



**Stream Bank Stabilization Design for  
Urbanized Segment of the Whippany River  
Between Lake Pocahontas and the Railroad Crossing  
Town of Morristown, Morris County, NJ**

**Prepared for:**

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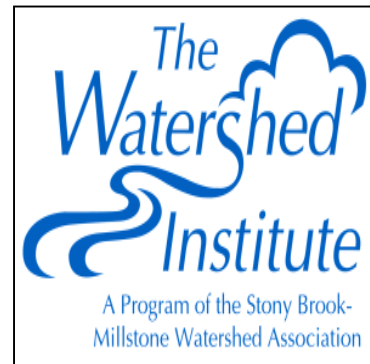
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## **1.0 Introduction**

This report details the efforts taken by the Whippany River Watershed Action Committee (herein referred to as WRWAC), along with its technical consultant Princeton Hydro, LLC and the project's primary partner, the Bethel A.M.E Church, to develop restoration strategies for an urbanized segment of the Whippany River located in Morristown, New Jersey. The original scope and intent of the project focused on the preparation of concept designs and specifications for the repair of a severely eroded stream bank segment located immediately upgradient of the Center Street Bridge and adjacent to the Bethel A.M.E Church. In addition to the stream segment being highly eroded, the majority of the existing vegetation was dominated by invasive species that provided minimal soil stability. The original focus of the project was to develop a restoration plan that would address this particular erosion problem, replace the invasive vegetation with native vegetation and develop engineering concepts to protect this segment of the stream from further scour and loss.

However, while investigating the factors responsible for this stream segment's erosion, the study area became expanded. In doing so, the project team was able to evaluate the stream in a more regional context: examining it from its point of origin at the Lake Pocahontas dam to the Center Street Bridge crossing. Expanding the area of analysis provided us with a more expansive and definitive database from which a broader suite of management and restoration options could be evaluated. As such, within this report Princeton Hydro provides stream restoration recommendations that extend beyond the Bethel A.M.E. Church property. As a result, this report brings to attention larger scale projects, which if implemented in the future, will result in the restoration of greater river functions and values. This includes channel stability, flood storage, and stream/riparian habitat that could be conducted within a more holistic context and with greater overall positive impacts. While our suggested approaches are geared to the maximization of the stream's natural resource values, it also respects (and augments) the integrity of existing property and existing infrastructure. As a result, we believe that not only can the project's original primary focus area be protected from further impacts, but the potential to mitigate to some extent the flooding and erosion from the Lake Pocahontas Dam all the way to, and even down gradient of, the Center Street crossing.

## **2.0 Desk Top Review**

The Whippany River is classified by the NJDEP (N.J.A.C 7:9B) as a freshwater, non-trout ecosystem (FW2-NT). The site is situated in the Upper Passaic, Whippany, and Rockaway Watershed, and is referred to by the NJDEP as Watershed Management Area #06. The hydrologic unit code for this segment of the river is HUC-14 02060103020050, Whippany River between Malapardis to Lake Pocahontas. In preparing this report, Princeton Hydro obtained and reviewed information from a number of sources to determine current site conditions and evaluate potential project challenges. Some of these data were also used as part of the subsequent hydrologic and hydraulic analyses discussed herein. The immediate project area located between Center Street and Martin Luther King Avenue is depicted on the project area map and the watershed project area is depicted on the aerial map included in Appendix A.

### **2.1 New Jersey State Study and FEMA Flood Insurance Study**

The project areas are included in both agencies' studies and models (refer to Appendix B). The New Jersey State Study depicts the 100-Year Flood Boundary, Floodway Boundary, and Flood Hazard Area Design Flood. All three events overtop both Martin Luther King Street (Water Street) and Center Street. The Floodway and Flood Hazard Boundaries also extend past Coal Avenue. This overtopping is likely

caused by backwater from the culvert beneath the railroad crossing as well as the other stream crossings.

The State Study profile of the reach of concern illustrates the water surface elevations (WSEL) for the 10-year, 50-year, 100-year, 500-year and the New Jersey Flood Hazard Area Design Floods. Martin Luther King Avenue can pass the 10-year flood; however, the Central Avenue crossing only passes this flow under pressure and by creating backwater. Martin Luther King Avenue passes the other depicted flows under pressure, whereas Central Avenue overtops during the Flood Hazard and 500-Year floods. The Erie-Lackawanna Railroad Crossing passes all flows without overtopping but does create backwater.

The Flood Insurance Study (FIS) for the Town of Morristown, New Jersey effective July 3, 1986 and the firm effective May 19, 1981 depict similar flood events and the same results as the state study. It is recommended that, upon release of the updated FIS and digital firm, they are reviewed and this report updated accordingly.

## **2.2 Geographic information System (GIS) Data**

Princeton Hydro obtained and reviewed the information within a variety of shapefiles provided by the State of New Jersey and the Highlands Council.

### **A. Soils**

There are three main soil types in the project area: Fluvaquents and Udifluents, Rockaway-Rock outcrops and urban land-riverhead complex. All of the possible projects will be within the Urban Land River Head Complex. This material is the coarse-loamy, very deep, well to moderately well drained soil which has been built upon.

### **B. Landuse/Landcover**

The landuse type of the area of concern is predominately urban with wetlands, forest, and water. The areas included in the project site and surrounding vicinity are categorized and defined below.

1. Residential: High Density or Multiple Dwellings: This category contains either high-density single units or multiple dwelling units on 1/8 to 1/5-acre lots. These areas are found in the densely populated urban zones and generally are characterized by impervious surface coverage of approximately 65%.
2. Commercial/Services: Areas that contain structures predominantly used for the sale of products and services are classified as Commercial and Services. The main buildings, secondary structures and supporting areas such as parking lots, driveways and landscaped areas are also placed under this category, unless the landscaped areas are greater than one acre in size, in which case they are put into a separate category.
3. Bridge Over Water: Bridges over water are characterized by having significance in the delineation of watercourses flowing below. Any bridge or portion of roadway constructed over a mappable open water body has been identified and characterized as water. Although the bridge surface is impervious, the structure does not impact or alter the impervious nature of the water flowing below.
4. Railroad Facilities: Railway facilities include railroads and spurs as well as stations, parking lots, roundhouses, power generators, and repair and switching yards. Spurs that connect industrial or extractive pick-up points with main rail lines are included in the appropriate industrial or extractive category.

5. Other Urban or Built-Up Land: Included are undeveloped, open lands within, adjacent to or associated with urban areas. Some structures may be visible, as in the case of abandoned residential or commercial sites that have not yet been redeveloped. The land cover in these areas may be brush-covered or grassy. Large, maintained lawns common to some residential areas, and those open areas of commercial/service complexes, educational installations, etcetera, are also included. Undeveloped, but maintained lawns in urban parks are also part of this category, if a specific recreational use is not evident. In addition, areas that have been partially developed or redeveloped but remain unfinished are included.
6. Recreational Land: Under this category are included those areas which have been specifically developed for recreational activities, if these areas are open to the general public. Any facilities that are part of a resort complex and open only to patrons of the hotel or motel are not mapped under category 18, but under Commercial and Services category. Facilities mapped as recreational land may charge user fees to the public, such as public golf courses, or they may be free to the public, such as ball fields on public school grounds.
7. Deciduous Forest (>50% Crown Closure): The average height of the stand is at least 20 feet. This category contains deciduous stands with crown closures greater than 50%.
8. Streams and Canals: This category includes rivers, creeks, canals and other linear water bodies that have a minimum width of 80 feet.
9. Artificial Lakes: Artificial impoundments of water larger than three (3) acres used for irrigation, flood control, municipal water supplies, recreation, landscaping and hydro-electric power or the result of an active extractive operation are included in this category. Dams, bulkheads, spillways and other water control structures should be evident and are critical for accurately identifying these features.
10. Deciduous Wooded Wetlands: These wetlands are closed canopy swamps dominated by deciduous trees normally associated with watercourses, edges of marshes, and isolated wetlands. The important canopy species includes *Acer rubrum*, *Nyssa sylvatica*, *Fraxinus pennsylvanica*, *Salix nigra*, *Quercus bicolor*, *Q. phellos*, *Q. falcata*, *Liquidambar styraciflua*, and *Platanus occidentalis*. These species combine to form a series of mixed hardwood lowland habitats.

Landuse/Landcover is used in calculating the amount of runoff and how quickly it will reach the receiving water body. These values are used in the modeling of water surface elevations and determining how much water will be entering a channel or other body of water at a particular time. Based on landuse in this project area, it can be said that the drainage area will have a relatively high runoff rate and reach a water body quickly compared to other uses.

#### C. Known Contaminated Sites

The NJDEP list of known contaminated sites lists six (6) sites within the potential project area(s). The sites are ranked based on the Site Remediation Program's 1989 Case Assignment Manual. It is the intent of the Site Remediation Program that remedial levels be determined for the overall degree of contamination at a site, recognizing that individual areas of concern may involve remedial actions of varying levels. These levels are described below.

- B - Remedial level associated with emergency response, simple removal activities of contaminants, usually no impact to soil or groundwater (GW).
  - An emergency action taken to stabilize an environmental and/or health threatening situation from sudden or accidental release of hazardous substances.

- Appropriate remedial actions involving a single phase of limited or short-term duration.
- A single phase remedial action in response to a single contaminant category effecting only soils. May be a sub-site of a more complex case. Does not include ground water investigation or remediation.
- Examples of level B cases include, but are not limited to "cut-n-scrape"; surface drum removals; installation of fences; temporary capping or tarping.
- C1 - Remedial levels are associated with simple sites, one or two contaminants localized to soil and the immediate spill or discharge area.
  - A remedial action which does not involve formal design where source is known/identified. May include the potential for ground water contamination.
  - Examples of C-1 cases are regulated or unregulated storage tanks containing gas or heating oil; septic tanks etc.
- C2 - Remedial levels are associated with more complicated contaminant discharges, multiple site spills and discharges, more than one contaminant, with both soil and GW impacted or threatened.
  - A remedial action which consists of a formal engineering design phase and is in response to a known source or release. Since the response is focused in scope and addresses a known, presumably quantifiable source, this remedial level is of relatively shorter duration than responses at sites with higher remedial levels. Usually involves cases where ground water contamination has been confirmed or is known to be present.
- C3 - Remedial levels are associated with high complexity and threatening sites. Multiple contaminants, some at high concentrations with unknown sources continuing to impact soils, GW and possibly surface waters and potable water resources. Dangerous for direct contact with contaminated soils.
  - A multi-phase remedial action in response to an unknown and/or uncontrolled source or discharge to the soils and/or ground water. In this remedial level the contamination is presumed unquantifiable and, therefore, no determinable timeframe for the conclusion of the remedial action is known.
- D - Same conditions as C3 except that D levels are also usually designated Federal "Superfund Sites".
  - A multi-phase remedial action in response to multiple, unknown and/or uncontrolled sources or releases affecting multiple medium which includes known contamination of groundwater. In this remedial level, the contamination is presumed unquantifiable and, therefore, no determinable timeframe for the conclusion of the remedial action is known.

Golderes Junk Yard, Morristown Gas Works (Former) and Dare & Health Department offices have levels ranging from C2 to D. There are other known sites in the area; however, excavation and project limits are not anticipated in or around those areas. Table 1 below summarizes the characteristics of these three (3) known contaminated sites.

Table 1: Known Contaminated Sites

SITE NAME	ADDRESS	AGENCY TRACKING NUMBER	LEAD - CASE ASSIGNMENT	REMEDIAL LEVEL
GOLDERES JUNK YARD	14 COAL AVE	G000007268	BCM: Bureau of Case Management	D: Multi-Phased RA - Multiple Source/Release to Multi-Media Including GW
MORRISTOWN GAS WORKS (FORMER)	1, 5 & 14 COAL AVE	24455	BCM: Bureau of Case Management	D: Multi-Phased RA - Multiple Source/Release to Multi-Media Including GW
DARE & HEALTH DEPARTMENT OFFICES	65 SPRING ST	G000011316	BFO-N: Bureau of Field Operations - Northern	C2: Formal Design - Known Source or Release with GW Contamination

The Township of Morristown owns the properties surrounding the Golderes Junk Yard and Morristown Gas Works sites. During visits to the site, Princeton Hydro observed approximately seven (7) monitoring wells along the stream banks. These wells are reportedly still monitored by PSE&G.

The properties around the DARE and Health Department Offices are owned by Town of Morristown, Bethel A.M.E. Church, and Norine Cohen.

Prior to any project design being completed in these areas, information regarding the contaminants, possible work restrictions, and health hazards shall be obtained from the Township, NJDEP, or other regulatory agency.

#### D. Parcels

The provided Highlands Council Parcel data for Morris County and a block and lot search for assessment records revealed that the majority of the possible projects described in sections 3.0 and 4.0 below are on land owned by the township, by an entity of the township or a partner of the project. The exception is the western stream bank between Martin Luther King Avenue and Block 3501 Lot 6.

### 2.3 USGS Gage

There is a US Geological Survey (USGS) stream located on the Whippany River approximately 1.75 miles downstream of the railroad crossing. The stream gage is identified as USGS 01381500 Whippany River at Morristown, New Jersey. The gage is located at latitude 40°48'26" and longitude 74°27'25" within the Morristown sewage treatment plant. The drainage area to the gage is 29.4 square miles with records from August 1921 through the present.

The gage data will be used to calibrate and/or verify the hydraulic models used during final design phase(s) of the project.

## **2.4 NJDEP Department of Landuse**

An Open Public Records Act (OPRA) request was submitted to the NJDEP Department of Landuse to obtain any Flood Hazard or other permits that may have been obtained for work completed on the bridges. No information was provided.

## **2.5 NJDEP Department of Dam Safety**

An OPRA request was submitted to the NJDEP Department of Dam Safety to obtain records for Lake Pocahontas. The Department provided Princeton Hydro with a copy of the June 1995 report entitled "Improvements to Pocahontas Dam" as prepared by O'Brien and Gere Engineers, Inc. The report documented repairs, deficiencies, and modifications necessary to improve the dam's status from fair to good. The report also included HEC-1, HEC-2, and Dam Breach analysis in order to determine the inundation area for the spillway design storm (1/2 Probable Maximum Flood) and the Emergency Action Plan. This analysis was also used to determine the spillway capacity – the spillway does not have sufficient capacity to pass the design storm which overtops the earthen portion of the dam by 4.5 feet. The recommendations included:

- Repair the erosion of the stream channel downstream of the apron
- Repair the wall spalling
- Repair the crib wall erosion
- Replace the existing sluice gate, stem and operator to provide emergency drawdown capacity
- Armor the earth abutments with erosion resistant material to provide the safe discharge of flows up the Spillway Design Flood.
- The dam should be strengthened to meet the minimum stability criteria for all specified loading conditions. It was reported that the most cost effective method would be to install post-tensioned soil anchors installed vertically from the crest.

Princeton Hydro does not have documentation to determine if any of the above recommendations have been completed.

## **3.0 Field Investigation**

Princeton Hydro completed a field assessment and obtained survey measurements on January 31, 2012. This assessment included six (6) cross sections in the vicinity of Central Avenue. These cross-sections can be found on Sheet 3 of 3 in Appendix E.

### **3.1 Staff Gauge and Erosion Pins**

While onsite, a staff gauge and two (2) erosion pins were installed on the river right stream bank adjacent to the Bethel A.M.E. Church, as shown in Figures 1, 2, and 3. At the time of installation, the staff gauge was surveyed to have a zero elevation of 92.11 feet in the assumed datum and the reading on the gauge was 1.69 feet, thus the observed water surface elevation was 93.80 feet. The erosion pins were also surveyed and initial measurements from the end of the pin to the bank were taken. The upper pin was measured to be 6.5 inches extended from the bank and the lower pin at 7.5 inches extended from the bank. Erosion of the bank will result in greater exposure of the pins. It is anticipated that volunteers of the church and community will continue to monitor these devices and provide the information to Princeton Hydro. The collected data will be used to calibrate the data at the USGS gauge to the site and determine the rate of erosion of the bank.



*Figure 1: Staff Gauge and Erosion Pins*



*Figure 2: Staff Gauge*



*Figure 3: Erosion Pins*



### **3.2 Fluvial Geomorphic Assessment**

In addition to the site at the Bethel A.M.E. Church, Princeton Hydro investigated and surveyed the upstream and downstream sections of the reach extending from the municipal baseball field to the NJ Transit railroad bridge to determine the geomorphic condition and dominant geomorphic processes.

As is expected in an urban watershed, the subject reach of the Whippany River exhibits signs of impairment due to altered watershed hydrology. The increased runoff volume and peak flows that result from the interception of precipitation by impervious surfaces exert greater erosive forces against channel boundaries. Over time, this has induced geomorphic adjustments to the channel, mostly incision and bank erosion, which has impaired habitat, and threatened private property and public infrastructure.

In the following paragraphs, channel dimensions, bank conditions, and floodplain position are compared to describe the geomorphic condition of the reach; three typical geomorphic metrics are used. First, the width-depth ratio is the ratio of channel width to channel depth at bankfull flow; values less than 12 suggest a narrow, constricted condition. Second, entrenchment ratio (i.e. width of the flood prone area to the channel width) is a measure of connection between a channel and its floodplain. The floodplain provides a pressure release valve for a stream, helping to dissipate erosive forces. Ideally, flow over-tops the channel banks during floods and spreads out across the floodplain where it becomes shallower and slower; the potential for scour and erosion-related damage in the channel and on the banks is reduced. Without access to a floodplain, flood flows are constrained within the channel, which can cause extensive bed and bank erosion depending on the channel substrate. Flood flows contained in the channel cause extensive bed and bank erosion, disturb stream substrate, degrade habitat features such as pools and riffles, and eliminate sediment bars and riparian vegetation. Entrenchment ratio values below 2.0 indicate an unstable condition. Finally, bank height ratio (i.e. the lowest bank height divided by the bankfull maximum depth) is a measure of channel incision and a more sensitive index of how connected a stream is to its floodplain. Bank height ratio values greater than 1.5 indicate a highly unstable condition.

At the Bethel A.M.E. Church, the river right bank is near vertical and filled approximately four feet above the bankfull elevation. River left bank is lower but the adjacent floodplain is also filled. Low width-depth ratio (10) and high entrenchment (1.5) indicate a narrow, entrenched channel. The slope of the river right bank is potentially unstable although several large mature trees appear to be providing stability. The unstable condition could be counteracted by grading back the river right bank and by excavating floodplain fill from the river left side (see Site Specific Design Concepts Area of Concern #1).

Immediately upstream of the Bethel A.M.E. Church property, a municipal parking lot on river right and a masonry retaining wall on the left bank fill the floodplain and encroach into the channel. At this cross-section, width-depth ratio (9.4) and bank height ratio (1.6) indicate a highly incised condition. Banks would otherwise be failing if not for the structural retaining walls. Floodplain access is severely limited. The condition could be addressed by removing the encroaching structures and providing a re-graded right bank and accessible floodplain on river left (see Site Specific Design Concepts Area of Concern #2).

Approximately 300 feet upstream of the Bethel A.M.E. Church property, in the vicinity of the existing masonry public access ramp, the channel appears to be well connected to the floodplain on river left. At this cross-section, slightly higher width-depth ratio (15), higher entrenchment ratio (2.2), and low bank height ratio (~1) indicate a stable condition with accessible floodplain. The right bank, however, is

reinforced with a concrete retaining wall and the adjacent floodplain is filled by the back lot of an unoccupied commercial property. Removal of the retaining wall and excavation of the fill would provide additional floodplain for the project reach (see Site Specific Design Concepts Area of Concern #4 and Area of Concern #6).

The Center Street Bridge influences the hydraulic conditions at the sections described above. The low height of the bridge over the channel causes higher flows to be constricted and results in backed up flow in the upstream reach. This backed up condition reduces flow velocities and bank erosion, but also serves to raise flood elevations. These field observations corroborate the FEMA flood maps described previously.

Downstream of the Center Street Bridge, the floodplain (albeit, paved parking lot) is lower in elevation and provides reasonable access for the channel. At the first riffle downstream of the bridge, a slightly higher width-depth ratio, (16), high entrenchment ratio (>2.2), and low bank height ratio (~1) indicate a stable condition with accessible floodplain. However, downstream as the channel bends east, the channel is adjacent to the natural valley wall. At this location, the banks are steep and sloughing in places. While the steep condition is natural, the elevated peak flows have increased shear stress and induced erosion. Grading back the banks is not possible or practical at the base of the natural valley wall; however, installing boulder toe protection can help reduce the rate of erosion. In addition, a transverse bar / riffle has developed that directs flow into the valley wall. A re-directive structure, such as a log-vane, can be installed to further reduce the erosive shear stress against the valley wall (see Site Specific Design Concepts Area of Concern #5).

In general, encroachment into the floodplain and structural bank revetments are producing unstable channel conditions and exacerbating flooding throughout the project reach. Measures to reverse those effects can reduce flood damages and improve channel conditions and ultimately ecological value. The following sections outline several concepts for addressing these issues.

## **4.0 Site Specific Design Concepts**

The locations of the areas of concern with concept design plans have been included in Appendix F.

### **4.1 Area of Concern #1**

Area of concern (AOC) #1 is located along river right and extends approximately 60 feet upstream from the Center Street Bridge as shown in Figure 4. This area is adjacent to the Bethel A.M.E. Church and its access driveway. This bank is relatively steep with three (3) 24 inch plus diameter trees growing within the bank. There is also a utility pole near the edge of the sidewalk with wires extending through the trees to the church. The bridge abutment has riprap of about 4-8 inches in diameter to protect it from scour from both the stream and the 6 inch PVC pipe outfall located near the top of the bank, as seen in Figure 5. This pipe is assumed to be connected to roof leaders.

*Figure 4: AOC #1 Overview*



*Figure 5: AOC #1 near Center Street Bridge*



The erosion of the banks is expected to be caused by the fluctuations in the water surface elevation created by the backwater from the bridge. Thus the velocities would be relatively low and banks and floodplains can be re-graded, stabilized with vegetation and a boulder toe similar to the detail shown in Figure 6. In addition, the three (3) trees shown in Figure 7 will be cut flush with the bank so the stumps may remain for added stabilization. The boulder toe could be created from the stone retaining wall removed along river left just upstream.

Figure 6: Bank Stabilization with Grading and Boulder Toe

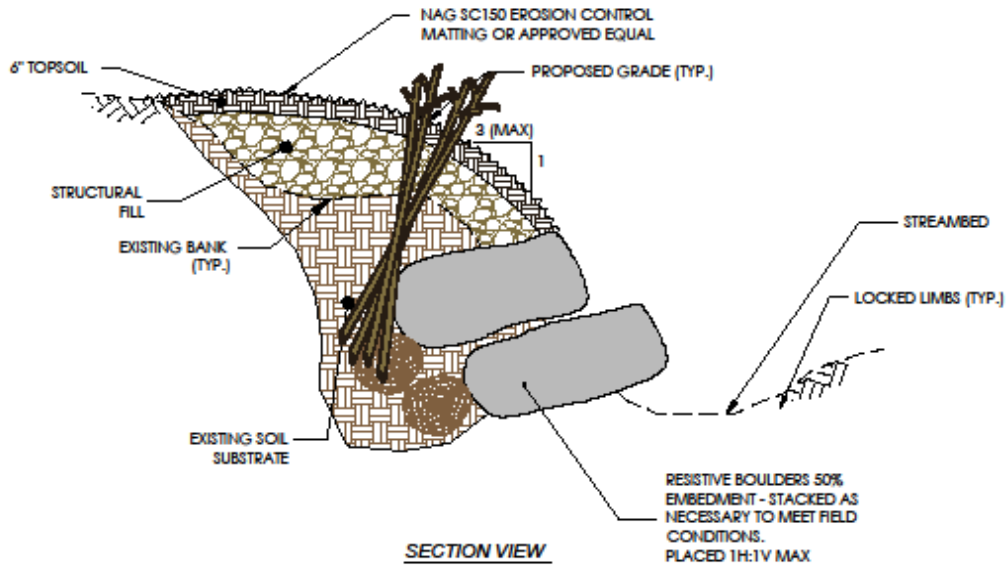


Figure 7: AOC #1 Trees to be Removed



#### A. Next Steps

Considering this project is on the property of the Bethel A.M.E. Church, one of the project partners and supporters, property owner certification should not be an issue. In order to proceed, the area shall be surveyed by a New Jersey licensed land surveyor. Princeton Hydro will prepare the design plans and permit materials as necessary for the project. Upon receipt of all permits and approvals, Princeton Hydro will prepare the construction bid package for the WRWAC and oversee the construction.

B. Cost

It is anticipated that the following are the expected costs for design, permitting and construction.

1. Design and Permitting - \$30,000
2. Construction - \$40,000

**4.2 Area of Concern #2**

Area of Concern #2 is a continuation of Area of Concern #1, extending to the concrete retaining wall as shown in Figure 8. This area extends through a number of properties including ones owned by Bethel A.M.E. Church, the Township of Morristown, and other private parties. AOC #2 is characterized by bare jagged banks with fences hanging into stream, see Figure 9. The fences are collecting debris during high flows and decreasing flowable area.

*Figure 8: Area of Concern #2 Upstream end near the Concrete Retaining Wall.*



*Figure 9: Area of Concern #2 Fences Leaning into the Stream*



The banks included within AOC #2 are anticipated to be stabilized in a similar manor as AOC #1 and Figure 6 above. As shown on Sheet 1 of 3 of the attached plans, tree 4 shall remain as the tree roots protect a large portion of the bank, as seen is Figure 10. The up slope side of the tree is anticipated to be used as a reference elevation for grading back the bank.

*Figure 10: Area of Concern 2 Tree 4 to Remain*



**A. Next Steps**

First and foremost, support and permission to do work on the properties must be obtained from the respective property owners. This may be by means of a letter of support prior to design plans and then temporary construction easements for access and installation of the proposed work. In order to proceed, the area shall be surveyed by a New Jersey licensed land surveyor. Princeton Hydro will prepare the design plans and permit materials as necessary for the project. Upon receipt of all permits and approvals, Princeton Hydro will prepare the construction bid package for the WRWAC and oversee the construction.

**B. Cost**

It is anticipated that the following are the expected costs for design, permitting and construction.

1. Design and Permitting - \$30,000
2. Construction - \$75,000

### **4.3 Area of Concern #3**

Area of Concern #3 is located on the grounds of the Bethel A.M.E. Church located off the eastern rear corner of the building (Figure 11), near the end of the paved accessway (Figure 12).

*Figure 11: Area of Concern #3 Eastern Corner of the Church*



*Figure 12: Area of Concern #3 Church Accessway*

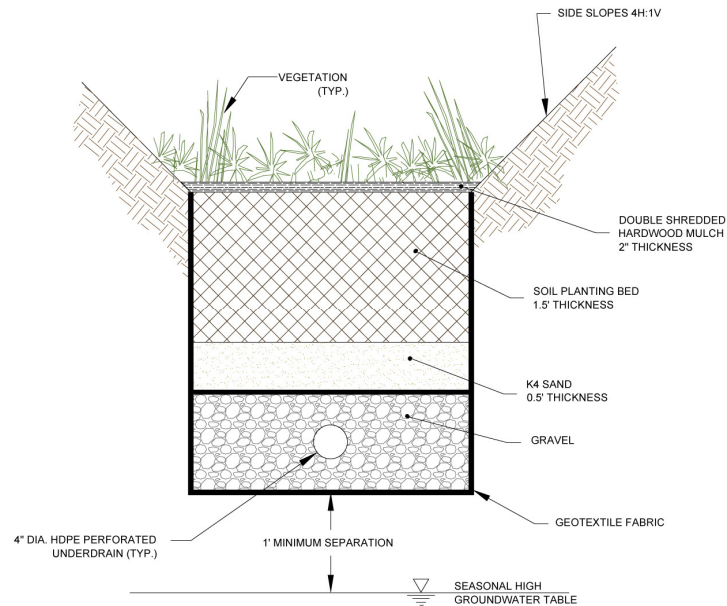


It is proposed to disconnect the roof leaders from the building and have them discharge into a rain garden similar to the design shown in Figure 13. It is assumed that groundwater will be close to the expected bottom elevation of the rain garden and/or that soil conditions not suitable for infiltration will



be encountered, thus the system will need to be lined with geotextile fabric and under drained. Rain gardens will provide water quality treatment and water retention for the runoff entering the system.

Figure 13: Rain Garden Detail



#### A. Next Steps

Considering this project is on the property of the Bethel A.M.E. Church, one of the project partners and supporters, property owner certification should not be an issue. In order to proceed, the area shall be surveyed by a New Jersey licensed land surveyor. Princeton Hydro will prepare the design plans and permit materials as necessary for the project. Upon receipt of all permits and approvals, Princeton Hydro will prepare the construction bid package for the WRWAC and oversee the construction.

#### B. Cost

It is anticipated that the following are the expected costs for design, permitting and construction.

1. Design and Permitting - \$20,000
2. Construction - \$45,000

#### **4.4 Area of Concern #4**

Area of Concern #4 is located on river left opposite AOC #2 and on property owned by Town of Morristown. The property includes a small parking lot outlined with wooden bollards, and is wooded along the stream bank and grassed along the remaining areas; refer to Figures 14 through 17.

*Figure 14: Area of Concern #4 Downstream Limit*



*Figure 15: Area of Concern #4 Wooded Stream Corridor Looking Upstream*



*Figure 16: Area of Concern #4 Grassed Area*



*Figure 17: Area of Concern #4 Wooded Stream Corridor, Grassed Area and Parking Lot Looking Downstream*



It is proposed to excavate the grassed area to the elevation similar to the bank, creating more floodplain at a lower elevation as shown in Figure 18 below. This will be created with varied micro-topography to increase habitat diversity. In addition, the stone retaining wall, as shown in Figure 19, shall be removed and used for toe protection in AOC #1 and #2. The purpose of the concrete and stone access ramp shown in Figure 20 is unknown. The ramp is proposed to be removed and, to increase awareness and appreciation for the environment, public access to the stream will be maintained here in a manner that does not obstruct flow as the ramp currently does.

Figure 18: Area of Concern #4 Floodplain Creation

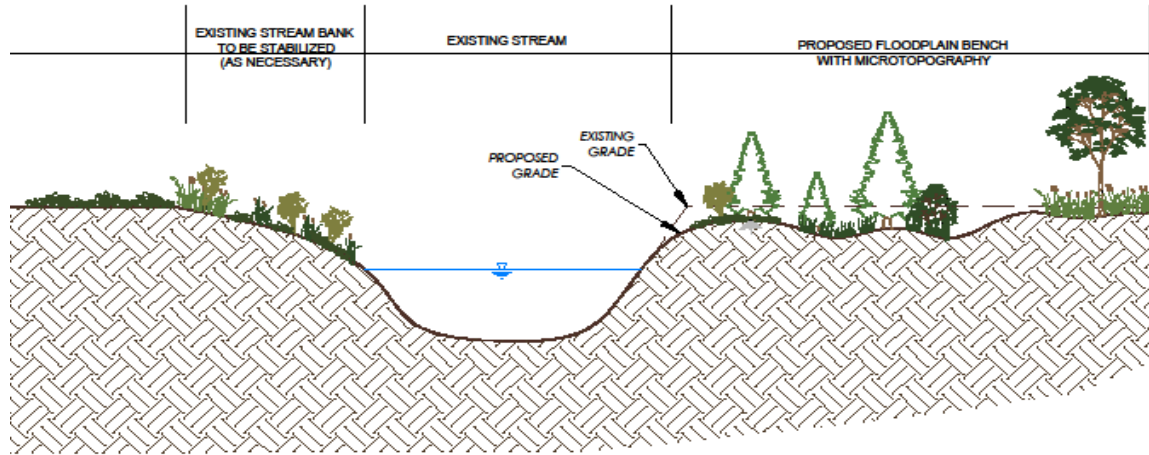


Figure 19: Area of Concern #4 Stone Retaining Wall



*Figure 20: Area of Concern #4 Concrete and Stone Ramp*



#### A. Next Steps

This area is in close proximity to two known contaminated sites. Before moving forward with any design steps, the following must be determined:

- What are the contaminants?
- What are the restrictions on the property?
- Are there any environmental protection elements installed (i.e. cap, liner, vents, etc.)?
- Is excavation and/or additional remediation allowed?

If the answers to these questions favor a floodplain creation, then the area shall be surveyed by a New Jersey licensed land surveyor. Princeton Hydro will prepare the design plans and permit materials as necessary for the project. Upon receipt of all permits and approvals, Princeton Hydro will prepare the construction bid package and oversee the construction.

#### B. Cost

It is anticipated that the following are the expected costs for design, permitting and construction.

1. Design and Permitting- \$43,000
2. Construction - \$550,000

### **4.5 Permits and Approvals**

#### A. NJDEP – Flood Hazard Area

A Flood Hazard Area Individual Permit will be necessary for excavation, and bank stabilization within channel, riparian zone, floodway, and/or flood fringe.

#### B. NJDEP – Fresh Water Wetlands

A General Permit 20 - Bank Stabilization and a General Permit 16 for floodplain creation will need to be obtained.

C. Morris County Soil Conservation District

The installation of AOC#1 through #4 will exceed 5,000 square feet of disturbance, thus requiring a Soil Erosion and Sediment Control Permit.

D. Town of Morristown

Some of the projects are within the right-of-way of Center Street a township maintained roadway. The Township is anticipated to want to review the design plans and modeling to ensure no detrimental impacts to the roadway. Additionally, the Township will likely require a review of the plans prior to agreement of a temporary construction easement.

E. Morris County

According to representatives from Morristown Engineering Department, Morris County has jurisdiction of stream crossings (bridge and culverts) within the Township. It is our experience that the County will require a review of the project to ensure no impacts to flows through the culvert and no increased scour potential.

## 5.0 Watershed Design Concepts

### 5.1 Area of Concern #5

Area of Concern #5 is located along the bend between the Center Street Bridge and the railroad bridge. This area is characterized as transverse bar which is directing flows into the high, steep banks. These banks are sloughing into the stream. Figures 21 through 23 depict the main characteristics of this stream corridor.

*Figure 21: Area of Concern #5 Overview*



*Figure 22: Area of Concern #5 Steep Slopes and Bank Sloughing*



*Figure 23: Area of Concern #5 Transverse Bar directing flow against sloughing bank.*



The eroded slopes and adjacent areas will have bank stabilization measures with a boulder toe, similar to Figure 24. In addition, it is proposed to install a redirection feature such as a weir within the stream to direct flows away from the banks, similar to Figure 25.

Figure 24: Area of Concern #5 Proposed Stabilization Detail

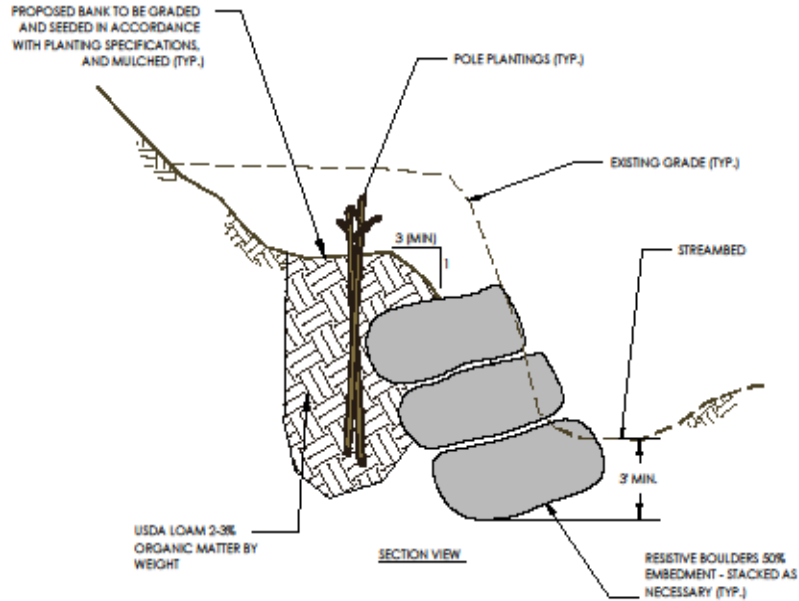
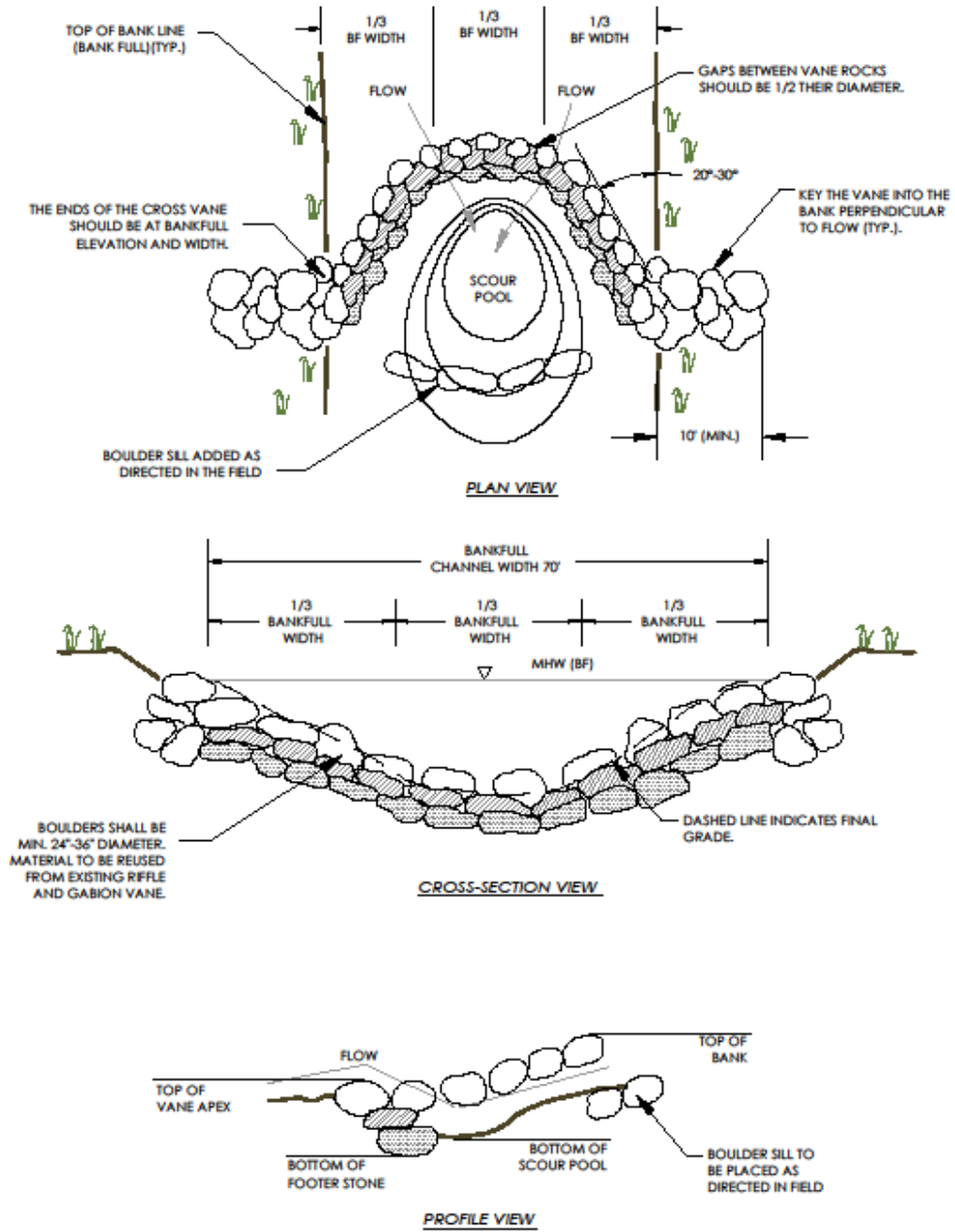




Figure 25: Area of Concern #5 Proposed Weir Detail



#### A. Next Steps

It is reported that the Town of Morristown owns a portion of the property; confirmation of this and support from other, adjacent property owners will be necessary. Once the adjacent property owners agree to the project, the area shall be surveyed by a New Jersey licensed land surveyor. Princeton Hydro will prepare the design plans and permit materials as necessary for the project. Upon receipt of all permits and approvals, Princeton Hydro will prepare the construction bid package and oversee the construction.

#### B. Permits and Approvals

##### 1. NJDEP – Flood Hazard Area

A Flood Hazard Area Individual Permit is necessary in order to install the weir and stabilize the banks. All proposed vegetation shall be non-invasive, native vegetation.

##### 2. NJDEP – Fresh Water Wetlands

A General Permit 20-Bank Stabilization will also need to be obtained.

##### 3. Morris County Soil Conservation District

This project is anticipated to have a Limit of Disturbance greater than 5,000 square feet and thus will require an approval from the soil conservation district.

#### C. Cost

It is anticipated that the following are the expected costs for design, permitting and construction.

1. Design and Permitting - \$35,000
2. Construction - \$75,000

### **5.2 Area of Concern #6**

Area of Concern #6 is located at the intersection of Martin Luther King Avenue and Flagler Street along the river right bank downstream of the Martin Luther King Avenue stream crossing. The property is currently for sale by owner and the building is shown in Figure 26 and the concrete channel shown is Figure 27. The property is mostly gravel with very little vegetation, as seen in Figure 28.

*Figure 26: Area of Concern #6 Building*



*Figure 27: Area of Concern #6 Concrete Channel*



*Figure 28: Area of Concern #6 Gravel Areas with Minimal Vegetation*



It is proposed to acquire the property and excavate the area creating a floodplain at a lower elevation, allowing for water backing up from the downstream crossings to be temporarily stored, as illustrated in Figure 18 above. The floodplain will be created with varied micro-topography increasing habitat diversity.

#### D. Next Steps

This property is currently owned by an individual whom had it up for sale at the time of the field investigation. The first step is to have a public entity acquire the property and be willing to implement the proposed project. If the property is acquired and the owner is in favor of floodplain creation, then the area shall be surveyed by a New Jersey licensed land surveyor. Princeton Hydro will prepare the design plans and permit materials as necessary for the project. Upon receipt of all permits and approvals, Princeton Hydro will prepare the construction bid package and oversee the construction.

E. Permits and Approvals

1. NJDEP – Flood Hazard Area

A Flood Hazard Area Individual Permit is necessary in order to create the floodplain. All proposed vegetation shall be non-invasive, native vegetation.

2. NJDEP – Fresh Water Wetlands

A Fresh Water Wetlands Permit will also need to be obtained.

3. Morris County Soil Conservation District

This project is anticipated to have a Limit of Disturbance greater than 5,000 square feet and thus will require an approval from the soil conservation district.

F. Cost

It is anticipated that the following are the expected costs for design, permitting and construction.

1. Design and Permitting - \$42,000
2. Construction - \$425,000

### **5.3 Area of Concern #7**

Area of Concern #7 is located upstream of Martin Luther King Avenue along river left, across the Whippany River from the baseball field. The bank and a portion of the stream are covered by a concrete platform. This platform is held up by series of columns and supports that are situated in the channel and reduce active flow area (see Figure 29). As can be seen in Figure 30 below, the platform extends over the channel as it meanders toward the Martin Luther King Avenue crossing. The most upstream extend of the platform and its columns have collapsed (see Figure 31).

*Figure 29: Area of Concern #7 View of the Platform and Columns*



*Figure 30: Area of Concern #7 View of the Platform from a Distance*

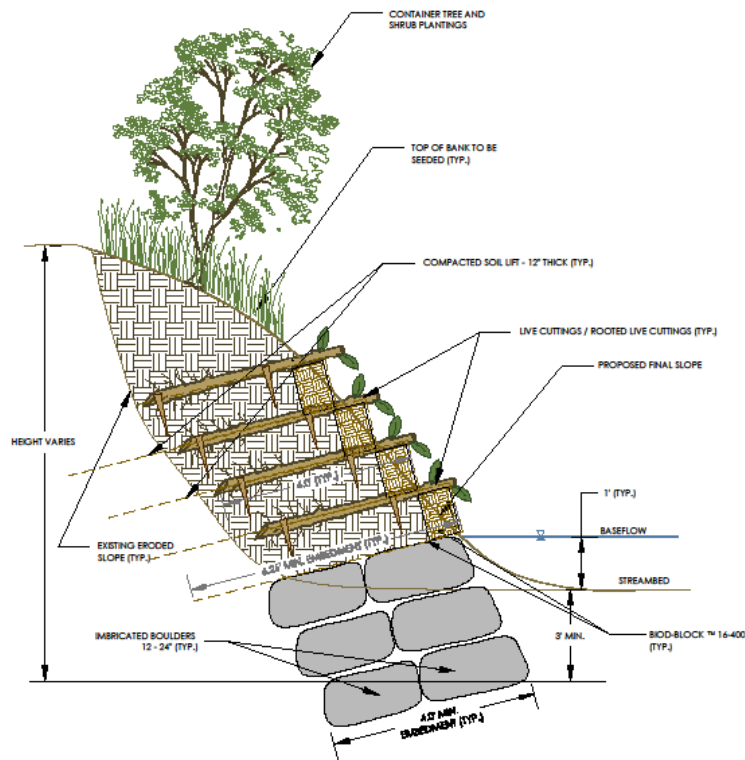


*Figure 31: Area of Concern #7 Collapse of the Platform*



It is proposed to remove the platform, columns, supports and all other associated structures, including as much of the retaining wall as possible. These features are creating a constriction of flow and their removal will be beneficial to flow and the recreational use of Patriots Path. It is proposed to stabilize the banks with a rock toe, geotextile wraps, and vegetation as shown in Figure 32. The earthen bank will provide increased ecological benefit to the riparian area and increase the flowable area during high flows.

Figure 32: Area of Concern #7 Bank Stabilization



#### A. Next Steps

This property is currently owned by Town of Morristown and Morris County. Upon approval by the property owner(s), the area shall be surveyed by a New Jersey licensed land surveyor. Princeton Hydro will prepare the design plans and permit materials as necessary for the project. Upon receipt of all permits and approvals, Princeton Hydro will prepare the construction bid package and oversee the construction.

#### B. Permits and Approvals

##### 1. NJDEP – Flood Hazard Area

A Flood Hazard Area Individual Permit is necessary in order to remove the platform and all of its support structures, and stabilize the bank. All proposed vegetation shall be non-invasive, native vegetation.

##### 2. NJDEP – Fresh Water Wetlands

A Freshwater Wetlands General Permit 20 will also need to be obtained.

##### 3. Morris County Soil Conservation District

This project is anticipated to have a Limit of Disturbance greater than 5,000 square feet and thus will require an approval from the soil conservation district.

#### C. Cost

It is anticipated that the following are the expected costs for design, permitting and construction.

1. Design and Permitting - \$50,000
2. Construction - \$275,000

#### **5.4 Area of Concern #8**

Area of Concern #8 refers to Lake Pocahontas and the dam that creates it. The dam is owned and operated by Town of Morristown and according to the June 1995 *Improvements to Pocahontas Dam Report* as prepared by O'Brien & Gere Engineering, the dam is in need of some repair. Figures 33 and 34 depict the dam at different time periods. A cross-section and a plan view of the spillway are shown below in Figures 35 and 36 as provided by O'Brien and Gere Engineering.

*Figure 33: Area of Concern #8 Current Pocahontas Dam<sup>1</sup>*



*Figure 34: Area of Concern #8 Historical Pocahontas Dam*



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<sup>1</sup> [http://www.nj.com/morristown/index.ssf/2009/09/army\\_corps\\_to\\_study\\_whether\\_to.html](http://www.nj.com/morristown/index.ssf/2009/09/army_corps_to_study_whether_to.html)





impoundment and downstream reach will be stabilized as necessary and planted with native plant material.

#### A. Next Steps

This property is currently owned by Town of Morristown. An informal meeting was recently held with municipal representatives to discuss the possibility of decommissioning the dam and ultimately removing this structure. In the process, steps would be taken to restore the stream and wetland complex that once existed in this area. The suggestion of removing the dam and eliminating the lake was negatively received. The lake is an important cultural and historic attribute of the municipality. Although the dam needs to be repaired, the lake's water quality was enhanced and its water depth increased via dredging; the desire at this time is to retain the structure and look for opportunities to improve the lake. As such, this project, although very promising, is not likely to be implemented in the immediate future. Should existing sentiment change and this project deemed desirable, the following actions would need to be taken in advance of or in support of implementing the project.

#### B. Permits and Approvals

##### 1. NJDEP – Dam Safety

Dam Safety has jurisdiction over all work regarding a regulated dam. Pocahontas Dam is regulated and thus its removal will need approval.

##### 2. NJDEP – Flood Hazard Area

With respect to the removal of the dam, this permit is covered within the Dam Safety approval. However, because action would be taken to restore the floodplain some form of FHA approval would be required.

##### 3. NJDEP – Fresh Water Wetlands

With respect to the removal of the dam, this permit is covered within the Dam Safety approval. However, some form of approval may be needed from NJDEP under the FWW regulations as part of any wetland restoration efforts conducted after the removal of the dam.

##### 4. Morris County Soil Conservation District

This project is anticipated to have a Limit of Disturbance greater than 5,000 square feet and thus will require an approval from the soil conservation district.

#### C. Cost

It is anticipated that the following are the expected costs for feasibility study, design, permitting and construction.

1. Feasibility Study - \$80,000
2. Design and Permitting - \$80,000
3. Construction - \$750,000 to \$1,500,000

The feasibility phase includes sediment sampling and analysis, and SHPO investigations for historical artifacts. The construction cost varies do to the unknowns related to the accumulated sediment behind the dam, its management, and stabilization. It should be also noted that some of the costs for this project could potentially be covered under a 319(h) grant or with funding acquired through American Rivers.

## 6.0 Conclusions

The studied stream segment of the Whippany River is subject to flooding largely as a result of the extensive amount of land development and historic floodplain encroachments that have occurred throughout the watershed. The impacts caused by the increased volume of runoff associated with the increase in impervious cover has been exacerbated over time by the filling and alteration of the stream's natural floodplain and overall lack of adequate stormwater management. Flooding is also exacerbated by the backwater attributable to the various stream crossings - in this case specifically, the Martin Luther King and Center Street bridges. Besides the flooding and backwater impacts attributable to stormwater runoff, another set of problems that have arisen over time can be defined as erosional. With the increased volume of runoff associated with development comes an increase in the rate of flow experienced in the stream. The erosional properties of these increased flows result in the scour and down cutting of the stream's banks. This further "disconnects" the stream from its floodplain, thus worsening problems.

Through this study it was possible to model the stream's response to storm events of various magnitudes and evaluate measures that could be implemented to mitigate existing and future erosional problems. What became evident through this study is that a regional-scale solution is needed. The removal of the Lake Pocahontas Dam and the subsequent conversion of the lake into a stream/wetland complex is a promising regional solution. However, as discussed, the lake is an important and historical fixture of the community. As such, removal of the dam and the conversion of the lake into a stream/wetland complex does not seem likely to occur.

However, we have identified a number of very feasible, smaller-scale projects. While these projects will not fully address the flooding and erosion impacts of this tributary of the Whippany River, they have significant merit. As illustrated above, each of the proposed projects has a positive impact on flood storage and each has the ability to mitigate existing, localized stream corridor erosion problems.

The project that needs to be given priority implementation consideration is the stabilization of the stream bank adjacent to the Bethel A.M.E. Church. As noted, this bank is severely eroded and will continue to erode at a steady rate unless stabilized. As documented herein (see Area of Concern #1), this can be accomplished using a combination of bioengineering and conventional engineering solutions. While the measures do not address the causes of the bank's erosion, they do provide a means of decreasing the further scour and loss of the stream bank. The overall value of the project and its regional benefits could be increased by implementing this project in concert with a number of other projects extending from the Center Street crossing to the Martin Luther King Avenue crossing.

The financial efforts to design and implement each of the design concepts can be reduced by combining the areas of concern that are in close proximity to each other. This is especially the case with areas of concern (AOC) 1 through 4. If conducted as one major project, it would be possible to correct the erosion problems along the west shore of the stream (including the section abutting the Bethel A.M.E. Church property), decrease the backwater and flooding conditions exacerbated by the Center Street crossing and reconnect this segment of the stream with its original floodplain. While somewhat ambitious due to permitting, ownership and historic contamination issues, this project should be earnestly pursued. It is the opinion of Princeton Hydro that this project could be funded through a 319(h) grant.

Finally, it should be noted that throughout this project there has been a strong commitment and extensive amount of support by the WRWAC's primary project partner, the Bethel A.M.E. Church. This is reflected first and foremost by the efforts taken by their volunteers to clear the stream bank of the invasive vegetation and their willingness to pursue future on-site projects, such as the use of pervious pavement and construction of a rain garden as detailed in Section 4.3 Area of Concern #3. More importantly, Reverend Sidney Williams, the Pastor of the Bethel A.M.E. Church, has personally organized meetings with various stakeholders, local legislators and others to develop the community support needed to see many of the above-noted projects to fruition.

Further evidence of the community's support of this project was evidenced through the combined efforts of the WRWAC and the Bethel A.M.E. congregation in the form of a stream cleanup conducted on the primary focus segment of the study stream, between Center Street and Martin Luther King Avenue crossings. The cleanup jointly sponsored by the WRWAC and the Bethel A.M.E. Church was the most successful in the history of the WRWAC. Over 100 volunteers removed over 82 bags - approximately 1,200 pounds - of trash. Debris removed from the stream included 20 bicycles, 2 chairs, a computer keyboard and circuit board, 3 car batteries, a box spring, 3 tires, 2 small appliances, a shopping cart, a "No Parking Sign", a crutch and 300 pounds of metal. The event was covered by local newspapers and WMTR, a local radio station.

## APPENDICES

APPENDIX A  
SITE LOCATION MAPS

**APPENDIX B  
SITE PHOTOS**

## APPENDIX C STATE AND FEMA STUDIES

APPENDIX D  
GIS MAPS



APPENDIX E  
CONCEPT DESIGN PLANS