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.
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Section I – Introduction

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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.
Map 1: Study Area - Ellicott City, Howard County, MD
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.
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.
Map 2: Hudson Branch Data Collection Locations
Road Crossings

Map 3: Road Crossing Locations
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

Map 4: Erosion Site Locations
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 stream’s 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.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Downcutting</th>
<th>Lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td><strong>Threat to Infrastructure</strong></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td><strong>Severity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td><strong>Correctability</strong></td>
<td></td>
<td>Limited</td>
<td>Moderate</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>Access</strong></td>
<td></td>
<td>Limited</td>
<td>Moderate</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>
Debris Blockages

Map 5: Debris Blockage Locations
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.

<table>
<thead>
<tr>
<th>Extent</th>
<th>Complete</th>
<th>Half</th>
<th>Minor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
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<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact</th>
<th>Left Bank</th>
<th>Right Bank</th>
<th>Scour</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3 – Total Debris Blockages: 9
Map 6: Channelization Locations
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.

<table>
<thead>
<tr>
<th>Bank Affected</th>
<th>Left</th>
<th>Right</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Deposition</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Vegetation</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Flood Wall</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Table 4 – Total Channelization: 3
3.3 Point Locations & Descriptions – Map Plates

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

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

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

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

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

Point # 105
Location: 39.26736, -76.79599
Description: Building crossing with low overhead.
Point # 106
Location: 39.26746, -76.79649
Description: Debris blockage. Large tree and debris in channel, some demolition related.

Point # 107
Location: 39.26713, -76.79669
Description: Building crossing with low overhead.

Point # 108
Location: 39.26694, -76.79725
Description: Confluence of streams.

Point # 109
Location: 39.2671, -76.79759
Description: Erosion site; failed stream wall.

Point # 110
Location: 39.26712, -76.79764
Description: Building crossing with failed stream wall along left bank.
Point # 111
Location: 39.26734, -76.79786
Description: Building crossing. Many boulders and smaller rock debris present.

Point # 112
Location: 39.26738, -76.79867
Description: Building crossing. Pillars and failed wall currently being repaired.

Point # 113
Location: 39.26714, -76.79925
Description: Bridge with concrete steps and steel pipe.
Point # 114
Location: 39.26811, -76.79984
Description: Road crossing. Upstream end of bridge.

Point # 116
Location: 39.26734, -76.80012
Description: Erosion site. Former location of foot bridge.

Point # 115
Location: 39.26727, -76.80013
Description: Confluence, six foot outfall of culvert.

Point # 117
Location: 39.26763, -76.80023
Description: Large tunnel beneath Main Street and restaurant.

Point # 118
Location: 39.26806, -76.79969
Description: Road crossing. Upstream end of arch.
Point # 119
Location: 39.26829, -76.79965
Description: Building crossing. Left side rock wall being repaired.

Point # 120
Location: 39.2685, -76.79995
Description: Erosion site. Failing concrete and block wall.

Point # 121
Location: 39.26884, -76.80005
Description: Erosion site. Minor erosion on right bank.

Point # 122
Location: 39.26893, -76.80018
Description: Road crossing. Large culvert pipe outlet.

Point # 123
Location: 39.26872, -76.79981
Description: Erosion site. Right bank rip-rapped, but clear erosion issues still exist.
Point # 124
Location: 39.26908, -76.80176
Description: Erosion site. Large erosion hole behind headwall.

Point # 125
Location: 39.26924, -76.80202
Description: Erosion site. Failing and undercut concrete wall.

Point # 126
Location: 39.26925, -76.80233
Description: Erosion site. Portion of rock wall failure.

Point # 127
Location: 39.26931, -76.80251
Description: Steel footbridge to house.

Point # 128
Location: 39.26932, -76.80261
Description: Erosion site. Upstream end of wall near footbridge.
Point # 129
Location: 39.26932, -76.8029
Description: Erosion site. Right bank, large tree failure along bank.

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

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

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

Point # 133
Location: 39.26981, -76.80405
Description: Erosion site. Large scour behind old wall on left bank.
Point # 134
Location: 39.26977, -76.80429
Description: Road crossing. Downstream end of culvert.

Point # 135
Location: 39.26986, -76.80484
Description: Road crossing. Upstream end of culvert.

Point # 136
Location: 39.26994, -76.80509
Description: Channelization. Rock wall failing on right bank.

Point # 137
Location: 39.27009, -76.80625
Description: Road crossing. Downstream end of culvert.
Point # 138
Location: 39.26883, -76.80768
Description: Road crossing. Upstream end of culvert.

Point # 139
Location: 39.26886, -76.80784
Description: Erosion site. Rock wall failure on left bank.

Point # 140
Location: 39.26849, -76.80819
Description: House overhanging the stream channel.

Point # 141
Location: 39.2684, -76.80902
Description: Building crossing.
Point # 142
Location: 39.26848, -76.80934
Description: Erosion site. Failed wall on left bank, large chunk of wall in the stream.

Point # 143
Location: 39.26868, -76.80977
Description: Bridge crossing/Channelization. Concrete lined channel.

Point # 144
Location: 39.26895, -76.81023
Description: Bridge crossing. Foot bridge to historical school building.

Point # 145
Location: 39.26901, -76.81058
Description: Erosion site. Failed stone wall on left bank.
Point # 146
Location: 39.26893, -76.81133
Description: Erosion site. Failed wall along left bank.

Point # 147
Location: 39.26939, -76.81317
Description: Erosion site/Channelization. Sandbag/concrete wall present.

Point # 148
Location: 39.26918, -76.81265
Description: Erosion site. Right bank is eroded, as well as ~25 ft section of left bank adjacent to a lawn.

Point # 149
Location: 39.26937, -76.81311
Description: Road crossing. Bridge at Frederick Road.

Point # 150
Location: 39.26987, -76.81308
Description: Road crossing. Bridge at Frederick Road.
Point # 151
Location: 39.27051, -76.81407
Description: Debris blockage. Sycamore tree across channel.

Point # 152
Location: 39.27056, -76.81425
Description: Erosion along left bank.

Point # 153
Location: 39.27040, -76.81439
Description: Erosion site. Large tree and a lot of debris on point bar.

Point # 154
Location: 39.27054, -76.81508
Description: Erosion site. High band outside of meander, hard soil.

Point # 155
Location: 39.27018, -76.81543
Description: Debris blockage. Sediment accumulation along the central bar.

Point # 156
Location: 39.27014, -76.81562
Description: Road crossing. Two 7 foot pipe culverts.
Point # 157
Location: 39.26999, -76.81656
Description: Road crossing. Downstream end of culvert at Frederick Road.

Point # 158
Location: 39.26979, -76.81679
Description: Road crossing. Upstream end of culvert at Frederick Road.

Point # 159
Location: 39.26968, -76.81709
Description: Erosion site/Debris blockage. Undercut bank and trees present.

Point # 160
Location: 39.26954, -76.81725
Description: Erosion site/Debris blockage. Flow around boulders caused erosion on left bank.

Point # 161
Location: 39.26964, -76.81755
Description: Road crossing.

Point # 162
Location: 39.27015, -76.81783
Description: Road crossing. Route 29 overpass, end of study area.
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.
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
<table>
<thead>
<tr>
<th>Pole #</th>
<th>Lat (Decimal Degrees)</th>
<th>Long (Decimal Degrees)</th>
<th>General Description</th>
<th>Type</th>
<th>Material</th>
<th>Shape</th>
<th># of Cells</th>
<th>Dimensions</th>
<th>Fish Blockage</th>
<th>Erosion Below Outfall</th>
<th>Embedded</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>39.267770</td>
<td>-76.794770</td>
<td>RR Crossing, beginning of study area.</td>
<td>Bridge</td>
<td>Concrete/Stone</td>
<td>Arch</td>
<td>1</td>
<td></td>
<td>No</td>
<td>No</td>
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<td>-</td>
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<tr>
<td>101</td>
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<td>-76.795080</td>
<td>Lower end of tunnel under Maryland Ave.</td>
<td>Bridge</td>
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<td>-</td>
<td>1</td>
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<td>No</td>
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<td>103</td>
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<td>-76.797000</td>
<td>Building Crossing</td>
<td>Bridge</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
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<td>No</td>
<td>No</td>
<td>-</td>
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<td>104</td>
<td>39.267320</td>
<td>-76.795930</td>
<td>Bridge Crossing</td>
<td>Bridge</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>105</td>
<td>39.267360</td>
<td>-76.795990</td>
<td>Building Crossing</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>107</td>
<td>39.267130</td>
<td>-76.796690</td>
<td>Building crossing, roughly 9 feet from invert to bottom beam flange.</td>
<td>Bridge</td>
<td>-</td>
<td>-</td>
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<td>No</td>
<td>No</td>
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<tr>
<td>110</td>
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<td>Building crossing, many boulders and smaller rock debris present.</td>
<td>Bridge</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
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</tr>
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<td>111</td>
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<td>Building crossing, many boulders and smaller rock debris present.</td>
<td>Bridge</td>
<td>-</td>
<td>-</td>
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<td>No</td>
<td>No</td>
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<td>112</td>
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<td>-76.798670</td>
<td>Bridge with concrete stops, steel pipe.</td>
<td>Bridge</td>
<td>Concrete</td>
<td>-</td>
<td>1</td>
<td></td>
<td>Yes</td>
<td>No</td>
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<td>-</td>
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<td>Bridge with concrete stops, steel pipe.</td>
<td>Bridge</td>
<td>Concrete</td>
<td>-</td>
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<td></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<td>114</td>
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<td>Upstream end of bridge</td>
<td>Bridge</td>
<td>Concrete</td>
<td>-</td>
<td>1</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>-</td>
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<td>117</td>
<td>39.267830</td>
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<td>Large tunnel under Main Street and Mexican Restaurant.</td>
<td>Box Culvert</td>
<td>Concrete</td>
<td>-</td>
<td>1</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>-</td>
</tr>
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<td>Upstream end of arch</td>
<td>Arch</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<td>Beam and building crossing, left rock wall repaired.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
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<td>No</td>
<td>No</td>
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<tr>
<td>122</td>
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<td>-76.800180</td>
<td>Large culvert pipe outlet</td>
<td>Pipe Culvert</td>
<td>Corrugated Metal</td>
<td>-</td>
<td>1</td>
<td>8'x15'</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>124</td>
<td>39.269080</td>
<td>-76.801760</td>
<td>Upstream end of large culvert, lower lip of culvert curved up.</td>
<td>Pipe Culvert</td>
<td>Corrugated Metal</td>
<td>Elliptical</td>
<td>1</td>
<td>8'x15'</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>127</td>
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<td>Steel foot bridge to house</td>
<td>Bridge</td>
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<td>-</td>
<td>-</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>-</td>
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<tr>
<td>134</td>
<td>39.269770</td>
<td>-76.804250</td>
<td>Downstream end of culvert</td>
<td>Pipe Culvert</td>
<td>Corrugated Metal</td>
<td>Round</td>
<td>1</td>
<td>8.5'</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>135</td>
<td>39.268650</td>
<td>-76.804840</td>
<td>Upstream end of culvert</td>
<td>Pipe Culvert</td>
<td>Corrugated Metal</td>
<td>Round</td>
<td>1</td>
<td>8.5'</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>-</td>
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<td>Downstream end of culvert</td>
<td>Pipe Culvert</td>
<td>Corrugated Metal</td>
<td>Round</td>
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<td>9' @ outlet</td>
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<td>138</td>
<td>39.268330</td>
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<td>Upstream end of culvert</td>
<td>Pipe Culvert</td>
<td>Corrugated Metal</td>
<td>Round</td>
<td>1</td>
<td>7.5' @ inlet</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<td>141</td>
<td>39.268400</td>
<td>-76.809030</td>
<td>Building crossing</td>
<td>Bridge</td>
<td>Concrete</td>
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<td>1</td>
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<td>No</td>
<td>No</td>
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<td>143</td>
<td>39.268150</td>
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<td>Foot bridge to historical school building</td>
<td>Bridge</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>150</td>
<td>39.268870</td>
<td>-76.813100</td>
<td>Bridge at Frederick Road</td>
<td>Bridge</td>
<td>Concrete</td>
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<td>No</td>
<td>No</td>
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<tr>
<td>156</td>
<td>39.270140</td>
<td>-76.815630</td>
<td>Two 7 foot pipes</td>
<td>Pipe Culvert</td>
<td>Corrugated Metal</td>
<td>Round</td>
<td>2</td>
<td>7'</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>-</td>
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<td>157</td>
<td>39.269990</td>
<td>-76.816560</td>
<td>Downstream end of culvert at Frederick Road</td>
<td>Pipe Culvert</td>
<td>Corrugated Metal</td>
<td>Elliptical</td>
<td>1</td>
<td>8'x12'</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>158</td>
<td>39.267990</td>
<td>-76.817990</td>
<td>Upstream end of culvert at Frederick Road</td>
<td>Pipe Culvert</td>
<td>Corrugated Metal</td>
<td>Elliptical</td>
<td>1</td>
<td>8'x12'</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>161</td>
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<td>Bridge</td>
<td>Box Culvert</td>
<td>Concrete</td>
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<td>162</td>
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<td>-76.817830</td>
<td>Route 29 overpass, end of study area.</td>
<td>Bridge</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
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</tr>
<tr>
<td>Point #</td>
<td>Latitude (Decimal Degrees)</td>
<td>Longitude (Decimal Degrees)</td>
<td>General Description</td>
<td>Type of Erosion</td>
<td>Cause</td>
<td>Bank Height</td>
<td>Length</td>
<td>Threat to Infrastructure</td>
<td>Severity</td>
<td>Correctability</td>
<td>Access</td>
<td></td>
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<td>---------</td>
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<td>----------------------------</td>
<td>---------------------</td>
<td>-----------------</td>
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<tr>
<td>109</td>
<td>39.267100</td>
<td>-76.795900</td>
<td>Erosion on right bank high up before building with pillars.</td>
<td>Lateral</td>
<td>Failed wall - left bank stone - large pieces missing, being repaired.</td>
<td>5'</td>
<td>50'</td>
<td>-</td>
<td>Severe</td>
<td>Limited</td>
<td>Limited</td>
<td></td>
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<tr>
<td>112</td>
<td>39.267300</td>
<td>-76.798670</td>
<td>-</td>
<td>Lateral</td>
<td>Former location of foot bridge now gone.</td>
<td>6'</td>
<td>30'</td>
<td>-</td>
<td>Severe</td>
<td>Easy</td>
<td>Easy</td>
<td></td>
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<tr>
<td>116</td>
<td>39.267340</td>
<td>-76.800120</td>
<td>-</td>
<td>Lateral</td>
<td>Large failure</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>118</td>
<td>39.268000</td>
<td>-76.799690</td>
<td>-</td>
<td>Lateral</td>
<td>Failing concrete and block wall</td>
<td>8'</td>
<td>50'</td>
<td>-</td>
<td>Severe</td>
<td>Easy</td>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>39.268500</td>
<td>-76.799050</td>
<td>Right bank rip-rapped but still has erosion issues and remnant wall.</td>
<td>Lateral</td>
<td>Downstream of stacked stone wall w/ rip-rap on top left bank.</td>
<td>8'</td>
<td>40'</td>
<td>-</td>
<td>Moderate</td>
<td>Easy</td>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>123</td>
<td>39.268840</td>
<td>-76.800050</td>
<td>Right bank</td>
<td>Lateral</td>
<td>Large tree failure along bank.</td>
<td>6'</td>
<td>30'</td>
<td>-</td>
<td>No</td>
<td>Minor</td>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>124</td>
<td>39.269000</td>
<td>-76.801760</td>
<td>Large erosion hole behind headwall.</td>
<td>Lateral</td>
<td>Left bank, high up, looks like tree failed.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>39.269200</td>
<td>-76.803000</td>
<td>-</td>
<td>Lateral</td>
<td>Failing and undercut concrete wall.</td>
<td>8'</td>
<td>-</td>
<td>-</td>
<td>Severe</td>
<td>Moderate</td>
<td>Moderate</td>
<td></td>
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<tr>
<td>126</td>
<td>39.269250</td>
<td>-76.803300</td>
<td>-</td>
<td>Lateral</td>
<td>Portion of rock wall failure.</td>
<td>13'</td>
<td>20'</td>
<td>-</td>
<td>No</td>
<td>Moderate</td>
<td>Easy</td>
<td></td>
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<tr>
<td>128</td>
<td>39.269310</td>
<td>-76.802610</td>
<td>-</td>
<td>Lateral</td>
<td>Upstream end of wall near footbridge.</td>
<td>20'</td>
<td>50'</td>
<td>-</td>
<td>Yes</td>
<td>Severe</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>129</td>
<td>39.269370</td>
<td>-76.802900</td>
<td>Right bank</td>
<td>Lateral</td>
<td>Large tree failure along bank.</td>
<td>40'</td>
<td>50'</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
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<tr>
<td>130</td>
<td>39.269500</td>
<td>-76.802800</td>
<td>-</td>
<td>Lateral</td>
<td>Failed concrete wall on right bank, 50' section.</td>
<td>6'</td>
<td>100'</td>
<td>-</td>
<td>No</td>
<td>Moderate</td>
<td>Moderate</td>
<td></td>
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<td>131</td>
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<td>-</td>
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<td>Large scour behind old wall, left bank.</td>
<td>7'</td>
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<td>-</td>
<td>No</td>
<td>Severe</td>
<td>Moderate</td>
<td></td>
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<td>-</td>
<td>Lateral</td>
<td>-</td>
<td>6' 70'</td>
<td>-</td>
<td>Yes</td>
<td>Severe</td>
<td>Moderate</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>139</td>
<td>39.268860</td>
<td>-76.807840</td>
<td>Left bank</td>
<td>Lateral</td>
<td>Rock wall failure.</td>
<td>7'</td>
<td>-</td>
<td>-</td>
<td>Yes</td>
<td>Severe</td>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>142</td>
<td>39.268480</td>
<td>-76.809340</td>
<td>-</td>
<td>Lateral</td>
<td>Failed wall on left bank, large chunk of wall in creek.</td>
<td>8'</td>
<td>75'</td>
<td>-</td>
<td>Yes</td>
<td>Severe</td>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>145</td>
<td>39.269010</td>
<td>-76.810580</td>
<td>Left bank</td>
<td>Lateral</td>
<td>Failed stone wall.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Moderate</td>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>146</td>
<td>39.268950</td>
<td>-76.811050</td>
<td>-</td>
<td>Lateral</td>
<td>High eroding slope.</td>
<td>30'</td>
<td>75'</td>
<td>-</td>
<td>-</td>
<td>Severe</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>147</td>
<td>39.268910</td>
<td>-76.813330</td>
<td>Right bank</td>
<td>Lateral</td>
<td>Failed wall along left bank.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Moderate</td>
<td>Easy</td>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>148</td>
<td>39.269180</td>
<td>-76.812650</td>
<td>Right bank; Additionally, 25 foot section along left bank adjacent to town.</td>
<td>Lateral</td>
<td>-</td>
<td>5' 100'</td>
<td>-</td>
<td>No</td>
<td>Minor</td>
<td>Easy</td>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>149</td>
<td>39.269390</td>
<td>-76.813170</td>
<td>-</td>
<td>Lateral</td>
<td>-</td>
<td>4' 100’</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>152</td>
<td>39.270560</td>
<td>-76.814250</td>
<td>Erosion along left bank.</td>
<td>Lateral</td>
<td>-</td>
<td>6' 50’</td>
<td>-</td>
<td>No</td>
<td>Moderate</td>
<td>Easy</td>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>153</td>
<td>39.270400</td>
<td>-76.814390</td>
<td>Large tree and lots of debris on point bar.</td>
<td>Lateral</td>
<td>S-curve</td>
<td>-</td>
<td>-</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Easy</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>154</td>
<td>39.270540</td>
<td>-76.815080</td>
<td>-</td>
<td>Lateral</td>
<td>High bank outside of meander, hard soil resists weathering.</td>
<td>12'</td>
<td>50’</td>
<td>-</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>159</td>
<td>39.269680</td>
<td>-76.817090</td>
<td>-</td>
<td>Lateral</td>
<td>Undercut bank and trees, will lose eventually.</td>
<td>5'</td>
<td>25’</td>
<td>No</td>
<td>Minor</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>39.269540</td>
<td>-76.817250</td>
<td>Flow around boulders caused erosion of left bank.</td>
<td>Lateral</td>
<td>-</td>
<td>4' 15’</td>
<td>-</td>
<td>Minor</td>
<td>Easy</td>
<td>Easy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Howard County Office of Emergency Management (OEM)
## Tiber-Hudson Branch - Debris Blockages

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

## Tiber - Hudson Branch - Channelization

<table>
<thead>
<tr>
<th>Point #</th>
<th>Latitude (Decimal Degrees)</th>
<th>Longitude (Decimal Degrees)</th>
<th>Description</th>
<th>Bank Affected</th>
<th>Deposition</th>
<th>Vegetation</th>
<th>Flood Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>136</td>
<td>39.269940</td>
<td>-76.805090</td>
<td>Rock wall - failing on right bank</td>
<td>Both</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>143</td>
<td>39.268680</td>
<td>-76.809770</td>
<td>Concrete lined channel</td>
<td>Both</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>149</td>
<td>39.269390</td>
<td>-76.813170</td>
<td>Sandbag/Concrete bag wall</td>
<td>Right</td>
<td>Yes</td>
<td>No</td>
<td>-</td>
</tr>
</tbody>
</table>
APPENDIX B: POTENTIAL 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.

<table>
<thead>
<tr>
<th>Grant Program Name</th>
<th>Address and Telephone Contact Information</th>
<th>Eligible Activities</th>
<th>Federal, State and Local Cost Share Requirements</th>
<th>Other Program Characteristics</th>
<th>Grant Application Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuing Authorities Program (CAP)</td>
<td>USACE Washington DC 20314; 202-761-4561</td>
<td>Initiates a short reconnaissance effort to determine Federal interest in proceeding. If there is interest, a feasibility study is performed.</td>
<td>Federal - 65% Local- 35%</td>
<td>A local sponsor must identify the problem and request assistance. Small flood control projects are also available.</td>
<td>Anytime</td>
</tr>
<tr>
<td>Federal Emergency Management Agency, Hazard Mitigation Grant Program (HMGP)</td>
<td>Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21401</td>
<td>Grants can be used for management costs, information dissemination, planning, technical assistance and mitigation projects.</td>
<td>Federal - 75% Local - 25%</td>
<td>Local governments must be in compliance with the National Flood Insurance Program to be eligible. Projects must be environmentally sound and cost effective.</td>
<td>After a Presidential Disaster Declaration</td>
</tr>
<tr>
<td>Federal Emergency Management Agency, Pre Disaster Mitigation Grant Program (PDM)</td>
<td>Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21401</td>
<td>Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations.</td>
<td>Federal - 75% Non Federal - 25%</td>
<td>PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds.</td>
<td>Annual-Spring/Summer</td>
</tr>
<tr>
<td>Federal Emergency Management Agency, Flood Mitigation Assistance Program (FMA)</td>
<td>Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21401</td>
<td>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.</td>
<td>Federal - 75% Non Federal - 25%</td>
<td>Available once a Flood Mitigation Plan has been developed and approved by FEMA.</td>
<td>Annual-Spring/Summer</td>
</tr>
<tr>
<td>Small Business Administration (SBA) Pre-disaster Mitigation Loan Program</td>
<td>Herbert L. Mitchell, Office of Disaster Assistance, Small Business Administration, 409 3rd Street, SW, Washington, DC 20415;202-205-6734</td>
<td>Activities done for the purpose of protecting real and personal property against disaster related damage.</td>
<td>No information</td>
<td>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.</td>
<td>Anytime</td>
</tr>
<tr>
<td>Grant Program Name</td>
<td>Address and Telephone Contact Information</td>
<td>Eligible Activities</td>
<td>Federal, State and Local Cost Share Requirements</td>
<td>Other Program Characteristics</td>
<td>Grant Application Due Date</td>
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</tr>
<tr>
<td>National Flood Insurance Program (NFIP)</td>
<td>Maryland Emergency Management Agency 5401 Rue Saint Lo Drive Reisterstown, MD 21136</td>
<td>Provides financial protection by enabling persons to purchase insurance against floods, mudslide or flood related erosion.</td>
<td>Varies</td>
<td>Includes Federally backed insurance against flooding, available to individuals and businesses that participate in the NFIP</td>
<td>Anytime</td>
</tr>
<tr>
<td>U.S. Economic Development Administration, Economic Adjustment Program</td>
<td>U.S. Department of Commerce Economic Development Administration Curtis Center, 601 Walnut Street, Ste 140 South Philadelphia, PA 19106-3323 215-597-4603</td>
<td>Improvements and reconstruction of public facilities after a disaster or industry closing. Research studies designed to facilitate economic development.</td>
<td>Federal - 50%-70% Local- 30%-50%</td>
<td>Documenting economic distress, job impact and proposing a project that is consistent with a Comprehensive Economic Development Strategy are important funding selection criteria.</td>
<td>Anytime</td>
</tr>
<tr>
<td>U.S Economic Development Administration, Public Works and Development Facilities</td>
<td>U.S. Department of Commerce Economic Development Administration Curtis Center, 601 Walnut Street, Ste 140 South Philadelphia, PA 19106-3323 215-597-4603</td>
<td>Water and sewer, Industrial access roads, rail spurs, port improvements technological and related infrastructure</td>
<td>Federal - 50%-70% Local- 30%-50%</td>
<td>Documenting economic distress, job impact and projects that is consistency with a Comprehensive Economic Development Strategy are important funding selection criteria.</td>
<td>Quarterly Basis</td>
</tr>
<tr>
<td>Community Development Block Grants / Entitlement Grants</td>
<td>Office of Block Grant Assistance, 451 Seventy Street SW., Washington, DC 20410-7000;202-708-3587</td>
<td>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.</td>
<td>No information</td>
<td>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.</td>
<td>After a Presidential Disaster Declaration</td>
</tr>
<tr>
<td>Historic Preservation: Repair and Restoration of Disaster-Damaged Historic Properties</td>
<td>Infrastructure Division, Response and Recovery Directorate, FEMA, 500 C Street SW., Washington DC 20024 ; 202-646-4621.</td>
<td>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.</td>
<td>Federal - 75% Local - 25%</td>
<td>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.</td>
<td>After a Presidential Disaster Declaration</td>
</tr>
<tr>
<td>Grant Program Name</td>
<td>Address and Telephone Contact Information</td>
<td>Eligible Activities</td>
<td>Federal, State and Local Cost Share Requirements</td>
<td>Other Program Characteristics</td>
<td>Grant Application Due Date</td>
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<td>----------------------------------------</td>
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</tr>
<tr>
<td>Transportation: Emergency Relief Program</td>
<td>Federal Highway Administration, FHWA, DOT, 1200 New Jersey Avenue, Washington, DC 20590; 202-366-4043</td>
<td>Provides aid for the repair of Federal-aid roads, roads on Federal lands and county level federal-aid roads.</td>
<td>Federal - 100%</td>
<td>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.</td>
<td>After serious damage to Federal-aid roads or roads on Federal lands caused by a natural disaster or by catastrophic failure.</td>
</tr>
<tr>
<td>Animals: Emergency Haying and Grazing</td>
<td>Emergency and Non-insured Assistance Programs, FSA, USDA, 1400 Independence Ave, SW, Washington, DC 20013; 202-720-4053</td>
<td>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.</td>
<td>No information</td>
<td>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.</td>
<td>Anytime</td>
</tr>
<tr>
<td>Emergency Watershed Protection Program</td>
<td>Natural Resources Conservation Service 14th and Independence Avenue, SW Washington, DC 20250</td>
<td>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.</td>
<td>Federal - 75% Local - 25%</td>
<td>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.</td>
<td>TBD</td>
</tr>
<tr>
<td>Watershed Protection and Flood Prevention Program</td>
<td>Natural Resources Conservation Service 14th and Independence Avenue, SW Washington, DC 20250</td>
<td>To provide technical and financial assistance in carrying out works of improvement to protect, develop, and utilize the land and water resources in watersheds.</td>
<td>Varies due to project type.</td>
<td>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.</td>
<td>TBD</td>
</tr>
<tr>
<td>Watershed Surveys and Planning</td>
<td>Natural Resources Conservation Service 14th and Independence Avenue, SW Washington, DC 20250</td>
<td>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.</td>
<td>No information</td>
<td>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.</td>
<td>Anytime</td>
</tr>
<tr>
<td>Grant Program Name</td>
<td>Address and Telephone Contact Information</td>
<td>Eligible Activities</td>
<td>Federal, State and Local Cost Share Requirements</td>
<td>Other Program Characteristics</td>
<td>Grant Application Due Date</td>
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<td>--------------------------------------------------------</td>
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<td>----------------------------</td>
</tr>
<tr>
<td>Emergency Advance Measures for Flood Prevention</td>
<td>USACE Washington DC 20314; 202-761-4561</td>
<td>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.</td>
<td>No information</td>
<td>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.</td>
<td>TBD</td>
</tr>
<tr>
<td>Emergency Streambank and Shoreline Protection</td>
<td>USACE Washington DC 20314; 202-761-4561</td>
<td>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.</td>
<td>No information</td>
<td>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.</td>
<td>TBD</td>
</tr>
<tr>
<td>Small Flood Control Projects</td>
<td>USACE Washington DC 20314; 202-761-4561</td>
<td>Authorizes the construction of small flood control projects that have not already been specifically authorized by Congress.</td>
<td>No information</td>
<td>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.</td>
<td>TBD</td>
</tr>
<tr>
<td>Flood: Emergency Advance Measures for Flood Prevention</td>
<td>USACE Washington DC 20314; 202-761-4561</td>
<td>To mitigate, before an event, the potential loss of life and damages to property due to floods.</td>
<td>No information</td>
<td>Assistance may consist of temporary levees, channel cleaning, preparation for abnormal snowpacks, etc.</td>
<td>Anytime</td>
</tr>
<tr>
<td>Cooperating Technical Partners</td>
<td>CFDA Number: 97.045</td>
<td>Flood Hazard Mapping products</td>
<td>Federal - 100%</td>
<td>Provides technical assistance, training, and/or data to support flood hazard data development activities.</td>
<td>TBD</td>
</tr>
<tr>
<td>Grant Program Name</td>
<td>Address and Telephone Contact Information</td>
<td>Eligible Activities</td>
<td>Federal, State and Local Cost Share Requirements</td>
<td>Other Program Characteristics</td>
<td>Grant Application Due Date</td>
</tr>
<tr>
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<td>-------------------------------------------</td>
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<td>-----------------------------</td>
</tr>
<tr>
<td>Map Modernization Management Support</td>
<td>CFDA Number: 97.070</td>
<td>Community outreach on Flood Mapping</td>
<td>Federal - 100%</td>
<td>Provides funding to supplement, not supplant, ongoing flood hazard mapping management efforts by the local, regional, or State agencies.</td>
<td>TBD</td>
</tr>
</tbody>
</table>