects of repairs to, restoration of, or mitigation hazards to disaster-damaged historic structures working in concert with the requirements of the Stafford Act.	Federal - 75% Local - 25%	Eligible to State and local governments, and any political subdivision of a State. Also, eligible are private non-profit organizations that operate educational, utility, emergency, or medical facilities.	After a Presidential Disaster Declaration

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Transportation: Emergency Relief Program	Federal Highway Administration, FHWA, DOT, 1200 New Jersey Avenue Washington, DC 20590; 202-366-4043	Provides aid for the repair of Federal-aid roads, roads on Federal lands and county level federal-aid roads.	Federal - 100%	Application is submitted by the State department of transportation for damages to Federal-aid highway routes, and by the applicable Federal agency for damages to roads on Federal lands.	After serious damage to Federal-aid roads or roads on Federal lands caused by a natural disaster or by catastrophic failure.
Animals: Emergency Haying and Grazing	Emergency and Non-insured Assistance Programs, FSA, USDA, 1400 Independence Ave, SW, Washington, DC 20013; 202-720-4053	To help livestock producers in approved counties when the growth and yield of hay and pasture have been substantially reduced because of a widespread natural disaster.	No information	Assistance is provided by the Secretary of Agriculture to harvest hay or graze cropland or other commercial use of forage devoted to the Conservation Reserve Program (CRP) in response to a drought or other similar emergency.	Anytime
Emergency Watershed Protection Program	Natural Resources Conservation Service 14th and Independence Avenue, SW Washington, DC 20250	Implementing emergency recovery measures for runoff retardation and erosion prevention to relieve imminent hazards to life and property created by a natural disaster that causes a sudden impairment of a watershed.	Federal - 75% Local - 25%	It cannot fund operation and maintenance work or repair private or public transportation facilities or utilities. The work cannot adversely affect downstream water rights and funds cannot be used to install measures not essential to the reduction of hazards.	TBD
Watershed Protection and Flood Prevention Program	Natural Resources Conservation Service 14th and Independence Avenue, SW Washington, DC 20250	To provide technical and financial assistance in carrying out works of improvement to protect, develop, and utilize the land and water resources in watersheds.	Varies due to project type.	Watershed area must not exceed 250,000 acres. Capacity of a single structure is limited to 25,000 acre-feet of total capacity and 12,500 acre-feet of floodwater detention capacity.	TBD
Watershed Surveys and Planning	Natural Resources Conservation Service 14th and Independence Avenue, SW Washington, DC 20250	To provide planning assistance to Federal, State, and local agencies for the development of coordinated water and related programs in watersheds and river basins. Emphasis is on flood damage reduction, erosion control, water conservation, preservation of wetlands and water quality improvements.	No information	These watershed plans form the basis for installing needed works of improvement and include estimated benefits and costs, cost-sharing, operation and maintenance arrangements, and other information necessary to justify the need for Federal assistance in carrying out the plan.	Anytime

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Emergency Advance Measures for Flood Prevention	USACE Washington DC 20314; 202-761-4561	To perform activities prior to flooding or flood fight that would assist in protecting against loss of life and damages to property due to flooding.	No information	There must be an immediate threat of unusual flooding present before advance measures can be considered. Any work performed under this program will be temporary in nature and must have a favorable benefit cost ratio.	TBD
Emergency Streambank and Shoreline Protection	USACE Washington DC 20314; 202-761-4561	Authorizes the construction of emergency streambank protection measures to prevent damage to highways, bridge approaches, municipal water supply systems, sewage disposal plants, and other essential public works facilities endangered by floods or storms due to bank erosion.	No information	Churches, hospitals, schools, and other non-profit service facilities may also be protected under this program. This authority does not apply to privately-owned property or structures.	TBD
Small Flood Control Projects	USACE Washington DC 20314; 202-761-4561	Authorizes the construction of small flood control projects that have not already been specifically authorized by Congress.	No information	There are two general categories of projects: structural and nonstructural. Structural projects may include levees, floodwalls, diversion channels, pumping plants, and bridge modifications. Nonstructural projects have little or no effect on water surface elevations, and may include flood proofing, the relocation of structures, and flood warning systems.	TBD
Flood: Emergency Advance Measures for Flood Prevention	USACE Washington DC 20314; 202-761-4561	To mitigate, before an event, the potential loss of life and damages to property due to floods.	No information	Assistance may consist of temporary levees, channel cleaning, preparation for abnormal snowpacks, etc.	Anytime
Cooperating Technical Partners	CFDA Number: 97.045	Flood Hazard Mapping products	Federal - 100%	Provides technical assistance, training, and/or data to support flood hazard data development activities.	TBD

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Map Modernization Management Support	CFDA Number: 97.070	Community outreach on Flood Mapping	Federal - 100%	Provides funding to supplement, not supplant, ongoing flood hazard mapping management efforts by the local, regional, or State agencies.	TBD