

Upper Delaware River Watershed  
Livingston Manor, NY

Flood Risk Management  
And  
Ecosystem Restoration

Feasibility Report



March 2016



**U.S. ARMY CORPS OF  
ENGINEERS  
PHILADELPHIA DISTRICT**



**New York State Department of  
Environmental Conservation**

## Executive Summary

### 1. Introduction

This report presents the results of the Upper Delaware River Watershed, Livingston Manor, New York Feasibility Study. The purpose of the Livingston Manor Feasibility Study (hereafter called the Study) was to provide recommendations for future actions to investigate potential flood risk management solutions and identify ecosystem restoration opportunities that could be implemented within the study area. The flood risk management and restoration opportunities considered during the study included alternative solutions to reduce the recurrence of frequent flooding and to restore and/or improve degraded fish and wildlife habitat within the community of Livingston Manor. Restoration opportunities that contributed to the reduction of nuisance flooding were considered a high priority for this study since these opportunities could also provide incidental flood damage reduction in addition to ecosystem restoration benefits.

The Livingston Manor Study was authorized through Resolution #2495 adopted by the Committee on Transportation and Infrastructure of the U.S. House of Representatives on May 9, 1996. Pursuant to the Congressional resolution on the Upper Delaware River Watershed, the District completed an Expedited Reconnaissance Report in July 1997 (amended in February 2008) to determine Federal interest in the areas of flood control, ecosystem restoration, water quality control, comprehensive watershed management and other allied purposes.

The recurring flooding problem in the Livingston Manor area has been documented since the late 1800's with significant events recorded in June 1969, June 1973, January 1996, November 1996, September 2004, April 2005, June 2006, and September 2012. Typical damages include inundation of residential and commercial structures, as well as erosion of roads, retaining walls, and bridge abutments. In addition, some of the storms have resulted in the loss of life and important local infrastructure. From the January 1996 storm alone, Sullivan County reported infrastructure damages of \$5,500,000 and property damages of \$4,400,000.

This feasibility report documents the initial planning and engineering efforts required to determine potentially implementable solutions that provide reduction in surface water levels during frequently recurring events, including erosion and sediment stabilization features that also provide ecosystem benefits through habitat improvements. The analysis for this report focused mainly on the Little Beaver Kill (LBK) Watershed since historically that is the area with most frequently recurring annual flood damages.

The New York State Department of Environmental Conservation (NYSDEC), as the non-Federal Sponsor, and the U.S. Army Corps of Engineers (Corps) initiated the feasibility phase of the study on May 26, 2009. The actual study work began in September 2009 when the non-federal cost share funds were received by the Corps. The feasibility phase study cost was shared equally between the Corps and the Sponsor.

## 2. Major Conclusions and Findings

### a. Planning Objectives

The investigation of the problems and opportunities in the study area led to the establishment of the following planning objectives:

- Reduce frequent flooding damages in the Livingston Manor area for at least the 5% Annual Chance Exceedance (ACE) (20 year) event by 2020.
- Stabilize degraded stream channels in the Livingston Manor area using sustainable design techniques.
- Improve degraded riparian buffers with native vegetation by 2020.

### b. Alternatives

A wide range of alternatives were formulated to address the planning objectives. Findings relative to these alternatives are as follows: based on an evaluation of the various alternatives, including the environmental impacts, design elements, estimated costs, and flood reduction benefits, Plan J was determined to be the recommended plan. Plan J is composed of a widening of the Little Beaver Kill at the Main St. Bridge, installing a 4 x 10 ft box culvert at the Main St. Bridge, and stabilizing one mile of stream upstream from the Main St. Bridge to the old airport site. This plan has measurable flood damage reduction benefits, as well as incidental benefits to the riparian buffer.

The Federal objective in water resources planning is to contribute to the National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders and other planning requirements. Accordingly, it was found that Plan J best meets the NED objective of maximizing national economic benefits and therefore has been identified as the NED plan. In addition, Plan J provides additional environmental benefits. Furthermore, Plan J has strong local support and in the opinion of the sponsor best meets the needs of the local community.

### c. Features of the Recommended Plan

Primary features of the recommended plan (Plan J) are shown in Figures 5.1 and 5.2, and are summarized below:

- ✓ Plan J - widening of the Little Beaver Kill floodway at the Main St. Bridge
- ✓ Plan J – installing a 4 x 10 ft box culvert at the Main St. Bridge

- ✓ Plan J – stabilizing approximately one mile of stream upstream from the Main St. Bridge to the Airport property site.

#### d. Benefits and Costs of the Recommended Plan

The economic results indicate a 2.31 benefit/cost ratio with \$412,000 in annual net benefits to the Nation. In addition, this plan will have incidental environmental benefits by improving approximately 9 acres of riparian habitat (to insure stream stability) around the newly designed stream channel. Under Plan J, annual damages from flooding should decrease by approximately \$727,000. Furthermore, since trout fishing is a large component of the local economy and important to the culture of the region, Plan J provides essential flood risk management benefits desired by the local community, but done in a manner compatible with a trout stream.

### **3. Areas of Controversy**

There has been very little controversy for the study or recommended plan to date.

### **4. Unresolved Issues**

Due to financial constraints of the non-federal sponsor, this study was limited in its scope and focused mainly on frequently recurring flood damages within the Little Beaver Kill Watershed. If additional sponsor funding becomes available, further investigations into other watersheds (e.g., Willowemoc) could be explored further in the future.

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## **1.0 Introduction**

This report presents the results of the Upper Delaware River Watershed, Livingston Manor, New York Feasibility Study. The purpose of the Livingston Manor Feasibility Study (hereafter called the Livingston Manor Study) was to provide recommendations for future actions to investigate potential flood risk management solutions and identify ecosystem restoration opportunities that could be implemented within the study area. The flood risk management and restoration opportunities considered during the study included alternative solutions to reduce the recurrence of frequent flooding and restore and/or improve degraded fish and wildlife habitat within the community of Livingston Manor. Ecosystem restoration opportunities that also contributed to the reduction of nuisance flooding were considered a high priority for this study.

### **1.1 Study Authorization**

The Livingston Manor Study was authorized through Resolution #2495 adopted by the Committee on Transportation and Infrastructure of the U.S. House of Representatives on May 9, 1996. The resolution states:

“Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army is requested to review the report of the Chief of Engineers on the Delaware River, published as House Document numbered 522, 87th Congress, 2nd Session; as it relates to the Upper Delaware River Watershed in New York State, and other pertinent reports, with a view to determine whether any modifications of the recommendations contained therein are advisable in the interest of flood control, ecosystem restoration, water quality control, comprehensive watershed management and other allied purposes.”

### **1.2 Study Area**

The study area is located at the junction of the Little Beaver Kill and Willowemoc Creeks within the hamlet of Livingston Manor (population 1,482), Town of Rockland, Sullivan County, about 76 miles northwest of New York City (Figures 1.1 through 1.5). Livingston Manor has been flooded five times out of eight years from 1999 - 2006, including three consecutive major events during September 2004, April 2005 and June 2006. The main damage area is located in the downtown Livingston Manor area consisting of residences and businesses situated adjacent to the confluence of the Little Beaver Kill and Willowemoc Creeks. Some flood damages have also occurred along the left bank (facing downstream) of Willowemoc Creek during major flood stages, and to the sewage treatment plant on the left bank downstream of the main damage area. Although overbank flows of Willowemoc Creek are relatively rare occurrences, high flows in that stream cause a backwater condition in the Little Beaver Kill, and occasionally Cattail Brook, frequently resulting in overbank flooding of those streams. An additional contributing factor to the backwater flooding along the Little

Beaver Kill can be attributed to the development encroachment into the floodplain adjacent to the Main St. Bridge as well as the narrow opening of the bridge itself.

The Little Beaver Kill channel has changed course away from its previous alignment into a series of gravel borrow pits along an abandoned airstrip located approximately one mile upstream of downtown Livingston Manor. This interruption in the natural hydrologic flow along with a lack of riparian buffer has degraded the aquatic habitat in the Little Beaver Kill by raising water temperatures and removing riffle pool complexes. Thermal conditions on the Little Beaver Kill have been extensively studied by the New York State Department of Environmental Conservation (NYSDEC). Resolution of the thermal problem and other ecological issues involving channel stability, erosion and deposition, and wetland/floodplain losses are also a high priority of the NYSDEC and stakeholder organizations such as The Nature Conservancy and Trout Unlimited. As a result of this channel realignment, the quality of aquatic habitat in the Little Beaver Kill has declined, as summer temperatures regularly exceed lethal thermal limits for native brook trout.

There are several water resource problems associated with the area surrounding Livingston Manor along the Little Beaver Kill, Willowemoc Creek and Cattail Brook. These problems include flooding, fish habitat impairment, sediment management, as well as loss of floodplain and riparian buffer habitat. The study examined all practicable ecosystem restoration and flood damage reduction alternatives, including, but not limited to structural (floodwalls, levees, wetland creation/restoration, etc.) or non-structural (flood proofing, buy-outs, etc.) solutions.

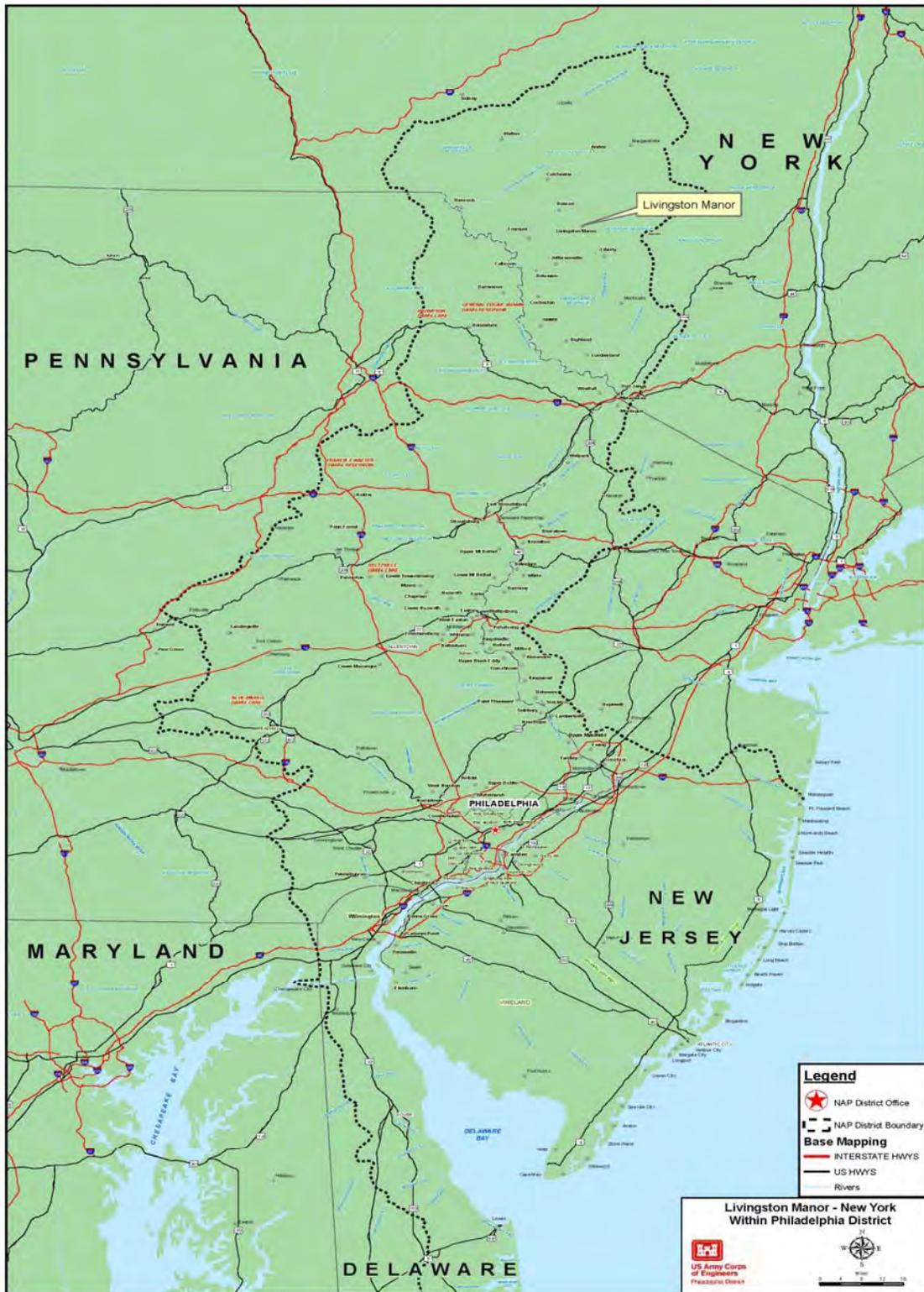


Figure 1.1: Location of Livingston Manor

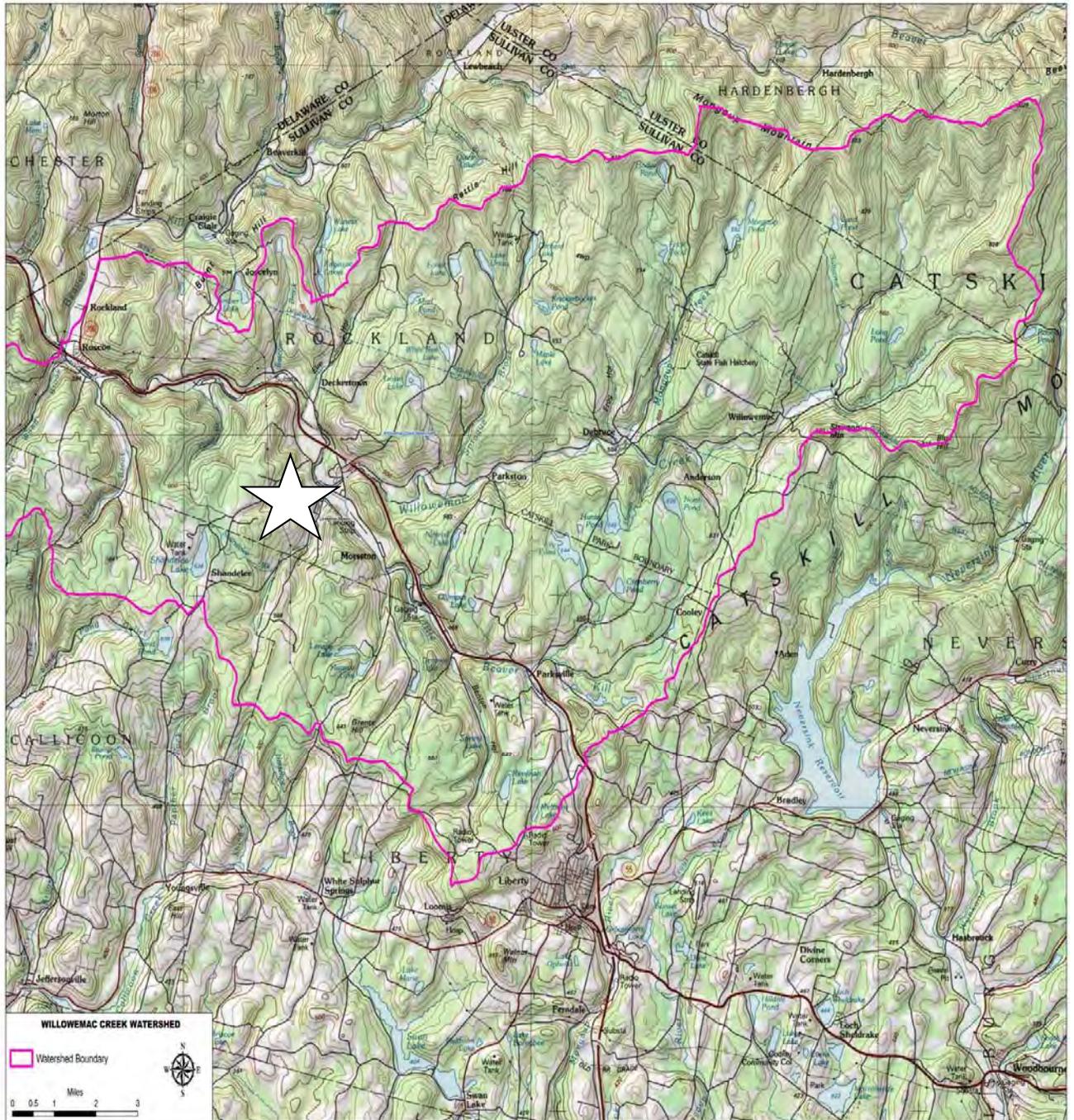


Figure 1.2: Livingston Manor Watershed Boundary

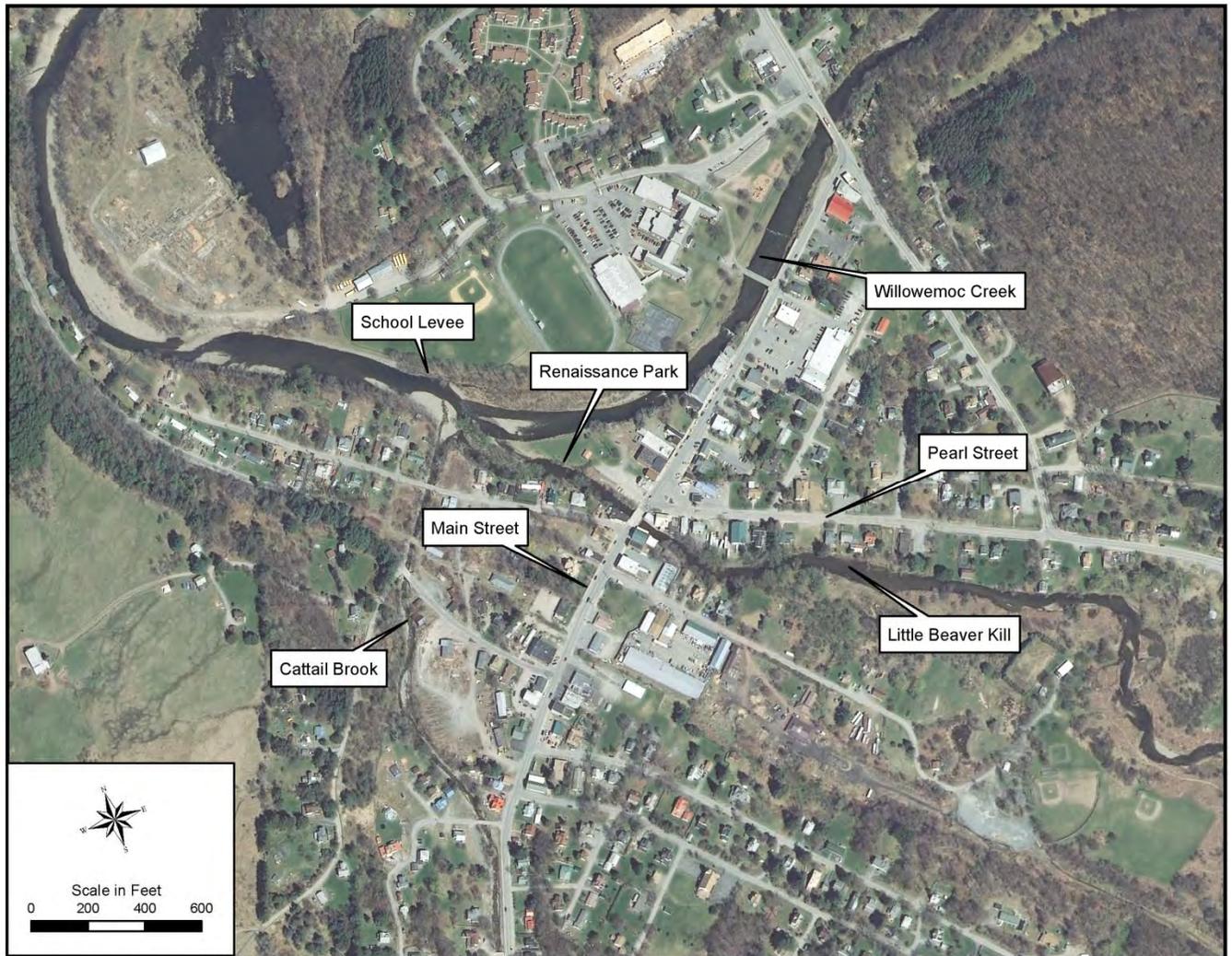


Figure 1.3: Aerial photo of Downtown Livingston Manor with key features noted.



Figure 1.4: The topography of the Livingston Manor Downtown Area.



**Figure 1.5: Aerial view of the confluence of the three streams (Willowemoc Creek, Little Beaver Kill, and Cattail Brook).**

### **1.3 Study Purpose and Scope**

The purpose of a feasibility study is to ensure the timely and economical completion of a quality feasibility report that is expected to recommend an implementable solution to the identified problems.

This feasibility report presents the results of a feasibility level study conducted pursuant to the previously mentioned resolutions and will accomplish the following:

- a. Provide a complete presentation of study results and findings so that readers can reach independent conclusions regarding the reasonableness of recommendations
- b. Provide a sound and documented basis for decision makers at all levels to judge the recommended solution(s).

This report documents the analysis of existing conditions, without project conditions, plan formulation, and some draft project designs in order to provide recommendations for solutions that reduce recurring flood damages within the community of Livingston Manor, as well as improvements that increase aquatic habitat for ecosystem restoration purposes throughout the study watershed. The evaluations were based on site-specific technical information developed during the course of the study. These included analysis of recent and historical flooding records, hydraulic modeling; and preliminary economic, geotechnical, environmental, and cultural resource investigations.

This feasibility report details the following for the study area:

- a. Define problems and opportunities.
- b. Identify potential solutions.
- c. Identify costs and benefits of potential solutions.
- d. Present a recommended plan.
- e. Present an Environmental Assessment for the proposed federal action in accordance with Section 102 of the National Environmental Policy Act of 1970.

### **1.4 Prior Studies, Reports and Related Projects**

The U.S. Army Corps of Engineers (Corps) was given authority to conduct a reconnaissance study and ensuing feasibility level investigations by the U.S. House of Representatives, Committee on Transportation and Infrastructure Resolution #2495 -- Upper Delaware River Watershed, New York, adopted May 9, 1996. Pursuant to this resolution, the Upper Delaware River Watershed, New York, Reconnaissance Study [905(b) analysis] was initiated in 1996 and completed in 1997. This study identified problems and opportunities within the area focusing on ecosystem restoration and flood risk management issues.

The addendum to the 905b Analysis for the Upper Delaware River Watershed in New York completed and approved in March 2008 indicated that there is sufficient Federal interest to warrant further investigation into flood damage reduction and ecosystem restoration in Livingston Manor, New York. Flooding is a major concern in the hamlet of Livingston Manor. In the last 20 years, Livingston Manor has had six major flood events. The Town of Rockland submitted 88 National Flood Insurance Program claims of over \$1.9 million as a result of the September 2004 and April 2005 storms alone. In addition, the quality of native trout habitat in the Little Beaver Kill has declined, as summer temperatures regularly exceed lethal thermal limits for native brook trout. The Livingston Manor area can no longer support a successful summertime cold-water trout fishery.

The Philadelphia District then proceeded with coordination of a feasibility study with the New York State Department of Environmental Conservation (NYSDEC) as the local sponsor. Based upon further negotiations with NYSDEC, the Project Management Plan (PMP) and a Feasibility Cost Sharing Agreement (FCSA) for a two-phased feasibility study was negotiated. The FCSA was subsequently executed on May 26, 2009.

There are several water resources problems associated with the area surrounding Livingston Manor along the Little Beaver Kill, Willowemoc Creek and Cattail Brook. These problems include flooding, fish habitat impairment, erosion and sediment management, as well as loss of floodplain and riparian buffer habitat. The study examined all practicable flood damage reduction and ecosystem restoration alternatives, including, but not limited to structural (floodwalls, levees, wetland creation/restoration, etc.) or non-structural (flood proofing, buy-outs, etc.) solutions. Alternatives for this project were developed in accordance with the Corps' Environmental Operating Principles, which aim to foster unity of purpose on environmental issues, reflect a new tone and direction for dialogue on environmental matters, and ensure that employees consider conservation, sustainability, environmental preservation and restoration in all Corps activities.

Initial study scoping efforts have been collaborated with multiple Federal, State, and local agencies including the Federal Emergency Management Agency (FEMA) Region II, the New York State Department of Transportation, Sullivan County and the Town of Rockland. In addition to the non-federal sponsor (NYSDEC) and the agencies above, there are several non-profit environmental organizations (The Nature Conservancy, Trout Unlimited, and Open Space Institute) interested in participating in the feasibility study to reduce flood damages through the restoration of flood plains and stream habitat at the same time. Future study efforts will be coordinated with other Federal, state and local agencies as well as interested stakeholders.

### 1.5 Project History

Flooding problems and ecological degradation within the project area have been studied by a number of federal, state, and local agencies over the past 50 years. The following is a list of the prior studies with brief summaries or each:

*Flood Skimming Study, Beaver Kill Creek, Rockland, New York.* September 1967. Prepared by U.S. Army Corps of Engineers (USACE). A dam was proposed that would reduce flooding in one third of Rockland.

*Open File Report, Flood of July 27-28, 1969.* 1969. Prepared by USGS. The flood exceeded all stream flows since 1937 (gage installation date). The flood was greater than the 100-year event and damaged 20 residences, campgrounds, a motel and a sewer treatment plant.

*Draft Reconnaissance Report, Livingston Manor and Roscoe, NY.* August 1970. Prepared by USACE. The report described flooding problems from Willowemoc Creek upstream of the Beaver Kill in Roscoe to two miles upstream of Livingston Manor. In 1969, flood damages totaled \$509,000 in Livingston and \$37,000 in Roscoe-Rockland. The report proposed levees, channel relocation, a flume and a wall structure to reduce flood damages. The expected cost/benefit ratio of the proposed project was 1.3.

*Economic Damage Assessment, Rockland Township.* 1976. Prepared by Justin & Courtney, Inc. for USACE. The Little Beaver Kill caused major flooding in Livingston Manor due to a blockage at the Main St. Bridge and upstream ice jams.

*Livingston Manor Reconnaissance Report.* September 1979. Prepared by USACE. The report documented minor flooding every 2 years and major flooding every 10 to 25 years. Solutions such as upstream reservoirs, major stream relocations and dredging were determined to be uneconomical and environmentally detrimental.

*Flood Insurance Study.* 1993. Prepared by FEMA. The study indicated that in 1951, a 1,000-foot levee was constructed along the left bank of the Willowemoc Creek below Cattail Brook. It also noted the Willowemoc Creek as a major source of flooding and recommended the construction of a 600-foot flood wall and levee on the right bank at the High School.

*Upper Delaware River Watershed Expedited Reconnaissance Study.* 1997. Prepared by USACE. Reported damages from the January 1996 flood which damaged 232 houses, 20 mobile homes, 27 businesses, 3 apartment buildings, and water and sewer treatment plants.

*Draft Preliminary Restoration Plan for Little Beaver Kill Trout Habitat.* 2003. Prepared by The Bioengineering Group, Inc. for USACE. The plan involved restoration of a section of the Little Beaver Kill that had been thermally degraded. It included a 2,600 foot channel realignment, bank stabilization, floodplain wetland creation, borrow pit filling, and establishment of forested riparian buffer.

*Beaver Kill – Willowemoc Watershed Initiative 1994-2002.* 2003. Prepared by Trout Unlimited. An assessment of trout habitat in the Beaver kill and Willowemoc watersheds using applied hydrogeomorphic analysis.

*Livingston Manor Airport-Mitigation Site Evaluation.* 2004. Prepared by LU Engineers for NYSDOT. Discussion of the restoration of 800 yards of the Little Beaver Kill and creation of wetlands adjacent to the existing gravel pits. No significant flood reduction benefits were anticipated.

*Pre-Disaster Mitigation Grant.* 2005. Prepared by FEMA. A grant for the removal of 15 properties with repetitive flood damages. DRBC analyzed FEMA's National Flood Insurance Program for a total of 40 repetitive loss properties and 5 severe repetitive losses.

*Feasibility Analysis Report.* 2005. Prepared by McFarland-Johnson, Inc. The report indicated that a dry lake bed with storage volume of 700 acre-feet would be needed to provide protection from a 100-year return-period flood. A downstream levee was still considered necessary.

*Flood Mitigation/Ecosystem Restoration Feasibility Study, Potential Study Concepts.* 2006. Prepared by McFarland-Johnson, Inc. for the Town of Rockland. The study identified potential flood mitigation solutions that included: floodwater storage and stream restoration

on the airport property; a flood wall and levee setback with channel relocation and riparian restoration along Pearl Street; stream relocation at the gravel pits; floodplain storage and wetland creation at the former poultry plant site; expansion of the Main St. Bridge with restoration of the floodplain; levee removal at the high school; additional culvert installation at Covered Bridge Road; and floodwater storage and wetland creation through modification of existing impoundments in the Little Beaver Kill watershed (e.g., Matawa Lake).

*New York State Hazard Mitigation Plan.* 2006. Prepared by URS for FEMA. The purpose of this study was to document the maximum flooding elevations that occurred as a result of the heavy rains during the week of June 25, 2006.

*Initial Appraisal Report.* 2006. Prepared by USACE. Following flooding damages of \$1.9 million in the Town of Rockland in September 2004 and April 2005, the report suggested solutions for the future. The structural solutions included channel improvements, floodwater bypassing, and modification of detention basins. Nonstructural solutions included flood proofing, raising structures, buyouts, floodplain restoration, and wetland creation.

*Technical Support for Feasibility Study.* 2007. Prepared by McFarland-Johnson for USACE. Study collected existing stream channel cross section data and recommended stability and hydrology and hydraulics analysis.

*Addendum to Upper Delaware River Watershed Expedited Reconnaissance Study of 1997.* 2008. Prepared by USACE. The reexamination of the Upper Delaware River Watershed in New York State to identify problems, needs and opportunities for improvements relating to local flood damage reduction, ecosystem restoration, water quality, and watershed management.

*Multi-Jurisdictional Study for the Delaware River Basin.* 2008. Prepared by USACE. A discussion of basin-wide flooding and water resource issues, including the Town of Rockland. Determined that the Town of Rockland does not want a structural flood damage reduction project that adversely impacts the natural values of the area.

2.0 Problem Identification

2.1 Problem Analysis

The Livingston Manor area has been subject to both local and widespread damage caused by the flooding of lands and property adjacent to its streams. Three waterways and their associated watersheds reach a confluence at the southern end of Livingston Manor. These waterways are the Willowemoc Creek, Little Beaver Kill Creek, and Cattail Brook. Repetitive flooding in Livingston Manor begins at a 5-year return-period flood interval for Little Beaver Kill Creek.

The area has a long history of flooding dating back to the late 1800s. Significant flooding also occurred in June 1969 and 1973. The Livingston Manor watersheds, like many others in the nation have been impacted by flooding because people live, work, travel, and recreate in floodplains, and because their land use activities have increased the runoff from watersheds and changed the hydraulics of the floodplain itself. As illustrated on the 2006 FEMA floodplain map (Figure 2.1), most of the Town lies within the 100-year floodplain.

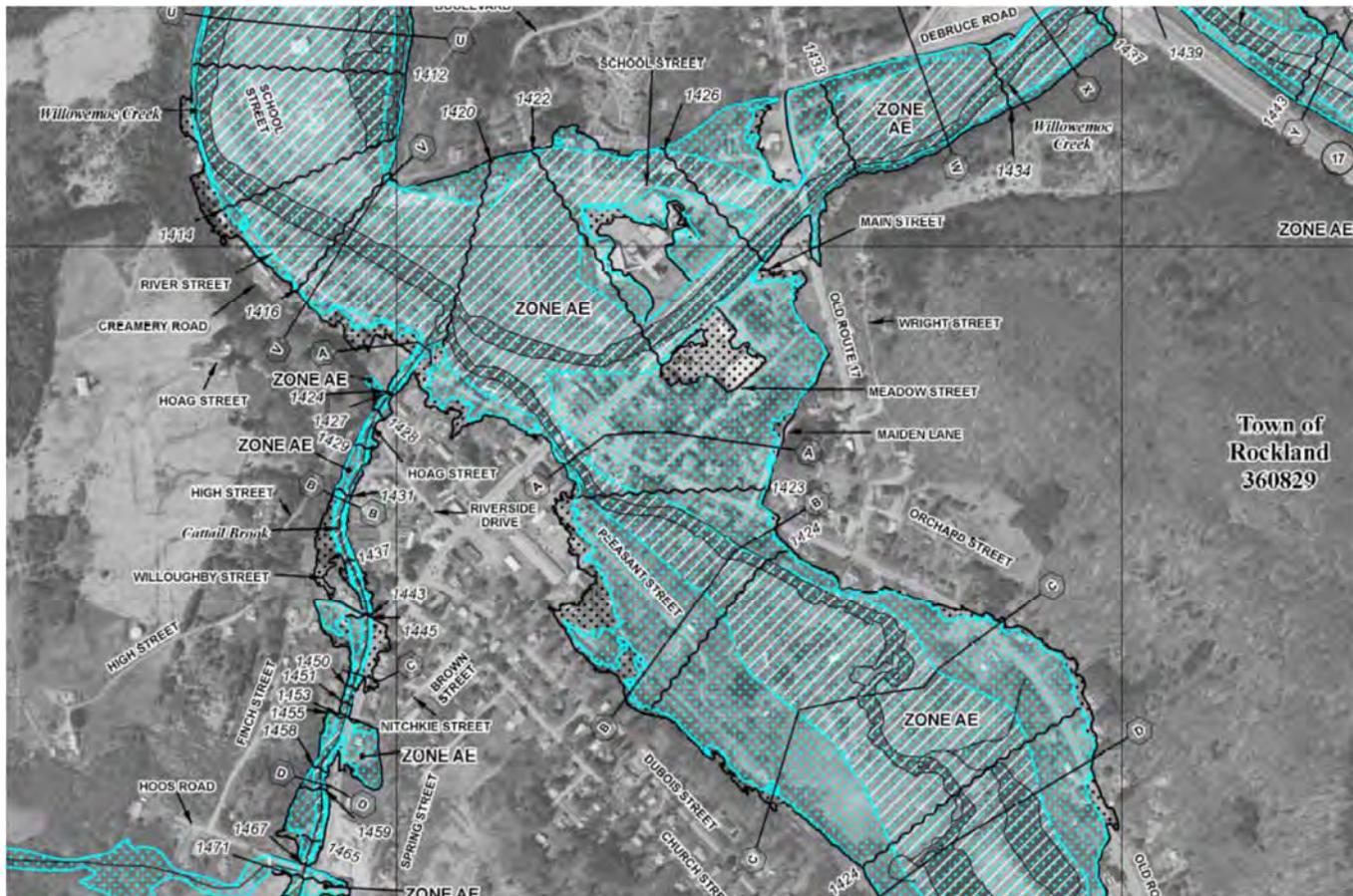


Figure 2.1: FEMA floodplain map depicting the 100-yr floodplain.

Flood events typically occur when storms move across the area with long duration or intense rainfalls. These storms are of two general types; storms of tropical origin (hurricanes) or storms of extra-tropical origin such as thunderstorms and northeasters. The movement of warm moist air into contact with surrounding air of lower temperature produces the violent thunderstorms and intense precipitation of the summer months and the northeasters of the cool months. The latter are of coastal origin and are accompanied by severe winds and heavy precipitation. When these storms are both slow moving (long duration) and intense, the worst flooding events are likely to occur. Other floods are caused by combinations of storms, snowmelt, and ice jams.

### **2.1.1 Recent Flood Events**

In the past 20 years, the Livingston Manor area has been inundated by numerous flood events. For example, in 1996, flooding occurred in both January and November resulting in damaged roads, bridges, bridge piers and abutments, and several retaining walls. Total damage in 1996 to Sullivan County infrastructure was \$5.5 million and damage to private property was \$4.4 million. Major flooding also occurred in the subsequent years of 2004-2006. These three consecutive years of flooding was unprecedented and resulted in widespread damage to public and private property.

The June 2006 flood event was a major event for the Delaware River Watershed. This event was the result of extremely heavy rainfall over the Delaware River Basin from June 24 to 28. The National Weather Service data indicates that 6 to 15 inches of rain fell in the Schuylkill, Lehigh, and upper Delaware River watersheds during the five day period. During the evening of June 27, National Weather Service flash flood warnings were in effect for nearly all counties in the Pennsylvania and New York portions of the basin. The highest flows in recorded history were observed during the June 2006 storm event at various USGS gages located on streams and tributaries in the upper portion of the study area watershed. The normal reading on the stream gage on the downstream main stem Beaver Kill Creek at Cooks Falls is 185 cubic feet per second (cfs). During the June 2006 storm, this gauge was recorded at 45,900 cfs before the gauge station submerged and malfunctioned. Normal flow on the adjacent West Branch of the Neversink River in Claryville is 50 cfs. For this event it was recorded at 8,000 cfs before the gauge was inundated. On July 1, 2006, President Bush declared a major disaster for the State of New York triggering the release of federal funds to help communities recover from the severe storms and flooding in June 2006.

As recently as September 2012, approximately 5-7 inches of rain fell within 24 hours, and the Cattail Brook overtopped its banks causing widespread property damage within Livingston Manor, including the loss of three bridges.

### **2.1.2 Damages to Flood Prone Areas**

Impacts to Livingston Manor from flooding have been widespread and severe. Extensive damage to local infrastructure and private homes has occurred as a result of flooding. Six devastating floods have occurred in the area in the last 20 years (Jan 1996, December 2000, September 2004, April 2005, June 2006, and September 2012). Reported damages from these three major consecutive floods were:

September 2004: \$770,000  
April 2005: \$1,000,000  
June 2006: \$4,000,000

The last two of these events were floods of record (April 2005 and June 2006). After the 2005 flood event, FEMA approved and is currently implementing a Voluntary Acquisition buyout of 15 homes at cost of \$1.8 million. Of this amount, \$1.45 million was provided by FEMA. Local interests are still responsible for their share of \$360,000. The June 2006 event resulted in the first recorded flood fatality. A 15-year old girl drowned as her house collapsed into Cattail Brook.

Other losses associated with flooding events in the area have been streambank erosion and channel migration. Both of these have resulted in threats to public facilities, utility lines, and private and commercial structures.

Various areas of Livingston Manor are more susceptible to flooding than others. Some of the areas frequently impacted by flooding include Main St. Park (Figure 2.2), Main St. Bridge area (Figures 2.3 - 2.5), Pearl St. (Figure 2.6), and the Cattail Brook area (Figures 2.7 and 2.8).



**Figure 2.2: The Main Street Park area at the confluence of the Willowemoc and Little Beaver Kill creeks.**



**Figure 2.3: Looking upstream from the Main St. Bridge at an area normally impacted by flooding events.**



**Figure 2.4: Looking downstream at the Main St. Bridge, an area normally impacted by flooding events.**



**Figure 2.5: Aerial view of Main St. Bridge (Note: the building on the right upstream bank adjacent to the bridge has since burned down).**



**Figure 2.6: Livingston Manor downtown area (Pearl Street) during 2006 flood event.**



**Figure 2.7: A house located on the Cattail Brook.**



**Figure 2.8: Cattail Brook looking downstream to confluence with Willowemoc Creek.**

### **2.1.3 Ecological Impacts of Flooding**

The detrimental impacts of the persistent and widespread flooding in the vicinity of Livingston Manor are not only damages to buildings and infrastructure. The flooding has also resulted in ecological degradation of the streams and riparian areas. The ecological problems include the scouring of habitat, channel instability, debris in the streams, thermal pollution, erosion and deposition, and wetland/floodplain losses.

Wetlands have been lost along the streams for a number of reasons including the construction of dams for recreational impoundments, residential development, and agriculture. This loss of wetlands has resulted in the elimination of two of the major functions that wetlands serve, which are sediment removal and wildlife habitat. Since the wetlands are not present to filter and retain sediment during out of bank flood events, much of it remains in the stream and increases turbidity, which can severely degrade the fish habitat. Many semi-aquatic and terrestrial organisms also rely on wetlands as a specialized habitat and cannot relocate once the wetlands have been eliminated.

Wetlands, as well as upland riparian areas, typically provide a vegetative cover for streams that helps to regulate the water temperature by shading out sunlight. This helps to maintain the cooler water temperatures that are required by native and sport fish such as trout. When the wetland and riparian vegetation is removed, the temperatures in the streams become too warm to sustain fish populations, especially in the summer months. Thermal stress caused by high summer water temperatures in the Willowemoc and Little Beaverkill represent a limiting factor for trout populations in the lower and mid river system in many years (Trout Unlimited, 2003).

The ecological impacts also result in secondary economic impacts in the project area. Since fishing is a major tourist industry in Sullivan County, the health of the streams and the fish populations are essential to the economic well-being of the region. The increased sedimentation and the thermal pollution that have resulted from the loss of wetlands and riparian vegetation have made long sections of the streams inhospitable for local fish populations.

Another secondary economic impact related to ecological conditions is the exacerbation of floods due to wetland loss. Wetlands act like a sponge that provides natural flood storage during storm events. When they are eliminated and this storage capacity is taken away, the flood levels and damages downstream worsen. Resolution of these ecological issues is a high priority of the NYSDEC and stakeholder organizations such as The Nature Conservancy and Trout Unlimited.

## **2.2 Problem and Opportunity Identification**

The problems identified in the Livingston Manor (Little Beaver Kill, Cattail Brook, and Willowemoc Creek Watersheds) are:

- Recurring flood damages to the commercial and residential areas of Livingston Manor and the Town of Rockland.
- Streambank erosion along Cattail and Little Beaver Kill within Livingston Manor.
- Degraded fish habitat in the watershed as a result of the scouring of stream beds and banks and loss of wetlands and riparian vegetation.
- Loss of fish habitat due to flooding, industrial activities (past dredging of stream), and stream encroachment by infrastructure (e.g., bridges).
- Invasive species (e.g., Japanese knotweed) colonizing streambanks and other natural areas.

There are opportunities in the Livingston Manor watersheds to:

- Reduce flooding damages in the Livingston Manor area.
- Restore degraded stream channels in the watershed.
- Move sewer infrastructure out of the floodplain.
- Restore the natural floodplain at the former Poultry Plant.
- Reduce frequent flooding in the Town of Rockland.
- Improve recreation along the world renowned trout fishery.
- Remediate a stream in an area dug for gravel pits.
- Improve water quality, which will reduce filtration and treatment costs.
- Improve unique bird watching opportunities along the waterfront.
- Restore degraded trout breeding habitat which can reduce the restocking frequency.
- Improve trout habitat to increase eco-tourism revenue
- Restore wetlands for flood water storage, sediment filtration, and wildlife habitat.
- Create a management plan for invasive species in the watershed.
- Improve water quality and aquatic habitat for imperiled native freshwater mussels.

### Goals, Objectives, and Constraints

The goals of the Upper Delaware River Watershed, Livingston Manor Study are to reduce the occurrence of frequent flooding damages within the community of Livingston Manor, NY and improve aquatic habitat conditions for trout populations in the Little Beaver Kill Creek watershed. The objectives of the study include:

- Reduce flooding damages in the Livingston Manor area for the less than 5% ACE (20 year) event by 2020.
- Reduce flooding damage along Main Street and Pearl Street in downtown Livingston Manor by 2020.
- Reduce the water surface elevation of storm floods along Pearl Street in Livingston Manor by 2020.
- Stabilize approximately one mile of stream channel along the LBK up to the old airport site by 2020.
- Replant floodplain areas in the old airport site with native vegetation by 2020.
- Reestablish native plant species in riparian buffer areas by 2020.

The study has numerous constraints associated with it. The following are constraints of the study:

- Flood reduction strategies and structures must not further degrade trout habitat.
- Minimize the relocation of structures from downtown Livingston Manor.
- Flood reduction strategies may not impact federally listed endangered species.
- Flood reduction strategies must be acceptable to the non-federal sponsor and community.
- Ecosystem restoration options must not increase community flooding.

### **3.0 Existing Conditions (Without Project Condition)**

#### **3.1 Site Description**

##### **3.1.1 Climate**

The project area drainage basin lies predominantly in Sullivan County, New York. Descriptions below for the climate in Sullivan County were taken, in part, from the 1989 Soil Survey of Sullivan County, New York. Winters are cold and summers are warm in Sullivan County. The climate in the area is of the humid continental type. Valley areas in the south and east parts of the county are somewhat warmer and upper slopes and mountaintops are somewhat colder. Precipitation is generally heavy and evenly distributed throughout the year. In summer, it falls primarily during thunderstorms. Heavy rains from slow moving thunder storms occasionally cover the entire area and cause severe flooding. Table 3.1 provides historic precipitation and temperature data for the Livingston Manor project area. On average, the warmest month is July with the highest recorded temperature (99 degrees Fahrenheit) recorded in 1953 and 1988. January is the average coolest month of the year with the lowest temperature (-26 degrees Fahrenheit) on record occurring in 1963 (The Weather Channel, 2010).

The total annual precipitation averages 50 inches. Overall, rainfall is well distributed throughout the year. Thunderstorms occur approximately 31 days each year, with most occurring in summer. The average seasonal snowfall exceeds 70 inches. The greatest snow depth at any one time during the period of record was 48 inches. On the average, 58 days of the year have at least 1 inch of snow on the ground. The average relative humidity in mid-afternoon is about 60 percent with humidity at its highest during nights. The sunshine is experienced approximately 60 percent of the time possible during the summer and 35 percent of the time possible in winter (United States Department of Agriculture, 1989).

Potential impacts to environmental resources, particularly water resources, through changes in climate have increasingly become an important topic to discuss. The Intergovernmental Panel on Climate Change concluded that observed climate records and projections provide evidence that freshwater resources are vulnerable and may be strongly impacted and have wide ranging consequences on ecosystems and human societies (Bates et al, 2008). Observed evidence from around the world shows natural systems are being affected regionally with emphasis on temperature increases (Intergovernmental Panel on Climate Change, 2007). A United States Geological Survey study of the projected implications of climate change in the Delaware River watershed showed that with increasing median temperatures in the Beaver Kill and Willowemoc watershed, an increase in winter flows, decreased summer base flows and earlier runoff events were expected (Ayers et al, 1994). In responding to climate change at the regional level, integrated watershed management strategies include protecting and restoring natural systems, recognizing water quantity and water quality linkages, coordinating land and water resources management, and others (Brekke et al, 2009). In an effort to combat climate change at the local level in the state of New York, a partnership between local communities and the State are formed. Any county,

city, village or town can join this partnership called “Climate Smart Communities”. The objective of the partnership is to reduce greenhouse gas emission and save taxpayer dollars. Sullivan County is on the New York State list of climate smart communities (New York State Department of Conservation, 2010d).

**Table 3.1: Monthly temperature and precipitation averages for Livingston Manor, New York (The Weather Channel, 2010).**

Month	Average High Temp.	Average Low Temp.	Mean Temp.	Record High Temp.	Record Low Temp.	Average Precipitation
January	31 °F	11 °F	21 °F	62 °F (2007)	-21 °F (1981)	3.77 inches
February	34 °F	13 °F	23 °F	73 °F (1954)	-26 °F (1963)	2.87 inches
March	43 °F	21 °F	32 °F	82 °F (1986)	-8 °F (1967)	3.77 inches
April	54 °F	32 °F	43 °F	89 °F (1976)	-3 °F (1982)	4.30 inches
May	66 °F	43 °F	55 °F	91 °F (1979)	19 °F (1986)	4.87 inches
June	74 °F	51 °F	63 °F	92 °F (2005)	31 °F (1986)	4.84 inches
July	79 °F	56 °F	68 °F	99 °F (1988)	38 °F (1988)	4.67 inches
August	78 °F	54 °F	66 °F	95 °F (2001)	34 °F (1986)	4.29 inches
September	70 °F	47 °F	58 °F	99 °F (1953)	24 °F (1974)	4.48 inches
October	59 °F	36 °F	47 °F	84 °F (1986)	15 °F (1972)	4.00 inches
November	46 °F	28 °F	37 °F	80 °F (1982)	2 °F (1951)	4.21 inches
December	35 °F	18 °F	26 °F	65 °F (2001)	-16 °F (1980)	3.86 inches

USACE guidance requires consideration of changing hydrology through time, specifically possible changes in a project’s function if the quantity and the timing of the runoff from the watershed changes in the future. There are two driving forces for such changes: changing landscape (e.g. urbanization) and changing climate. Technically, the issue of changing landscape is described with the term, homogeneity (or lack thereof) and the issue of climate uncertainty or climate change is described with the term, stationarity (or lack thereof).

USACE guidance on the issue of homogeneity has long existed. Engineering Regulation (ER) 1110-2-1450, Hydrologic Frequency Estimates, mandates that the issue of homogeneity be addressed in statistical analysis of gage records and Engineering Manuals (EM) 1110-2-1415,

Hydrologic Frequency Analysis and 1110-2-1417 Flood-Runoff Analysis provide techniques for handling non-homogeneity. The homogeneity of the Little Beaver Kill and Willowemoc watersheds was considered and is documented in Appendix A (Hydrology and Hydraulics). Given the very low, present level of imperviousness, the landscape has not materially changed since the USGS gages were first established. It is unlikely that any future development will manifest as non-homogenous stream flows.

In the past, because of lack of knowledge and data, the issue of stationarity was not considered. That is, the climate was assumed stable and future storms were assumed to be of the same type and same magnitude of past storms. However, due to advances in technology, stationarity is now being addressed by the USACE as reflected in, Engineering Construction Bulletin (ECB) 2014-10, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects. Annual peak flows and daily flows of three gages surrounding the study area were examined. Neither increasing nor decreasing trends in flows were detected in the data. Frequency duration precipitation estimates were also examined for signs of a temporal trend. None were detected. Details of the analysis can be found in Appendix A (Hydrology and Hydraulics).

### **3.1.2 Air Quality**

Air pollution originates from various sources including industry, motor vehicles, energy facilities, and many other human activities. Air pollution has the potential to harm human health and damage ecosystems. The Clean Air Act of 1970, last amended in 1990, required the United States Environmental Protection Agency (USEPA) to set National Ambient Air Quality Standards (NAAQS) for wide-spread pollutants from numerous and diverse sources considered harmful to the environment and public health (United States Environmental Protection Agency, 2010b). The USEPA has set NAAQS standards for six “criteria” pollutants including carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO<sub>2</sub>), Ozone (O<sub>3</sub>), particulate matter (PM), and sulfur dioxide (SO<sub>2</sub>).

The Department of Environmental Conservation implements the state and federal air pollution control and monitoring programs in the State of New York. Air quality is monitored by the Division of Air Resources. Air quality monitoring is conducted by placing air monitors at various locations within the state. More than 80 ambient air quality continuous and manual monitoring sites exist across the state. Direct real time measurements include gaseous criteria pollutants (ozone, sulfur dioxide, oxides of nitrogen, carbon monoxide), PM<sub>2.5</sub> (particulate matter with less than 2.5 microns diameter), and meteorological data. Collected data is compiled into ambient air quality reports and are provided to the public and technical community. The EPA’s “Green Book” identifies those areas of the country and the criteria pollutants that persistently exceed the national ambient air quality standards and are designated non-attainment. From 1980 through 2010, Sullivan County New York has been within attainment standards established by USEPA (United States Environmental Protection Agency, 2010a).

An Air Quality Index (AQI) developed by the USEPA is published daily for regions in New York as a means of reporting air quality to the general public. The state has been broken down into eight “Air Quality Health Advisory” regions. Sullivan County is located within Region III known as the Lower Hudson Valley advisory region. The AQI tells how clean or polluted the air is, and what associated health effects might be a concern (Table 3.2). It was created as an easy way to correlate levels of different pollutants to one scale; the higher the AQI value, the greater the health concern. When levels of ozone and/or fine particles are expected to exceed a higher threshold AQI value, an Air Quality Health Advisory is issued which alerts sensitive groups to take necessary precautions (New York State Department of Conservation, 2010a). In the Earth's lower atmosphere, near ground level, “bad” ozone is formed when pollutants emitted by motor vehicles, power plants, industrial boilers, refineries, and other sources react chemically in the presence of sunlight and is a harmful air pollutant. Fine Particle pollution (Particulate Matter) in the air includes a mixture of solids and liquid droplets. Some particles are emitted directly; others are formed in the atmosphere when other pollutants react. Those less than 2.5 micrometers in diameter are so small that they can enter the lungs, potentially causing serious health problems. The forecasting season for ozone is from May through September, whereas, fine particulate sampling is conducted year round.

**Table 3.2: New York Air Quality Index Table  
(New York State Department of Conservation, 2010a)**

Air Quality Index Values (when AQI is in this range....)	Levels of Health Concern (air quality conditions are.....)	Cautionary Statement (per Air Quality level.....)
0 to 50	Good	Air quality is considered satisfactory and air pollution poses little or no risk
51 to 100	Moderate	Air quality is acceptable. Some pollutants may pose a moderate health concern for a very small number of people who are unusually sensitive.
101 to 150	Unhealthy for sensitive groups	Member of sensitive groups may experience health effects. General public not likely affected.
151 to 200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious effects.
201 to 300	Very unhealthy	Health alert, everyone may experience more serious health effects
301 to 500	Hazardous	Health warnings of emergency conditions. The entire population is more likely to be affected.
<b>FINE PARTICLES</b>		
Air Quality Values	Levels of Health Concern	Cautionary Statements
0 to 50	Good	None
51 to 100	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion.

101 to 150	Unhealthy for sensitive groups	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.
151 to 200	Unhealthy	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
201 to 300	Very unhealthy	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.
301 to 500	Hazardous	People with heart or lung disease, older adults, and children should remain indoors and keep activity levels low. Everyone else should avoid all physical activity outdoors.
<b>OZONE</b>		
Air Quality Values	Levels of Health Concern	Cautionary Statements
0 to 50	Good	None
51 to 100	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion.
101 to 150	Unhealthy for sensitive groups	Active children and adults, and people with lung disease, such as asthma, should reduce prolonged or heavy exertion outdoors.
151 to 200	Unhealthy	Active children and adults, and people with lung disease, such as asthma, should avoid all exertion outdoors. Everyone else, especially children, should reduce prolonged or heavy exertion outdoors.
201 to 300	Very unhealthy	Active children and adults, and people with lung disease, such as asthma, should avoid all outdoor exertion. Everyone else, especially children, should avoid prolonged or heavy exertion outdoors.
301 to 500	Hazardous	Everyone should avoid all physical activity outdoors.

**3.1.3 Topography, Geology and Soils**

The topography, geology, and soils of the project and surrounding areas within Sullivan County have been exhaustively studied and catalogued by the U.S. Department of Agriculture, Soil Conservation Service in cooperation with Cornell University Agricultural Experiment Station. The information provided in this topography section was taken from the 1989 Soil Survey of Sullivan County, New York.

As described in the 1989 Sullivan County Soil Survey, Sullivan County lies mainly within the Appalachian Plateaus province, which is divided into several sections. The northern one-third of the county consists of the Catskill section. The largest part of the county is the Southern New York section just south of the Catskill Mountains. This part is a deeply dissected plateau that slopes gently to the southwest. The southeast edge of this plateau is bounded by a fairly steep, prominent escarpment. The highest elevations in the county are in

the Catskill section and include mountain elevations of 3,051 feet, 2,985 feet and 3,118 feet. Relief in this area is commonly steep. South of the Catskill Mountains in the Southern New York section, elevations range from about 2,000 feet in the north part to about 1,200 feet in the south part. The lowest elevation in this section is approximately 480 feet. Relief is generally steeper in the west part of this section and less steep in the central and south areas except for valley sides of the Delaware River and the lower Neversink River. A small part of southeastern Sullivan County lies in the Ridge and Valley province. In the Ridge and Valley section, elevations range from about 1,780 feet at the north to about 1,200 feet at the south end. The lowest point in this section is approximately 380 feet.

Bedrock underlying all physiographic areas of Sullivan County is of sedimentary origin. The bedrock formations are oldest at the southeast edge of the county next to Orange County and become progressively younger in a northwesterly direction toward Delaware County. The overall project area is located within the Catskill Formation of Middle and Upper Devonian age rock. The Beaver Kill basin is underlain by this bedrock (Reynolds, 2000). These rocks are mainly red and grayish brown sandstone and shale and include the Stony Clove and Katsburg Formations and the undifferentiated Hamilton Group. The Livingston Manor project area is within the Lower Katsburg bedrock formation (Dsd) with portions of the watershed falling within the Upper Katsburg bedrock formation (Djwh).

Map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. There are approximately 122 major soil mapping units in Sullivan County, New York. Of these, approximately 55 are found within the project area. The types of work and land disturbance expected in the proposed study would be located within open water and floodplain areas. Table 3.3 lists those soil series and mapping units typically found within these landforms of the project area (United States Department of Agriculture, 1989).

**Table 3.3: Project area soil series and mapping units**

SOIL SERIES	MAJOR MAP UNIT	MAP UNIT SOIL NAME	RATING
Barbour Series	Bb	Barbour loam	All areas are Prime Farmland
Bash Series	Bs	Bash Silt loam	Prime Farmland if drained
Cheshire Series	CsB	Cheshire channery loam, 3-8 % slopes, stony	All areas are Prime Farmland
Cheshire Series	CsF	Cheshire channery loam, 35-60 % slopes, stony	Not Prime Farmland
Fluvaquents	Fu	Fluvaquents-Udifluvents complex, frequently flooded	Not Prime Farmland
Lackawanna Series	LaD	Lackawanna channery loam, 15-25 % slopes	Not Prime Farmland

Pompton Series	PmA	Pompton gravelly fine sandy loam, 0-3 % slope	All Areas are Prime Farmland
Suncook Series	Sn	Suncook fine sandy loam	Farmland of Statewide Importance
Tunkhannock Series	TkA	Tunkhannock gravelly loam, 0-3 % slopes	All areas are Prime Farmland
Udorthents	Ud	Udorthents, smoothed	Not Prime Farmland
Wellsboro Series	WeC	Wellsboro gravelly loam, 8-15 % slopes	Farmland of Statewide Importance

**3.1.4 Prime and Unique Farmland**

Prime Farmlands, as described in the 1989 Soil Survey for Sullivan County, New York include:

*“The U.S. Department of Agriculture defines prime farmland as the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to produce a sustained high yield of crops while using acceptable farming methods. Prime farmland produces the highest yields and requires minimal amounts of energy and economic resources, and farming it results in the least damage to the environment. An area identified as prime farmland must be used for producing food or fiber or must be available for those uses. Thus, urban and built-up land and water areas are not classified as prime farmland.”*

Unique Farmlands, as described by the United States Department of Agriculture’s (USDA) Soil Surveys include:

*“Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season and moisture supply needed to produce sustained high quality and/or high yields of a specific crop when treated and managed according to modern farming methods. Examples of such crops are citrus, olives, cranberries, fruit and vegetables.”*

The general criteria for prime farmland include: favorable temperature and growing-season length, a generally adequate and dependable supply of moisture from irrigation or precipitation, acceptable levels of acidity or alkalinity, permeability to air and water, and few or no rocks. Prime farmland is not flooded during the growing season, excessively erodible, and is not saturated with water for long periods of time. The slopes generally range from 0 to 8 percent. The Sullivan County survey area contains about 39,000 acres of prime farmland that represents about 6.2 percent of the total acreage in the survey area. The majority of the prime farmlands are located in the west-central part of the county. The soil map units that make up prime farmland only in the Sullivan County survey area are listed in Table 3-4. Some soils in Table 3-4 are classified as prime farmland if certain limitations of the soil are

overcome. The measures needed to overcome the limitations of these soils are given in parentheses after the name of the map unit (United States Department of Agriculture, 1989). As per coordination with the Sullivan County Soil District, no prime agricultural soils in the Livingston Manor project area will be affected by proposed work.

**Table 3.4: Sullivan County Prime Farmland Soils**

<b>Map Symbol</b>	<b>Soil Name</b>
Bb	Barbour loam
Bs	Sash silt loam (where drained)
ChA	Chenango gravelly loam, 0 to 3 percent slopes
ChB	Chenango gravelly loam, 3 to 8 percent slopes
LaB	Lackawanna channery loam, 3 to 8 percent slopes
LeB	Lewbeach silt loam, 3 to 8 percent slopes
LoB	Lordstown silt loam, 3 to 8 percent slopes, stony
Pe	Philo silt loam
PrnA	Pompton gravelly fine sandy loam, 0 to 3 percent slopes
PrnB	Pompton gravelly fine sandy loam, 3 to 8 percent slopes
Po	Pope silt loam, occasionally flooded
Pp	Pope very fine sandy loam, rarely flooded
Ra	Raynham silt loam (where drained)
Re	Red Hook sandy loam (where drained)
RhA	Riverhead sandy loam, 0 to 3 percent slopes
RhB	Riverhead sandy loam, 3 to 8 percent slopes
SaB	Scio silt loam, 2 to 6 percent slopes
TkA	Tunkhannock gravelly loam, 0 to 3 percent slopes
TkB	Tunkhannock gravelly loam, 3 to 8 percent slopes
UnA	Unadilla silt loam, 0 to 2 percent slopes
UnB	Unadilla silt loam, 2 to 6 percent slopes
VaB	Valois gravelly sandy loam, 3 to 8 percent slopes
Wa	Wallington silt loam (where drained)

**3.1.5 Land Use, Recreation and Tourism**

Land use in the county ranges from vast open space areas such as the Upper Delaware Scenic and Recreational River and Catskill Park to densely populated areas and farming communities (Sullivan County Division of Public Works, 2010). Sullivan County is approximately seventy eight percent forested making it one of the most forested counties in the state (Sullivan 2020 Volume II: The Toolbox, 2005). Non forested areas of disturbance within the county are associated primarily with residential uses and active agriculture. Land uses in the county include vacant lands, commercial, recreational, industrial, conservation, and agricultural such as row crops, orchards, livestock and others.

Sullivan County was officially formed in 1809. Timber was abundant within the county and was in great demand during that time period. Timber rafting was the first major industry in Sullivan County. The construction of the Delaware and Hudson Canal system in 1828 resulted in exponential population growth and the transition to the tanning industry

throughout the mid-1800. As a result of the landscape change (removal of trees) and depletion of forests associated with timber harvesting and tanning, the tanning and timber harvesting industries diminished. The county transitioned to the tourism industry in the late 1800's which was viable until the mid-1900. During this period, numerous resorts and hotels prospered. Sullivan County resorts offered a fresh and clean countryside with amenities such as fishing, golf, skiing, and other forms of entertainment for many people coming from metropolitan areas such as New York City. Factors that resulted in the decline of the tourism industry in the 1960's included inexpensive air travel, proliferation of air conditioning, and the growth of suburbia. Presently, tourism is still the primary industry within the county.

The Sullivan County economic policy is to redefine its image as a tourism destination by capitalizing on natural and scenic features, the arts and culture, and adventure and recreational sports found within the county. The 2020 Sullivan County tourism goal states "Create a diversified tourism industry with a balanced mix of year-round activities that include eco-tourism and recreational venues, agri-tourism, casinos, hotels and resorts, and the cultural arts" (Sullivan 2020 Volume II, 2005).

Sullivan County offers museum and historic sites, antique shops, art galleries, and golf courses as opportunities and attractions. The county maintains The Delaware and Hudson Canal Linear Park, Lake Superior State Park, Minisink Battleground Park, Stone Arch Bridge Historical Park, Livingston Manor Covered Bridge Park, Sullivan County Museum, and Fort Delaware Museum of Colonial History. The Upper Delaware River and the Catskill Mountains also provide for outdoor activities such as horseback riding, boating, camping, and eagle watching. Hunting, fishing, and hiking are major recreation activities in the area. More than one hundred reservoirs, ponds, and lakes, in the county are available for water sports. The Delaware River provides opportunities for canoeing and fishing and is designated a wild and scenic river.

The Sullivan County area lays claim to being the "birthplace of fly-fishing in the United States" largely because of trout fishing on the 27-mile-long Willowemoc Creek which flows between Livingston Manor and Roscoe, New York, where it intersects the Beaver Kill. The streams are stocked annually by the State of New York. All of the stocked fish (1 million pounds each year) for the Catskills as well all the reservoirs in the New York City water supply come from the Catskill Fish Hatchery just northeast of Livingston Manor in DeBruce, New York. The Catskill Fly Fishing Center and Museum is on the northern edge of Livingston Manor and is located near the Willowemoc Creek. Trout fishing in the Beaver Kill and Willowemoc watershed contributed nearly 10 million dollars to the Town of Rockland in 1994 alone (Conyngham and Gillespie, 2003).

### **3.1.6 Hazardous, Toxic and Radioactive Waste**

Hazardous, Toxic and Radioactive Wastes (HTRW) are defined as any "hazardous substance" regulated under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA §103) of the United States Code (42 U.S.C. §9603). Hazardous substances regulated under CERCLA include: 1) "hazardous wastes" under Section 3001 of

the Resource Conservation and Recovery Act (RCRA), 2) "hazardous substances" identified under Section 311 of the Clean Air Act, 3) "toxic pollutants" designated under Section 307 of the Clean Water Act, 4) "hazardous air pollutants" designated under Section 112 of the Clean Air Act, and 5) "imminently hazardous chemical substances or mixtures" that the Environmental Protection Agency (EPA) has taken action on under Section 7 of the Toxic Substance Control Act.

A database search of HTRW locations in the study area was completed by Environmental Data Resources for the USACE Philadelphia District in 2006. The purpose of the database searches and reports was to identify potential HTRW sources as a preface to future, focused site identification and investigations.

Table 3.5 presents the category of HTRW and the number of sites that the database searched identified as being within the study area. Note that these numbers should be considered to be approximate values as there was some interpretation as to where the sites fell relative to the floodplain. Often times there are more than one address or report for a given site number, particularly where there were spill or release reports in the database. In addition, there was the Hammond Acid plant located in the Willowemoc Valley, which distilled hardwoods for formaldehyde and alcohol, and that had significant impacts on the watershed. The area has since re-vegetated and the former plant location is outside the current project boundary.

A review of the database search indicated that a majority of the identified sites were related to oil spills, primarily due to heating oil system overflowing or system failures. These are relatively small spills and due to the locations (in or near homes or commercial properties) are likely to have been properly remediated. Additionally, since they are located in or near private properties, they are not likely to be in areas considered for project activities. Although no specific HTRW sites were identified within the areas proposed for modification or excavation, further investigation of these areas is strongly recommended to better characterize the materials and to sample and analyze materials for chemical constituents and concentrations.

**Table 3.5: HTRW Sites in the Project Area**

<b>Category</b>	<b>Number of Sites</b>
RCRA Small Quantity Waste Generator	1
Facility Index System (FINDS)	4
Leaking Storage Tanks (LTANKS)	3
Historic Leaking Storage Tanks (HIST LTANKS)	3
Underground Storage Tank (UST)	1
Historic Underground Storage Tank (HIST UST)	2
Aboveground Storage Tank (AST)	1
Historic Aboveground Storage Tank (HIST AST)	1
Hazardous Waste Manifest (MANIFEST)	1
New York State Spills Information (NY SPILLS)	17

New York State Historic Spills Information (NY HIST SPILLS)	8
State Pollutant Discharge Elimination System (SPDES)	1

Areas of potential modification in support of flood-related work with possible HTRW interests would include the poultry production property (chemicals, fuel utilities and a discolored seep area), the airport property (chemical, fuel and deicer products) and any properties that were subjected to fuel spills. Eder Associates conducted sampling on the poultry plant site in 1997 and the results indicated the presence of hazardous materials on site. Further investigation and remediation of this site would be needed by the State and local municipality prior to any work by the Corps on this property. This site is not within the proposed project area. The Corps did complete geotechnical and environmental testing of the sediment in the proposed project area (airport and floodway expansion area) in 2015 (results can be found in Section 6.1.6).

**3.1.7 Wild and Scenic Rivers**

Congress created the National Wild and Scenic Rivers System in 1968 to preserve the free flowing conditions of certain rivers with outstanding natural, cultural, and recreational values for the enjoyment of present and future generations. The Wild & Scenic Rivers Act 1968 PL 92-542 classifies rivers as wild, scenic, or recreational. Wild rivers are rivers or sections of rivers that are free of impoundments and generally inaccessible except by trails. Scenic rivers are rivers or sections of rivers that are free of impoundments, contain watersheds and shorelines largely primitive and undeveloped but are accessible in places by roads. Recreational rivers are rivers or sections of rivers readily accessible by roads or railroads, may have some shoreline development, and may have past impoundments or diversions.

On November 10, 1978, a 73 mile segment of the Delaware River from the confluence of the East and West Branches below Hancock, New York, to the existing railroad bridge downstream of Cherry Island in the vicinity of Sparrow Bush, New York was designated *The Upper Delaware Scenic and Recreational River*. This segment includes parts of five counties to include Sullivan County, New York. The Beaver Kill and Willowemoc Creek drain the northwest part of the county, flowing westward into Delaware County and eventually into the East Branch of the Delaware River. The project area is not a wild and scenic river but is found within the watershed of the Upper Delaware River.

**3.1.8 Aquatic Resources and Wetlands**

**3.1.8.1 Surface Waters**

As described in the Sullivan County (1989) Soil Survey, most of Sullivan County is drained by the Delaware River or its tributaries. A small area located in the east part of the county flows into the Hudson River drainage system. The Beaver Kill and Willowemoc Creek drain the northwest part of the county, flowing westward into Delaware County and eventually into the East Branch of the Delaware River. Streams draining the west and south parts of the

County include Hankins Creek, Callicoon Creek, and Ten Mile River. The Mongaup River drains a large part of the central and south parts of the county. The Neversink River flows from Ulster County into the northeast part of Sullivan County, continues southward through the towns of Fallsburg, Thompson, and Forestburg and then flows into Orange County. The Basher Kill drains much of the town of Mamakating in the east part of the county. The Shawangunk Kill, Homowack Kill, and Rondout Creek drain some extreme east parts of the county and eventually flow into the Hudson River.

Generally, the streams in Sullivan County have cut deeply into the landscape and have steep valley sides and relatively narrow flood plains. Livingston Manor is located at the confluence of the Little Beaver Kill, Cattail Brook, and the Willowemoc Creek. The project area is located within the drainage basin of the Delaware River. Little Beaver Kill originates in hills northeast of Parksville, NY. The Little Beaver Kill flows to the west and joins the Willowemoc Creek. The Willowemoc subsequently discharges into the mainstem Beaver Kill in the village of Roscoe, NY. Reynolds (2000) referenced a study of hydrogeological factors that affect stream flows in Catskill streams and other areas. Of the 13 Catskill streams studied, the Beaver Kill and Willowemoc Creek had the highest mean annual discharges. It was concluded that dry weather flows of these streams are sustained by groundwater being discharged primarily from sandstone members of the Catskill Formation bedrock underlying the basin.

Waters of the State of New York are provided a water quality classification based on existing and expected best usages with standards of quality and purity established for all classifications. The classification system has been developed by the New York State Department of Environmental Conservation. Stream classifications of water bodies in the project area are classified as C (TS) according to the NYSDEC. Streams classified as C (T) or higher are subject to NYSDEC’s Protection of Waters permit program. The “T” designation indicates that the waters are suitable for trout, and the “TS” designation indicates the waters are suitable for trout spawning. Table 3.6 shows the State classification and standard associated with the three main stream systems within the project area.

**Table 3.6: New York State waterbody classification for waters in the project area.**

Stream Name	Classification	Standard Designation
Little Beaver Kill	B (Best usage for swimming, other recreation, and fishing)	T (Trout waters)
Willowemoc Creek	C (Best usage for fishing)	TS (Trout waters suitable for spawning)
Cattail Brook	B (Best usage for swimming, other recreation, and fishing)	TS (Trout waters suitable for spawning)

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Overall, the surface water quality of the Little Beaver Kill and Willowemoc Creek are very good to excellent. Seasonal high water temperatures and thermal stress is the main water quality concern and the main limiting factor affecting aquatic species and trout production in the 100 square mile project study area. Although many factors play a part in increases in water temperatures and the subsequent stress on aquatic species in the project area, the major overlying concerns include impacts from heated road runoff, loss of riparian and instream cover, stream gravel mining activities, sedimentation, unstable stream channel geometry, stormwater management, and floodplain loss (New York State Department of Environmental Conservation, 2002; Conyngham, J and N. Gillespie, 2003).

#### 3.1.8.2 Stream Habitat and Stability

The current stream stability and subsequent habitat availability in the Little Beaver Kill and Willowemoc Creeks has been the result of numerous anthropogenic and natural impacts over time in the watershed and specifically the project area. Encroachments into flood plains, stream gravel mining, straightening and armoring of channels, transportation system development (railroads and road systems), infrastructure and bridge construction and maintenance, poor stormwater management, increased flows, and drought are but a few of the impacts that have helped create and presently define the stream system seen today in the project study area. In an assessment of basin geomorphology and fluvial processes in the Beaver Kill-Willowemoc watershed, Conyngham and Gillespie, (2003) noted the following findings:

- Uppermost watershed sites show generally good to excellent habitat, with low width/depth ratios and high pool distribution.
- Width/depth ratios increase significantly as drainage area increases—although some increase is to be expected, the rate of increase in this parameter exacerbates the system’s vulnerability to thermal extremes. Bedrock exercises local controls at specific sites.
- Incised, trapezoidal channels and lack of thalweg (deepest thread of the channel, holding the lowest base flow) characterize the lower system (associated with high width/depth ratios). The channel width at extreme low flows is essentially the same as it is at bankfull flows, and the entrenchment ratio is low. This geometry has negative implications for thermal stress, homogenous hydraulics, and very high velocities during high flow events.
- Lack of pool habitat in the lower Beaver Kill—the longitudinal profiles, aerial photographs, and car/foot surveys show a decreasing distribution of true low-gradient, low velocity, deep pool structures as drainage area increases.
- Coarsening of substrate—average size of river substrate should decrease as one descends the channel system and gradients decrease. In the Beaver Kill/Willowemoc system the opposite is true.

- Presence of chute cutoffs, split channels, and truncated meanders, affecting width/depth ratios and channel slopes in the lower system.
- A high presence of bank armor characterizes certain reaches, particularly in the lower system.
- Associated with loss of floodplains, infrastructure encroachment, bank armoring, and gravel mining. The channel planform and sinuosity have been affected by avulsions and meander truncation.
- The lowest section of the river may be rebuilding a stable geometry due to increased sediment supply and grade control at the mouth of the system.
- Surveys indicate multiple instances of gravel deltas or hardened, channelized sections at tributary mouths, limiting or eliminating fish passage in the lower discharges of summer droughts and fall spawning periods.
- Significant portions of the original floodplain throughout the middle and lower reaches of the system have been compromised or eliminated by presence of road beds, rail beds, bridges, fill, berms, or incision of reaches of stream bed. Low entrenchment ratios in areas with well-developed floodplains (now abandoned and functioning as terraces) are strong indicators of incision.
- Impacts are largely absent in the upper system, locally present in middle reaches, and prevalent in lower sections of the Beaver Kill and many of its tributaries. The level of impact in the lower system is moderate, due to the system's large substrate. High width/depth ratios and trapezoidal channels exacerbate climatic thermal stress. Fisheries restoration goals should be to improve biological conditions in moderate years and reduce thermal stress in extreme years by narrowing overwide channels, restoring cross-sectional complexity, and restoring tributary mouths for fish passage and thermal refuges.

### 3.1.8.3 Groundwater

The main source of water in Sullivan County is ground water. Ground water is drawn from three kinds of aquifers: bedrock, glacial till, and glacial outwash. The glacial outwash yields the greatest amount of water and provides several public water supplies. The bedrock aquifer is the most commonly used and widely available source of water. Fractures in the rock hold ground water. This kind of aquifer can supply small or moderate amounts of water. Glacial till is generally not a reliable source of water because its yields are low. Three hundred and seventy one wells drilled into the Catskill formation showed well depths ranging from 5 to 960 feet with an average yield of 25 gallons per minute and a range of 0 to 600 gallons per minute (Reynolds, 2000). Surface water from lakes or reservoirs supplies water for several of the larger communities in the county. Springs supply water in small amounts (United States Department of Agriculture, 1989). Groundwater from the Catskill Formation is used for domestic, municipal, and industrial water supplies and generally has excellent water quality without treatment (Reynolds, 2000).

### 3.1.8.4 Wetlands

The U.S. Fish and Wildlife Service utilizes a wetland and deepwater habitats classification system developed by Cowardin et al (1979) which places ecologically similar habitats into a hierarchal system that permits wetland classification down to dominance types, which are based on dominant plants or substrates. The system can be used for inventory and mapping for Federal and State wetland inventories. It also has provided a uniformity of wetland terminology. The U.S. Fish and Wildlife Service use this classification to determine wetland status and trends.

The National Wetlands Inventory project, administered by the U.S. Fish and Wildlife Service, was established to generate information about the characteristics, extent and status of the Nation's wetlands and deepwater habitats. This information is used by Federal, State, and local agencies, academic institutions, U.S. Congress, and the private sector. The Emergency Wetland Resources Act of 1986 directs the Service to map the wetlands of the United States. The National Wetlands Inventory uses information on hydrology, hydrophytes, and hydric soils to delineate wetlands and deepwater habitats in accordance with national photographic, cartographic, and digitizing standards.

The project area watershed has a variety of wetland resources. These wetland resources vary in landscape position, size, vegetation, hydrological condition, and function. Some more notable functions include: stream flow maintenance; sediment retention; diverse wildlife habitats; surface water detention; and nutrient transformation. These functions likely play an important role in project area water quality and flood management. As seen in Figure 3.1, wetlands mapped in the project area are typically hydraulically or physically connected to stream resources. Table 3.7 provides the alpha numeric wetland codes and classification description of each wetland type found in the project area based on data taken from the U.S. Fish and Wildlife Service wetlands mapper. New York State's freshwater wetlands are protected under the Freshwater Wetlands Act (Article 24) of the Environmental Conservation Law.



**Table 3.7: Livingston Manor project study area wetlands  
(U.S. Fish and Wildlife Service 2010b)**

<b>Wetland Code</b>	<b>System</b>	<b>Sub-System</b>	<b>Class</b>	<b>Sub-Class</b>	<b>Water Regime</b>	<b>Special Modifier</b>
PEM1A	Palustrine	*	Emergent	Persistent	Temporarily Flooded	*
PEM1C	Palustrine	*	Emergent	Persistent	Seasonally Flooded	*
PEM1E	Palustrine	*	Emergent	Persistent	Seasonally Flooded/ Saturated	*
PEM1Ch	Palustrine	*	Emergent	Persistent	Seasonally Flooded	Diked/ Impounded
PEM1Eh	Palustrine	*	Emergent	Persistent	Seasonally Flooded/ Saturated	Diked/ Impounded
PEM1Fh	Palustrine	*	Emergent	Persistent	Semi- Permanently Flooded	Diked/ Impounded
R3UBH	Riverine	Upper Perennial	Unconsolidated Bottom	*	Permanently Flooded	*
R3USA	Riverine	Upper Perennial	Unconsolidated Shore	*	Temporarily Flooded	*
PUBHh	Palustrine	*	Unconsolidated Bottom	*	Permanently Flooded	Diked/ Impounded
PUBHx	Palustrine	*	Unconsolidated Bottom	*	Permanently Flooded	Excavated
PUBH	Palustrine	*	Unconsolidated Bottom	*	Permanently Flooded	*
PUBFb	Palustrine	*	Unconsolidated Bottom	*	Semi- Permanently Flooded	Beaver
PSS1A	Palustrine	*	Scrub-Shrub	Broad- Leaved Deciduous	Temporarily Flooded	*
PSS1C	Palustrine	*	Scrub-Shrub	Broad- Leaved Deciduous	Seasonally Flooded	*
PSS1E	Palustrine	*	Scrub-Shrub	Broad- Leaved Deciduous	Seasonally Flooded/ Saturated	*
PFO1A	Palustrine	*	Forested	Broad- Leaved Deciduous	Temporarily Flooded	*

### 3.1.9 Vegetation

The vegetation of the project area watershed reflects the environmental conditions (geology, climate, soils, disease, elevations, and urban development) associated with the physiographic provinces and the disturbance history, both natural and anthropogenic. A wide variety of native and introduced species can be found within forested as well as non-forested areas of the county and project area.

The Catskill Mountains have elevations which range from less than 1,250 feet above sea level (asl) in the valleys to more than 4,000 feet asl on the peaks. Most of the project area is approximately 1,400 feet asl. Nearly 40% of the watershed is protected by inclusion in the Catskills Forest Preserves “forever wild” status. Widespread logging and acid factory-related cutting during the nineteenth century has resulted in mostly even-aged stands. Invasive plants have changed the character and composition of some vegetation communities. The area landscape consists mostly of northern hardwood forest with species such as American beech (*Fagus grandifolia*), Paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), black cherry (*Prunus serotina*), quaking aspen (*Populus tremuloides*), eastern hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), mixed oaks (*Quercus spp.*), black willow (*Salix nigra*), and American sycamore (*Platanus occidentalis*). Understory woody plants may include witch hazel (*Hamamelis virginiana*), striped maple (*Acer pennsylvanicum*), dogwood (*Cornus spp.*), nannyberry (*Viburnum lentago*), serviceberry (*Amelanchier canadensis*), American hornbeam (*Carpinus caroliniana*), and sumac (*Rhus typhina*) among others. Many species of herbaceous plants such as wildflowers, grasses, sedges, and ferns are found in the project area as well. These are found in the former airfield, former poultry processing plant, and in riparian areas (United States Fish and Wildlife Service 2010a).

In addition to the native tree and understory species listed above, the watershed has become home to various introduced plants which can be extremely aggressive and tend to crowd out native groups. Some common invasive woody and herbaceous vegetation likely to occur within and in the proximity of the project area are provided in Section 3.1.12.

### 3.1.10 Wildlife Resources

#### 3.1.10.1 Birds

Wildlife species found in the region are based on the various habitat types present. Birds are found at all elevations and some, like the Bicknell's thrush (*Catharus bicknelli*), are associated with habitat in higher elevations. The project area is located near the Upper Delaware River, Pepacton Reservoir and Catskill Peaks Important Bird Areas, as designated by the Audubon Society. Raptors are common during migration but concentrations are not high compared to other areas of the State (hawk watch sites are found near Oneonta and Port Jervis). However, the Delaware River is an important wintering area for bald eagles (*Haliaeetus leucocephalus*). Other raptors expected to be found in the area include red-tailed hawk (*Buteo jamaicensis*) red-shouldered hawk (*Buteo lineatus*), northern goshawk (*Accipiter gentilis*), Cooper's hawk (*Accipiter cooperii*), sharp-shinned hawk (*Accipiter*

*striatus*), great horned owl (*Bubo virginianus*), barred owl (*Strix varia*), and the eastern screech owl (*Megascops asio*) (United States Fish and Wildlife Service 2010a).

More than 200 species of birds have been documented in the Catskills such as dark-eyed junco (*Junco hyemalis*), warblers such as the black and white (*Mniotilta varia*), black-throated blue (*Dendroica caerulescens*), black-throated green (*Dendroica virens*), blackburnian (*Dendroica fusca*), mourning (*Oporornis philadelphia*), yellow-rumped (*Dendroica coronata*), Canada (*Wilsonia canadensis*), and yellow (*Dendroica petechia*). In addition, song sparrow (*Melospiza melodia*), eastern kingbird (*Tyrannus tyrannus*), eastern phoebe (*Sayornis phoebe*), mourning dove (*Zenaidura macroura*), least flycatcher (*Empidonax minimus*), red-winged blackbird (*Agelaius phoeniceus*), common grackle (*Quiscalus quiscula*), common yellowthroat (*Geothlypis trichas*), wood thrush (*Hylocichla mustelina*), great blue heron (*Ardea herodias*), black-capped chickadee (*Poecile atricapillus*), winter wren (*Troglodytes troglodytes*), golden-crowned kinglet (*Regulus satrapa*), hermit thrush (*Catharus guttatus*), solitary vireo (*Vireo solitarius*), Canada goose (*Branta canadensis*), wood duck (*Aix sponsa*), mallard (*Anas platyrhynchos*), American black duck (*Anas rubripes*), hooded merganser (*Lophodytes cucullatus*), and common merganser (*Mergus merganser*) can be expected to be found in the project area (United States Fish and Wildlife Service 2010a).

#### 3.1.10.2 Mammals

Mammals are common in the Catskills and a few are restricted to the large tracts of forest habitat that remain there. White-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), coyote (*Canis latrans*), red (*Vulpes vulpes*) and gray (*Urocyon cinereoargenteus*) fox, river otter (*Lontra canadensis*), bobcat (*Lynx rufus*), beaver (*Castor canadensis*), long-tailed weasel (*Mustela frenata*), Mink (*Mustela vison*), woodchuck (*Marmota monax*), eastern chipmunk (*Tamias striatus*), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), and the opossum (*Didelphis virginiana*) are all found in this region. Various types of moles, like the eastern mole (*Scalopus aquaticus*) and the star-nosed mole (*Condylura cristata*), inhabit this section of the state as do voles, like the meadow vole (*Microtus pennsylvanicus*) and the woodland vole (*Microtus pinetorum*). Red squirrels (*Tamiasciurus hudsonicus*) and gray squirrels (*Sciurus carolinensis*) are commonly seen and there are no less than four species of shrews (Soricidae spp.) found in the Catskills. Types of mice, like the white-footed mouse (*Peromyscus leucopus*) and the deer mouse (*Peromyscus moniculus*), are common in this combination of forests, fields, and urban areas. Other smaller mammals found in the Catskills are the eastern cottontail rabbit (*Sylvilagus floridanus*), little brown bat (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silvered-haired bat (*Lasionycteris noctivagans*). The eastern porcupine (*Erethizon dorsatum*) is also an inhabitant of the area (U.S. Fish and Wildlife Service 2010a).

### 3.1.10.3 Reptiles and Amphibians

Common reptiles and amphibians of the Catskills include the timber rattlesnake (*Crotalus horridus*), northern copperhead (*Agkistrodon contortrix*), eastern milk snake (*Lampropeltis triangulum*), smooth green snake (*Liochlorophis vernalis*), northern ringneck snake (*Diadophis punctatus*), common garter snake (*Thamnophis sirtalis*), and the northern redbelly snake (*Storeria occipitomaculata*). Turtles, like the snapping turtle (*Chelydra serpentina*), painted turtle (*Chrysemys picta*), and the eastern box turtle (*Terrapene carolina*) are found here. Northern spring peeper (*Pseudacris crucifer*), bullfrog (*Rana catesbeiana*), gray tree frog (*Hyla versicolor*), green frog (*Rana clamitans*), wood frog (*Rana sylvatica*), northern leopard frog (*Rana pipiens*), pickerel frog (*Rana palustris*), eastern American toad (*Bufo americanus*), red-spotted newt (*Notophthalmus viridescens*), spotted salamander (*Ambystoma maculatum*), northern dusky salamander (*Desmognathus fuscus*), northern red back salamander (*Plethodon cinereus*), northern spring salamander (*Gyrinophilus porphyriticus*), and the northern two-lined salamander (*Eurycea bislineata*) are found in the Catskills region (U.S. Fish and Wildlife Service 2010a).

In addition to the bird, mammal, reptile and amphibian species listed above, the watershed has become home to various introduced species which can be extremely aggressive and tend to crowd out or compete with native groups. Some common invasive species that may occur within and in the proximity of the project area are provided in Section 3.1.12.

### 3.1.10.4 Finfish and Invertebrate Species

A variety of aquatic organisms are found inhabiting aquatic areas encompassing the Little Beaver Kill, Willowemoc, and Cattail Brook watersheds. In general, aquatic organisms found in Catskill streams include invertebrates, mollusks, and fish. As documented by Smith and Kraft (2005) and the USFWS (2010), common fish species identified in the watershed include slimy sculpin (*Cottus cognatus*), rock bass (*Ambloplites rupestris*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), chain pickerel (*Esox niger*), Cyprinidae spp., pumpkinseed (*Lepomis gibbosus*), brown bullhead (*Ameiurus nebulosus*), creek chub (*Semotilus atromaculatus*), fall fish (*Semotilus corporalis*), longnose dace (*Rhinichthys cataractae*), common shiner (*Luxilus cornutus*), fathead minnow (*Pimephales promelas*), American shad (*Alosa sapidissima*), American eel (*Anguilla rostrata*), white sucker (*Catostomus commersoni*), young of year and adult brook trout (*Salvelinus fontinalis*), young of year and adult brown trout (*Salmo trutta*), young of year and adult rainbow trout (*Oncorhynchus mykiss*), Eastern blacknose dace (*Rhinichthys atratulus*), tessellated darter (*Etheostoma olmstedii*), cutlip minnow (*Exoglossum maxillingua*), sea lamprey (*Petromyzon marinus*), and margined madtom (*Norurus insignis*).

Salmonid species play an important ecological and economic role in the region. Three species of trout are found in the Delaware River system including brook, rainbow, and brown. A 2000 creel survey by the New York State Department of Environmental Conservation on the Beaver Kill and its tributaries, including 5.4 miles of the Little Beaver Kill and 4.2 miles of the Willowemoc, revealed brook, brown, and rainbow trout inhabiting most, but not all, tributaries. Maximum summer water temperatures (>70 degrees F) in

shallow streams appear to be the limiting factor for trout populations. Very little fishing activity was observed on the Little Beaver Kill during the creel survey, although the stream has been annually stocked with over 2,000 brown trout. The Willowemoc has been annually stocked with over 18,000 brown trout in past years. Wild populations of trout are also present. Public fishing rights have been secured by the New York State Department of Environmental Conservation on both the Little Beaver Kill and Willowemoc, but access is not continuous nor granted for both sides of the waterways within the project area (United States Fish and Wildlife Service 2010a). A 2002 angler use survey for the Beaver Kill watershed showed that 10% of anglers interviewed were from the New York counties of Sullivan, Ulster and Delaware with 42% interviewed visiting from New York – New Jersey metropolitan area. The survey also demonstrated the international significance of the project area with surveyed anglers originating from Puerto Rico, Holland, Poland, Portugal, South Africa, Japan, Yugoslavia, Romania, Canada, and England.

Invertebrates are present in every conceivable biotic habitat, and in most ecosystems they constitute the groups with greatest species richness. Invertebrates are ecologically involved with virtually every biotic process occurring in natural communities, from pollination, herbivory, and predation to soil formation, disease transmission, nutrient cycling and decomposition to name only a few. A host of aquatic invertebrate species can be found within waterways of the region. The Stream Biomonitoring Unit of the New York State Department of Environmental Conservation uses aquatic macro-invertebrates to monitor the water quality of the State's rivers and streams. Macro-invertebrates were collected and identified by the New York State Department of Environmental Conservation during a July 26<sup>th</sup>, 1994 stream survey of the Little Beaver Kill and its tributaries (New York State Department of Environmental Conservation, 1994a). Of the 12 orders positively identified during the survey, the presence of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) in a sample are the Orders most often recognized as being associated good water quality and used to make educated assumptions on the general condition of a particular water body or sampling location. The 1994 Little Beaver Kill Watershed survey confirmed the presence of approximately 21 Families, 31 genera, and 39 species within these three Orders. A 1994 survey of the Willowemoc Creek in Sullivan County confirmed the presence of approximately 19 Families, 31 genera, and 35 species within these three Orders (New York State Department of Environmental Conservation, 1994b).

### 3.1.11 Threatened and Endangered Species

Endangered species are those whose prospects for survival are in immediate danger because of a loss or change of habitat, over-exploitation, predation, competition or disease. Threatened species are those that may become endangered if conditions surrounding the species begin or continue to deteriorate.

A review of data on Federally-listed species protected pursuant to the ESA reveals extant and extirpated populations of northern monkshood (*Aconitum noveboracense*), a threatened species in the region. While no records were found for the project area, occurrences have been reported within 5 miles. This includes a 1983 record south east of the project site and another record approximately 5 miles south, found in 1989, but neither population was found

during surveys in 2004. The northern monkshood is also a State-listed threatened species. Another State-listed species is the ensiform rush (*Juncus ensifolius*). This endangered species, like the northern monkshood, has been found in the region but not the project area. A survey in 2004 found this species less than 5 miles from the project site. While no longer Federally-listed, the State-listed endangered bald eagle has been observed in the project area. In addition, several bald eagle nests are found in the region and are at least 10 miles from the project site. Eagle foraging along larger streams and rivers is becoming more common in the Catskills (United States Fish and Wildlife Service 2010a).

A user defined search was conducted on the New York State Department of Conservation (2010c) Nature Explorer website to obtain lists of rare species and significant natural communities that are listed in the databases of the New York State Natural Heritage Program. A search was conducted for Sullivan County, New York and the general watershed limits of the study area used as the search criteria. Table 3.8 lists the species and communities shown as being within the defined search areas.

**Table 3.8: Rare species and significant natural communities list for Sullivan County, New York and project area watershed (New York State Department of Conservation, 2010c)**

Group Community	Species		Protection Status	
	Common Name	Scientific Name	State	Federal
<b>Birds</b>	Bald Eagle	<i>Haliaeetus Leucocephalus</i>	Threatened	NA
	Henslow’s Sparrow	<i>Ammodramus henslowii</i>	Threatened	NA
	Least Bittern	<i>Ixobrychus exilis</i>	Threatened	NA
	Pied-billed Grebe	<i>Podilymbus podiceps</i>	Threatened	NA
	Sedge Wren	<i>Cistothorus platensis</i>	Threatened	NA
<b>Reptiles</b>	Bog Turtle	<i>Glypsemis muhlenbergii</i>	Endangered	Threatened
	Timber Rattlesnake	<i>Crotalus horridus</i>	Threatened	NA
<b>Amphibians</b>	Hellbender	<i>Cryptobranchus alleganiensis</i>	Special Concern	NA
<b>Butterflies and Moths</b>	Karner Blue	<i>Plebejus Melissa samuelis</i>	Endangered	Endangered
<b>Beetles</b>	Appalachian Tiger Beetle	<i>Cicindela ancocisonemsis</i>	NA	NA
	Cobblestone Tiger Beetle	<i>Cicindela marginipennis</i>		NA
<b>Mussels and Clams</b>	Brook Floater	<i>Alasmidonta varicosa</i>	Threatened	NA
	Dwarf Wedgemussel	<i>Alasmidonta heterodon</i>	Endangered	Endangered
<b>Animal Assemblages</b>	Bat Colony	NA	NA	NA
<b>Flowering Plants</b>	Hooker’s Orchid	<i>Platanthera hookeri</i>	Endangered	NA
	Jacob’s Ladder	<i>Polemonium vanbruntiae</i>	Rare	NA
	Northern Monk’s-hood	<i>Aconitum noveboracense</i>	Threatened	Threatened
<b>Ferns and Fern Allies</b>	Blunt-lobe Grape Fern	<i>Botrychium oneidense</i>	Endangered	NA
<b>Uplands</b>	Beech-Maple Mesic Forest	NA	NA	NA
<b>Freshwater Nontidal Wetlands</b>	Dwarf Shrub Bog	NA	NA	NA

	Spruce-Fir Swamp	NA	NA	NA
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### 3.1.12 Invasive Species

The Catskill Regional Invasive Species Partnership (CRISP) is a cooperative partnership that promotes prevention, early detection, rapid response and broader control of invasive plant species to protect the natural resources in the Catskill Region. Members of the partnership include: the Catskill institute for the environment, the Catskill Center for Conservation and Development, New York State Department of Environmental Protection, New York State Department of Environmental Conservation, the Nature Conservancy, among others. CRISP conducts public outreach, management activities, and supports research about ecological impact and effective controls of invasive plant species (Catskill Regional Invasive Species Partnership 2010). Table 3.9 provides a CRISP compiled list of invasive plant species affecting the Catskill Mountain Region.

**Table 3.9: Invasive plant species in the Catskill Mountain Region**

Regional Status			
Common Name	Scientific Name	Form	Habitat Area
Approaching the Region (Not yet detected)			
Brazilian Water Weed	<i>Egeria densa</i>	Aquatic	Lakes, rivers
European Frog-bit	<i>Hydrocharis morsus-ranae</i>	Aquatic	Lakes, rivers
Kudzu	<i>Pueraria Montana var. lobata</i>	Vine	Uplands
Limited Distribution			
Pale swallow-wort	<i>Cynanchum rossicum</i>	Vine	Uplands
Glossy buckthorn	<i>Frangula alnus</i>	Shrub	Open uplands, wetlands
Giant hogweed	<i>Heracleum mantegazzianum</i>	Herb	Open uplands, riparian areas
Eurasian water milfoil	<i>Myriophyllum spicatum</i>	Aquatic	Lakes, rivers
Mile-a-minute	<i>Polygonum perfoliatum</i>	Vine	Uplands
Limited Distribution but Established			
Tree of heaven	<i>Ailanthus altissima</i>	Tree	Uplands
Black swallow-wort	<i>Cynanchum louisiae</i>	Vine	Uplands
Burning bush	<i>Euonymus alatus</i>	Shrub	Uplands
Japanese stilt grass	<i>Microstegium vimineum</i>	Grass	Forested uplands
Water chestnut	<i>Trapa natans</i>	Aquatic	Lakes, rivers
Widespread			
Norway maple	<i>Acer platanoides</i>	Tree	Forested uplands
Garlic mustard	<i>Alliaria petiolata</i>	Herb	Forested uplands
Japanese barberry	<i>Berberis thunbergii</i>	Shrub	Forested uplands
Asiatic bittersweet	<i>Celastrus orbiculatus</i>	Vine	Uplands
Spotted knapweed	<i>Centaurea stoebe ssp. micranthos</i>	Herb	Open uplands
Autumn/Russian olive	<i>Elaeagnus umbellate, E. angustifolia</i>	Shrub	Open uplands
Japanese/Giant knotweed	<i>Fallopia japonica, F. sachalinensis</i>	Herb	Riparian areas, uplands
Bush honeysuckle	<i>Lonicera spp.</i>	Shrub	Uplands
Purple loosestrife	<i>Lythrum salicaria</i>	Herb	Wetlands
Common reed	<i>Phragmites australis</i>	Grass	Wetlands

Buckthorn	<i>Rhamnus cathartica</i>	Shrub	Open uplands
Multiflora rose	<i>Rosa multiflora</i>	Shrub	Open uplands

Many species of non-native invasive plants and animals are known to be currently established in the project area, especially along waterways. Japanese knotweed, garlic mustard, common reed, and purple loosestrife are common plants. Didymo or *Didymosphenia geminata* is a noxious slimy plant also known as “rock snot” that has been found in Catskill streams. Also present in the watershed is zebra mussel (*Dreissena polymorpha*), quagga mussel (*Dreissena bugensis*), finger nail clam (*Sphaeracea spp.*), mud snail (*Bithynia tentaculata*), flathead catfish (*Pylodictis olivaris*), and hemlock wooly adelgid (*Adelges tsugae*). Japanese knotweed appeared to be the most ubiquitous invasive species in the project area (U.S. Fish and Wildlife Service 2010a).

**3.1.13 Cultural Resources**

The prehistory of the Northeast United States is conventionally divided into various cultural periods. These periods are further divided into sub-periods or phases based upon distinguishing cultural, technological, or economic changes.

**3.1.13.1 The Contact Period (AD 1600 – 1800)**

Archaeological sites of historic period are marked by objects of European manufacture, in very small quantities at first, but in greater numbers at later times until nearly all of the imperishable material is that bought from traders. For much of the State the date of the first visible European influence is about 1550 A.D., but trade goods appear earlier near the coast and later in the Delaware River Valley.

European colonization of North America resulted in significant changes in Indian life. European diseases - smallpox, tuberculosis, and many others - had a devastating effect on a population which had never developed immunity to them. Competition for land and trade led to the constant wars of the early historic period and a general breakdown of the old order.

When the first Dutch, English and Swedish settlers arrived in what is now Sullivan County, they met with bands of Native Americans who were descendants of the Unami and Munsee speaking groups who inhabited the Delaware and Hudson River Valleys for centuries. These aboriginal groups were known as the Lenni Lenape, or “original people”. The arrival of the Europeans in the 17<sup>th</sup> century forced the Lenape westward, eventually settling in Ontario, Canada, New York, Missouri, Wisconsin, Kansas and Oklahoma (Conway 2009).

**3.1.13.2 European Influence and History**

In 1716, Johannes Hardenbergh purchased a large tract of land known as the Hardenbergh Patent in what is today Sullivan, Ulster and Delaware Counties from the Chief of the Native

Americans living in the area. Timber was abundant in the area, and soon great logs were being floated down the Delaware River for use in the growing ship building industry in Philadelphia (Frisbie 1996).

Shares in the Hardenbergh patent changed hands frequently; however, prior to 1790 there were few people in the area except the Mamakating, Lumberland, Cohecton and Neversink districts. It was then that Robert Livingston, who had purchased five-sixteenths of the densely forested Hardenbergh patent with others, pushed the location of men on their lands by either sale or lease, and by 1800 there were more than 3,000 inhabitants of the county (Frisbie 1996).

Samuel F and John P. Jones founded the village of Monticello in 1804, with brother John felling the first tree and brother Samuel instrumental in the construction of the Newburgh-Cohecton Turnpike. The turnpike was the first improved road in the area that connected the Hudson River with the Delaware River, and one of two infrastructure improvements that helped to detach the southwestern corner of Ulster County as its own County chartered in 1809. The County name was chosen to honor Major General John Sullivan who, along with Brigadier General James Clinton, led an American campaign against the Loyalists and the Iroquois in 1779 and drove them out of the area (Conway 2009).

The other improvement was the building of the Delaware and Hudson Canal which opened in 1828. The canal was conceived to carry Pennsylvania coal to the Hudson River for transport to New York City. By 1850 the population of Sullivan County increased to more than 25,000 residents. The canal was also instrumental in a second industry of the County: Tanning (Frisbie 1996).

The hemlock trees in Sullivan County produced superior leather products. Approximately forty tanneries sprung up across the county, each with its own immigrant community, mostly from Ireland who came specifically to work the trade. The tanning industry thrived till the end of the 1880s when the hemlock trees were depleted (Conway 2009).

With the depletion of the trees by both the timber and tanning industries, Sullivan County had to look to another industry in order to sustain itself. In the 1840s the area turned to tourism. Tanneries and logging camps were replaced with hotels and boarding houses built by private developers to accommodate visitors who flocked to the riverside for its beauty and recreational opportunities touted by writers and painters of the era, and the completion of the Monticello & Port Jervis Railroad in 1871 brought tourists and thus, prosperity to the rest of the county (Conway 2009).

Tourism continued to thrive until the early 1900s when the promise of clean air and clean water shifted from recreation to a possible cure for tuberculosis. The construction of several treatment facilities, most notably the Loomis Sanitarium, soured the “freshness” of the area and diminished the tourist trade. However, this did not deter many middle and working class New York City residents of Jewish descent, who began frequenting the Catskill mountain resorts from the 1920s to the 1970s (Falk 2012).

In February 2010, A.D. Marble & Company cultural resource professionals conducted Phase IA Historic Resources Investigations to document known and expected architectural and archaeological resources within the Area of Potential Effect (APE) for the ten potential alternatives for flood damage reduction and ecosystem restoration in the hamlet of Livingston Manor, Sullivan County, New York. The focus of the investigation was to identify those resources listed, eligible, or potentially eligible for listing in the National Register of Historic Places (National Register).

#### **3.1.14 Infrastructure and Transportation**

Sullivan County contains numerous primary, secondary, and tertiary roadways with limited railroad and air transportation options. Of the 9 state routes (17, 17B, 42, 52, 52A, 55, 55A, 97, and 206) and one U.S. Route (209) found in the county, State Route 17 is the main artery of travel between the northern and southern portions of the county. As part of a major ongoing New York State Department of Transportation project, State Route 17 is scheduled to become part of Interstate 86 (Sullivan County Division of Public Works, 2010). As part of this highway construction, the Parksville Interchange has been constructed upstream of Livingston Manor along the Little Beaver Kill headwaters. The potential impact of this new construction was analyzed to determine if the new interchange induced flooding in Livingston Manor. The runoff from the 9.7 acres of net imperviousness associated with the Parksville Interchange will not increase the flood potential at Livingston Manor because of the runoff attenuation within the various detention basins, the infiltration within the grass swales due to the ponding behind the check dams and the negligibility of the impervious area (0.05%) relative to the Little Beaver Kill watershed (19,200 acres) at Livingston Manor. Hydrologic calculations by NYSDOT indicate no change in the 10year and 100year discharge on Little Beaver Kill at the downstream end of the project.

In addition, Sullivan County maintains a highway system of approximately 140 routes. Sullivan County maintains approximately 400 miles of roads and 100 bridges. Livingston Manor contains numerous secondary and tertiary roads and bridges. In addition, two State Route 17 bridge overpasses cross Willowemoc both upstream and downstream of Livingston Manor. Old Route 17 passes directly through the city limits as does County Road 149. One active railroad remains in Sullivan County along with 8 airports of which only one is public. No active railroads or airports are in or near Livingston Manor.

#### **3.1.15 Socioeconomic Conditions**

Table 3.10 displays comparative population data for Livingston Manor, Sullivan County and New York State. Livingston Manor is a census designated place (CDP) as established by the United States Census Bureau. A CDP is a populated area (a concentration of population) that is delineated each decennial census for statistical purposes by the United States Census Bureau.

**Table 3.10: Town, County, and State Population from 1960 through 2000 (U.S. Census Bureau, 2010).**

<b>Location</b>	<b>1960</b>	<b>1970</b>	<b>1980</b>	<b>1990</b>	<b>2000</b>	<b>2010</b>
<b>New York</b>	16,782,000	18,237,000	17,557,000	17,990,455	18,976,457	19,378,087
<b>Sullivan County</b>	45,272	52,580	65,155	69,277	73,966	77,547
<b>Livingston Manor</b>	2,080	1,522	1,436	1,482	1,355	1,221

As of the census of 2010 (Table 3.11), Livingston Manor, New York had a population of 1,221 people and 514 households residing in the CDP. The racial makeup of the CDP was 88.4% White, 5.0% African American, 0.7% Native American, 1.5% Asian, 1.9% from other races, and 2.5% from two or more races. Hispanic or Latino of any race was 10.3% of the population. The population density was 437.6 per square mile (168.8/km<sup>2</sup>). There were 619 housing units at an average density of 199.9/mi<sup>2</sup> (77.1/km<sup>2</sup>).

The population in the CDP was spread out with 6.8% under the age of 18, 18.7% from 18 to 24, 16.0% from 25 to 44, 31.7% from 45 to 64, and 17.2% who were 65 years of age or older. The median age was 42.5 years. For every 100 females there were 73.9 males

Of the 514 households, 35.7% had children under the age of 18 living with them, 39.3% were married couples living together, 12.0% had a female householder with no husband present, and 46.8% were non- families. Twenty five percent of all households were made up of individuals and 11.1% had someone living alone who was 65 years of age or older. The average household size was 2.62 and the average family size was 3.21.

The median income for a household in the CDP was \$45,769, and the median income for a family was \$47,222. Females had a median income of \$24,375 versus \$22,250 males. The per capita income for the CDP was \$21,854. About 22.7% of the population were below the poverty line, including 38.2% of those under age 18 and 0.0% of those ages 65 or over.

**Table 3.11: Year 2010 partial census for Livingston Manor, Sullivan County, and New York State.**

Subject	Livingston Manor		Sullivan County		New York State	
	Number	% of Total	Number	% of Total	Number	% of Total
<b>GENERAL CHARACTERISTICS</b>						
Total population	1,221	100.0	77,547	100.0	19,378,102	100.0
Male	600	49.1	39,614	51.1	9,377,147	48.4
Female	621	50.9	37,933	48.9	10,000,955	51.6
Median age (yrs)	35.2	(X)	41.7	(X)	38.0	(X)
Under 5 years	35	2.9	4,626	6.0	564,943	2.9
18 years and over	931	76.2	59,971	77.3	7,887,307	40.7
65 years and over	190	15.6	11,455	14.8	1,533,408	7.9
<b>RACE</b>						
One race	1,190	97.5	75,251	96.9	18,827,379	97.9
White	1,079	88.4	63,910	82.3	12,764,402	66.4
Black or African American	61	5.0	6,645	8.6	2,990,591	15.6
American Indian and Alaska Native	9	0.7	469	0.6	66,876	0.3
Asian	18	1.5	1,090	1.4	1,392,380	7.2
Native Hawaiian and Other Pacific Islander	0	0.0	0	0.0 %	5,334	0.0 %
Some other race	23	1.9	3,137	4.0	1,607,796	8.4 %
Two or more races	31	2.5	2,374	3.1	402,373	2.1 %
Hispanic or Latino (of any race)	126	10.3	9,916	12.8	2,867,583	17.1 %
<b>SOCIAL CHARACTERISTICS</b>						
Population 21 years and over	725	(X)	57,048	(X)	13,981,517	(X)
High school graduate or higher	561	77.8	28,658	76.2%	10,899,784	84.4
Bachelor's degree or higher	367	50.6	40,750	16.7 %	4,145,534	32.1
Civilian veterans (civilian population 18 years and over)	98	(X)	5,673	(X)	868,764	(X)
Foreign born	64	(X)	7,581	(X)	4,375,945	(X)
<b>ECONOMIC CHARACTERISTICS</b>						

In labor force (population 16 years and over)	571	60.1	37,087	59.8	9,808,150	63.7
Mean travel time to work in minutes (workers 16 years and over)	25.2	(X)	28.7	(X)	31.3	(X)
Median household income in 1999 (dollars)	27,159	(X)	49,388	(X)	55,603	(X)
Median family income in 1999 (dollars)	29,167	(X)	60,805	(X)	67,405	(X)
Per capita income in 1999 (dollars)	13,047	(X)	25,336	(X)	30,948	(X)
Families below poverty level	74	22.0	18,190	13.0	4,656,115	10.8
<b>HOUSING CHARACTERISTICS</b>						
Household population	514	99.6	48,675	(X)	7,317,755	(X)
Average household size	2.62	(X)	2.50	(X)	2.57	(X)
Average family size	3.21	(X)	3.05	(X)	3.20	(X)
Total housing units	639	100.0	49,186	100.0	8,108,103	100.0
Occupied housing units	514	80.4	30,139	61.3	7,317,755	90.3
Owner-occupied housing units	280	54.5	20,207	67.0	3,897,837	53.3
Renter-occupied housing units	234	45.5	9,932	33.0	3,419,918	46.7
Vacant housing units	125	19.6	19,047	100.0	790,348	100.0
Median housing value (dollars)	162,500	(X)	186,900	(X)	283,700	(X)
(X)- Data unavailable or not applicable.						

Vacancy rates, or housing units not lived in on a permanent basis, are used as a potential indicator of distressed regions. In 2010, Sullivan County had a vacancy rate of 38.2% and Livingston Manor had a vacancy rate of 16.8%. These high vacancy rates are likely attributed to seasonal tourism in which many homes are used as vacation homes or rented seasonally.

Although recreation and tourism are important economic considerations for Sullivan County, agriculture represents one of the largest economic sectors in the county, with the combined output value of agriculture exceeding \$60,000,000 in 2004. Sullivan County is a leading supplier of specialty poultry products to the New York Metropolitan Area (Sullivan County,

New York, 2010) New York State Agricultural Districts no.'s 1 and 4 are mapped within Sullivan County. Although a substantial amount of agricultural lands are mapped, changes in technology, urban sprawl, and the vacation industry have resulted in the number of farms decreasing over the past few decades (Sullivan County Division of Public Works, 2010).

### **3.1.16 Environmental Justice**

Executive Order 12898, entitled “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.” This EO directs Federal agencies “to make achieving environmental justice part of its mission by identifying and addressing, as appropriate disproportionately high and adverse human health or environmental effects of programs, policies, and activities on minority populations and low income populations in the United States....” The purpose of this order is to avoid the disproportionate placement of adverse environmental economic, social, or health impacts from Federal actions and policies on minority and low-income populations. In order to prevent the potential for discrimination and disproportionately high and adverse effects on specific populations, a process must identify minority and low-income populations that might be affected by the implementation of a proposed action or alternatives.

As defined by the “Environmental Justice Guidance Under NEPA” (CEQ, 1997), “minority populations” includes persons who identify themselves as Asian or Pacific Islander, Native American or Alaskan Native, black (not of Hispanic origin), or Hispanic. Race refers to Census respondents’ self-identification of racial background. Hispanic origin refers to ethnicity and language, not race, and may include persons whose heritage is Puerto Rican, Cuban, Mexican, Central or South American.

A minority population exists where the percentage of minorities in an affected area either exceeds 50 percent or is meaningfully greater than in the general population. Low-income populations are identified using the Census Bureau’s statistical poverty threshold, which is based on income and family size. The Census Bureau defines a “poverty area” as a census tract with 20 percent or more of its residents below the poverty threshold and an “extreme poverty area” as one with 40 percent or more below the poverty level.

As of the census of 2010, there were 1,355 people residing in Livingston Manor, New York. The racial makeup of this census designated place was 85.4 percent White, 6.2 percent African American, 1.0 percent Asian, 0.1 percent Native American or Alaskan, 2.2 percent from two or more races and 5.1 percent some other race. The median income for a household in the CDP was \$29,159 and the median income for a family was \$29,167. The per capita income was \$13,047. About 22.0 percent of families and 26.1 percent of the population were below the poverty level. The project area is considered a “poverty area” but is not considered to be one of a minority population.

## **3.2 Hydrologic and Hydraulic Analyses**

In order to accurately identify and evaluate the flooding problems, hydrologic and hydraulic models were developed for Willowemoc Creek, Little Beaver Kill Creek, and Cattail Brook within the study area using the latest existing data which was supplemented and updated as necessary. This analysis reflects the existing conditions or the without project condition of the study area. These models were then used to recreate and understand different flooding events and to assess the effectiveness of various flood reduction alternatives.

### **3.2.1 Background**

The Willowemoc Creek, Little Beaver Kill Creek, and Cattail Brook all flow through and converge within Livingston Manor, NY. At the confluence, they have drainage areas of approximately 65 square miles (Willowemoc), 30 square miles (Little Beaver Kill), and 7 square miles (Cattail), with a combined drainage area of 102 square miles.

From a hydraulic standpoint, the study area for this effort extends downstream from the confluence of the three streams approximately 2 miles. The total drainage area at this point is approximately 104 square miles.

Figure 3.2 is an orthophotographic image made available through the United States Department of Agriculture (USDA), dated 2006, overlaid with streams and pertinent geographic information that detail the surrounding area.

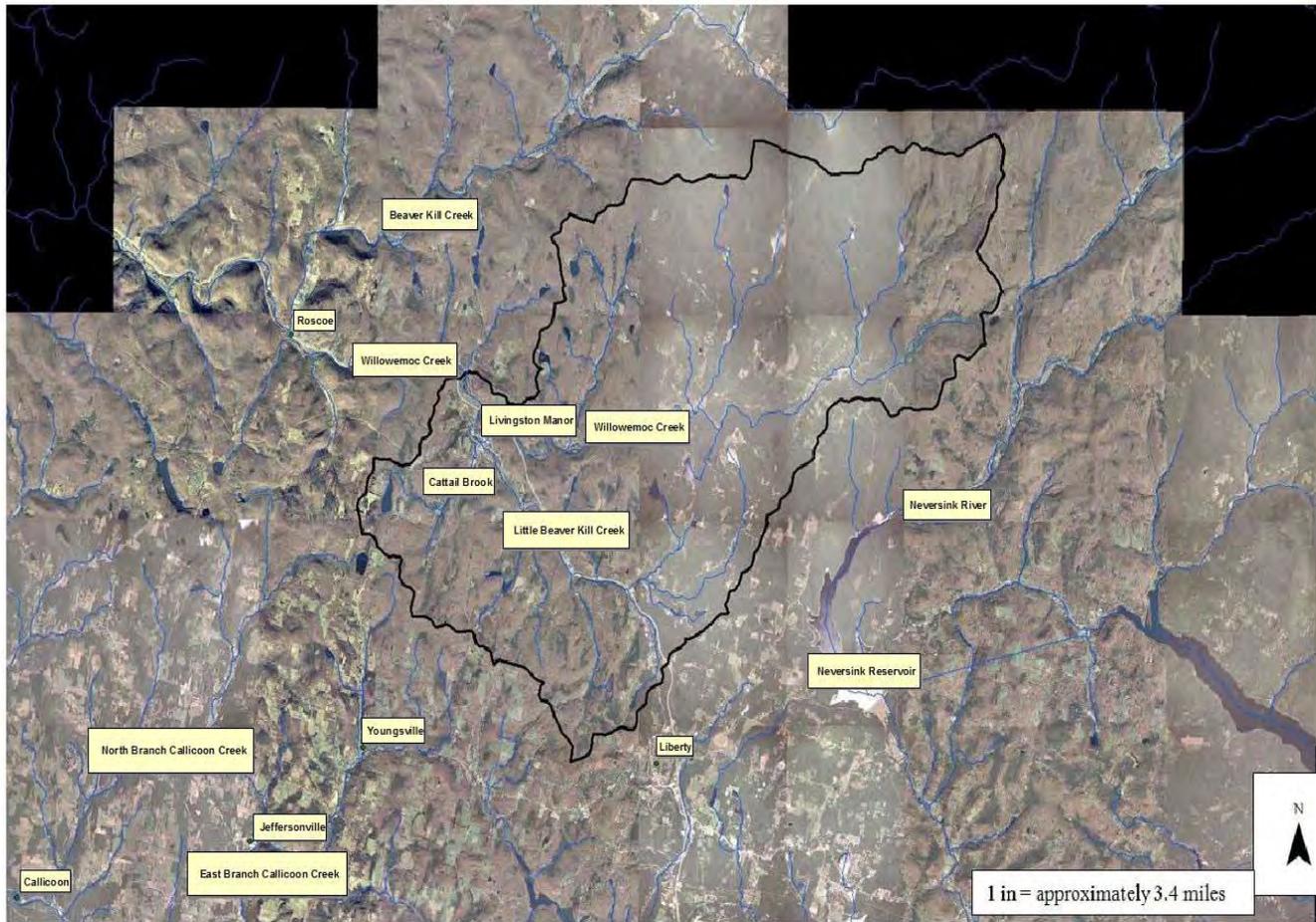


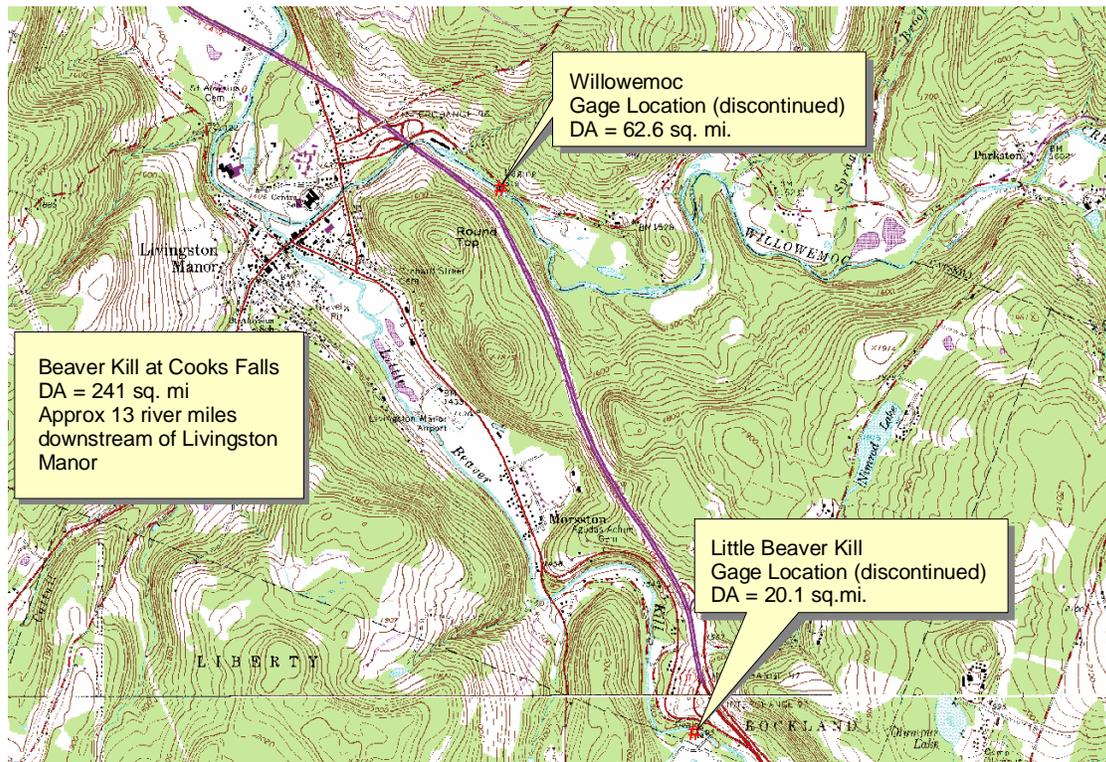
Figure 3.2: Study area for the hydrologic and hydraulic analyses.

## 3.2.2 Discharge Frequency Analysis

A discharge frequency analysis was conducted in order to determine the magnitudes of flow associated with given annual chance of exceedance (ACE). The ACE is defined as that (level of) event that has a particular chance of being equaled or exceeded in any year (i.e., the yearly chance of a given size flood or larger occurring). It is the inverse of the return period multiplied by 100 —i.e., a flood with an ACE of 1% is the 100-year return-period flood.

The frequency discharges for Willowemoc Creek and Little Beaver Kill were based on a statistical analysis of USGS Stream Gage 01419500 (Willowemoc Creek near Livingston Manor, NY) and Gage 01420000 (Little Beaver Kill near Livingston Manor, NY). However, since gage records were discontinued at the Willowemoc and Little Beaver Kill gages in 1973 and 1981, respectively, it was necessary to extrapolate the readings at these gages especially for the major rain events in 1996, 2004, 2005 and 2006. Data from a gage which still exists and generates readings, Gage 1420500 (Beaver Kill Creek at Cooks Falls), was used for the extrapolation. The frequency discharges for Cattail Brook were also derived using the Willowemoc, Little Beaver Kill and Beaver Kill gauges.

The locations of the three gages relative to Livingston Manor are shown in Figure 3.3 and pertinent data for the gages is provided in Table 3.12.



**Figure 3.3: Locations of USGS stream gages in the study area.**

**Table 3.12: USGS Stream Gage Data**

Gage	Drainage Area (sq mi)	Period of Record
01419500 Willowemoc	62.6	08-11-1938 12-21-1973
01420000 Little Beaver Kill	20.1	02-12-1925 05-12-1981
1420500 Beaver Kill	241	03-28-1914 07-23-2008

A statistical analysis of the available stream gage data was performed and the frequency discharges for the Willowemoc, Little Beaver Kill and Cattail Brook were prorated to various locations in Livingston Manor. Additional information on this analysis can be found in the Hydrologic and Hydraulic Analysis in Appendix A.

**3.2.3 Hydrologic Model**

The runoff of the Willowemoc Creek and its tributaries was quantified using multiple modeling methods. The Hydrologic Engineering Center’s Hydrologic Modeling System (HEC-HMS), version 3.4, and Engineering Research and Development Center’s (ERDC) Gridded Surface-Subsurface Hydrologic Analysis (GSSHA), version 5.0, were used in conjunction to develop an accurate rainfall-runoff model.

HEC-HMS is a generalized modeling program that is designed to simulate dendritic watershed systems through the use of deterministic mathematical models. HEC-HMS has the ability to model a wide range of watersheds using an equally wide range of rainfall-runoff procedures.

GSSHA is a physically-based modeling program that utilizes a fully distributed parameter routine with two-dimensional overland flow, one-dimensional unsteady diffusion channel routing, and coupled groundwater/surface water interaction. A physically-based model, such as GSSHA, has the ability to produce more accurate historic and frequency-discharge hydrographs than a lumped (or quasi-distributed) unit-hydrograph method, especially in the absence of calibration data.

The HEC-HMS model allows the assessment of proposed reservoir modifications and can be used by the locals for land use planning. The modeled watershed is shown in Figure 3.4. The watershed was divided into 86 sub-basins for the area of interest. A large number of sub-basins increases the accuracy of the model and reduces the effort required to modify the model for various proposed solutions.

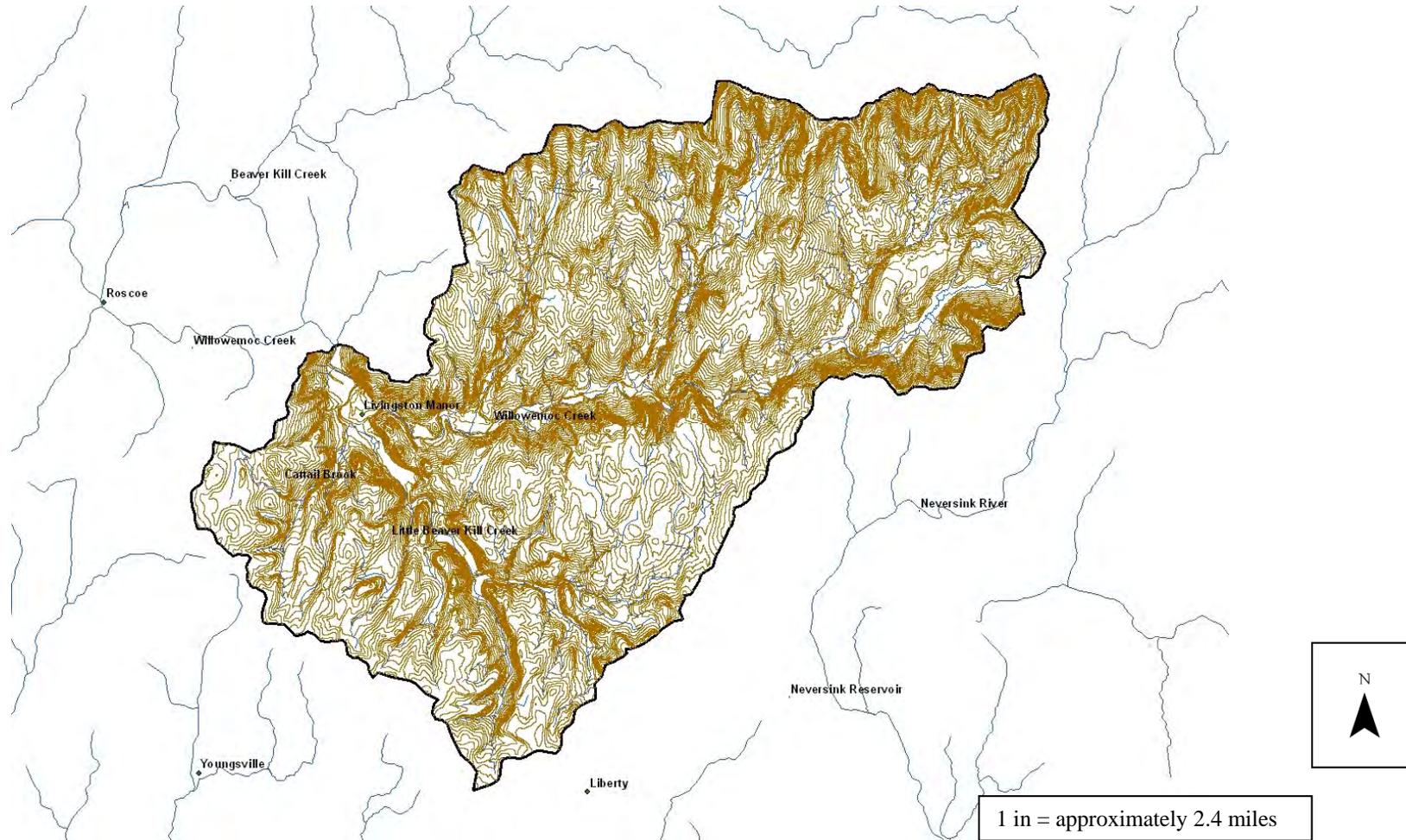


Figure 3.4: HEC-HMS Modeled Watershed

Storage areas within the modeled watershed were also analyzed to determine their relative effects on downstream flows. The lakes that were modeled are:

- Denman Lake
- Lenape Lake
- Lilly Pond
- Matawa Lake
- Mongaup Pond
- Nimrod Pond
- Orchard Lake
- Paramount Pond
- 2nd Pond @ Parksville
- Tanzman Lake
- Shandelee Lake

The locations of all modeled reservoirs are shown in Figure 3.5.

A more detailed description of the hydrologic analysis can be found in the Hydrologic and Hydraulic Analysis in Appendix A.

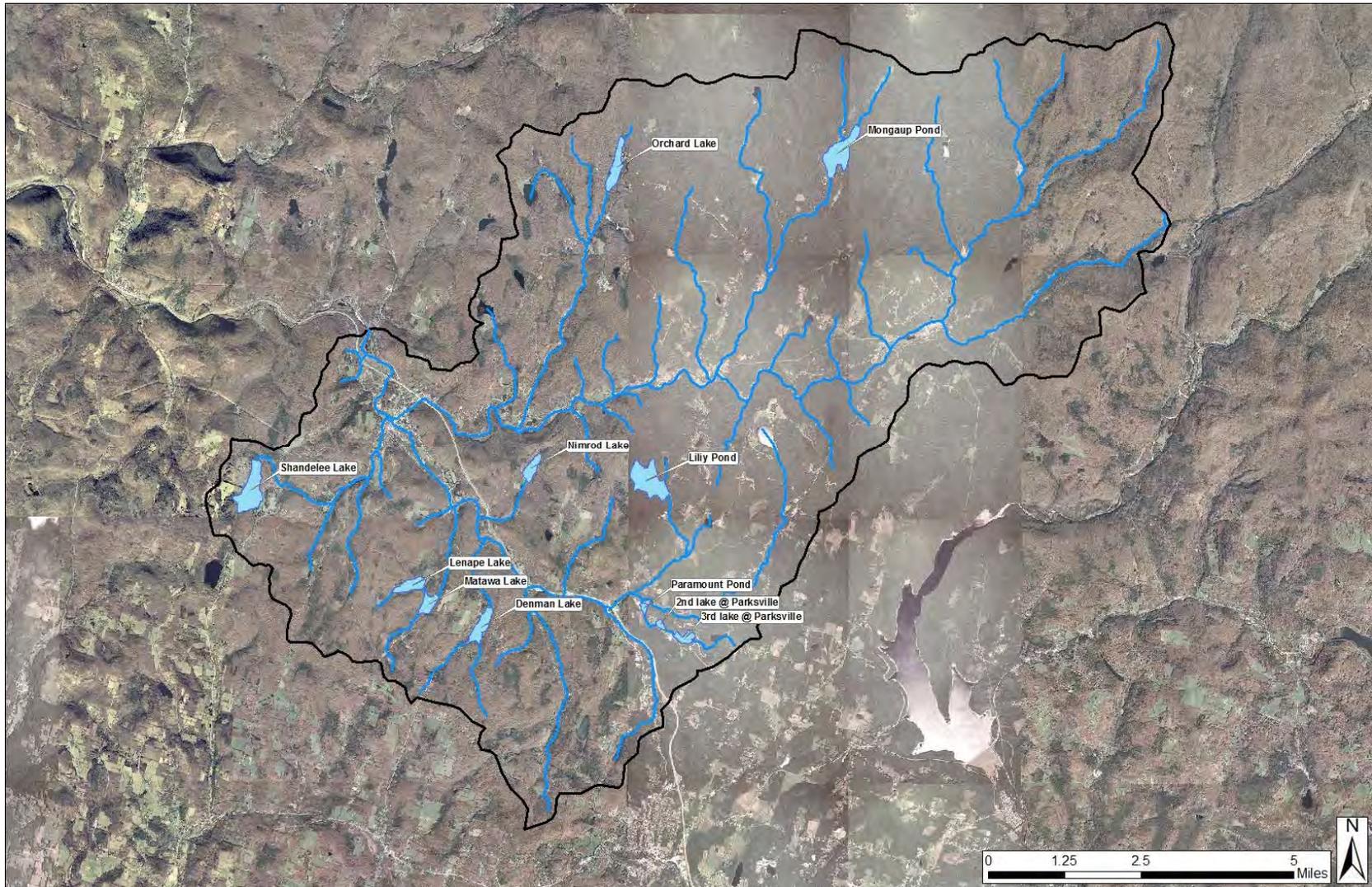


Figure 3.5: Modeled Reservoirs

### **3.2.4 Hydraulic Model**

The frequency discharges were transformed into water surface elevations (wsel) with the USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS) version 4.1.

Three primary HEC-RAS models were created within the area of interest. Willowemoc Creek was modeled for 14,641 linear feet (lf), Little Beaver Kill Creek for 6,972 lf, and Cattail Brook for 5,975 lf.

Portions of Livingston Manor along the Willowemoc Creek are protected by levees on both the left and right overbanks. However, for some events the levees are flanked at the upstream end and/or overtopped. Under such conditions the water surface elevations in the main channel of the Willowemoc are not the same as the water surface elevations in the "back channels" behind the levees. The Willowemoc floodplain was analyzed with three models: a main stem Willowemoc model and two back channel models. The back channel on the right overbank is labeled, "channel behind the school" and the back channel on the left overbank is labeled, "channel behind the levee on the LOB". The limits of the five HEC-RAS models were set to encompass all known damage locations and all locations of possible hydraulic solutions.

The main stem Willowemoc HEC-RAS model required the use of 62 cross sections and 5 bridge crossings. These bridges include:

- Covered Bridge Road
- Route 17 Bridge below Livingston Manor
- Foot Bridge leading to High School
- Old Route 17
- Route 17 Bridge above Livingston Manor

The channel behind the school has no bridges and required 24 cross-sections. The channel behind the levee on the left overbank has no bridges and required 11 cross-sections.

The levees and wall along the Willowemoc are modeled as lateral structures. The levees' elevations, which were field surveyed, determine the discharges for the two back channel models and correspondingly the flow that remains in the main channel of the Willowemoc Creek downstream of the diversion points. As such, the modeling of the levees is critical to accurate water surface elevations throughout Livingston Manor.

Hydraulically the levees were assumed not to fail during overtopping and interior water surface elevations were assumed not to exert a backwater effect on the levee. However, these levees do not appear to have been maintained or to meet USACE requirements and failures of portions of the levee could occur.

An example of the cross sections created for the HEC-RAS modeling of Willowemoc Creek is provided in Figure 3.6. Two foot contours are shown. The remaining cross section figures

for Willowemoc Creek, as well as the cross sections for Little Beaver Kill and Cattail Brook, are provided in Appendix A.

The Little Beaver Kill HEC-RAS model required the use of 30 cross sections and 1 bridge, which was the Main St. Bridge.

The Cattail Brook HEC-RAS model required the use of 37 cross sections and 7 bridges crossings. These bridges include:

- River Street
- An Access Road approximately 198 feet upstream
- Creamery Road
- Finch Street
- A Private Road approximately 469 feet upstream
- Hoos Road
- Main Street (County Road 149)

The five HEC-RAS models were run with the frequency discharges as determined in the hydrologic analysis. The hydraulic performance of the lateral structures in diverting water out of the main Willowemoc channel to the two back channels was assessed. Knowledge of levee performance is required because of the complex interaction between the main stem Willowemoc and the two back channels as mediated by the lateral structures. For example, raising a levee would reduce flow into a back channel but it would also increase the flow in the Willowemoc downstream of what was once a diversion point. The frequency water surface profiles are the basis for calculating economic damages.

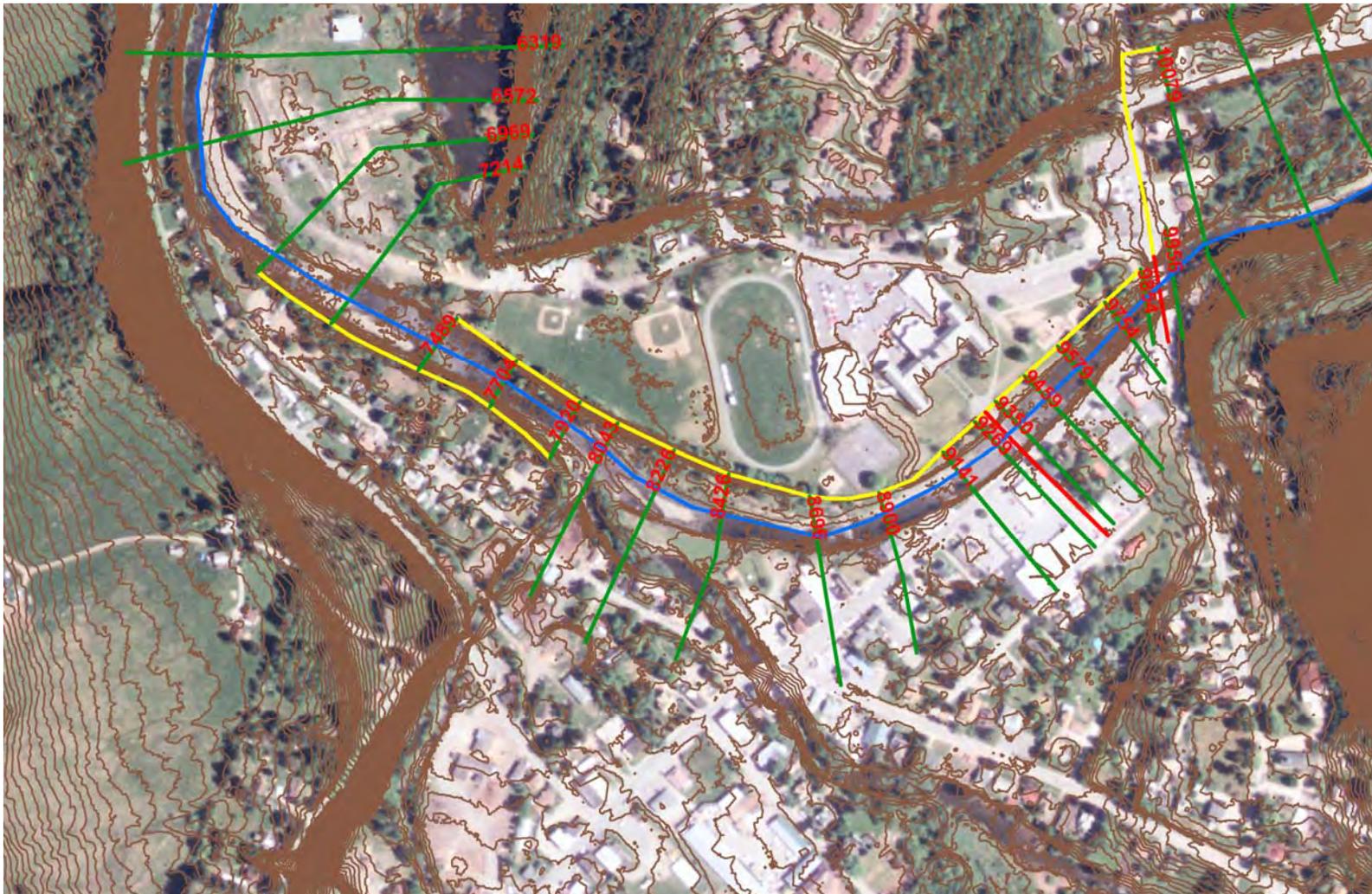


Figure 3.6: Example of the cross sections created for the HEC-RAS modeling of the Willowemoc Creek

Channel changes since completion of the Interim Without Project hydraulic analysis (May 2013) required an update to the Little Beaver Kill Creek hydraulic model. The without project HEC-RAS model was edited to incorporate the most recent channel elevations surveyed by the USFWS in May 2015 and to remodel the Main St. Bridge to reflect the remnants of the burned out building on the upstream right over bank. The without project water surface elevations at the river stations are provided in Table 3.12 and the frequency profile plots can be found in Appendix A.

**Table 3.13 Little Beaver Kill Creek Without Project Frequency Water Surface Elevations.**

River Station	WSEL (ft-NAVD88)							
	2yr	5yr	10yr	25yr	50yr	100yr	250yr	500yr
X-316 (316 ft upstream of the confluence with Willowemoc)	1415.48	1417.92	1419.6	1421.55	1422.53	1423.19	1423.93	1424.45
X-824 (824 ft upstream of Willowemoc – at the Main St. Bridge)	1418.24	1420.69	1423.27	1424.97	1425.47	1425.63	1427.05	1427.56
X-942 (118 ft upstream of Main St. Bridge)	1419.27	1422.14	1424.01	1425.36	1425.88	1426.18	1427.45	1428.01
X-1101	1419.61	1422.53	1424.27	1425.62	1426.2	1426.58	1427.82	1428.40
X-1337	1419.79	1422.63	1424.34	1425.69	1426.27	1426.67	1427.90	1428.49
X-1697 (873 ft upstream of Main St. Bridge)	1419.91	1422.69	1424.38	1425.73	1426.32	1426.73	1427.97	1428.57
X-2138	1420.03	1422.76	1424.44	1425.79	1426.38	1426.81	1428.04	1428.65
X-3293 (2469 ft upstream of Main St. Bridge)	1419.98	1422.79	1424.47	1425.82	1426.43	1426.86	1428.09	1428.70
X-3917	1420.10	1422.84	1424.50	1425.85	1426.46	1426.89	1428.12	1428.74
X-5862 (5038 ft upstream of Main St. Bridge)	1423.88	1424.50	1425.38	1426.48	1427.07	1427.53	1428.61	1429.20

3.3 Economic Model/Flood Damage Analysis

Structures within the area of interest were surveyed and values were assigned to each structure. Structures were grouped into economic reaches to ensure an accurate spatial distribution of the damages (Figures 3.7 – 3.9). A hydraulic cross-section was assigned to each economic reach as means of correlating the water surface elevation-frequency results with the surveyed structures. Average annual damages were calculated for each reach. The majority of the damage was located along Little Beaver Kill Creek.

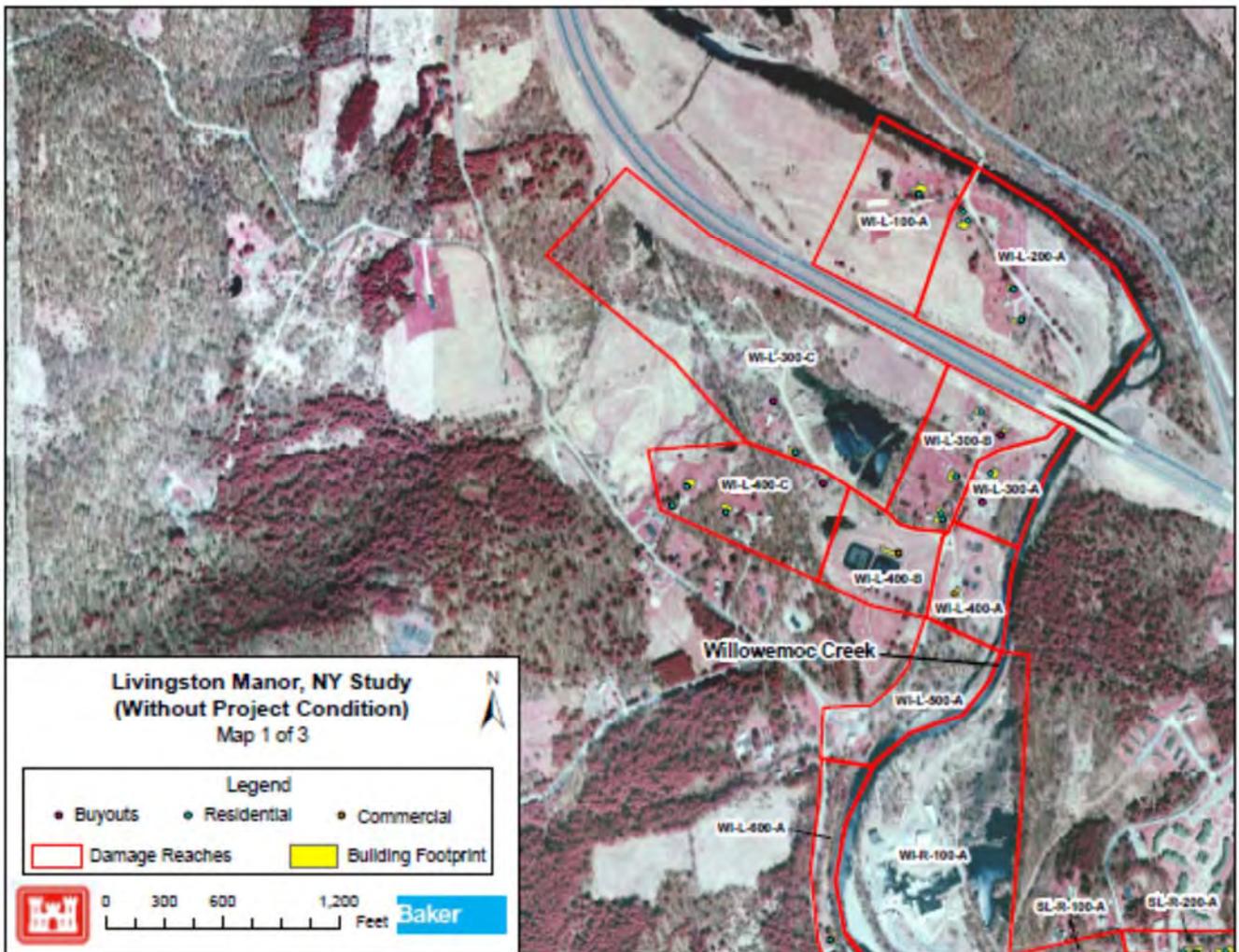


Figure 3.7: Economic Damage Reaches (Route 17, downstream of Downtown area).

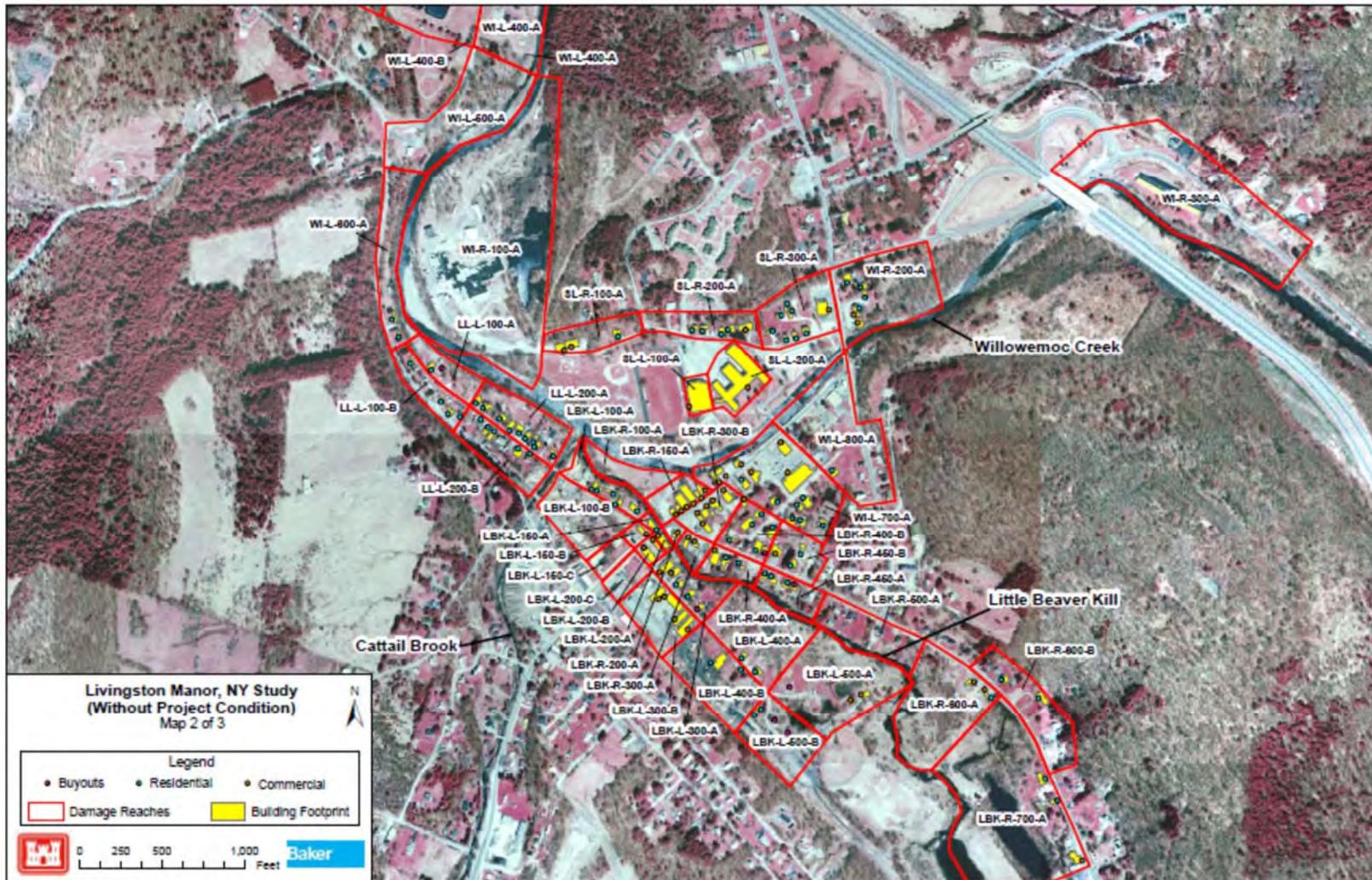


Figure 3.8: Economic Damage Reaches (Downtown area).

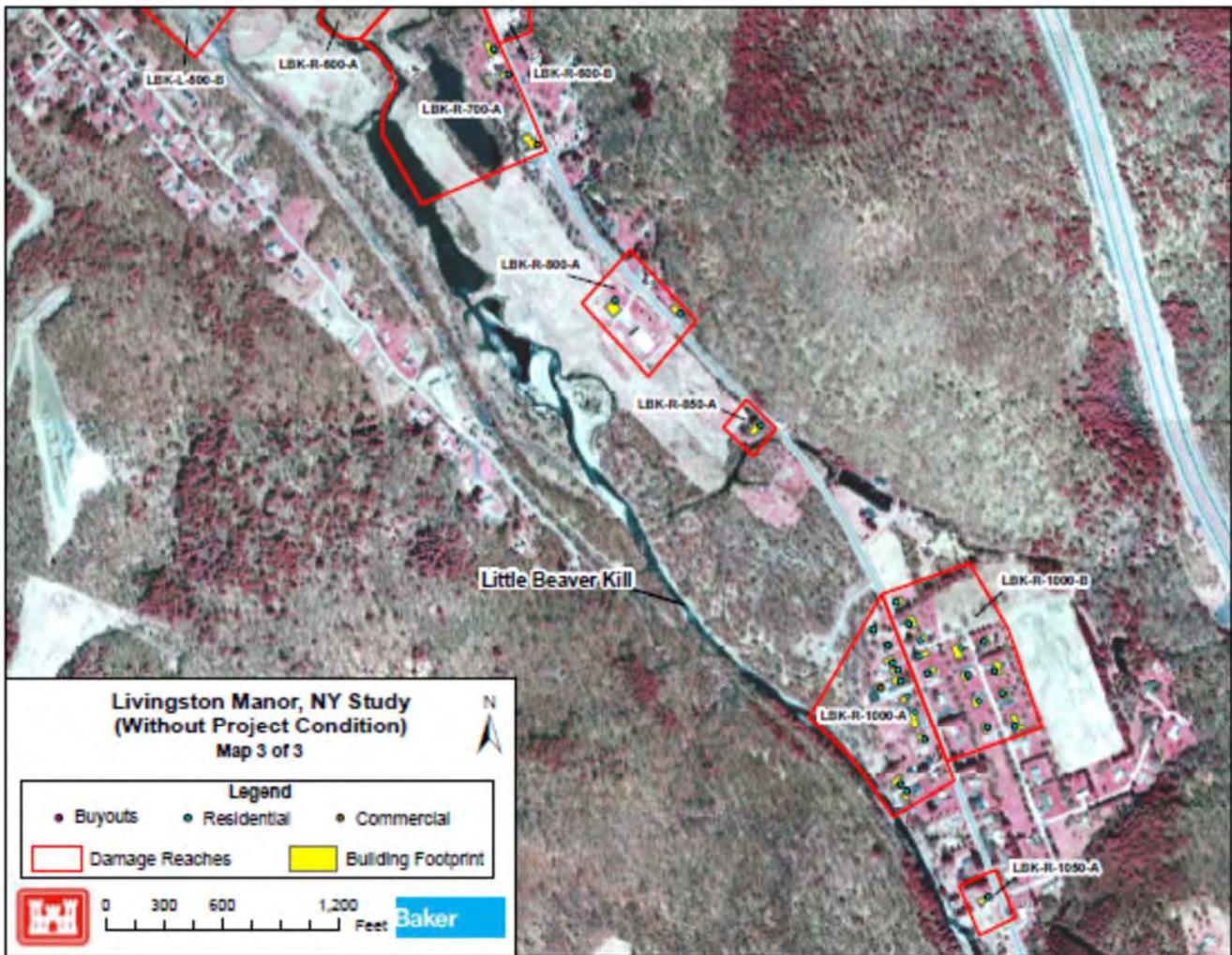


Figure 3.9: Economic Damage Reaches (abandoned airport, upstream of Downtown area).

## 4.0 Plan Formulation

### 4.1 Problems, Goals, Objectives and Criteria

The Federal objective in making investments in flood risk management is to contribute to the National Economic Development (NED), consistent with protecting the Nation's environment, and / or to the National Ecosystem Restoration (NER). Contribution to NED is achieved by increasing the net value of the nation's output of goods and services, expressed in monetary units. NED contributions must also consider the environmental effects of proposed changes on ecological, cultural, and aesthetic attributes of natural and cultural resources. Contribution to the NER is achieved by increasing the net value to the nation's output of significant habitat, expressed in habitat units. Plans formulated during this study were evaluated based on their contribution to NED, consistent with protection of the nation's environment, and their contribution to NER.

The optimum level of flood risk management that can be justified will be determined by analysis. Risk management measures must function without causing adverse effects in other areas (primarily downstream). When an NED plan is identified, the risk or uncertainty associated with the plan, that is, the magnitude of residual damages or potential effects associated with failure above flood design levels, will be determined by analysis. The plan should be complete and not require additional future improvements other than normal Operation and Maintenance (O&M). The plan must be realistic, state-of-the-art, and in compliance with sound engineering practice.

The NED objective is maximization of the economic worth of alternative plans. For flood risk management projects, this objective relates to a plan's capability to manage flood risk by comparing the plan's economic benefits with the project cost on an annualized basis. The amount that a project's economic benefits exceed the project cost is defined as net benefits. In the plan formulation process, the plan that yields the greatest net benefits best meets the NED objective.

The relationship of benefits to costs is expressed in terms of a benefit-cost ratio (BCR). Flood risk management benefits are the monetary savings or benefits due to damages prevented, reduction in the cost of emergency services, and reduction of economic disruption. These project benefits are subsequently annualized to represent an annual benefit applicable for the period of analysis. The project cost, which includes the construction, or first cost, the interest (opportunity cost) on the first cost during construction, the O&M costs, and the interest to amortize the project cost over the period of analysis are also annualized to represent an annual project cost applicable for the period of analysis. The annual benefits and the annual costs are then related in a ratio of benefits to costs. To be economically feasible, a plan must ultimately have greater benefits than costs or, more specifically, a BCR greater than 1.0, based on the current applicable Federal interest rate.

Recommendations should seek to provide a plan that reasonably maximizes net benefits, unless certain provisions can be applied to supersede this criterion. One such provision

allows a locally preferred plan (LPP) to be selected as the recommended plan, if the plan yields greater net benefits than any smaller scale alternative. Recommended plans that are less costly than the NED Plan would be cost-shared on the same basis as the NED Plan. In the absence of special legislation, Federal participation in a recommended plan that is more costly than the NED Plan would be limited to the Federal share of the NED Plan, unless the increased cost is deemed worthy of warranting Federal participation, and is specified as such in the exception. Cost sharing may then be calculated on the same basis as the NED Plan.

Aquatic ecosystem restoration was recognized as a Corps mission in 1996, thereby allowing investigation of alternatives and implementation of aquatic ecosystem restoration projects to be cost-shared between the Federal government and the local sponsor. Plans formulated for restoration vary from those formulated for flood risk management in that 1) they make environmental improvement an objective, 2) the ultimate design is self-maintaining, 3) restoration science is relatively new and unproven, and 4) policy constraints differ.

In order to determine the NER plan, alternative plans are considered, costs are developed and outputs/benefits are defined. Traditional benefit-cost analysis is not possible with non-monetary benefits or outputs. Therefore, cost-effectiveness/incremental cost analysis (CE/ICA) is used to determine the NER plan. The recommended plan should be the justified alternative and scale having the maximum of monetary and non-monetary (habitat units) beneficial effects over monetary and non-monetary costs. (In other words, it is the plan that provides the most for the money). This plan occurs where the incremental beneficial effects just equal the incremental costs or, alternatively stated, where the extra environmental value is just worth the extra costs.

In some instances, plans may be formulated to meet several different types of objectives. NED and NER plans are commonly combined together into one plan known as the Combined Plan. Combined Plans may not produce the greatest number of benefits in either category; there are trade-offs that are considered. However, they do produce benefits to both categories, and are often more efficient than two projects formulated independently for different, single purposes. Also, there may be opportunities to include features to address additional, secondary, purposes such as recreation. For Combined Plans, costs are allocated to each purpose. The costs are then compared to the benefits to determine the effectiveness of the plan relative to each purpose.

The following sections list the planning goals, objectives and criteria used for this study to formulate and evaluate Federal interest in alternative plans to address flood risk management and associated ecosystem restoration.

#### **4.1.1 History of Past Flooding and Ecological Degradation**

The severe, repetitive, damaging floods in the Livingston Manor area have been documented since the late 1800's with significant events recorded in June 1969, June 1973, January 1996, November 1996, September 2004, April 2005 and June 2006. These floods caused millions of dollars in damage to homes, businesses, and infrastructure and resulted in Federal disaster declarations. Typical damages include inundation of residential and commercial structures, as well as erosion of roads, retaining walls, bridge piers and abutments. From the January,

1996 storm alone, Sullivan County reported infrastructure damages of \$5,500,000 and property damages of \$4,400,000. Approximately 20 miles of county roads suffered severe damage to shoulders, pavement, embankments, and drainage systems. Immediate repairs were needed for at least 20 bridges and their adjacent roadways, including 2 which were destroyed.

There are several water resources problems associated with the area surrounding Livingston Manor along the Little Beaver Kill, Willowemoc Creek and Cattail Brook. The study area is famous for the excellent fishing found in its streams. Brown, rainbow, and brook trout are the dominant sport fish. These streams serve as spawning and nursery areas for larger stocked streams and reservoirs and they are stocked annually to supplement natural trout populations. However, these fisheries are threatened by environmental degradation through destruction of in-stream habitat and increased turbidity as the result of bank and channel erosion, poor sediment management, flooding, and flood recovery efforts. The loss of wetlands and riparian buffers in the study area has also been cited as a concern because of the loss of associated benefits such as improved water quality, flood protection, and quality fish and wildlife habitat.

## **4.1.2 Planning Goals**

### General Goals

- Make investments in flood risk management to contribute to the NED, consistent with protecting the Nation's environment or to NER.
- Where feasible, manage flood risk in the study area.

### Study-Specific Goals

- Reduce damages from frequently recurring flooding within the community.
- Identify opportunities for, and feasible methods of, flood risk management and related ecosystem restoration in the study area.
- Improve aquatic habitat conditions for sustainable native trout populations.

## **4.1.3 Planning Objectives**

### General Objectives

- Address the specific needs and concerns of the general public within the study area.
- Be flexible to accommodate changing economic, social, and environmental patterns and changing technologies.
- Integrate with and complement other related programs within the study area.
- Provide information to the public on existing and predicted flood risk in the study area; provide information on flood risk management measures.

### Study-Specific Objectives

- Reduce frequent flooding damages in the Livingston Manor area for at least the 20-year storms by 2020.
- Stabilize degraded stream channels in the Livingston Manor area using sustainable design techniques.
- Improve degraded riparian buffers with native vegetation by 2020.

#### **4.1.4 Planning Criteria**

##### General Planning Criteria

###### *Technical*

- Plans must be sound, safe, acceptable engineering and environmental solutions.
- Plans must be in compliance with good engineering and environmental practice, taking into account low risk of failure, and the safety of human lives and property.
- Plans must be realistic and must not rely on future research and development of key components, although they should contain a monitoring component to assess success and identify corrective actions as appropriate.
- Plans must be consistent with existing local plans for flood risk management.
- Plans must be complete and not depend on future projects to provide the necessary flood protection.
- The 1% ACE (100-year) flood flow water surface elevation should not increase more than 0.2 foot with a structural flood risk management alternative in place.

##### Economic – National Economic Development

- The recommended plan must be economically feasible; i.e., the plan's benefits must exceed the cost of the plan.
- Alternative plans should be evaluated using the current Federal interest rate and price levels over a 50-year period of analysis.
- Annualized costs must include the cost of operation, maintenance, repair, rehabilitation, and replacements.
- Plans must be efficient. They must represent optimal use of resources in an overall sense.
- Plans must consider avoiding impacts. Where this is not possible, minimization should next be considered, followed by mitigation or replacement, if justified.

- Where opportunities exist to enhance significant environmental resources, the plan should incorporate all justified measures.

### Economic – National Ecosystem Restoration

- The project should restore ecosystem structure, functions, and values.
- The project should result in improved environmental quality.
- The improvement should be of great enough national significance to justify Federal expenditure.
- The measures taken to improve environmental quality should result in a more naturalistic and self-regulating system.
- The measures should reestablish, to the extent possible, a close approximation of predevelopment conditions.

### Environmental and Social

- Evaluate structural, nonstructural, and restoration measures in accordance with guidelines established by the National Environmental Policy Act of 1969 (Public Law 91 190), as amended, and the Principles and Guidelines for Water and Related Land Resources Implementation Studies, as developed by the U.S. Water Resources Council, dated July 1983.
- Promote the protection and enhancement of areas of natural beauty and human enjoyment.
- Protect areas of valuable natural resources.
- Protect quality aspects of water, land, and air resources in the watershed.
- Protect against possible loss of life and hazards to health.
- Promote safety.
- Preserve and enhance social, cultural, educational, and historical values within the project area.
- Minimize and, if possible, avoid the displacement of people and destruction or disruption of community cohesion.

In addition, all Corps civil works projects must be in compliance with the agency's Environmental Operating Principles (EOP) and Doctrine.

- Strive to achieve environmental sustainability.
- Recognize the interdependence of life and the physical environment.
- Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.

- Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.
- Seek ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycles of our processes and work.
- Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.
- Respect the views of individuals and groups interested in Corps activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the Nation's problems that also protect and enhance the environment.

#### Study-Specific Planning Criteria

- Make sure plans recognize the presence and number of historic structures; avoid or minimize impacts to historic character through retrofit measures. Assure compliance with Section 106 of the National Historic Preservation Act.
- Recognize the historic and current function of the streams in the lives of the study area communities and avoid severing the communities' connections to these streams. Recognize the streams as a visual, recreational, and economic resource to the communities.
- Take past and current planning and management efforts into account in formulation of new flood risk management measures. Recognize previously identified limitations on the feasibility and suitability of large structural water control projects on the streams.
- Recognize the various existing landforms in the study area that were not constructed nor maintained as flood risk management measures, but are currently depended on to function in that role.
- Account for potential contaminated sites in the development of flood risk management measures. Avoid changes to existing landforms that would increase flows into or from potentially contaminated areas.
- Recognize on-going human activities and land-usage in identification of potential sites and measures for flood risk management-related ecosystem restoration.

## **4.2 Plan Formulation Approach**

An array of potential solutions is available for consideration to address flooding issues. Most options were addressed by the Corps in the July 1997 *Upper Delaware River Watershed, New York, Expedited Reconnaissance Study Section 905(b) (WRDA 86) Analysis* and the Addendum, which was completed in February 2008. The current study revisits the previously identified options using updated information, including surveys, mapping and modeling in the assessment, as well as considering new or modified alternatives.

The Corps worked with the local sponsor and cooperating agencies to establish a plan formulation approach for the Feasibility Study for Livingston Manor, reflecting the Corps' Planning Guidance, Strategic Plan, Environmental Operating Principles, and Collaborative Planning Guidance.

Corps guidance and planning initiatives have been coordinated with the study team to establish the plan formulation approach. This effort was undertaken to establish and coordinate an agreed-upon process that would be followed for plan development.

Taken as a whole, the plan formulation approach recognizes the need to balance flood risk management and ecosystem restoration opportunities with other social and environmental needs within the study area. In addition to the no action alternative, as represented by the without project future condition, the broad range of alternatives is discussed below.

#### **4.2.1 Range of Alternatives**

A general description of the range of alternatives evaluated is provided in the section below. The approach to developing a comprehensive plan is to separately identify and evaluate the over-arching regional management measures, and the more localized measures necessary to address specific problems or opportunities. The watershed measures and local measures will be identified for possible implementation for the overall study area, either separately or in combination with other alternatives.

The individual structural and nonstructural measures have initially been developed separately as features to address flood damages, and ecosystem restoration needs. Once the evaluation of these features has been undertaken, the measures will be evaluated to identify features that are complementary and could be combined together.

##### **4.2.1.1 Structural Measures**

Structural measures consist of structures designed to control, divert, or exclude the flow of water from the flood-prone areas to the extent necessary to reduce damages to property, hazards to life or public health, and general economic losses.

##### **4.2.1.2 Nonstructural Measures**

Nonstructural measures are those activities that can be undertaken to move what is being damaged out of harm's way, rather than attempting to alter the movement of water.

Nonstructural measures include a variety of techniques, including land-use controls to limit future development in the flood hazard areas, acquisition or relocation of flood-prone development, and retrofit of existing structures.

##### **4.2.1.3 Ecosystem Restoration**

Ecosystem restoration measures seek to restore the functional outputs of important habitats within the study area. Restoring wetlands can also provide localized flood risk management by slowing the speed of floodwaters, absorbing the force of flow, detaining floodwaters, and

filtering out suspended solids. Through these actions, wetlands have the potential to lower flood heights and reduce the erosive potential of the water.

#### **4.2.2 Floodplain Management Plan**

It should also be acknowledged that in addition to identifying a recommended plan for Federal participation, it is also possible to identify alternatives, which if not implemented by the Federal government, could be recommended as elements that could be locally implemented and considered as part of a Floodplain Management Plan (FPMP) or an expanded FPMP. As part of any Corps flood risk management project, a requirement for project implementation is that a FPMP be in place within one year of signing the Project Partnership Agreement (PPA) with a non-Federal construction partner. This study helps to identify alternatives that have local support that could comprise elements of an expanded FPMP, such as land development regulation. The Town of Rockland updated their Comprehensive Plan in 2010 and this plan (Section 3.3.2) demonstrates compliance with updated floodplain ordinances and floodplain management.

#### **4.2.3 Iterative Approach**

The planning process for the study has followed the Corps' six-step, iterative planning process:

1. Specified Problems and Opportunities
2. Inventoried and Forecast Conditions Without Project
3. Formulated Alternative Plans
4. Evaluated Alternative Effects
5. Compared Alternative Plans
6. Selected Recommended Plan

For the Feasibility Study for Livingston Manor, this six-step procedure was followed, with the formulation, evaluation and comparison steps (Steps 3-5) repeated iteratively in each of the three Cycles described below. Each phase of investigation developed alternative measures to an increased level of detail to determine whether the alternative measures should be considered further, or eliminated. The three phases of analysis include the following:

- Cycle 1 – Screening of Measures
- Cycle 2 – Initial Assessment of Alternative Plans
- Cycle 3 – Incremental Alternative Plan Development and Assessment

The following sections provide a summary of the approach to this iterative process. Cycle 1 was the screening of flood risk management and ecosystem restoration measures to address water resource needs in the study area relative to the Principles and Guidelines. Cycle 2 of the iterative planning approach evaluated alternative design storm conditions and spatial extent of protection to select the most appropriate scale (storm discharge or spatial extent) for the measure. Cycle 3 of the analysis developed comprehensive alternative plans for the study

area by developing combinations of the different alternatives. For the Feasibility Study, a consistent terminology was used for describing alternatives, based upon the level of detail, and refinement. These terms generally were: 1) measures, 2) alternatives, and 3) alternative plans. The term “measure” was used in the screening process when describing the types of solutions that are available for flood risk management and are concept-level in detail. Measures are single features or activities which address the planning objectives. The term “alternative” represented a specific plan for an area, with specific design objectives, which represent a single risk management measure. The term “alternative plan” was defined as combinations of one or more measures, which can be integrated together, or varied by location to accomplish the desired objectives of flood risk management, and ecosystem restoration.

#### 4.2.3.1 Cycle 1 - Screening of Measures

The screening of the full array of potential measures was performed to identify the specific measures that could potentially address the identified problems and opportunities. The Screening of Measures was undertaken in several parts. First, a full range of measures was evaluated qualitatively to determine if they were appropriate solutions to the identified ecosystem restoration and flood risk management problems. Each measure was then evaluated relative to evaluation criteria of completeness, effectiveness, efficiency, and acceptability derived from the Principles and Guidelines for Water and Land Related Resources Implementation Studies (P&G).

A comparison was made of the estimated annual costs of local structural measures to the without project existing Average Annual Damages (AAD) of affected development to help guide assessments of cost effectiveness and economic efficiency; and to determine if the measures were likely to meet the P&G requirement for cost efficiency. For flood risk management measures, the benefits must exceed the costs. In general, if the annual cost of a measure significantly exceeds the maximum amount of damage that could be prevented, it was clear that the measure will not meet the standards for cost efficiency.

In evaluating the cost efficiency of structural and nonstructural alternatives, preliminary layouts and costs were developed. These preliminary costs were compared to the AAD in the protected reaches.

Ecosystem restoration measures were identified based on site-specific needs and opportunities. These measures are developed so that they can potentially address the needs for both ecosystem restoration and flood risk management. The Cycle1 Screening filters the suite of possible solutions to those measures that are consistent with the evaluation criteria of completeness, effectiveness, efficiency, and acceptability, and identifies measures for more refined evaluation during the Cycle 2 assessment.

#### 4.2.3.2 Cycle 2 - Initial Assessment of Alternative Plans

Cycle 2 of the iterative formulation initiated a preliminary concept-level design of the more limited range of alternatives and analyses of economic issues. This included preliminary design of alternatives at various scales, dimensions or levels of risk management. Each alternative was compared to the without project condition. Nonstructural alternatives were

developed considering groups of structures with similar levels of flood risk, such as all structures within the 50% ACE (2 year) or 20% ACE (5 year) floodplains. Preliminary benefit analyses were performed for each of these flood risk management alternatives. In the second half of Cycle 2, incremental cost and benefits of increasing levels of risk management were compared to identify which alternatives maximize NED benefits and to identify appropriate scales for further consideration. Also at this point, the study evaluated the environmental effects of each alternative to avoid or minimize undesirable environmental impacts and to maximize economic efficiency. This did not involve detailed design and development of management plans, but was of sufficient detail to ensure that potential costs were considered in the plan evaluation process.

#### 4.2.3.3 Cycle 3 - Incremental Alternative Plan Development and Assessment

The third cycle of the analysis developed comprehensive alternative plans for the study area by developing combinations of the different alternatives. This involved identifying the combination with the most cost-effective watershed flood risk management alternative and the most cost-effective ecosystem restoration and structural and nonstructural flood risk management alternatives. Nonstructural measures were considered both on a community and study area-wide (watershed) basis to identify potential NED solutions.

In areas where either structural or nonstructural alternatives efficiently addressed the problems, multiple combined flood risk management plans will be developed. The NED Flood Risk Management Plan incorporated the most cost-effective approach for these areas, based on the highest net economic benefits in excess of costs.

The most cost-effective plan was selected by comparing the single-purpose NED or NER plans to any multi-purpose plans to verify that the final recommended plan meets NED/NER criteria. To ensure that the recommended plan still met NED/NER criteria after implementation of watershed measures, the most cost-effective local plans were evaluated in combination with the watershed plan.

### **4.3 Description of Measures – Cycle 1**

#### **4.3.1 Description of Flood Risk Management Measures**

Section 4.5 presents a description of the watershed, structural, nonstructural and ecosystem restoration measures for flood risk management and ecosystem enhancement. A discussion of the watershed measures is provided first. Watershed measures are implementable outside the boundary and authority of individual municipalities, and include techniques such as large-scale flood forecasting and warning, and reservoir management. Structural measures, which seek to redirect or restrain the flow of floodwaters, are then described. The following sections describe nonstructural options, grouped into the categories of land use and regulatory measures; building retrofit measures; and land acquisition measures. This is followed by a description of ecosystem restoration measures and a description of potential ecosystem restoration opportunities in the study area.

**4.3.2 Watershed Measures****4.3.2.1 Flood Warning System**

The process of notifying local residents of impending floods can be divided into flood forecasting, warning, and preparedness planning. It is important to note that an effective flood warning system is an important element of other flood risk management measures, helping to protect human life and to ensure correct operation of gates, pumps and closure structures.

Forecasting and warning is primarily a program of the National Weather Service (NWS). While flood forecasting and warning are generally regional in nature and, thus, appropriately handled by agencies with larger jurisdictions, flood preparedness and planning are a local responsibility and part of the All Hazard Mitigation Plan currently required by FEMA.

**4.3.2.2 Reservoir Management**

This technique involves planned methods by which existing reservoirs can be used for multiple purposes, including flood risk management, water supply, recreation, and power generation, while achieving the primary purposes of those facilities. For example, volume in a water supply reservoir can be drawn down in anticipation of forecast spring flooding from snowmelt. The reduction in volume allows for greater retention of floodwaters, which in turn restores the reservoir to its target volume. If multiple reservoirs are present in a watershed, coordination must be used to identify and achieve the multi-use objectives. Typically such coordination would require the involvement of multiple municipalities or counties.

**4.3.3 Structural Measures****4.3.3.1 Levees and Floodwalls**

In general, floodwalls and levees function within the limits of their design to confine flood flows to the existing channel footprint, prevent breakout of floodwaters, and provide protection against flooding. Interior drainage facilities are often required to handle stormwater that ponds behind the barriers. Levees and floodwalls can be combined with closure structures, such as stoplog closures and gate closures, which are manually installed over roadways, bridges, and railways prior to flooding to provide a continuous barrier against flooding to a pre-determined elevation. Levees are earthen embankments, whereas permanent floodwalls are usually built out of concrete or sheetpile, and temporary floodwalls can be constructed out of a variety of materials. Temporary floodwalls are stored as reusable segmented sections that are then put in place and attached to each other in anticipation of the arrival of floodwaters. Typically, temporary floodwalls can take the place of sandbag floodwalls. They can also be used to augment permanent flood barriers such as berms or levees. Permanently installed, deployable flood barriers can also be used. These barriers can be constructed to deploy automatically when floodwaters reach the structure, using hydrostatic pressure to raise the barrier into place.

**4.3.3.2 Channel Modification**

Channel modification involves widening, deepening or straightening of existing channels, creation of new channels, and the modification of highway and railroad bridges that constrict the channel. Dredging involves mechanical removal of shoaled or deposited material (sediment) from river and tributary beds.

#### 4.3.3.3 Dams or Flow Detention

Flood control dams can have a permanent pool of water behind them, or they may be designed to not retain a permanent pool. This second kind is known as a dry dam. Both types are designed to allow regular passage of water through them and to form a flood pool behind them during heavy rainfall events. Behind dry dams, the land reserved for the temporary flood pool can host compatible uses, such as farming or recreation, when a pool is not present. Since dry dams do not require a permanent pool, they may be more acceptable to the local community.

A typically smaller form of flow detention, known as detention basins, are used to attenuate the peak flow rate of run-off by temporarily storing large volumes of stormwater, then releasing them at a controlled rate of flow. This alternative was considered as a means to create flood storage areas in the floodplain by enclosing a large area with a dike. During floods, the floodwaters would overflow into the storage area. Stored floodwaters would then be released slowly through a downstream outlet. Placing flood control storage areas in the floodplain would require an extensive amount of land to achieve any measurable water surface elevation reductions.

#### 4.3.3.4 Dam Removal

Dam removal would remove controls on downstream flows from former impoundment areas. The technique is used to restore natural flow to rivers, potentially reduce flooding on tributaries and areas upstream of the dam. For ecosystem restoration purposes, it can be used to improve the ability of fish to travel upstream to spawning habitats.

### **4.3.4 Nonstructural Measures**

#### 4.3.4.1 Land Use and Regulatory Measures

The measures described below are designed to direct the location and nature of new development and redevelopment to manage risks from flooding and other hazards.

*Zoning and Land Use Controls:* State and regional regulations and municipal ordinances can be used to restrict development or redevelopment of structures in at-risk areas. The controls may restrict permitted uses, size, density, and structural siting. Examples include required setbacks from riverfronts or other flood-prone areas. If widely applied, such restrictions can help provide a buffer area between development and areas of greatest risk. Zoning and Land Use Controls have already been implemented by the Town of Rockland and can be found in the 2010 Town of Rockland Comprehensive Plan.

*New Infrastructure Controls and Landform/Habitat Regulations:* Restrictions on the installation of infrastructure or new connections to existing infrastructure in hazard areas can serve to reduce development, while the use of higher infrastructure standards such as

recharge basins can reduce flood risk during storms. Landform and habitat regulations can restrict development in floodprone and/or environmentally sensitive areas and promote the function of natural floodplains. New infrastructure controls were implemented by NYSDOT with construction of a single highway interchange between Liberty and Livingston Manor NY. In addition, structure relocations have been implemented through partial removal of sewer plant infrastructure out of floodplain and completion numerous property buyouts through FEMA and Sullivan County funding sources.

*Construction Standards and Practices:* Locally adopted, enforceable codes can regulate the use of building materials and design standards to minimize damage from assorted hazards, including high winds, heavy rains, and flooding. Examples include reinforced foundation footings, piers and foundations, roof anchoring, and provision of adequate drainage.

*Insurance Program Modifications:* In general, this technique consists of modifications to the National Flood Insurance Program (NFIP) to adjust risk classifications and premiums to reflect flooding hazards at current levels. This can be achieved through remapping floodprone areas using the latest available hydrology, topographic mapping, and modeling methods. Accurate classification of flood risk may discourage or reduce development or redevelopment within high-risk areas.

*Tax Incentives:* This technique provides tax benefits to property owners for various measures to reduce or eliminate future flooding damage. Such measures include retrofits to existing buildings to reduce flood damage and the establishment of conservation easements, land donation arrangements, or other development restrictions on undeveloped land susceptible to flooding.

#### 4.3.4.2 Building Retrofit Measures

Building retrofit measures are designed to protect damageable property from floodwaters by preventing the water from entering a structure, moving the structure out of flood prone areas, elevating the structure above flood elevations, or modifying the structure so that designated portions (e.g., lower floors or basements) are designed to flood without incurring damage. All exterior losses such as damage to grounds, utilities, roads, crops, etc., would be fully sustained in the future. Description of the assorted techniques follows.

*Structure Relocation:* Structure relocation involves physically picking a structure up and moving it out of the floodplain. As with buyouts, structure relocation can be a very effective means of eliminating losses from flood damage.

Relocation is, in many respects, the most effective method for retrofitting an existing structure to reduce damage. Ideally, the structure would be entirely removed from the hazard area, eliminating any potential for flood damage and adverse environmental effects such as the collapse of on-site waste disposal systems. A building can be relocated to a new site, or if sufficient space is available outside the floodplain, within the existing lot.

*Structure Elevation:* Structure elevation involves raising the structure in place, such that floodwaters flow beneath the occupied portion of the building. As described in *Selecting Appropriate Mitigation Measures for Floodprone Structures* - FEMA 551, March 2007, "Elevating a structure to prevent floodwaters from reaching living areas is an effective and

one of the most common mitigation methods. The goal of the elevation process is to raise the lowest floor to or above the required level of protection. This can be done by elevating the entire structure, including the floor, or by leaving the structure in its existing position and constructing a new, elevated floor within it. The method used depends on the construction type, foundation type, and flooding conditions.” This method is most applicable to frame construction. If a basement were present, it would need to be filled in. Structure elevation projects are more appropriate in areas that experience slower moving floodwaters.

*Structure Rebuilding:* Structure rebuilding involves construction of a new building on the same property instead of elevating, retrofitting, or otherwise modifying the existing building. The new building will be in compliance with local floodplain management requirements, with the main floor above the base flood elevation. This technique can be used when the existing building is in poor condition, has low value, may require special methods or remedial treatments to elevate, or because of its function is not suitable for elevation or other means of retrofit. Structures in the latter category include large non-residential structures such as firehouses. The existing building would be demolished and a new building be constructed, adhering to applicable floodplain management requirements and building codes.

*Free-Standing Barriers:* Structure perimeter protection is generally provided by a small levee or floodwall. Perimeter protection is more applicable to multi-building installations or small groups of buildings. A berm can be integrated into a landscaping plan to make it less intrusive. The structure must incorporate a method for discharging precipitation falling inside the perimeter, as well as any floodwaters that exceed the design of the structure.

*Dry Floodproofing:* Dry floodproofing is making a structure “watertight below the level that needs flood protection to prevent floodwaters from entering. A structure can be dry floodproofed using waterproof coatings or impermeable membranes to prevent seepage of floodwater through the walls, installing watertight shields over doors or windows, and installing sewer backup prevention measures” (FEMA, 2007). Because water will be accumulating outside the building, but not inside it, hydrostatic pressure will build up. If a basement is present, it must be specially designed to withstand the hydrostatic pressure, though pressure on all walls and floors must be considered. Applying a waterproof seal to the structure works best with heavily constructed masonry or concrete structures and flood conditions that are relatively brief in duration. Given the hydrostatic pressure against the structure, this technique is limited to areas that will experience less than three feet of flooding. This technique is not allowed under the NFIP for new or substantially improved or damaged residential structures located in the floodplain; however, it is allowed for non-residential structures in the floodplain.

The velocity of flooding is a primary consideration in the evaluation of dry floodproofing for a given structure. The technique is appropriate only for areas with slow flood velocity (less than three feet-per-second or fps), without threat of flash-flooding, and where flooding depths will be less than three feet.

*Wet Floodproofing:* Wet floodproofing a structure “consists of modifying the uninhabited portions (such as a crawlspace or an unfinished basement) to allow floodwaters to enter and exit. This ensures equal hydrostatic pressure on the interior and exterior of the structure and its supports. Equalized pressure will reduce the likelihood of wall failures and structural

damage. Wet floodproofing is not practical for most slab-on-grade structures that have the living space at or near ground level. Whether or not floodproofing is appropriate depends on the flood conditions, the design and construction of the structure, and whether the structure has been substantially damaged or is being substantially improved. However, many industrial or commercial structures could benefit greatly from wet floodproofing techniques (FEMA, 2007). All utilities need to be elevated or put in a watertight room. FEMA cautions that “wet floodproofing does not reduce flood insurance premium rates on residential structures. Premium rates can only be reduced through elevation of the residential structure above Base Flood Elevation. Non-residential structures can reduce flood insurance premium rates through other forms of floodproofing.”

The velocity of flooding is a primary consideration in the evaluation of wet floodproofing for a given structure. The technique is appropriate only for areas with slow flood velocity (less than three feet-per-second or fps) and without threat of flash-flooding. Wet floodproofing can be applied to a greater range of flooding depths (including deep flooding over six feet in depth). Thus, if the technique may be indicated for a given building, then a review of flood velocities in specific locations (e.g., at locations of the candidate building) will be required.

*Protection of Utilities:* The protection of utilities is the management of flood risk to building utilities such as electrical panels, HVAC units, and hot water heaters through in-place protection (placing utilities in flood-proof enclosures) or by elevating utilities above flood height, often by placing utilities in an addition to the original building. Utilities can be enclosed in floodproof concrete chambers or relocated from a flood-prone basement to a location above base flood elevation. The technique is most effective in areas with frequent low-level flooding below the main floor of structures.

*Structure Acquisition:* Structure acquisition (also known as structure buyout) is described thus: “acquiring and demolishing or simply demolishing a flood-prone structure is the most successful means of ensuring that a structure will not accumulate additional losses from future flood events” (FEMA, 2007). The structure is bought by a public party (such as the local sponsor) using cost-shared funds, and is no longer occupied. The structure is typically demolished and the property may be converted to recreational use. Acquisitions should accomplish the following: *a.* public acquisition and removal of flood-prone structures; *b.* assembly of vacant parcels to preclude development; *c.* prohibitions against new structures in the floodplain, or floodproofing and stormwater management in some limited cases; *d.* creation of recreation or natural wildlife areas and wetlands in appropriate areas; *e.* development of permanent public open space to provide new recreational opportunities; *f.* removal of, or adjustments to, the public infrastructure to eliminate intrusions into the floodplains and to prevent interruption of essential services during floods; and *g.* enforcement of land use controls to prevent redevelopment in acquired areas and establishment of water management standards at un-acquired properties (FEMA, 2007).

### **4.3.5 Land Acquisition Measures**

#### **4.3.5.1 Purchase of Property**

Purchase of property is the public acquisition of private developed or undeveloped lands vulnerable to flooding for long-term protection and preservation. Purchase of developed

lands requires purchase and removal of buildings. A requirement is the preparation of a plan for the alternate use of the land, which may include recreation or open-space uses.

#### 4.3.5.2 Easements and Deed Restrictions

Easements allow owners to retain full ownership of property but can either restrict certain uses or permit the use of land by the public or particular entities for specified purposes. Easements are generally established as part of the deed restrictions. For purposes of flood risk management, easements may restrict development of flood prone portions of property, or could be used to create flowage areas where floodwaters are directed en route to water bodies or detention basins.

### **4.3.6 Ecosystem Restoration Measures**

#### 4.3.6.1 Floodplain Reclamation/Wetland Restoration

Reclaimed floodplains and wetlands can provide localized flood risk management by slowing the speed of floodwaters, absorbing the force of flow, and detaining floodwaters. Through these actions, floodplains and wetlands can lower flood heights and reduce the erosive potential of the water, thereby minimizing property damage. Floodplain reclamation can be achieved through removal of buildings and flood control structures to allow floodwaters to return. Wetland restoration can expand upon the ecosystem services of existing wetlands by improving hydrology to increase flows and expand flood storage capacity. Habitat enhancements to benefit wildlife can also be incorporated into wetland restoration projects, including control of invasive species to promote the viability of desired native vegetation. Creation of wetlands from former uplands through changes in hydrology can support growth of wetlands vegetation, as well as yield the flood risk management benefits of wetlands, if properly placed within the landscape.

## **4.4 Evaluation of Measures and Recommendations for Further Screening – Cycle 2**

A more detailed review under the criteria of completeness, effectiveness, efficiency and acceptability of measures was conducted for Livingston Manor. Description of these criteria is provided below. Structural and nonstructural measures to be eliminated from further evaluation were identified, as well as those measures that are recommended for further evaluation in the next stages of the planning process.

### **4.4.1 Evaluation Criteria**

The evaluation of alternatives was structured to mirror the current Federal Principles and Guidelines for Water Resource Implementation Studies (P&G) assessment criteria that any plan must be complete, effective, efficient and acceptable. The following paragraphs discuss each of these criteria and identify some potential issues considered in the evaluation of the various alternative measures.

#### 4.4.1.1 Completeness

Completeness is the extent to which any alternative accounts for all necessary investments or other actions necessary to achieve the expected benefits. While the plans presented are generally technically complete, environmental regulations are likely to require mitigation for negative environmental effects and for induced flood impacts. The screening of alternatives recognizes that it is necessary to offset any loss of wetlands or in-stream habitats. This includes potential water temperature impacts if levee, floodwall or channel modification plans require the removal of trees and other vegetation. In addition, some of the areas along the streams are used as parkland or open space. Some of the structural measures may require “diversion” of parkland along the river. This diversion of use may require mitigation or replacement.

At some locations, various types of FEMA flood or hazard mitigation funds may have been used to acquire properties subject to flood damage. The use of FEMA funds for these properties includes deed restrictions that would preclude the use of the property for structural flood risk management. Because the screening analysis has not attempted to identify any conflicts with such properties, there is a possibility that the structural alignments are not implementable without considerable revision.

#### 4.4.1.2 Effectiveness

Effectiveness is the extent to which any alternative addresses the problems and opportunities. In general terms, the different measures considered for this screening vary in their effectiveness in addressing flood problems. Some of the structural measures, such as levees and floodwalls, seek to fully eliminate flooding from most events and avoid damage to both property and infrastructure and to avoid disruption of the community. Other measures, such as flood warning systems, are effective in reducing risks to life and easily moved property (cars and furnishings), but do not address the damage to building and infrastructure. The limitations in effectiveness are considered in the evaluation of various measures.

Detailed assessments of effectiveness for the current study were based on updated analysis of flood frequency, hydraulic flow lines and flood risk management. In order to comply with current Corps guidance regarding risk and uncertainty, each of these assessments now require explicit consideration of the uncertainty, or level of confidence, in the data. The various uncertainties will be incorporated into the Flood Damage Reduction Analysis (HEC-FDA) model and used to calculate the expected damage, confidence bands and the risk-based reliability. Such risk-based assessments typically include long-term risks and conditional non-exceedance assessments.

#### 4.4.1.3 Efficiency

Efficiency is the extent to which each alternative represents a cost-effective use of resources. The primary measures of efficiency on a Federal project are the net NED Benefits, NER benefits and the BCR. Nonstructural measures such as building retrofits or acquisition are typically cost-effective for structures with a high average annual probability of significant

flood damage. For areas where nonstructural measures appear technically feasible and implementable, the assessments evaluate protection limited to a range of floodplains, including areas with a high frequency of flooding.

#### 4.4.1.4 Acceptability

Acceptability is a measure of the implementability of each alternative with respect to support by the State and local entities and the public and the compatibility of the plans with existing laws, regulations and policies. The greatest concern about acceptability is the potential for levee/floodwall measures to have a negative impact on community character by cutting off the physical and visual connection to the river.

Other potential acceptability issues are related to the possibility of potential fatal flaws in the environmental permitting process or an inability to obtain the necessary lands, easements or relocations. There does not appear to be any major roadblocks to the environmental permitting process for this project.

These assessment criteria were met by the selected alternatives.

### **4.4.2 Watershed Alternatives**

#### 4.4.2.1 Flood Warning System

Flood warning system expansion that increases public receipt of warning information and advance knowledge of hazardous conditions (such as reverse 9-1-1 for floodplain areas) would provide benefits to all of the communities within the study area; however, options for real time flood warning systems are limited within the study area due to lack of ongoing funding sources to maintain flow gages upstream of the community. US Geological Survey has discontinued monitoring and have removed both gages that could have been used for this purpose.

#### 4.4.2.2 Reservoir Management

Six existing reservoirs located upstream of Livingston Manor in the Little Beaver Kill watershed were considered for modification to incorporate flood risk management purposes. Only reservoirs in the Little Beaver Kill were examined because the majority of the flood induced economic damages were identified within this watershed. Reservoirs in the Willowemoc watershed were not considered because their modification was judged to have a minor effect on flood damage reduction. This is due to the small drainage areas controlled by those reservoirs relative to the large drainage area of the Willowemoc Creek watershed.

The six reservoirs in the Little Beaver Kill watershed were examined to determine if they could be modified to reduce flows along Pearl Street in the downtown area during flood events. The reservoirs were selected based on issues of ownership and the relatively large drainage areas that they affected. In addition, this type of structural alternative is an investigation into a large scale project that could potential have an order of magnitude impact on flows and flooding. The six reservoirs and their drainage areas are shown in Figure 4.1.

In order to determine the benefits of modifying the reservoirs for increased storage, the hydrologic model was adjusted to simulate the removal of each upstream watershed to show the maximum possible benefit. This was equivalent to increasing the size of the reservoirs so that they could contain all potential runoff events. Given that this scenario is highly unlikely, the calculated flow reductions should be considered for analytical purposes only.

As shown on Table 4.1, the six reservoirs were assigned an order of effect, then each reservoir modification was added to the one previously to present cumulative effects represented as D1 – D6. The effect of each reservoir modification was assessed with a range of 24 hour rainfalls. The information in Table 4.1 can be used to construct flow reduction curves at Pearl Street for each of the alternatives. However, a flow reduction curve was calculated only for Plan D6 because it reflects cumulative flow reductions relative to existing conditions. The flow reduction curve was used to transform the existing discharge frequency curve to the D6 (combination of all six reservoirs) with-project discharge frequency curve and the result is shown on Table 4.2. During this scenario, all six dams must be modified concurrently in order to obtain the projected with-project discharge frequency shown on Table 4.2.

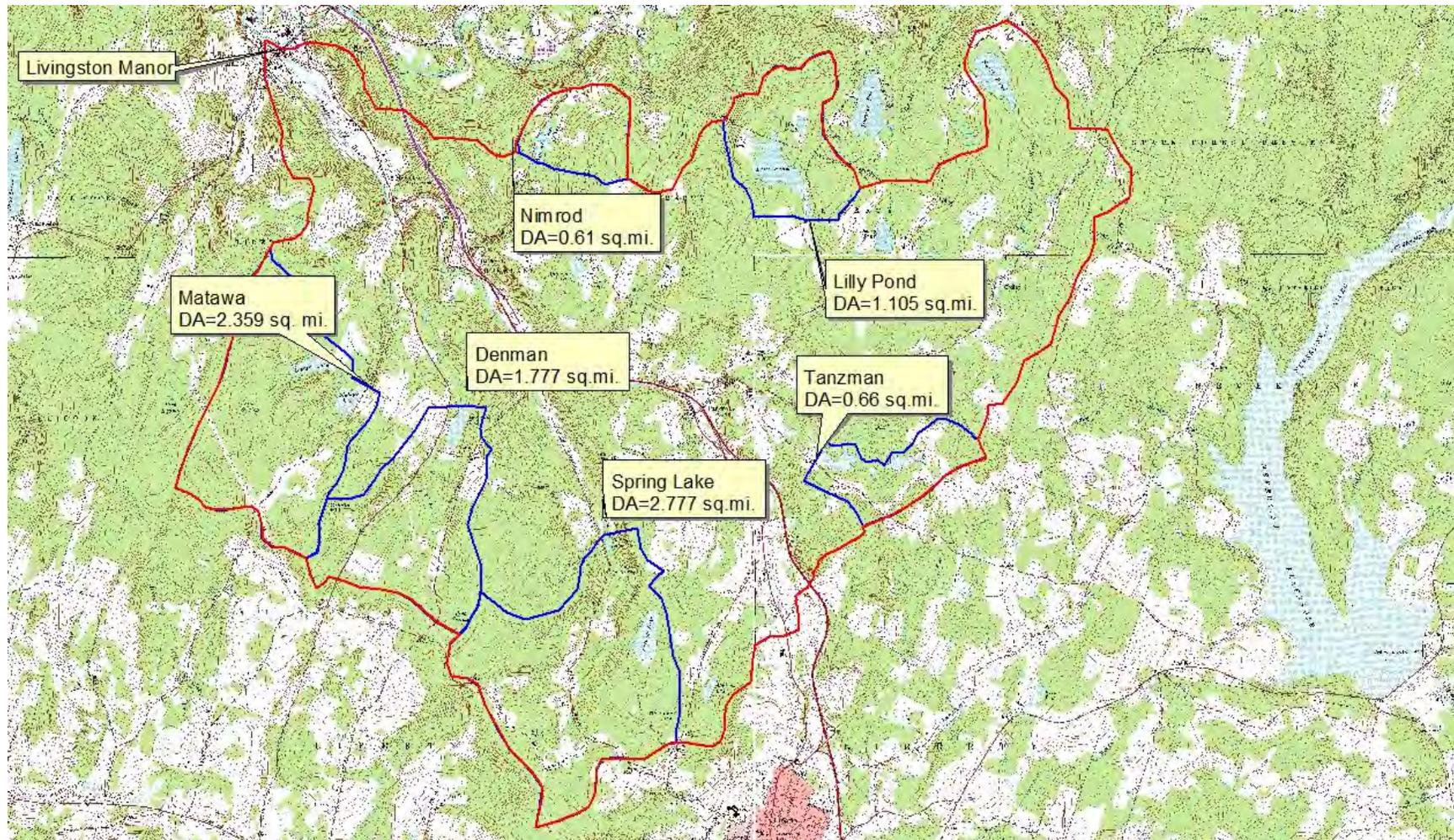


Figure 4.1: Six Reservoirs in the Little Beaver Kill Watershed.

Note: DA=Drainage Area

**Table 4.1: Flow Reductions at Pearl Street from Removing the Watershed Upstream of Existing Reservoirs.**

Condition	Description	Drainage Area Removed ( sq. mi)	Discharge at Pearl Street (cfs)				
			1 inch 24hr Storm	2 inch 24hr Storm	3inch 24hr Storm	5inch 24hr Storm	8 inch 24hr Storm
Existing		NA	85	606	1459	3751	9613
D1	Remove watershed Upstream of: Matawa Dam	2.359	81	598	1448	3729	9155
D2	Remove watershed Upstream of: Matawa, Denman dams	4.136	77	591	1439	3709	8616
D3	Remove watershed Upstream of: Matawa, Denman, Tanzman dams	4.796	76	588	1431	3698	8607
D4	Remove watershed Upstream of: Matawa, Denman, Tanzman, Nimrod dams	5.406	75	585	1427	3685	8324
D5	Remove watershed Upstream of: Matawa, Denman, Tanzman, Nimrod, Lilly Pond dams	6.511	73	583	1425	3682	8318
D6	Remove watershed Upstream of: Matawa, Denman, Tanzman, Nimrod, Lilly Pond dams and, Spring Lake	9.288	67	531	1305	3353	7387

Note: Removing the watershed upstream of the reservoir is equivalent to modifying the dam such that it captures all runoff from the smallest to the largest storm.

**Table 4.2: Discharge-Frequency for Reservoir Plan D6 at Pearl Street.**

Exceedance Frequency	Event (year)	Discharge (cfs) at Pearl Street	
		Existing	D6
99	1.01	510	446
50	2	1890	1690
20	5	3066	2741
10	10	3976	3508
4	25	5250	4385
2	50	6286	5097
1	100	7392	5859
0.4	250	9002	6967
0.2	500	10318	7929

Note: Drainage Area at Pearl Street is 30.2 sq. mi.

The flows in Table 4.2 apply downstream from the Airport Ponds to the mouth of Little Beaver Kill Creek. The water surface elevations corresponding to the frequency flows of Plan D6 were calculated with the existing (without project) condition hydraulic model and the results are provided in Tables 9.18, 9.19 and 9.20 of the Hydrologic and Hydraulic Analysis (Appendix A). Plan D6, along Pearl Street, produces water surface reductions across the frequency range.

### 4.4.3 Structural Measures

As with the watershed alternatives, the structural measures were primarily focused on Little Beaver Kill because a majority of the economic damages were found to occur in this area. However, two of the structural measures considered were located along the Willowemoc Creek. The goal of the structural measures was to reduce the frequency of wsels in downtown Livingston Manor. The structural measures include:

- Modification of the school ball field levees along the Willowemoc to lower the wsels at the mouth of Little Beaver Kill. The ball field modifications involved moving the levee landward and lowering the floodplain on the river side of the relocated levee.
- Lowering of Covered Bridge Road under Route 17 along the Willowemoc.
- Replacement of Main St. Bridge over the Little Beaver Kill with a wider bridge.
- Widening the floodway of the Little Beaver Kill downstream of Main St. Bridge
- Construction of a dry dam at the Airport Ponds.
- Modifying the outfall structure at the Matawa reservoir.

#### 4.4.3.1 Levees and Floodwalls

Levees and floodwalls are effective flood risk management measures in the following circumstances: *a.* damageable property is clustered geographically; *b.* a high degree of protection, with little residual damage, is desired; *c.* a variety of properties, including infrastructure, structures, contents, and agricultural property, are to be protected; *d.* sufficient real estate is available for levee construction at reasonable economic, environmental, and social costs; and *e.* the economic value of damageable property protected will justify the cost of constructing the new or enhanced levee and floodwalls. In addition, residents must be amenable to any visual effects associated with installation of a permanent levee or floodwall; these structures can block some, or all, of the view of the river, or otherwise reduce access.

The study considered relocation and modification of the ball field levee was intended to lower the water surface elevation of the Willowemoc Creek at the mouth of the Little Beaver Kill Creek. There were two types of modification: moving the levee landward toward the ball field; and moving the levee landward and then lowering the created floodplain approximately 2 feet. The floodplain would be lowered to the elevation of the existing 2-year water surface elevation of the Willowemoc. This would be done to maintain the sediment transport capacity of the Willowemoc. Three different relocation distances were analyzed for the levee: 300, 100 and 50ft. Due to the limited scope of this Feasibility Study, floodwalls were not analyzed as part of the study.

#### 4.4.3.2 Channel Modification

The first option that was considered for channel modification was along the Willowemoc, downstream of the center of town and the sewer plant, under the Route 17 Bridge. The concept was to remove a 30-ft width of the Route 17 road embankment to increase the width

of the floodplain. The increased width of the floodplain would allow for more flow area during out of bank flooding events.

The Main St. Bridge over the Little Beaver Kill is constrictive and causes a jump in the water surface across the bridge. This jump occurs even when the water surface does not touch the steel girder. A new wider bridge was the second option considered. It was assumed that the two buildings, upstream and downstream of the bridge on the left side of the creek will be purchased and demolished allowing the bridge’s width to be increased by 20 feet. A plan view of the proposed work is shown on Figure 4.2. Initially the new bridge was analyzed assuming a pier, but the majority of bridge modeling simulations assumed that a pier would not be required. In order to protect the fish habitat and to maintain sediment transport capacity, a channel bench approximately 5-feet above the existing channel would be placed under the new portion of the bridge.

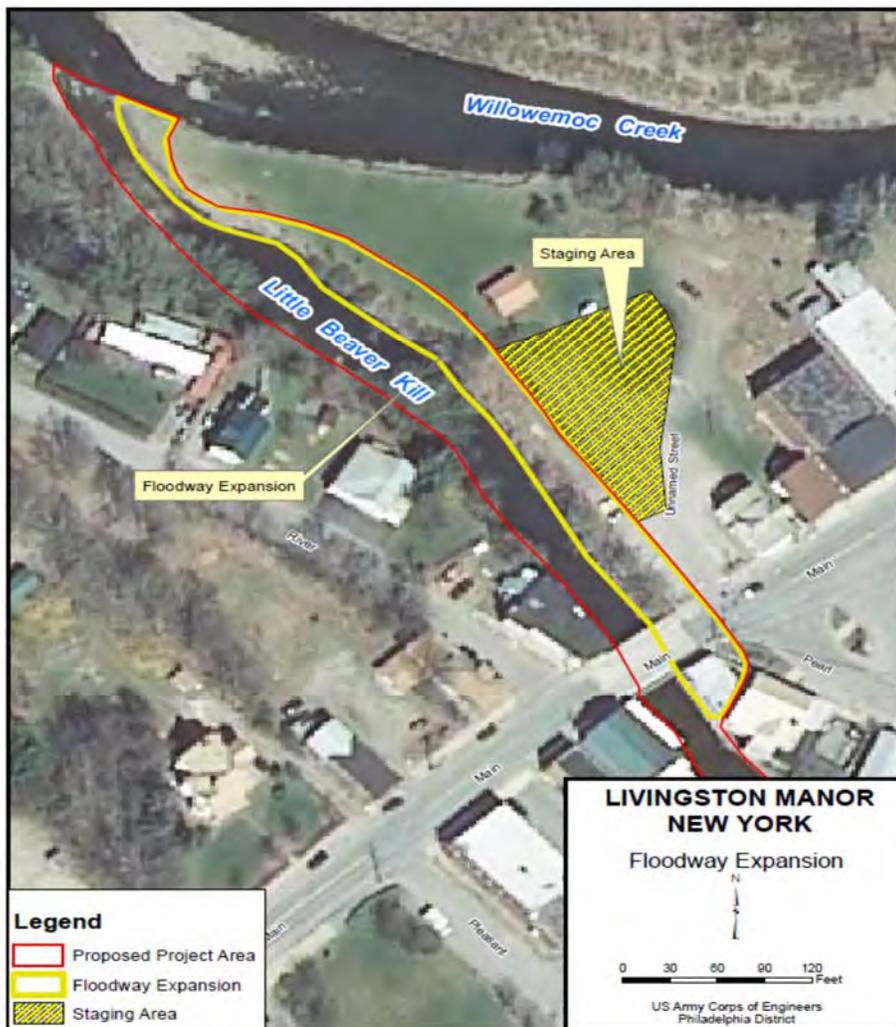


Figure 4.2: Plan View of Proposed Widening of Main St. Bridge

The third channel modification option involved lowering the water surface elevation of the Little Beaver Kill. Lowering the water surface energy at the downstream face of the existing Main St. Bridge can lower the water surface elevations on the upstream side of the bridge. One way to lower the energy at the downstream face of the bridge is to lower the channel bank height. The right side of the creek downstream from Main Street would be excavated creating a bench and providing more flow area. A floodway bench to accommodate the 50% ACE (2 year) event located approximately 6 feet above the existing channel was analyzed. Approximately 10 feet of the parking lot downstream of Main Street will need to be taken to allow for the relocated bench and side slopes.

Figure 4.3 is a plan view of the Park with the proposed bench contours shown. The highlighted “Limit of Excavation” shows the extent of the park which must be sacrificed to implement this option. The width of the bench is approximately 25 feet. Trees may be planted at the top of the newer lower banks, but the majority of the bench will be planted with native grass or other herbaceous vegetation to allow free flow during flood conditions.



**Figure 4.3: Plan view of streambank bench along Little Beaver Kill downstream of Main St. Bridge.**

#### 4.4.3.3 Modeling of Levee and Channel Modification Measures

Various combinations of levee and channel modification measures were considered to reduce flood damages along the Little Beaver Kill. A total of 26 separate hydraulic modeling

simulations were completed. Stage reductions were tabulated at various locations that are shown on Figure 4.4. The combinations of measures that were considered are provided below.

- Modify ball field levees only.
- Modify the bridge only.
- Modify bridge and ball field levee.
- Modify floodplain downstream of Main Street only.
- Modify floodplain downstream of Main Street and ball field levee.
- Modify floodplain downstream of Main Street and Main Street Bridge.
- Modify floodplain downstream of Main Street, Main St. Bridge and ball field levee.
- Modify floodplain downstream of the Main St. Bridge and stabilization of 1-mile of stream upstream.



**Figure 4.4: Locations of tabulated stage reductions.**

The results of the hydraulic modeling simulations are provided in the Hydrologic and Hydraulic Analysis (Appendix A). The results provide all of the stage reductions for the various combinations for the 20% ACE (5 year), 4% ACE (25 year), and 1% ACE (100 year) events. The stage reductions are likely to result in damage reductions, however even a plan with a large drop in water surface elevation may still result in flood water remaining out of bank.

#### 4.4.3.4 Cattail Brook Modeling

When this feasibility study was initiated, it was determined that a With Project analysis would not be performed for Cattail Brook because it infrequently exceeded its channel capacity. Even though there had been unprecedented flooding damages on Cattail Brook during a June 2006 event, this event was considered to be abnormal and the average annual damage potential on the brook was considered to be low.

However, on September 18, 2012 another rare rain event (6 inches of rain in a 2 hour period) caused major flooding and damages on Cattail Brook. The flooding was similar to the event that occurred in June 2006, when an intense rain storm coupled with massive tree debris blocked multiple bridges. Because of the debris blockage at Finch Street Bridge, the water jumped out of bank onto County Route 149 (Pearl Street) and flowed towards the center of Livingston Manor as a 2 feet deep torrent causing considerable erosion to the stream banks.

In response to the September 2012 event, the non-Federal sponsor (NYSDEC) and the Town of Rockland requested an abbreviated With Project analysis for Cattail Brook. The original HEC-RAS model (reflecting post 2006 conditions) was modified to reflect post September 2012 without project conditions. The September 2012 event destroyed two bridges (Hoos Road and a private driveway bridge) causing channel erosion. The private bridge was returned to the status quo ante and Hoos Road Bridge (a 20ft width) was replaced with a new bridge with a 40feet width. In addition, the bank downstream of Hoos Bridge had the riprap replaced including stepping back the stone to allow expansion of high water. The Town of Rockland indicated that the majority of the channel erosion was repaired such that the post June 2006 channel model is a reasonable representation of the post September 2012 condition. Therefore, the post September 2012 without project model is the post June 2006 existing condition model with Hoos Bridge modeled as a 40ft width span. Figure 4.5 provides an overview of the project area on the Cattail Brook.

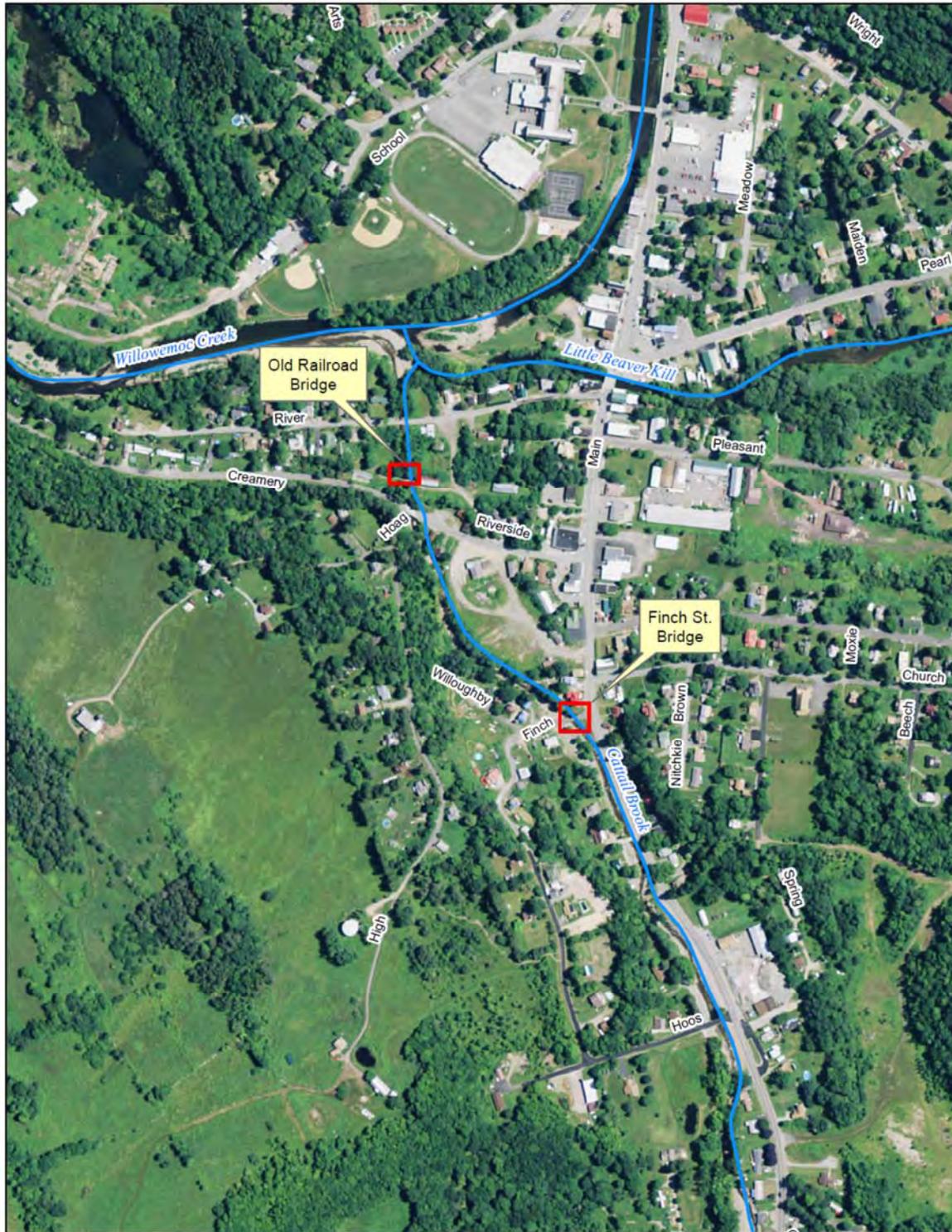


Figure 4.5: Overview of Cattail Brook

During this analysis, the following solutions were considered:

- A. Divert flow onto the left overbank upstream of Finch Bridge.
  - i) Diversion point approximately 50 feet upstream of bridge.
  - ii) Diversion point approximately 300 feet upstream of bridge.
- B. Increase the capacity of Finch Bridge by excavating a bench on the left downstream bank.
- C. Increase the capacity of Finch Bridge by excavating a bench on the right downstream bank.
- D. Replace Finch Bridge with a 40 feet width span.
- E. Remove the private bridge (downstream of Hoos Bridge).
- F. Remove old Railroad Bridge (between River and Creamery Roads).

It was determined that Option A had the potential to reduce the flow diversion onto Route 149 (Pearl Street), but at the cost of increased flow and possible increased damage to the houses along Willoughby Street. Therefore, this option was not considered any further. Hydraulic modeling was performed for the other solutions to determine their flood reduction potential as well.

The hydraulic modeling and analysis determined that the most immediate and effective solution for reducing flood damages along Cattail Brook to be a combination of the following measures:

1. Replace the existing Finch Street Bridge with a 40 feet span.
2. Demolish the old Railroad Bridge.
3. Encourage partnerships with local residents to re-plant the stream banks of Cattail Brook with native vegetation and create a riparian buffer around the brook. This practice will encourage the stability of the banks and potentially reduce future erosion and loss of mature trees. Various native small trees, shrubs and grasses can be planted along the streambank for erosion control and will enhance the property value. In addition, these planting would also provide important riparian habitat for local wildlife (e.g., birds).

The full analysis of Cattail Brook is provided in the Hydrologic and Hydraulic Analysis (Appendix A).

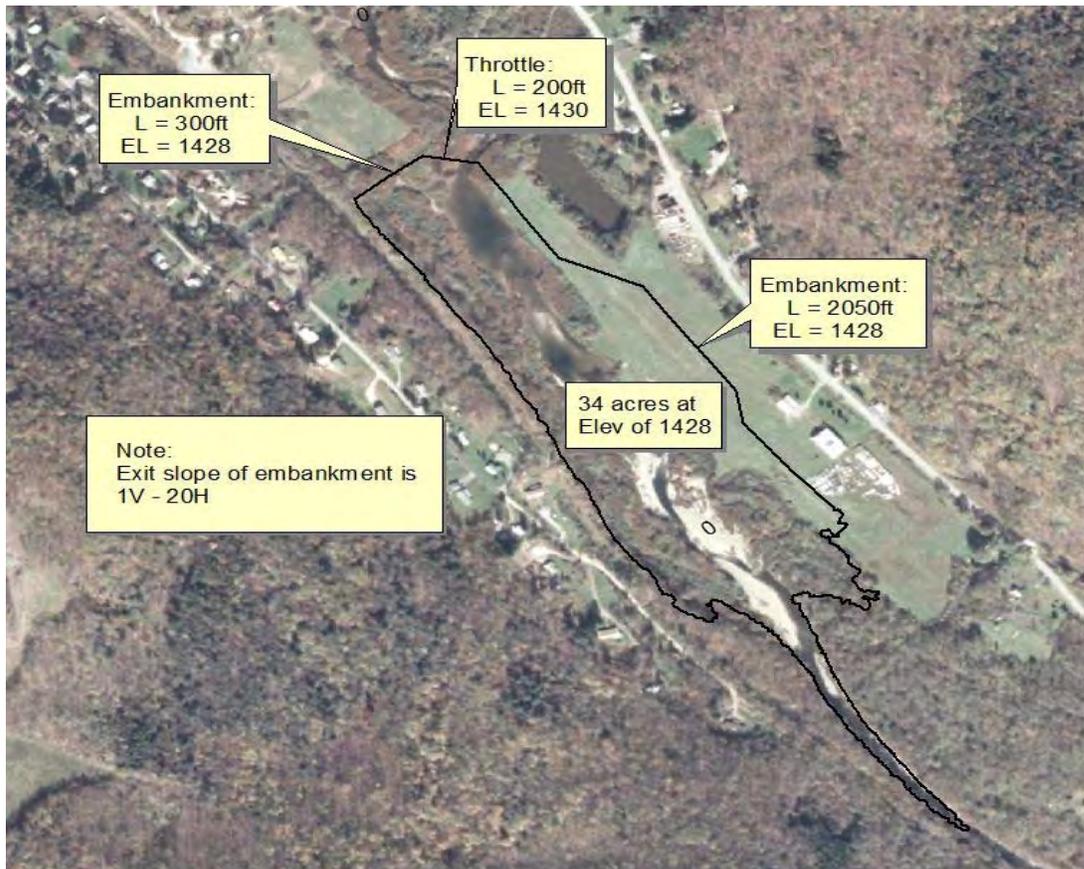
## 4.4.3.5 Dams or Flow Detention

### **Fulton Plan**

The first structural flow detention solution consists of a dry dam just upstream of Livingston Manor at the Airport Ponds. This solution is referred to as the Fulton Plan and is named after a local citizen who suggested it.

A possible concept plan for the Fulton Plan is shown in Figure 4.6. There is limited storage at the site so the embankment design allows for safe overtopping. This is accomplished with a 5% vegetated exit slope. The embankment across the channel is provided with sufficient freeboard to prevent overtopping. Three variations of the channel outlet were analyzed:

- A – Gated structure that releases inflow up to 1600 cfs.
- B – Constrictive open channel with a bottom width of 12 feet
- C – Constrictive open channel with a bottom width of 5 feet



**Figure 4.6: Fulton Plan**

Hydraulic modeling was performed to simulate the conditions if the 20% ACE (5 year), 10% ACE (10 year), 4% ACE (25 year), 2% ACE (50 year), and 1% ACE (100 year) events were routed through the proposed Fulton Plan detention structure. Flow reductions are shown in Table 4.3.

**Table 4.3: Reduced Flows (cfs) from the Fulton Plan.**

Condition	Outlet	5 year	10 year	25 year	50 year	100 year
Existing		3017	3921	5172	6218	7292
Fulton Plan -A	Gates, Max Release 1600cfs	2215	3512	5028	6200	7283
Fulton Plan -B	Open channel bottom width 12 ft	2594	3448	4909	6161	7277
Fulton Plan -C	Open channel bottom width 5ft	2535	3512	5044	6197	7282

The flows in Table 4.3 apply downstream from the Airport Ponds to the mouth of Little Beaver Kill Creek. The water surface elevations corresponding to the frequency flows of Fulton Plans A and B were calculated with the existing condition hydraulic model and the results are provided in the Hydrologic and Hydraulic Analysis (Appendix A). (Plan C was not run because the flows are similar to Plan B.)

### **Matawa Dam**

The second structural flow detention solution involved modification of the dam structure at the Matawa reservoir (Figure 4.7). Analysis of this measure was requested by the sponsor because the structure is owned by the Town of Rockland and would not need to be acquired if a project was to be built.



**Figure 4.7: Aerial view of the Matawa reservoir.**

Matawa Dam is a masonry structure constructed in 1949 for water supply. It no longer serves as a water supply and has become a run of river dam with inflow passing uncontrolled over its concrete spillway. The drainage area upstream of the dam is 2.359 sq. mi. with 1.009 sq. mi. controlled by the Lenape Dam located downstream. The drainage area of the Matawa tributary at its confluence with Little Beaver Kill is 3.22 sq. mi. The drainage area of Little Beaver Kill just downstream of the junction is 28.5 sq. mi.

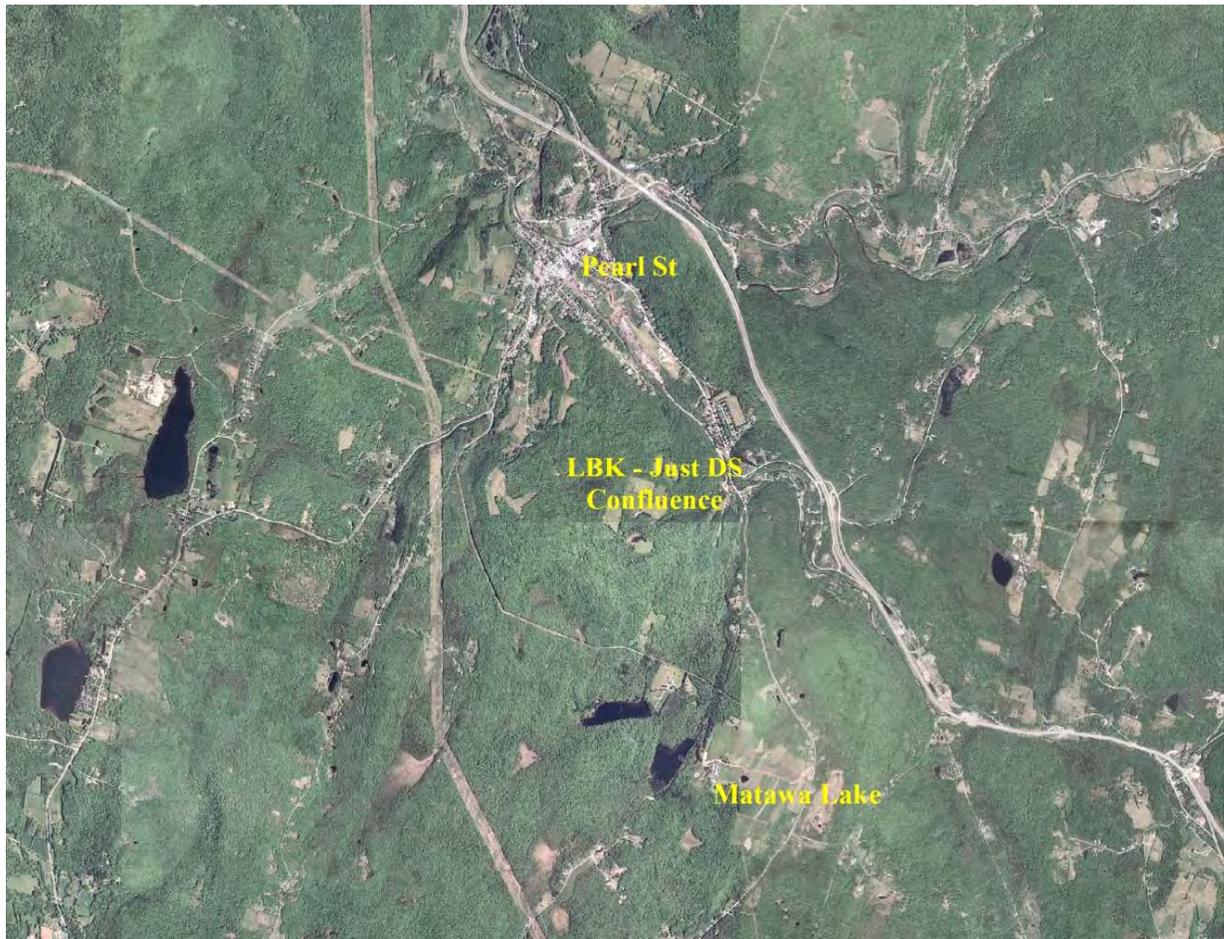
This measure would involve draining the existing pool and converting the existing structure to a dry dam. Base and moderate flows would be released through a low level outlet and larger flows would be impounded and released gradually after the flows on the Little Beaver Kill return to normal. Dimensions of the structure are provided in Table 4.4.

**Table 4.4: Dimensions of the Matawa Dam (NY State Inventory of Dams)**

Item	Value
Length	120 ft
Height	22 ft
Reservoir Surface Area	26 acres
Normal Storage	240 acre-ft
Maximum Storage	275 acre-ft
Maximum Discharge	215 cfs
Spillway Width	18 ft
Hazard Potential	Low

When a site visit was performed to examine the existing structure, a low level outlet was not observed. The installation of a functioning low level outlet would be necessary for this modification to be effective. The outlet would be required to pass base flow for environmental reasons and to quickly drain down the pool after a storm event to make storage available for the next storm event. The analysis assumed an empty reservoir for each storm analyzed. The analysis also assumed that there has been no sediment deposition in the impoundment since dam construction.

Hydrologic modeling was performed to simulate the conditions that would occur during various rainfall events if the Matawa Dam structure was to be modified. Results were tabulated at 3 locations: just downstream of Matawa Dam, on the Little Beaver Kill just downstream of the confluence with the Little Beaver Kill, and at Pearl Street (Figure 4.8). The results are provided in the Hydrologic and Hydraulic Analysis (Appendix A). It was determined that the modification of the dam would have the same effect as the theoretical removal of the watershed that was discussed as Plan D1 in the Reservoir Management Section of this report (Section 4.4.2.2). Hence, this measure alone will not result in a significant reduction in downstream water surface elevations during storm events.



**Figure 4.8: Matawa Dam - Discharge Tabulation Locations**

#### 4.4.3.6 Combinations of Structural Measures

After the preliminary concept-level designs for the different structural measures were evaluated independently, they were then combined with other measures to create a range of alternatives. These alternatives were evaluated to determine their potential effect on water surface elevations and related damages.

The alternative plans considered were:

Plan A – Remove 30-ft width of Route 17 road embankment downstream of the sewer plant to increase width of the floodplain.

Plan B – Relocation of the ball field levee along the Willowemoc Creek 300 feet landward without lowering the floodplain.

Plan C – Widening of the Main St. Bridge without a pier.

Plan D – Widening of the Little Beaver Kill floodplain downstream of the Main St. Bridge and widening of the Main St. Bridge without a pier.

Plan E – Widening of the Little Beaver Kill floodplain downstream of the Main St. Bridge, widening of the Main St. Bridge without a pier, and relocation of the ball field levee along the Willowemoc Creek 50 feet landward with lowering of the floodplain.

Plan F – Fulton Plan detention structure with open channel constriction, bottom width of 12 feet.

Plan G – Fulton Plan detention structure with open channel constriction, bottom width of 12 feet; and widening of the Little Beaver Kill floodplain downstream of the Main St. Bridge.

Plan H – Widening of the Little Beaver Kill floodplain downstream of the Main St. Bridge (with a 50% ACE (2 year) floodplain bench).

Plan I – Widening of the Little Beaver Kill floodplain downstream of the Main St. Bridge and relocation of the ball field levee along the Willowemoc Creek 50 feet landward with lowering of the floodplain.

Plan J- Widening of the Little Beaver Kill floodplain downstream of the Main St. Bridge, installation of 4 x 10 feet box culvert, and stabilization of 1-mile of stream upstream to insure stream stability and suspended sediment transport below the Main St. Bridge in downtown Livingston Manor.

Plan K- Plan J plus buyout of six structure in downtown Livingston Manor.

#### **4.4.4 Nonstructural Measures**

Section 4.4.3 discussed potential structural measures that could be implemented in the project area for flood risk management. Although all of the nonstructural measures will be considered for the project area, only the structure acquisition measure has been assessed in any detail at this stage of the feasibility study. This measure, commonly referred to as structure buyout, was given a preliminary evaluation for properties along Pearl Street, Main Street, and Maiden Lane that have historically sustained high flood damages.

#### **4.4.5 Alternatives Analysis – Cycle 3**

Following the screening and evaluation of the structural and nonstructural flood risk management measures, an alternatives analysis was performed to determine if the proposed solutions were likely to be cost effective and/or result in improved environmental quality.

For flood risk management measures to be considered cost effective, the benefits must exceed the costs.

#### 4.4.5.1 Nonstructural Measures

In early 2012, an initial appraisal of structures for Floodplain Evacuation Analysis was conducted. The analysis was conducted in accordance with CECW-PD, 22 January 2001, and Public Law 91-646. Eleven structures were identified from the Livingston Manor, NY inventory for further analysis.

In early 2016, CENAP-PL-D updated the analysis and identified six structures for further consideration. Those structures are found in the table above, along with each structure's Flood Risk Management (FRM) benefit provided to the Recommended Plan under the Livingston Manor, NY Section 205 study.

To summarize the analysis, if all structures are removed from the floodplain, than the Recommended Plan will be heavily affected. The BCR drops from 2.31 to 1.20. Net benefits decrease from \$412,000 to \$65,000. However, if structures liv0070, liv0071, liv0098, and liv0099 are bought-out and removed from the floodplain, than the BCR only drops to 2.08. It should be noted that the net benefits for the Recommended Plan would still decrease by \$65,730, if this was considered.

Furthermore, the Town of Rockland and Sullivan County have previously worked with the Federal Emergency Management Agency to buyout many structures in the floodplain that received consistent and heavy flooding damage. Buying additional structures out of the floodplain would have a detrimental effect on the socioeconomic center of Livingston Manor and the Town of Rockland.

Additional information on the buyout analysis can be found in Appendix C.

#### 4.4.5.2 Structural Measures

During the Cycle 3 screening, both Plan J and Plan G (a combination of Plans F and H) were given further consideration and analysis. Plan G had good flood damage reduction benefits; as well as, ecosystem restoration benefits. The economic results indicate a 1.23 benefit/cost ratio with \$41,935 in annual net benefits to the federal government. In addition, this plan restored approximately 3,200 linear feet of stream channel, 9 acres of riparian habitat, and 11 acres of wetland habitat to the local community. However, as additional analysis on the project were completed, it was determined that the proposed detention structure in Plan G (Fulton Plan) would qualify as a dam from both a State of New York and USACE perspective. This added to the complexity of this alternative, as well as the anticipated cost. Preliminary analysis also indicated that this alternative was likely to have a BCR below 1.0 and negative net benefits. A number of meetings and discussions were held with the non-federal sponsor and local partners to discuss this development. In addition, a tentative cost estimate associated with pursuing a dam at the airport site was completed. This initial cost

estimate for both design and construction, as well as the potential lengthy permit process for this proposed alternative led the team to screen out this alternative.

Table 4.5 provides a comparison of the estimated annual costs of the alternative plans and the Average Annual Damages of protected development to determine initial screening BCRs.

Table 4.5: Alternatives Analysis Results

STREAM	WITHOUT PROJECT	PLAN A Remove 30-ft width of Route 17 road embankment	PLAN B Move ball field levee along the Willowemoc 300 ft landward; the floodplain is not lowered	PLAN C Main St. Bridge widened without pier	PLAN D Widen LBK floodway downstream of Main St. Bridge; Main St. Bridge widened without pier	PLAN E Widen LBK floodway downstream of Main St. Bridge; Main St. Bridge widened without pier; ball field levee relocated 50 ft and floodplain lowered	PLAN F Fulton Plan - detention structure with open channel constriction; existing channel	PLAN G Plan F & Plan H combined	PLAN H Widen LBK floodway downstream of Main St. Bridge	PLAN I Widen LBK floodway downstream of existing Main St. Bridge; ball field levee relocated 50ft and floodplain lowered.	*PLAN J Widen LBK Floodway at Main St. Bridge, install 4 x 10 ft box culvert, and stabilize 1-mile of stream upstream of Main St. Bridge.	PLAN K Plan J & purchase of 6 structures in Downtown.
<b>ANNUAL DAMAGES</b>												
WILLOWEMOC	\$88,850	\$84,120	\$87,990	\$88,850	\$88,850	\$88,850	\$88,850	\$88,850	\$88,850	\$88,850	\$88,850	
LEFT LEVEE	\$40,130	\$40,080	\$38,800	\$40,130	\$40,130	\$40,130	\$40,130	\$40,130	\$40,130	\$40,130	\$40,130	
BEHIND SCH. LEVEE	\$99,600	\$100,050	\$91,020	\$99,600	\$99,600	\$99,600	\$99,600	\$99,600	\$99,600	\$99,600	\$99,600	
LITTLE BEAVER KILL	\$1,292,280	\$748,500	\$738,280	\$563,800	\$495,440	\$474,910	\$550,600	\$527,580	\$667,620	\$632,760	\$565,270	\$563,850 <sup>+</sup>
<b>TOTAL</b>	<b>\$1,520,860</b>	<b>\$972,750</b>	<b>\$956,090</b>	<b>\$792,380</b>	<b>\$724,020</b>	<b>\$703,490</b>	<b>\$779,180</b>	<b>\$756,160</b>	<b>\$896,200</b>	<b>\$861,340</b>	<b>\$793,850</b>	<b>\$563,850</b>
<b>ANNUAL BENEFITS</b>												
TOTAL AAB (AVERAGE ANNUAL BENEFITS)	NA	\$4,330	\$20,990	\$184,700	\$253,060	\$273,590	\$197,900	\$220,920	\$80,880	\$115,740	\$727,000	\$344,010 <sup>++</sup>
<b>COST AND BCR</b>												
CONSTRUCTION ESTIMATE	\$0	NA	\$1,211,000	\$3,700,000	\$4,357,000	\$5,484,000	\$3,188,000	\$3,845,000	\$657,000	\$1,784,000	\$7,697,000	
AAC (AVERAGE ANNUAL COST)	\$0	NA	\$56,372	\$172,235	\$202,818	\$255,280	\$148,401	\$178,985	\$30,583	\$83,045	\$315,000	
BCR (BENEFIT COST RATIO)	NA	NA	0.37	1.07	1.25	1.07	1.33	1.23	2.64	1.39	2.31	1.20
NET BENEFITS	NA	NA	-\$35,382	\$12,465	\$50,242	\$18,310	\$49,499	\$41,935	\$50,297	\$32,695	\$412,000	\$65,000

\*Recommended Plan; + The number represents the sum of EAD of the 6 structures. Per USACE floodplain evacuation guidance, each structure must be evaluated separately.; ++ The number represents the sum of AAB of the 6 structures. Per USACE floodplain evacuation guidance, each structure must be evaluated separately.

#### **4.4.6 Ecosystem Restoration**

Ecosystem restoration measures were considered during the screening of measures, but have not yet been taken to the concept-level of design in Cycle 2 (Initial Assessment of Alternative Measures) since the primary goal of this study was to identify measures that would reduce frequently recurring flood damages. A separate NER analysis was not conducted, but ecosystem measures were added to supplement the recommended plan as a more comprehensive solution to both flooding and habitat degradation for the community.

If ecosystem restoration measures are more fully developed in the future, they will be evaluated for their completeness, effectiveness, efficiency, acceptability, and significance. Significance is defined according to the following criteria:

- Scarcity – trends and relative abundance of the habitat.
- Connectivity- contributes to the connection of other important habitat pockets.
- Special Status Species- significant contribution to some key life requisite of special status species.
- Plan Recognition contributes to watershed or basin plans.

To be considered for Corps funding, sites are generally required to meet these multiple criteria. Regional or national significance is typically identified based on institutional, public or technical recognition.

A summary of the preliminary ecosystem restoration measures that were considered is provided below. The four main components included stream restoration through channel realignment and bank stabilization, establishment of a riparian buffer zone to help shade and further stabilize the channel, wetland floodplain creation, and filling of the borrow pits.

##### **4.4.6.1 Channel Re-Alignment and Riverbank Stabilization**

Approximately 3,200 linear feet of the Little Beaver Kill would be realigned within the floodway of the existing airport property using the principles of natural channel design. The reach would be designed with flood water attenuation, sediment movement, aquatic instream habitat, riparian cover, and stability as the focal points. To reduce the potential for sedimentation within the active stream channel in this area, a Rosgen Stream Type C4 and B4c was recommended to provide a more sustainable design solution. Stream velocities and slopes would be expected to provide the necessary stream power to pass bedload materials. Channel bed materials will be consistent with bed materials upstream of the project reach. In utilizing this type of design, the risk of erosion and head cutting is increased. As such, the riverbanks would be stabilized using hard (stone) materials for toe protection and in-stream grade-control and flow-deflecting structures (such as rock weirs and bend-way weirs) to maintain channel shape and form and protect the riverbank during flood events. The design would also provide instream and bank habitat diversity during base flow events. In addition, bioengineering, which would include erosion control blankets and native plantings, would be used to stabilize the slopes above the rock toe protection. The upper banks would be

bioengineered to tie into riparian buffers existing or created on the site. Finally, as part of this restoration, a sediment analysis would need to be completed since the current airport ponds are capturing sediment and once restored this sediment will be reincorporated into the new stream channel geomorphology.

#### 4.4.6.2 Forested Riparian Buffer Zone

The riparian buffer zone of the Little Beaver Kill in the airport area is limited to a grass/shrub community with a few isolated tree communities. The aquatic habitat can be improved by establishing a minimum 100 foot forested riparian buffer zone along each side of the Little Beaver Kill throughout the proposed project reach totaling approximately 12.0 acres. A vegetative canopy can shade the Little Beaver Kill and help return water temperatures into ranges that support brook trout, rainbow trout, and brown trout during the summer months, provide woody material to the stream reach, cover habitat and food resources for aquatic species, and bank stability with their root systems. The existing project area includes both native and non-native species. Japanese knotweed (*Polygonum cuspidatum*) is a dominant species in frequently flooded riparian areas and is well established throughout the project reach. The plant out-competes native species by emerging early in the spring and growing very rapidly. The plant is not an obligate hydrophyte, but thrives in the open, frequently disturbed conditions of a low lying flood plain and unstable banks. Establishment of Japanese knotweed can be prevented by monitoring, hand removal of plants found on the site, treatment with glyphosate, and repeated cutting during the growing season to retard stem growth. Planting the site with rapid growing and canopy-forming, deciduous riparian species that are native to the area may also retard establishment of Japanese knotweed in newly planted riparian areas. Species that are currently found on site and can be used in the riparian zone include eastern cottonwood, green ash, silky dogwood, speckled alder, and black willow. Regional or local experts would be consulted in developing planting plans and native species to be used in riparian and wetland restoration areas.

#### 4.4.6.3 Floodplain Wetlands Creation/Filling of the Borrow Pits (Airport Property)

The floodplain of the Little Beaver Kill adjacent to the project site is dominated by meadow grasses. If this floodplain were to be re-graded so that the borrow pits were filled and other areas lowered in elevation it would create conditions that would allow wetlands to re-establish in an area where they likely existed in the past. This could include emergent wetlands, scrub-shrub wetlands, and forested wetlands. The material excavated to create these depression wetlands would be used to fill the borrow pits. Additionally, the depression wetlands would increase flood storage capacity and potentially reduce flooding in Livingston Manor.

Portions of the site were observed to have been filled with construction/demolition debris, old automobile bodies and parts, tires, glass and other materials unsuitable for use in restored wetlands. This material appears to be concentrated near the developed portion of the site (buildings, parking area, and former runway). Further investigation involving construction of

soil test pits will be required. The nature of the fill material and the difficulty of removing and properly disposing of it may reduce the suitability of the airport site for wetland creation. The borrow pits will be filled with material excavated during the realignment of the Little Beaver Kill or offsite borrow material. The fill material in the borrow pits would be capped with topsoil and the borrow pits stabilized with native vegetation.

The development of wetland hydrology and vegetation would require removal of some soil on the premises. The natural groundwater elevation is estimated to be 3-4 feet below the ground surface near the airport runway. Removal of approximately 3-5 feet of surface soil material is anticipated for areas to be included within the wetland creation site. The wetland should incorporate a variety of water regimes to create habitat diversity. Various water regimes would be created by excavating variable amounts of surficial materials to create an uneven surface. The overall design shall be a mosaic of upland and wetland habitats that are re-vegetated utilizing native species. The plan would be to create approximately 11 acres of wetland on the site.

#### 4.4.6.4 Floodplain Storage and Habitat Restoration at former Poultry Plant along Willowemoc Creek

The floodplain habitat of the Little Beaver Kill in the former Poultry Plant is currently degraded from past land practices on the site. Excavating fill material from the Poultry Plant site and re-grading the area to create a functioning floodplain forest could provide improved fish and wildlife habitat. In addition, a restored floodplain at this site could provide minor flood storage, but is unlikely to provide significant flood damage reduction to the downtown area of Livingston Manor.

The site has great potential for habitat restoration and passive recreation features (e.g., walking trail) to provide an educational opportunity for visitors and the local community. Current information (Eder Associates 1997) on the site indicate the presence of contaminated sediments on the property. These contaminated sediments would need to be removed prior to any future restoration effort. In addition, the NYSDEC's Division of Environmental Remediation/Hazardous Waste Remediation has not been involved with the property and there has been no application to the NYSDEC's Brownfield Program for this property (P. Ferracane, Personal Communication, 2012).

#### 4.4.6.5 Levee Removal or Relocation at the Central High School

Removal of the levee protecting the athletic fields would open available floodplain areas. Under this option, a riparian buffer would be established along the Willowemoc Creek in this area. Riparian area recommendations for the airport project area would also apply for this and all other riparian area restoration efforts. Riparian cover would provide bank stability, flood water velocity reduction, water temperature reduction for aquatic species, and aquatic and terrestrial habitat. However, discussions between NYDEC and the high school officials at a meeting held on November 13, 2012 indicated that the high school did not have an interest

in moving the levee back from the edge of the Willowemoc Creek (P. Ferracane, Personal Communication, 2012). In addition, Livingston Central School had hired Woitd Engineering to design a repair of the existing berm (E.Weitmann, Personal Communication, 2013).

Due to cost issues and non-federal sponsor interest at this point in time, ecosystem restoration alternatives along the Willowemoc watershed were not carried forward in the study. Items discussed here should be looked at in more detail during future studies.

**5.0 Recommended Plan (With Project Condition)**

Based on an evaluation of the various alternatives, including the environmental impacts, design elements, and estimated costs; and in collaboration with the non-federal sponsor (NYSDEC) and the local municipality (Town of Rockland), the recommended plan was determined to be Plan J (Figures 5.1 and 5.2) which consists of widening the LBK floodway at the Main St. Bridge, installing a 4 x 10 ft culvert, and stabilizing approximately 1-mile of stream upstream (to the old airport site) of Main St. Bridge. This plan had strong flood damage reduction benefits (Table 4.5). The economic results indicate a 2.31 benefit/cost ratio with \$412,000 in annual net benefits to the federal government. Plan J is the NED plan. The table below provides a summary of the economic analysis results.

In addition, this plan includes approximately 1 mile of stream channel design, which will provide a sustainable flood reduction plan by managing sediment transport rates within the stream channel to avoid sediment deposits in downtown Livingston Manor, preventing future channel accretion and associated flooding. Plan J provided key flood damage reduction benefits to Livingston Manor and Under Plan J, average annual damages from flooding should decrease by approximately \$727,000. Furthermore, since trout fishing is important to the culture and economics of the region, Plan J provides incidental environmental benefits (re-planted riparian buffer) desired by the local community. As part of the stream stabilization component of the project, a 75 ft buffer on each side of the creek will be planted with native vegetation to insure the stream stability and this will result in approximately 20 acres of enhanced riparian buffer.

**Plan "J" Summary of Economic Analysis**

Average Annual Benefits	\$727,000
Average Annual Costs	\$315,000
BCR	2.31
Net Benefits	\$412,000

\*Applied FY 2015 Federal discount rate of 3.125%

\*2016 Price Level

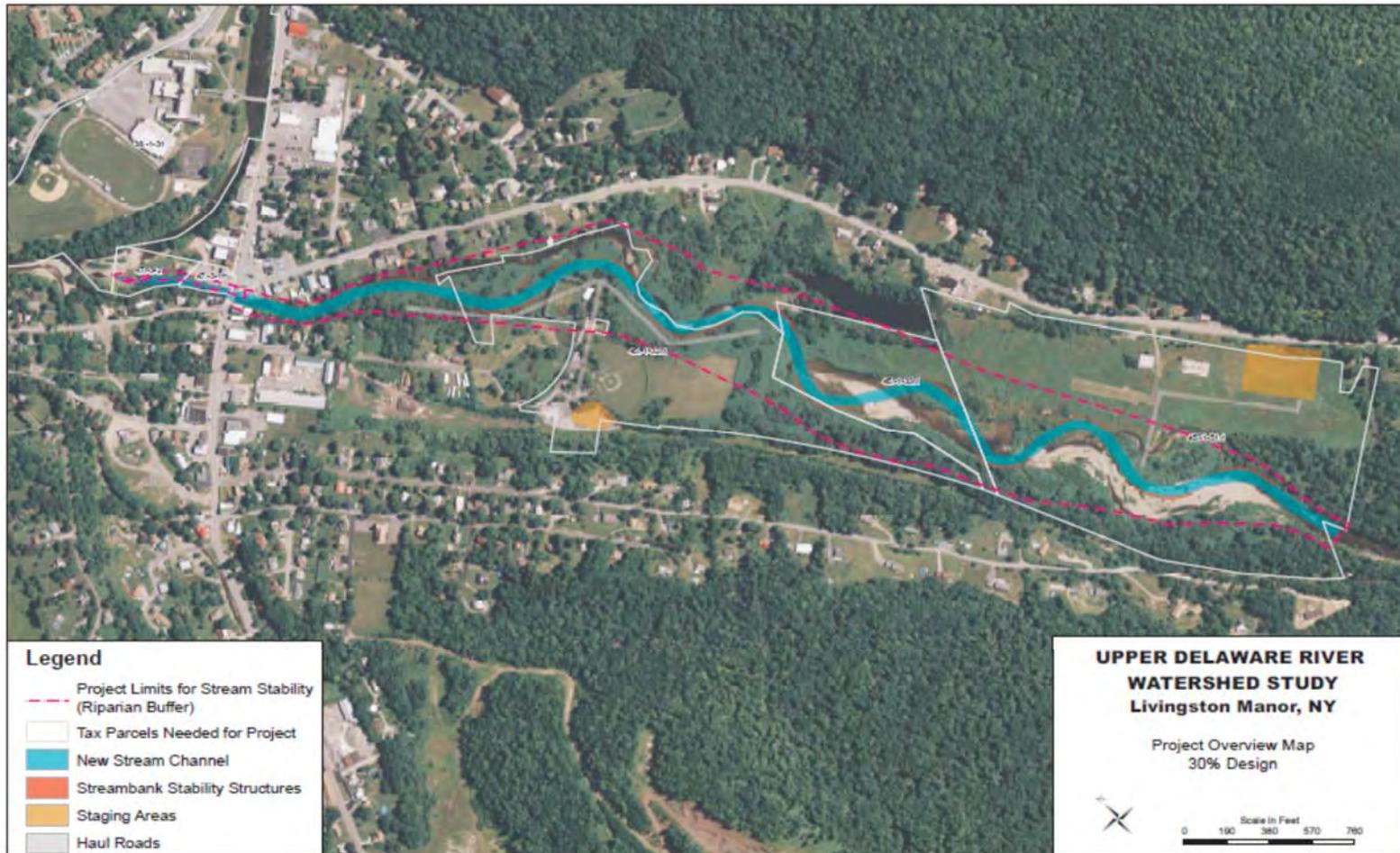


Figure 5.1: Plan J – Overview of the Recommended Plan.

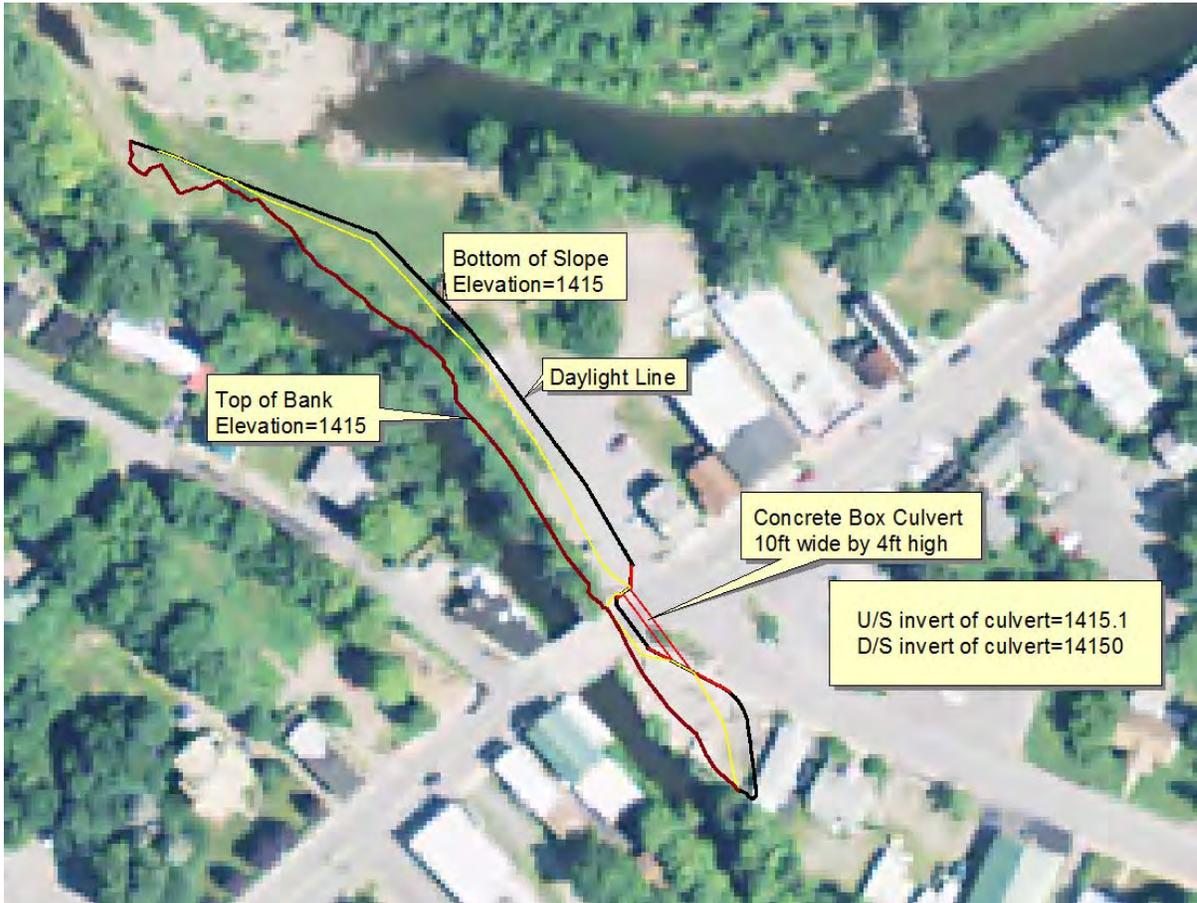
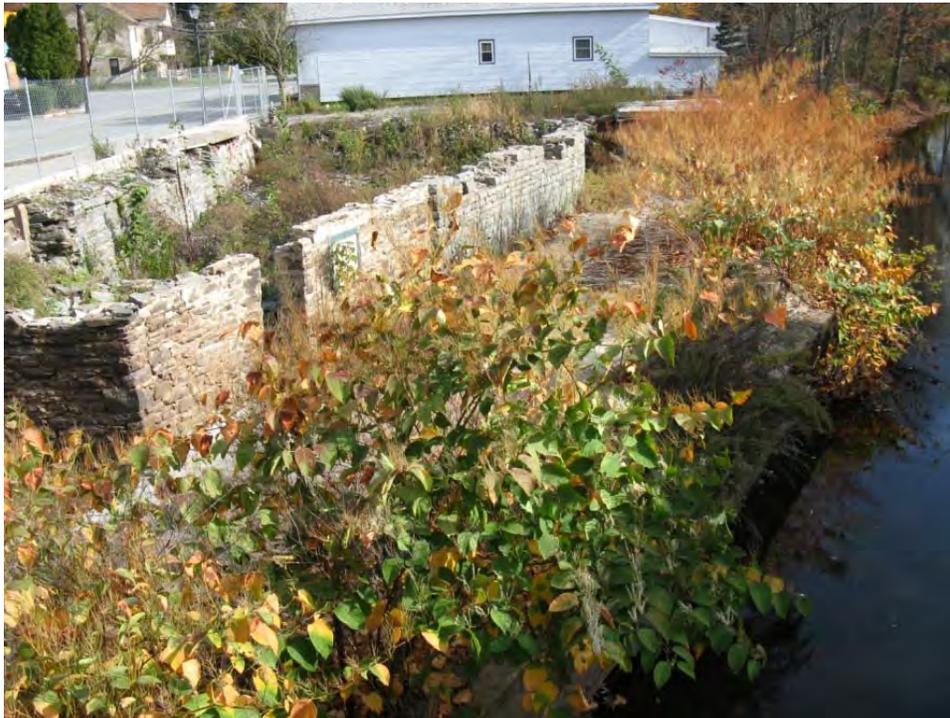


Figure 5.2: Plan J – Widening of the Little Beaver Kill floodway below the Main St. Bridge.

As mentioned above, Plan J consists of a modification the floodplain bench on the right overbank downstream of Main St Bridge, a 10ft wide by 4ft high box culvert placed on the right side of Main St Bridge, and channel stabilization starting just upstream of Main Street and extending approximately 1-mile to the upstream end of the Airport Ponds. The addition of the box culvert was made possible by a fire that destroyed the building just upstream of Main St Bridge. Figures 5.3 and 5.4 show the building pre and post fire, respectively. In a collaborative effort between agencies and to utilize the best available technical expertise, the upstream channel design (from Main St. Bridge to the old airport site) was completed by the U.S. Fish and Wildlife Service (USFWS) as documented in Appendix E. More details on the floodway expansion portion of the design can be found in Appendix F.



**Figure 5.3 – Previously existing building on ROB Upstream of Main St. Bridge.**



**Figure 5.4 - Remnant of Building upstream of Main St. Bridge.**

The plan view of the excavated bench is also shown on Figure 5.2. The top of bank / bench elevation of 1415 ft-NAVD88 was selected to match the existing bank full elevation under the Main St. Bridge. The width of the bench varies from 20ft to 35ft. The bench and the side slope (to the daylight line) will be planted with native grass vegetation for stabilization and will also minimize hydraulic losses. The 4 ft high, 10 ft wide box culvert is the largest that can be placed given the vertical and horizontal constraints.

Figure 5.3 shows that the building foundation wall sits on a concrete pad. The elevation of this pad is 1417.8 ft-NAVD88. As part of the culvert placement, the concrete pad (and the foundation wall) will be demolished and a vegetated bench at elevation 1415 ft-NAVD88 will be placed. The box culvert will see water only for flows greater than bank full which is estimated by the USFWS to be 800 cfs.

The plan view of the recommended plan's stable channel design for upstream of Main St. Bridge is shown on Figure 5.5. Further details of the design and typical riffle and pool cross-sections can be found in Appendix E. The outer bends at the pools will be armored with toe wood, while the upstream and downstream ends of the project will be stabilized with cross vanes. The width of disturbance varies, but the maximum width is approximately 525 feet.

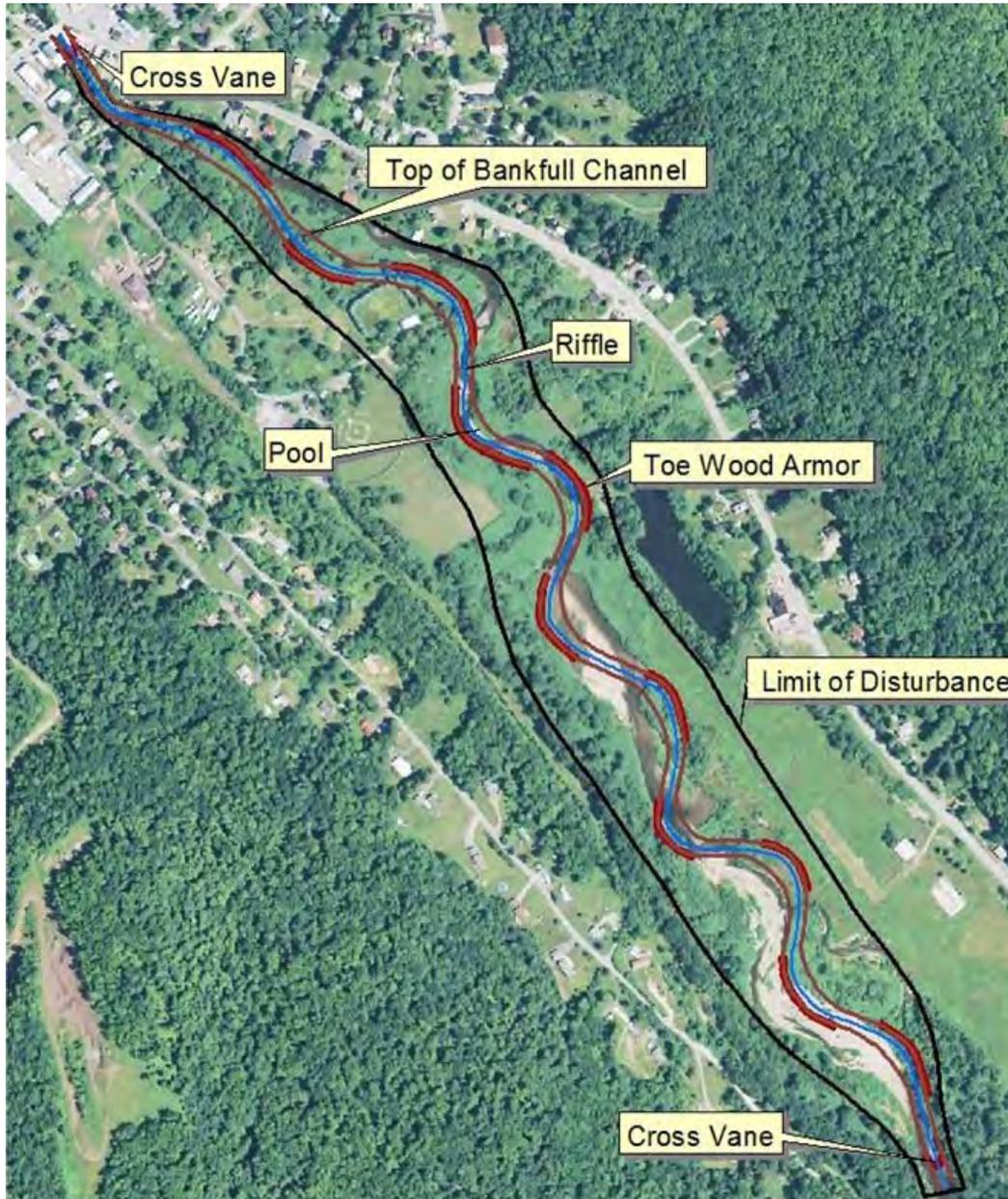


Figure 5.5 – Plan View of Post Interim Stable Channel Design

The calculated frequency water surface reductions resulting from the recommended plan can be found in Table 5.1. Stage reductions of over 2 ft for the 10% ACE (10 year) and 4% ACE (25 year) events are predicted upstream of Main St. Bridge along Pearl Street, the major damage center. Even the 1% ACE (100 year) event is predicted to have a 1 ft reduction. This will correlate to a 50% reduction in damages for the 10% ACE event and 56% reduction in damages for the 1% ACE event. Additional hydrologic and hydraulic analysis can be found in Appendix A.

**Table 5.1 Difference between the With Plan and Without Plan frequency water surface elevations at select river stations.**

River Station	(Feet)							
	2yr	5yr	10yr	25yr	50yr	100yr	250yr	500yr
X-316 (316 ft upstream of the confluence with Willowemoc)	0	<b>0</b>	<b>0</b>	0	0	0	0	0
X-824 (824 ft upstream of Willowemoc – at the Main St. Bridge)	-1.01	<b>-1.78 (21.4 inches)</b>	<b>-3.12 (37.4 inches)</b>	-3.22	-2.37	-1.23	-0.98	-0.45
X-942 (118 ft upstream of Main St. Bridge)	-1.89	<b>-3.12 (37.4 inches)</b>	<b>-3.76 (45.1 inches)</b>	-3.34	-2.15	-1.20	-0.89	-0.4
X-1101	-1.20	<b>-2.21</b>	<b>-2.51</b>	-2.38	-1.77	-1.04	-0.81	-0.39
X-1337	-1.18	<b>-1.96</b>	<b>-2.32</b>	-2.26	-1.69	-1.01	-0.79	-0.39
X-1697 (873 ft upstream of Main St. Bridge)	-0.97	<b>-1.79 (21.5 inches)</b>	<b>-2.20 (26.4 inches)</b>	-2.17	-1.64	-0.98	-0.78	-0.39
X-2138	-0.79	<b>-1.66</b>	<b>-2.11</b>	-2.11	-1.59	-0.97	-0.78	-0.41
X-3293 (2469 ft upstream of Main St. Bridge)	-0.47	<b>-1.54</b>	<b>-2.01</b>	-2.03	-1.55	-0.94	-0.76	-0.39
X-3917	0.15	<b>-1.46</b>	<b>-1.91</b>	-1.95	-1.49	-0.89	-0.72	-0.36
X-5862 (5038 ft upstream of Main St. Bridge)*	3.06	<b>2.95</b>	<b>2.46</b>	1.77	1.50	1.37	0.74	0.61

\*The H&H modeling indicates that between stream cross sections X4906 - X6159 the With Plan WSEL's are predicted to be higher than existing condition WSEL's. This is the result of the preliminary layout of the stabilized channel. In the airport pond area, the proposed channel and flood plain elevations are higher than the existing elevations. Analysis has indicated that these increased WSEL's may affect four structures in the area, one which is an occupied resident. In the design phase of the project, additional analysis will be completed to insure that these structures are not impacted, or, if so, proper mitigation will be proposed to alleviate any damages.

To further illustrate the flood depth reductions that are anticipated to result from the recommended plan, the floodwater depths for the Livingston Manor area are shown for the 20% ACE (5 year) and 10% ACE (10 year) events (Figures 5.6 and 5.7). The bolded columns above in Table 5.1 can be graphically visualized by reductions in water surface elevations in the two figures.

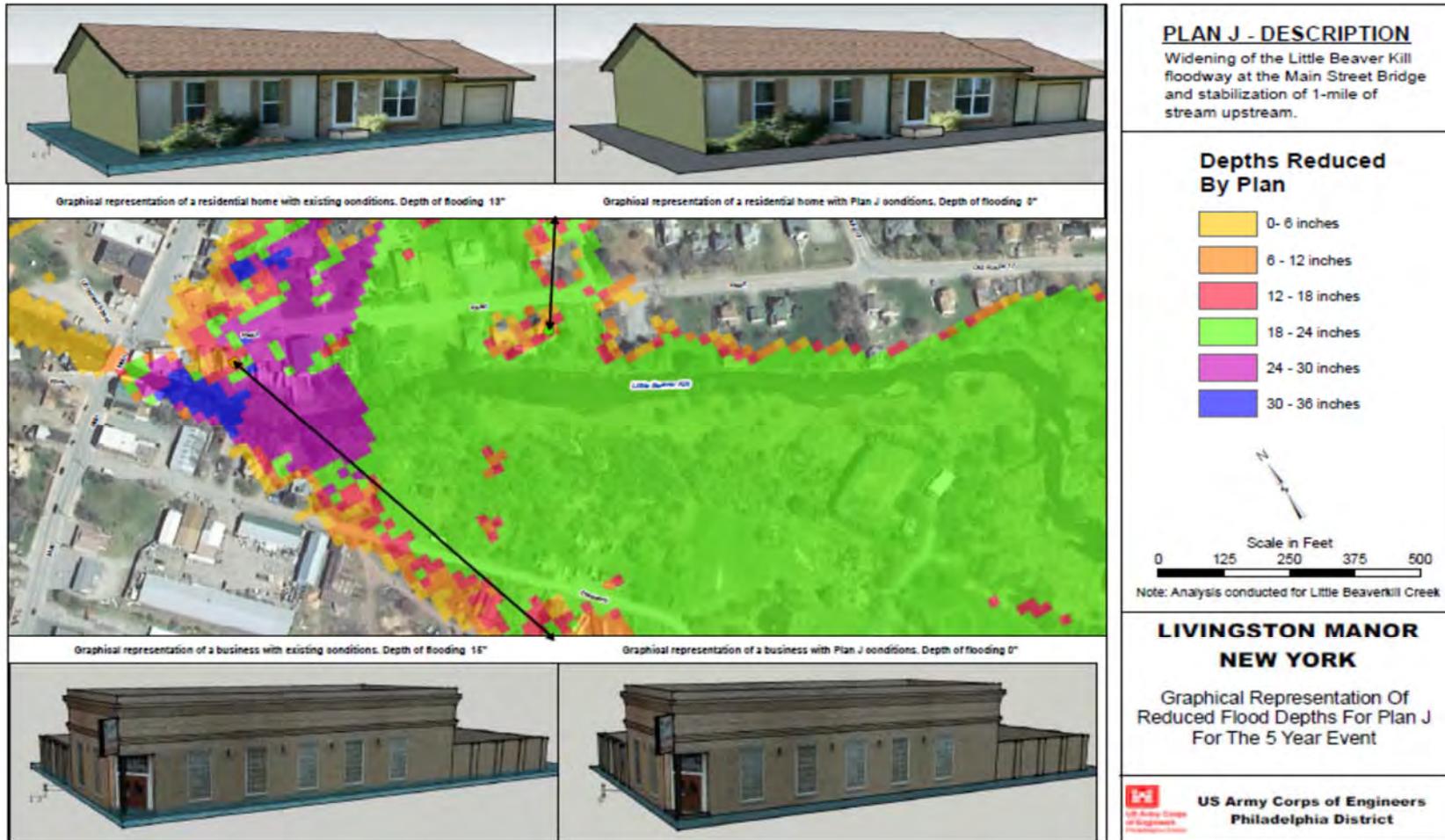


Figure 5.6: Reductions in flood depths for Alternative Plan J for the 20% ACE (5 year) event.

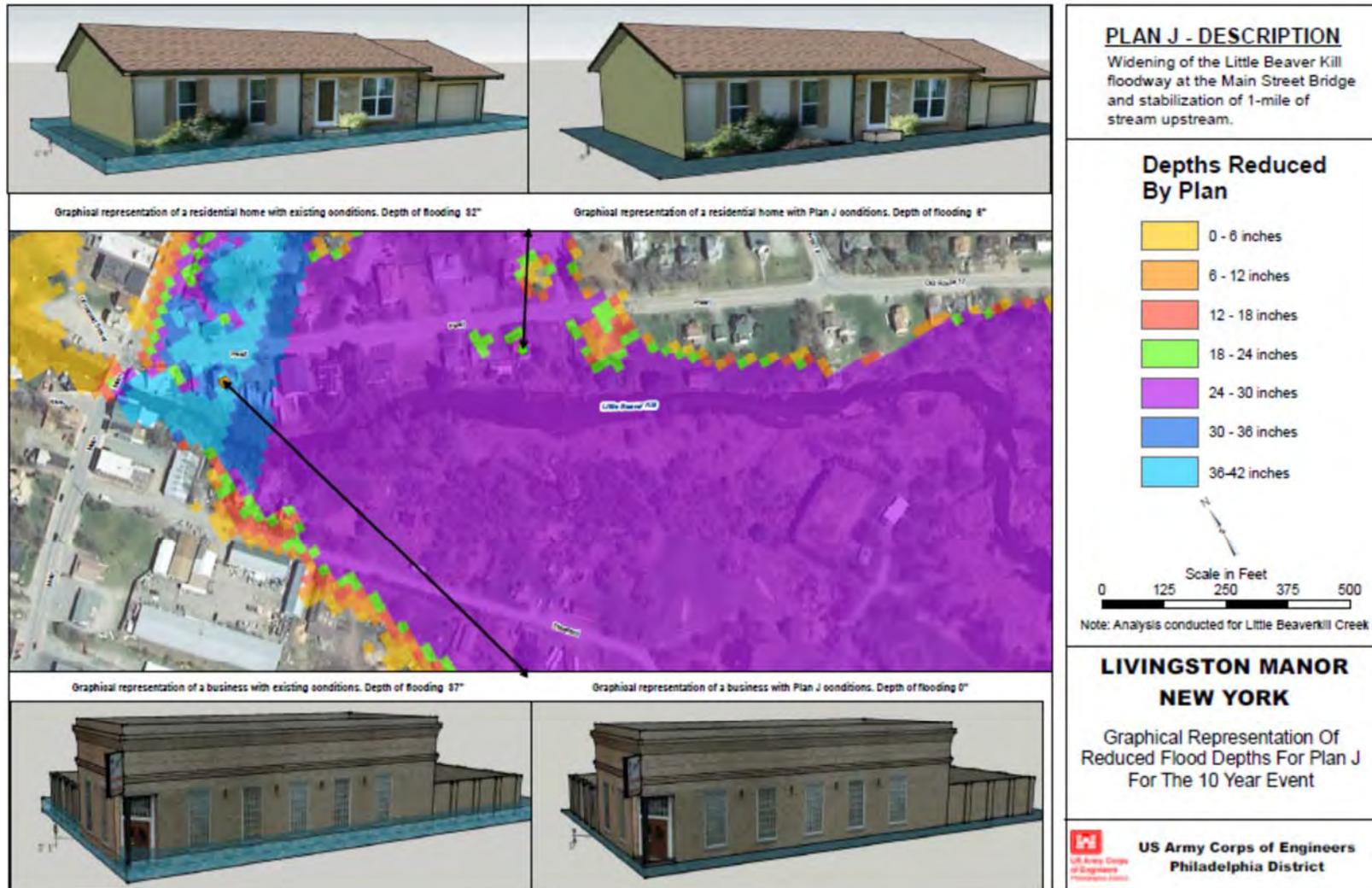


Figure 5.7: Reductions in flood depths for Alternative Plan J for the 10% ACE (10 year) event.

**5.1 Project First Cost**

The table below depicts the itemized costs broken down by each major cost category for TSP “J”. The costs are indexed in 2016 dollars. The Estimated Project Cost column represents the best estimate of the total for each itemized category. The Total Costs with Contingency column contains the estimated project costs plus the additional estimated contingency to account for cost uncertainty and the risk of price increases.

**Table 5.2 Summary of Itemized Costs.**

	<b>Estimated Project Costs</b>	<b>Total Costs with Contingency</b>
Bank Stabilization - floodway expansion	\$422,409	\$532,658
Bank Stabilization - stream stability & sediment transport area	\$4,348,655	\$5,483,654
PE&D	\$485,000	\$557,750
S&A	\$601,631	\$691,876
Lands/RE	\$500,000	\$575,000
Relocations	\$44,609	\$56,252
Fish & wildlife facilities	\$228,274	\$287,854
<b>Total Project First Cost</b>	<b>\$6,630,578</b>	<b>\$8,185,043</b>

Both Bank Stabilization cost categories, as well as, the Relocations and Fish & wildlife facilities rows have a 26.1% contingency applied to each respective estimate. Also, the PE&D, S&A, and Lands/RE rows all have a 15% contingency applied. Finally, the Total Project First Cost row displays the sum of both the cost columns. The total project first cost for Total Costs with Contingency column has a combined 23.44% increase for contingency from the first cost of the Estimated Project Costs column sum.

In order to appropriately compare the project costs to the average annual benefits that are estimated to be incurred through project implementation, the total project first cost must be annualized over the life of the project. Federal flood risk management projects are analyzed over a 50 year time horizon. The total project first cost with contingency of \$8,185,043 is the amount carried over for cost annualization. Further calculations for this process are displayed in the Economic Appendix.

Furthermore, to implement the recommended plan, support from the non-federal sponsor and local municipality is needed. In addition, the non-federal sponsor will be required to acquire all real estate needed for the construction and permanent operation and maintenance of the proposed project. This can be done through easement or outright purchase of property. In

support of this project, partners have recently (December 2015) acquired a large portion of the real estate (old airport property) that will be needed for the successful construction and completion of this project. Furthermore, letters of support from the NYSDEC, the proposed future non-federal sponsor, for the recommended plan and a key partner, the Town of Rockland, can be found in Appendix G. A draft real estate plan can also be found in Appendix G.

## **6.0 Environmental Impacts**

### **6.1 Site Description**

#### **6.1.1 Climate**

The USGS study of the projected implications of climate change in the Delaware River watershed showed that with increasing median temperatures in the Beaver Kill and Willowemoc watershed, an increase in winter flows, decreased summer base flows and earlier runoff events are expected. In response, at the regional level, integrated watershed management strategies include protecting and restoring natural systems, recognizing water quantity and water quality linkages, coordinating land and water resources management, and other strategies to address climate change concerns are being utilized.

Although impossible to directly correlate, the preferred alternative is expected to positively impact climate change in the region and its negative effects on the human population. Restoring stream system function, establishing a healthy riparian floodplain, and reducing high flow impacts on developed areas will provide long term positive climate impacts within and around the project area. Short term negative impacts may be expected as a result of CO<sub>2</sub> and other gases emissions during construction.

The USACE commissioned a survey report of climate change studies of the Northeast entitled, *Climate Change and Hydrology Literature Synthesis for the US Army Corps of Engineers Missions in the United States – Mid-Atlantic Region (HUC2)*, October 30, 2014 by CDM Smith. The Mid-Atlantic Literature Synthesis assessed the impact of global climate change to a number of climatologic parameters, but for purposes of this study only precipitation and stream flow are of interest. A majority of the reports predict a moderate increase in both precipitation (annual and monthly) and peak flows. A reasonable consensus exists that the intensity and frequency of extreme storm events will increase in the future. Significant uncertainty exists, however, with respect to the extent of these increases.

The No Action alternative can have a long term negative impact on the climate and developed areas in the project area and region. This alternative would not restore stream function and a healthy vegetated floodplain and riparian area. The potential for increased future flooding and its impact on developed and natural areas would remain. The unhealthy riparian zones will be unable to sequester CO<sub>2</sub> emissions and other gases at its maximum rate resulting in long-term adverse impacts to the regional climate.

#### **6.1.2 Air Quality**

The 1990 Clean Air Act Amendments include the provision of Federal Conformity, which is a regulation that ensures that Federal Actions conform to a nonattainment area's State Implementation Plan (SIP) thus not adversely impacting the area's progress toward

attaining the National Ambient Air Quality Standards (NAAQS). As of January 30, 2015 reporting, Sullivan County New York is within attainment standards established by USEPA.

The air quality at the project site is in attainment with air quality standards for the region (Sullivan County, New York). The proposed action does not require clean air act conformity analysis. The project would be expected to have a short-term, minor, localized effect on air quality due to emissions from construction equipment. Dust levels may rise slightly during land disturbance activities associated with the project. No significant negative long term change in air quality within or around the project area is expected.

The No Action alternative would have no effect on the existing air quality in and around the project area.

### **6.1.3 Topography, Geology and Soils**

Short-term minor impacts are expected to the local topography and soils in the Livingston Manor project area. Expansion of the floodway at the confluence of Willowemoc and Little Beaver Kill creeks will be a permanent change of the topography and soils in that area. In addition, the topography and upper soil layer will be disturbed and modified along the stream restoration portion of the project as a consequence of stream restoration work and riparian buffer construction activities. These areas will have natural contours established and stabilized using vegetation and other “hard” structures where applicable.

Soil erosion is possible from these disturbed areas during construction. An approved sediment and erosion control plan and National Pollution Discharge Elimination System Permit will be secured prior to construction activities commencing. Appropriate sediment and erosion controls will be utilized to prevent impacts to environmental resources in the area. Temporary water bars, straw bales, and other best management practices will be implemented to control temporary run-off to avoid channelization and other construction impacts. No significant long-term negative impacts to topography, geology or soils are expected. Long term positive impacts would include more stable stream banks and reduction of high flow erosive forces.

The No Action alternative would not have a direct impact on the topography and drainage, as no new changes would occur. However, the beds and banks in the project are unstable and contain easily erodible materials such as cobble. These areas would continue to be unstable and erode resulting in a long term negative impact on the topography and soils in the project area.

### **6.1.4 Prime and Unique Farmland**

As per coordination with the Sullivan County Soil District, no prime agricultural soils in the Livingston Manor project area will be affected by the proposed work.

**6.1.5 Land Use, Recreation and Tourism**

No long-term adverse impact to land use, recreation and tourism is expected as a result of the project. Outdoor recreation and tourism and specifically fishing are popular and economically important to the region and are associated, in part, with the open space, waterways, and forested areas found in the project area. A short-term and minimal impact to land use, recreation and tourism is expected during the construction activities. Public access will be restricted in all active construction areas to include riparian and stream areas and outdoor park and picnic areas. Although the public will not be able to access the project area during construction, adjacent stream reaches along the Little Beaver Kill, Willowemoc and other tributaries will be available. Long-term beneficial impacts as a result of the project are expected. Improvements to the stream and riparian habitats associated with the stream stabilization component of the project is expected to significantly benefit the land use, recreation and tourism in the project area and region.

Short-term adverse impacts to aesthetics are anticipated due to the construction activities. Stream, riparian and wetland areas will be constructed to promote a stable and functional aquatic system and will be more aesthetically pleasing than existing conditions. Removal of nuisance vegetation will allow native vegetation and supplemental plantings to compete and ultimately providing more natural landscapes. These actions would result in long-term benefits to the aesthetic resources and ultimately the recreation and tourism of the area.

Temporary impacts due to increased construction noise may be experienced by adjacent homeowners during the construction of the project. Construction activities will require the use of heavy equipment including but not limited to excavators, loaders, and dump trucks. A temporary increase in road traffic noise can also be anticipated. Under normal circumstances, noise will only be generated Monday through Friday during normal working hours and last only during the construction period. No long-term adverse noise impacts would be associated with construction activities.

Under the No Action alternative, conditions in the project area will remain the same or continue to degrade. No positive benefits in land use, recreation and tourism will be realized.

**6.1.6 Hazardous, Toxic and Radioactive Waste**

The 2006 HTRW database search of the project area did not identify any specific HTRW sites within the areas proposed for modification or excavation at that time. Further investigation of the recommended plan areas (old airport stream stabilization and floodway expansion) was conducted in 2015 to better characterize the materials and to sample and analyze materials for chemical constituents and concentrations. The results of this investigation are found in the report titled, *Final Site Investigation Report- Livingston Manor Flood Protection Project, Livingston Manor, Sullivan County, New York prepared by GTS Technologies dated July 2015* (Appendix B). Based on these efforts and results, no hazardous, toxic and radioactive waste impacts are expected as a result of the implementation of the project.

It is possible that the properties within the study areas could be subjected to spills, leaks, etc. during normal construction activities. All contractors performing work on the project will be required to maintain a Health and Safety Plan as per the USACE Safety and Health Requirements Manual EM 385-1-1 dated 03 September 1996 (Updates). Fueling and equipment maintenance guidelines to prevent accidental spills of fuel and oils during operations will be strictly enforced. No significant long-term impacts as a result of hazardous, toxic, and radioactive substances are expected.

The No Action alternative would have no impact on hazardous materials or substances as no changes or construction in the project area would occur.

### **6.1.7 Wild and Scenic Rivers**

The project area is not a wild and scenic river but is found within the watershed of the Upper Delaware Scenic and Recreational River. The Wild & Scenic Rivers Act 1968 PL 92-542 classifies scenic rivers as rivers that are free of impoundments, contain watersheds and shorelines largely primitive and undeveloped but are accessible in places by roads. Recreational rivers are rivers or sections of rivers readily accessible by roads or railroads, may have some shoreline development, and may have past impoundments or diversions.

The project will have no long term negative impacts on the Upper Delaware Scenic and Recreational River. Located on a tributary, the stream stabilization component of the project will have a long term positive impact in the immediate project area and downstream in the tributary network of the Upper Delaware Scenic and Recreational River.

The No Action alternative would allow unstable conditions to persist in the project area. These existing conditions not only impact the immediate project area, but have the potential to continue downstream.

### **6.1.8 Aquatic Resources and Wetlands**

#### **6.1.8.1 Surface Waters**

The New York State water body classification for primary waters in the project area include swimming, recreation and fishing with a designation as trout waters. No long-term adverse impacts to these classifications and to the surface waters in the project area are expected as a result of the project. Short term impacts may occur during construction activities associated with developing the stable stream channel, floodway expansion, and riparian areas for the project. These short term impacts will be minimized by insuring all necessary precautionary measures are implemented to ensure that the Little Beaver Kill and Willowemoc Creek surface water resources are protected from harmful discharges that may adversely affect aquatic life, and/or their recreational use. Some of these precautionary measures would include erosion and sediment controls, environmentally sound construction sequences, and others as established by the resource and permitting agencies.

Overall, the surface water quality of the Little Beaver Kill and Willowemoc Creek are very good to excellent. Seasonal high water temperatures and thermal stress is the main water quality concern and the main limiting factor affecting aquatic species in the project area. The major overlying factors impacting water quality include loss of riparian and instream cover, historic stream gravel mining activities, sedimentation, unstable stream channel geometry, stormwater management, and loss of floodplain connectivity in the project area. Long-term significant beneficial impacts as a result of the project are expected by restoring a stable and functioning stream system with floodplain connectivity and an improved riparian buffer.

Under the No Action alternative, conditions in the project area will remain the same or continue to degrade. No positive benefits in surface water quality will be realized.

#### 6.1.8.2 Stream Habitat and Stability

The floodplain and stream system function in the existing project area has been negatively impacted over time. Restoring function and improving 1.0 mile of stream mesohabitats (pool, riffle, and run), structure, sediment transport, riparian cover, channel sinuosity and thalweg, bank and bed stability and other aspects of the channel and riparian areas will result in positive and long term impacts on stream habitat and stability in the project area and watershed. In addition, by restoring flood plain connectivity, long term minor benefits would result from low frequency flood flows attenuation which will positively impact the overall stream habitat and stability in the project area. A short-term and minimal impact to stream habitat and stability is expected during the construction activities.

Under the No Action alternative, conditions in the project area will remain the same or continue to degrade. No positive benefits in stream habitat and stability will be realized.

#### 6.1.8.3 Groundwater

Floodway expansion, stream restoration, and riparian area restoration will involve land surface construction activity. Due to the nature of these construction activities, no negative short or long-term impacts on groundwater resources in the project area are expected. By increasing the floodplain connectivity in the project area and the potential of floodplain stormwater storage using expanded floodplains, wetland depressions, and a healthy riparian zone, it is expected that groundwater recharge in the project area may increase.

The No Action alternative would have no impact on groundwater resources as no changes or construction in the project area would occur.

#### 6.1.8.4 Wetlands

During the construction process of establishing stream channel sinuosity alignment and modifying floodplain elevations to improve floodplain function, approximately 0.75

acres of permanent wetland impacts are expected as a result of the project. One wetland being impacted is located within the Livingston Manor Rotary Park (approximately .25 acres). Other small pockets (total .50 acres) of wetland, outside of the main stream channel, along the project length stream fringe may also be negatively impacted during construction. These small wetland pockets are located within the existing floodplain and appear to be abandoned channels and relic side channels that maintain hydrology during portions of the year. These wetlands are classified palustrine scrub/shrub broad leaved deciduous and are seasonally flooded and saturated.

Impacts to these wetland areas cannot be minimized or avoided due to the extent of new channel alignment and construction activity for floodplain modifications. It is believed that the long-term negative impact to the existing wetlands will be offset with the long term significant positive impacts to the aquatic resources of the Little Beaver Kill. To “mitigate” for the potential loss of wetland function, all available floodplain areas will be designed to capture and temporarily hold water. Lower elevation floodplain depressions will be constructed along the newly developed channel and floodplain. In general, floodplain areas will be designed to capture and temporarily hold floodplain flows for extended infiltration rates and will be planted with floodplain/wetland seed mixes and native floodplain trees. This effort does not constitute mitigation for wetland losses but is an effort to enhance floodplain and future natural development of wetland function at little to no added cost to the project. The greatest ecological and environmental benefits of the project will be the restoration of instream habitats, native vegetative communities, and the creation of a stable and functioning channel and floodplain.

As the project moves forward into additional phases of study or design, coordination with applicable resource agencies will be pursued to determine whether or not the functioning lift of the project offset these wetland losses. No net loss of wetland function is expected to occur as a result of the project and no mitigation for these resources is anticipated. It has been determined that the proposed project will not significantly negatively affect water quality or the aquatic ecosystem, and has been found to be in compliance with Section 404(b)(1) of the Clean Water Act, as amended (Section 6.4). This wetlands and waters of the United States impact assessment is based on available information at this time. As the project moves into an additional phase of design, further study may show more or less expected impact. The potential impacts on these resources will be further evaluated at that time.

The No Action alternative would have no impact on existing wetland resources in the project area and no long term positive benefit would be realized from this as the stream system continues to degrade and be plagued by invasive species.

### **6.1.9 Vegetation**

A long term positive impact on vegetation within the project area is expected as a result of the project. The floodplain in the airport project area are open monotypic grass meadow dominated habitat that provides little stream bank and floodplain soil stability and

ecological value. Areas in and around the stream gravel ponds are dominated by monotypic stands of invasive Japanese Knotweed (*Fallopia japonica*) that out compete native species and provide little stream bank and floodplain soil stability and ecological value. These vegetative communities are a result of the anthropogenic disturbances in the watershed and do not provide the ecological or floodplain function that native plant communities would normally.

As part of the project, these areas will be converted into wetland depressions, upland and riparian zones. Native trees, shrubs and wetland and upland seed mixes will be planted in the disturbed areas associated with the project. Some natural re-vegetation within these areas is expected. The Corps will work closely with applicable resource agencies and interests in developing a re-vegetation plan for the project. The implementation of the planting plan will provide improvements to the quality and distribution of species composition and diversity across the landscape. As a result, the ecological and floodplain function in the project area would also improve.

The No Action alternative would allow the low quality and limited distribution of plant species across the landscape to continue to negatively impact the ecology and floodplain function in the project area. Poor root zones will allow bank and other erosion to continue resulting in unchecked sedimentation entering the stream. Continued long term adverse impacts to the project area would be expected.

#### **6.1.10 Invasive Species**

Many species of non-native invasive plants and animals are known to be currently established in the region. However, Japanese Knotweed is the most ubiquitous invasive species in the project area. Disturbed areas in the project area have become dominated by this non-native plant species. It provides little in the way of wildlife habitat, stream bank cover, soil stability, leaf litter for stream ecological processes, and out competes native vegetation. As part of the project, a construction and long term management plan to control the spread and growth of this species in the project area is needed. By working with partners to include the Catskill Regional Invasive Species Partnership, the Corps will develop a Japanese Knotweed invasive species management plan for the project. By reducing the current density of Japanese Knotweed in the area, controlling its spread, and replanting of native species, a more well balanced and stable ecological community will be developed.

#### **6.1.11 Wildlife Resources**

Birds, mammals, reptiles and amphibians are capable of moving, and would be expected to leave the project construction areas and relocate to areas in the immediate vicinity. Species that reside in these adjacent areas may be temporarily impacted by increases in species densities. Due to the amount of adjacent nearby habitat, it is expected that no significant adverse impact to wildlife resources will occur as a result of this project. Construction schedules and methodology will be based, in part, on timing restrictions

established by the resource agencies to protect species currently utilizing the project area. Coordination is ongoing with appropriate agencies.

Numerous wildlife species such as birds, mammals, reptiles, and amphibians will benefit from the positive changes in riparian and floodplain plant communities, and wetland and instream habitats associated with the project. Positive benefits in aquatic and terrestrial nesting, foraging, resting, cover and other habitats are expected. More than 200 species of birds have been documented in the Catskills. Many of these species are Migratory birds and are protected under the Migratory Bird Treaty Act. It is anticipated that migratory birds will benefit from the improvement of the vegetative community and ecology as a result of the project. In an effort to protect migratory birds during construction activities and to maximize the habitat improvements to the area, recommendations made by the U.S. Fish and Wildlife Service to avoid, minimize, and improve the bird habitat will be incorporated into the project wherever feasible (see Appendix B).

The No Action alternative would continue to have a negative impact on a variety of wildlife. The lack of proper flood plain connectivity, lack of well-established floodplain habitats, monotypic stands of invasive Japanese Knotweed, mowed grass areas at the airport site, and an unstable stream channel lacking quality habitats would persist and the overall value of the wildlife habitat would remain low. Habitats that do currently exist would continue to degrade.

#### 6.1.11.1 Finfish and Invertebrate Species

Aquatic life in the form of invertebrates and finfish inhabit the waters of the Little Beaver Kill, Willowemoc, and Cattail Brook watersheds in the project region. In general, aquatic organisms found in Catskill streams include invertebrates, mollusks, and fish. As a direct result of approximately 1.0 mile of physical instream stabilization work in the Little Beaver Kill, unavoidable short term (construction) and permanent (changes in channel form) impacts are expected on these aquatic species. Some finfish and invertebrates are mobile and would be expected to leave the stream construction areas and temporarily relocate to areas in the immediate vicinity. Staged construction activities will also reduce the short term impact on aquatic species as the construction will occur over a period of 9 months.

Portions of stream and riparian habitats currently being utilized by species in the project area will be removed as a consequence of constructing the new stable stream channel and riparian areas. The riparian and instream habitat enhancement efforts associated with the project will greatly offset these minor impacts. Significant long term beneficial impacts on finfish and invertebrates are expected by restoring a stable and functioning stream form and profile, creating instream habitats, and developing a functioning riparian zone. Salmonid species play an important ecological and economic role in the region. The stream and riparian habitat enhancement efforts will benefit those species. Improved biological conditions throughout the project area and further downstream is expected. As a result, no significant adverse impacts to invertebrate and finfish resources will occur as a result of this project. Any timing and other restrictions recommended or required by the resource agencies

will be considered or implemented to protect invertebrates and finfish species during project construction scheduling.

The No Action alternative would continue to have a negative impact on aquatic life. The lack of proper flood plain connectivity, unbalanced instream sediment supply, low riparian stream bank cover, and an unstable stream channel lacking quality riffle, run and pool habitats would persist and the overall value of the aquatic habitat would remain low. Habitats that do currently exist would continue to degrade.

### 6.1.12 Threatened and Endangered Species

It is anticipated that the selected alternative will not adversely affect state or federally listed species. Coordination with various Federal and State natural resource agencies was conducted and is ongoing to identify any threatened and endangered species that may be utilizing the project area. Threatened and endangered species have been found in the project's regional area but not within the immediate project area. Bald Eagle (*Haliaeetus leucocephalus*) nests are found in the region and are at least 10 miles from the project site. Other than the State-listed endangered bald eagle being observed in the project area, no other species potentially utilizing the area have been identified. Since the original USFWS coordination for the project, the Northern long-eared bat (*Myotis septentrionalis*) has been listed as a threatened species and is found within the project area and impacts to its habitat are possible. Through continued informal and formal consultation with the USFWS, Cortland, New York Field Office, a management approach for the project is needed to protect this species and its potential habitats in the area. The presence of roosting size trees within the project footprint is minimal with the majority of the project area containing meadow and shrub habitats. All potential roosting trees within the stream and riparian area alignment, that do not have to be removed for construction, will remain. Pre-construction surveys to determine the presence or absence of roosting trees will be performed in the next phase of the study. In addition, if trees suitable for roosting bats are found in the project area, seasonal restrictions (tree cutting authorized October 1st-March 31st) on tree removal activities will be instituted during construction to minimize any impacts on federally listed bats. Minor or no impacts to this species or its habitats are expected.

Due to the nature of this project and the mobility of the majority of species of concern, no significant negative impact to rare, threatened, and endangered species or their habitat is expected from the proposed action. Coordination under the Fish and Wildlife Coordination Act with the U.S. Fish and Wildlife Service is ongoing, and a final Section 2(b) letter will be received for this project prior to construction. In addition, the U.S. Fish and Wildlife Service is a partner on the project and designed the stream stability portion of the project. Recommendations developed through this coordination and partnership shall be considered for the project. The Corps will make all efforts to comply with all avoidance and construction timing restrictions recommended by the Federal and State resource agencies.

The No Action alternative would have no impact on rare, threatened, or endangered species in the immediate or surrounding areas. However, it should be noted, that the No-

Action alternative would allow the existing stream and riparian habitats to remain in their degraded state and continue to potentially not provide habitats for rare, threatened, or endangered species.

### **6.1.13 Cultural Resources**

A Phase IA cultural resource investigation was conducted for the feasibility study. The results of this investigation are found in the report titled, *Phase IA Historic Resources Investigation Technical Report, Livingston Manor, Sullivan County, New York* prepared by A.D. Marble and Company dated March 2010.

Ten alternatives were assessed during this investigation, and recommendations regarding the need for further analysis were provided. The recommended plan is a combination of elements of Alternatives 6, 8 & 9, and based on the recommendations of the report, additional above-and below-ground investigation will be needed in order to determine effects to historic properties.

In order to demonstrate compliance with Section 106, while allowing for the completion of the Section 106 process under the CAP authority, the USACE, in consultation with the Tribes, the SHPO, and the non-federal sponsor will develop and execute a Programmatic Agreement in accordance with 36 CFR § 800.6 and § 800.14 (b)(1)(ii).

A draft Programmatic Agreement (PA) was coordinated with the New York State Parks, Recreation & Historic Preservation Office, and the Tribes, consisting of the Delaware Tribe, the Delaware Nation, the Saint Regis Mohawk, the Stockbridge-Munsee Community of Mohican Indians, the Eastern Shawnee and the Oneida Nation in June of 2015. Comments were received and incorporated into the final document, and the final PA will be sent out for execution.

### **6.1.14 Infrastructure and Transportation**

The construction of the restoration project will slightly increase vehicular traffic on nearby roads surrounding the project area. Residents may be temporarily inconvenienced during the construction activities. However, project activities will be short-term and temporary and are not expected to significantly impact existing transportation routes. Temporary road and bridge closures and traffic delays are potential impacts on transportation in Livingston Manor during construction. These impacts will be short term and temporary in nature and the Corps will work with the local municipality in reducing any impacts the project may have on local travel. All utilities and utility right of ways have been identified in the project area. Some utilities will need to be relocated prior to construction of the recommended plan.

The No Action alternative would have no impact on infrastructure and transportation in the project area as no construction in the project area would occur.

**6.1.15 Socioeconomic Conditions**

Recreation and tourism are important economic considerations for Sullivan County. In addition to those, recreational angling is an important economic driver for the Livingston Manor project area and region. As a result of construction activities and the ultimate restoration of the stream and floodway, both short term negative impacts and long term positive impacts on the socioeconomic conditions in the project area are expected.

Short-term and temporary impacts on tourism and recreation may occur during construction. Construction activities will occur in the floodplain and stream. These activities will limit public access for recreation (wildlife viewing, angling, and others) and ultimately reduce the outdoor experience for tourists. During the construction period, it would be expected that reduced recreation and tourism will have a short term and temporary negative impact on the local economy.

Following the completion of the project, long-term positive impacts on socioeconomic conditions are expected. Improvements in vegetative floodplain communities, instream habitats, and the viewshed within the riparian buffer area will benefit both the natural environment and the recreation and tourism industry in the Livingston Manor project area. Public access will increase and the outdoor experience will be greatly enhanced. This increased recreation and tourism will have a long term positive and permanent impact on the local economy.

The No Action alternative has potential for long-term minor negative impacts on the area due to the continued reduction in recreational and outdoor opportunities as a result of the current and continued instability of the stream channel, lack of instream and riparian habitats, and their impacts on the socioeconomic conditions in the project area.

**6.1.16 Environmental Justice**

The project area is considered a census defined “poverty area” but is not considered to be one of a minority population. No disproportionate high and adverse human health or environmental effects on this “poverty area” are expected as a result of the Livingston Manor project. The project will comply with Executive Order 12898 and no adverse impact on any minority or low-income communities is expected. In addition, this project is in compliance with Executive Order 13045 - Protection of Children from Environmental Health Risks and Safety Risks. The No Action alternative would have no impact on environmental justice resources.

**6.1.17 Cumulative Impacts**

According to CEQ regulations, the cumulative impact is defined as the impact on the natural and human environment, which results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless

of who undertakes these actions. The proposed action must be evaluated with the additive effects of other actions in the project area to determine whether all the actions will result in a significant cumulative impact on the natural and human environment of the area.

No other known significant activities are planned within the project area and region that could potentially cumulatively affect the Livingston Manor project. It is expected that positive cumulative effects, as a result of the flood way, stream, and floodplain restoration in the project area will be realized. In addition, incidental positive cumulative effects from increased public access and recreational use are expected. All negative impacts associated with this project are short-term and minor. As a result, it is anticipated that future environmental benefits in both the Livingston Manor project area and surrounding watershed will be realized with respect to floodwater attenuation, stream stability resulting in reduced sediment loads and increased aquatic habitats, and direct physical improvements in riparian, wetlands, and instream habitats. It has been determined that there will be no cumulative negative impacts as a result of this project and long term positive cumulative impacts will be realized.

#### **6.1.18 Environmental Permits and Regulatory Compliance**

Compliance with environmental quality protection statutes and other environmental review requirements is ongoing and will be completed in the next phase of the project. A summary of project compliance with applicable federal environmental statutes and executive orders is provided in Table 6.1.

Work in waters of the United States, including wetlands, must be in compliance with Section 404 of the Clean Water Act. Therefore, a review of impacts associated with the potential discharge of fill material has been performed as per Section 404(b)(1) of the Clean Water Act (Section 6.4). It is believed that as a result of the stabilization of approximately one mile of stream reach that includes improvements and enhancements of channel morphology, instream and floodplain habitats, and floodplain and instream function that this project complies with Section 404(b)(1) of the Clean Water Act through U.S. Army Corps of Engineers Nationwide Permit authorizations under Section 404(e) of the Clean Water Act for wetland and stream restoration activities. Specifically, the project will comply with Nationwide Permit 27 *Aquatic Habitat Restoration, Establishment, and Enhancement Activities*. Nationwide Permit 27 authorizes the relocation of non-tidal waters, including non-tidal wetlands and streams, on the project site provided there are net increases in aquatic resources functions and services. The requirements of Executive Order 11990, Protection of Wetlands, are therefore met as a result of minimization of impacts to waters of the United States.

Work in waters of the United States, including wetlands, must be in compliance with Section 401 of the Clean Water Act. The New York State Department of Environmental Conservation is responsible for issuance or waiver of the Section 401 State water quality certification for any work, which may affect water or waterways in the state through their Protection of Waters Regulatory Program. As a project partner, the Corps will work closely

with the Department of Environmental Conservation to obtain necessary state approvals, including a Section 401 State Water Quality Certification prior to construction. Section 401 of the Clean Water Act Water Quality Certification is granted for the Nationwide Permit 27 in New York State by the New York State Department of Environmental Conservation if the project complies with all general conditions of the nationwide permit and specific state conditions. It is believed that the project will meet all applicable conditions for permit usage and will also be eligible for a blanket New York State 401 water quality certification.

Work in waters of the United States, including wetlands, must be in compliance with Section 404 of the Clean Water Act. Therefore, a review of impacts associated with the potential discharge of fill material has been performed as per Section 404(b)(1) of the Clean Water Act (Section 6.4). The requirements of Executive Order 11990, Protection of Wetlands, are therefore met as a result of minimization of impacts to waters of the United States.

The EPA delegated responsibility for National Pollutant Discharge Elimination System permits to New York in 1992. A State Pollution Discharge Elimination System permit will be secured from the Sullivan County Soil and Water Conservation District and the New York State Department of Environmental Conservation as applicable. In the State of New York, one or more acres of soil disturbance for a construction project must create a Soil Erosion and Sediment Control Plan and have it certified by the local District before any construction may commence to ensure that the project meets guidelines found in New York State Standards and Specifications for Erosion and Sediment Control dated August 2005. An approved Plan will be secured from the Sullivan County Soil and Water Conservation District prior to the start of construction activities for the project. Erosion and Sediment Control regulations and plans will be kept on site during all construction activities. Best management practices including stabilization of any disturbed areas will be employed.

## **6.2 Coordination**

The proposed project has been coordinated with the U.S. Fish and Wildlife Service (New York Field Office), U.S. Environmental Protection Agency Region 2, Delaware River Basin Commission, New York State Department of Environmental Conservation (numerous offices), Sullivan County Soil and Water Conservation District, United States Department of Agriculture, New York State Historic Preservation Office, Federal Emergency Management Agency Region 2, New York State Department of Transportation, and numerous other interests in the region. Copies of correspondence with Federal, State and local interests are provided in Appendix B.

<b>Table 6.1. Compliance with Applicable Federal Environmental Statutes and Executive Orders</b>	
<b>Federal Environmental Statutes</b>	<b>Compliance</b>
Clean Air Act, as amended (Public Law 88-206)	FULL
Clean Water Act, as amended (Public Law 95-217)	PARTIAL
Endangered Species Act of 1973, as amended (Public Law 93-205)	PARTIAL
Federal Insecticide, Fungicide, and Rodenticide Act (7 United States Code [U.S.C.] 136 et seq)	FULL
Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661, et seq.)	PARTIAL
Magnuson-Stevens Act	N/A
Migratory Bird Conservation Act (16 U.S.C. 715 to 715s)	PARTIAL
National Environmental Policy Act of 1969 (Public Law 91-190)	PARTIAL
National Historic Preservation Act of 1966, as amended (Public Law 89-665)	PARTIAL
Noise Control Act of 1972, as amended	FULL
Resource Conservation and Recovery Act (Public Law 94-580)	FULL
Rivers and Harbors Act	FULL
Water Resources Development Act of 1990 (PL 101-640)	FULL
Watershed Protection and Flood Prevention Act of 1954 (16 U.S.C. 1101, et seq.)	FULL
Wetlands Conservation Act (Public Law 101-233)	FULL
Wild and Scenic Rivers Act	FULL
<b>Executive Orders</b>	<b>Compliance</b>
Protection of Children from Health and Safety Risks (EO 13045)	FULL
Flood Plain Management (Executive Order 11988)	FULL
Protection of Wetlands (Executive Order 11990)	FULL
Federal Compliance with Pollution Standards (Executive Order 12088)	PARTIAL
Environmental Justice in Minority and Low-Income Populations (Executive Order 12898)	FULL
Recreational Fisheries (Executive Order 12962)	FULL
National Historic Preservation Act of 1969 (Executive Order 11593)	PARTIAL

**6.3 Environmental Summary**

This Environmental Assessment has evaluated potential environmental impacts associated with the flood protection project at Livingston Manor, New York. The findings herein have been prepared in accordance with the National Environmental Policy Act of 1969, as amended. The preferred alternative of floodway widening and stream stabilization was selected based, in part, on coordination with Federal and State resource agencies. This alternative provides flood risk benefits, restores the stability and function of the stream channel, and improves the riparian buffer in the floodplain.

The preferred alternative will have minor short-term negative impacts (Table 6.2). These impacts can be expected as a result of construction activities associated with excavation, filling, grading and construction of the floodplain and stream channel. Site specific design and construction prescriptions provided by the resource agencies that insure adequate protections are incorporated into the project to minimize negative impacts and protect existing resources during project implementation. Long term beneficial impacts are expected with flood risk benefits, floodplain and stream function and habitat with incidental benefits of improved water quality and recreation. Based upon the evaluation of environmental effects, the beneficial aspects outweigh the adverse minor impacts of the proposed action and no significant adverse impacts from the Proposed Action are expected.

**Table 6.2 Summary of Effects of Proposed Action and No Action Alternative**

<b>Resources</b>	<b>Proposed Action</b>	<b>No Action</b>
Climate	Short-Term Minor Adverse Impact Long-Term Minor Beneficial Impact	Long-Term Minor Adverse Impact
Air Quality	Short-Term Minor Adverse Impacts	No Impact
Topography, Geology and Soils	Short-Term Minor Adverse Impact Long-Term Minor Beneficial Impacts	Long-Term Minor Adverse Impact
Prime And Unique Farmland	No Impact	No Impact
Land Use, Recreation and Tourism	Short-Term Minor Adverse Impacts Long-Term Beneficial Impacts	No Impact
Hazardous, Toxic, And Radioactive Substances	No Impact	No Impact
Wild and Scenic Rivers	Possible Long-Term Minor Beneficial Impacts	No Impact
Aquatic Resources and Wetlands	Short-Term Minor Adverse Impacts Long-Term Major Beneficial Impacts	Long-Term Minor Adverse Impact
Terrestrial Vegetation	Long Term Major Beneficial Impacts	Long-Term Minor Adverse Impacts
Wildlife Resources and Fisheries	Short-Term Minor Adverse Impacts Long Term Major Beneficial Impacts	Long-Term Minor Adverse Impacts

Rare, Threatened And Endangered Species	Long-Term Minor Beneficial Impacts	Long-Term Minor Adverse Impacts
Cultural Resources	No Impact	No Impact
Infrastructure and Transportation	Short-Term Minor Adverse Impacts	No Impact
Socio-Economic Conditions	Short-Term Minor Adverse Impacts Long-Term Minor Beneficial Impacts	Long-Term Minor Adverse Impacts
Environmental Justice	No Impact	No Impact

**6.4 Section 404(b)(1) Analysis**

A review of the impacts associated with discharges to waters of the United States for the Livingston Manor Project in Sullivan County, New York is required by Section 404(b)(1) of the Clean Water Act, as amended (Public Law 92-500). The following 404(b)(1) analysis is based on available information of potential impacts to waters of the United States at this phase of project development. As the project moves into future phases with more detailed wetland delineation, stream sediment load analysis, and project designs, an update of the 404(b)(1) analysis may be warranted.

It is believed that as a result of the stabilizing approximately one mile of stream reach that includes improvements and enhancements of channel morphology, instream and floodplain habitats, and floodplain and instream function that this project complies with Section 404(b)(1) of the Clean Water Act through U.S. Army Corps of Engineers Nationwide Permit authorizations under Section 404(e) of the Clean Water Act for wetland and stream restoration activities. Specifically, the project will comply with Nationwide Permit 27 *Aquatic Habitat Restoration, Establishment, and Enhancement Activities*. Nationwide Permit 27 authorizes the relocation of non-tidal waters, including non-tidal wetlands and streams, on the project site provided there are net increases in aquatic resources functions and services.

Section 401 of the Clean Water Act Water Quality Certification is granted for this Nationwide Permit in New York State by the New York State Department of Environmental Conservation if the project complies with all general conditions of the nationwide permit and specific state conditions. It is believed that the project will meet all applicable conditions for permit usage and will also be eligible for a blanket New York State 401 water quality certification.

**I. Project Description**

**A. Location.** The proposed project is on the Little Beaver Kill, in the Village of Livingston Manor, Town of Rockland, Sullivan County, New York. Livingston Manor (population 1,482) is about 76 miles northwest of New York City and is in New York’s 22<sup>nd</sup> Congressional District. The project area begins at the confluence of the Little Beaver Kill

and Willowemoc Creeks and extends upstream on the Little Beaver Kill approximately 1 mile from the Main St. Bridge in Livingston Manor.

B. General Description. The Little Beaver Kill (Hydrologic Unit Code # 02040102) is a third-order tributary to the Willowemoc Creek in the Catskill Mountains. The headwaters of the Little Beaver Kill are at North Pond, approximately 2 miles southwest of the Village of Willowemoc, New York. The river flows approximately 12 miles to Livingston Manor, where it joins the Willowemoc Creek approximately 900 feet downstream of the Main St. Bridge in Livingston Manor. At its confluence with the Willowemoc Creek, the Little Beaver Kill has a mean daily discharge of 45 cfs and a drainage area of approximately 23 square miles. The watershed is primarily forested.

C. Purpose. The goal of the project is to provide flood relief to the Town of Livingston Manor by improving flood plain function, improve instream sediment transport within Little Beaver Kill Creek through stream stabilization efforts, and improve instream, riparian habitats along a 1 mile reach of Little Beaver Kill upstream of Livingston Manor.

D. General Description of Dredged or Fill Material

There are two types of discharges associated with this project: Construction of a new channel and realignment of the stream will require direct instream work and eventually the filling of the old existing channel using onsite fill material graded from the floodplain area; and the placement of rock in the river for habitat and flow control structures and protection of bridge abutments.

1. General Characteristics of Material

The USDA soil survey for Sullivan County, New York indicates that the soils within the project area are composed of the following soils described below:

Bash silt loam  
Fluvaquents-Udifluvents complex, frequently flooded  
Suncook fine sandy loam  
Ud-Udorthents, smoothed

Geotechnical evaluations of the on-site floodplain soils throughout the project area confirm soil survey classifications in the study area and indicate that gravel, sand, and silt are the prevalent soils within the study area and were generally alluvial soils typical of floodplain soils. In-situ densities range from loose to very dense, with most soils being medium dense to dense. Laboratory classifications of the soils included: well graded gravel with silt and sand, poorly graded gravel with silt and sand, silty gravel with sand, silty sand, silty sand with gravel, poorly graded sand with silt and gravel, and sandy silt.

2. A. Stabilization of bridge abutments and creation of instream habitat structures will require rock found on site or secured from a local quarry and consist of R6 stone and river stone found on site (various sizes)

B. Existing sediment and floodplain materials in the project area consist of sands/gravels/cobbles.

3. Quantity of Discharge (estimated):

A. The widening of the area around the Main St. Bridge will consist of the removal of 2,676 cubic yards of floodplain materials and the placement of 878 cubic yards of R6 stone for stabilization of bridge abutments.

B. The 1 mile of stream stability work involves the construction of a new stream channel and abandonment of the existing channel in many areas. Approximately 9 acres of stream channel below the Ordinary High Water Mark (OHWM) will be filled and replaced with a stable channel. Work will be accomplished in the dry whenever possible.

4. Source of Material:

A. Bridge abutment stabilizations will use stone secured from local quarries.

B. River bank and floodplain soils existing on site will be reused for the project.

E. Description of Discharge Sites

1. Location:

A. Instream channel work and relic channel filling will occur throughout the length of the project area. Instream stone and wood habitat structures will be placed in the channel at various locations necessary for a stable design and to provide instream habitat along the 1 mile stretch of river.

B. The floodplain will be lowered and stabilized at the Main Street bridge.

2. Size (acres):

A. 1 mile of stream channel (9 Acres of filled channel)

B. Bridge abutment: 0.04 acres

3. Type of Sites: cobble/gravel river bottom

4. Type of Habitat: riverine

5. Timing and Duration of Discharge:

A. Total project construction is approximately 9 months. The timing and duration of discharges will be based on construction sequences, environmental restrictions, and other factors. All efforts will be made to minimize impacts on waters and wetlands of the United States.

B. Floodway widening and bridge abutment: 4 weeks working in the floodplain of the stream channel.

F. Description of Discharge Method

As a result of creating a new stable stream alignment and channel throughout the project area, the method of discharge will involve direct filling of some sections of existing unstable stream channel and the restoration and stabilization of others.

## II. FACTUAL DETERMINATIONS

### A. Physical Substrate Determinations

1. The project is designed with channel water surface slopes falling within the range of acceptable values for the stream type being created. The new channel water surface will have an average slope of 0.0029 ft/ft to 0.00038 ft/ft with specific slope designs dependent on the stream reach location and meso-habitat feature (riffle, run, and pool).

2. Sediment Type: sand/cobble/gravel/river stone

3. Fill Material Movement: Whenever possible, fill material placement and new channel construction will be conducted in the dry using a bypass system. Disturbed and newly constructed areas will be stabilized. In channel sediment re-deposition by natural processes will occur once the new stream channel is completed. The channel and slope is designed to function under the watershed sediment supply. Any potentially unstable fill material will be allowed to move downstream or be redistributed naturally in the system.

4. Physical Effects on Benthos: Temporary, major effect on the benthos during stream channel construction; however, it's likely the benthos will quickly re-colonize the area after the channel is completed.

5. Actions taken to Minimize Impacts: The project construction will be sequenced to minimize impacts to aquatic resources. Work in waters and creation of the new channel and alignment will be performed as quickly as possible to minimize the amount of time equipment will need to be in the stream channel and any associated impacts of interrupted natural flows.

### B. Water Circulation, Fluctuation and Salinity Determinations

1. Water:

a. Salinity – No effect

b. Water Chemistry – Temporary, minor effect

c. Clarity – Temporary, major effect

d. Color - No effect

- e. Odor – No effect
- f. Taste - No effect
- g. Dissolved Gas Levels – Positive effect. Instream ponded areas will be restored to riffle and pool complexes resulting in increased turbulence and gas exchange.
- h. Nutrients – No effect
- i. Eutrophication – No effect
- j. Temperature - Positive effect following removal of instream gravel pit causing heating of water. Area of low velocity pooled water will be a free flowing stream maintaining cooler water temperatures. Riparian vegetation will decrease water temperatures over time.

2. Current Patterns and Circulation:

- a. Current Patterns and Flow – Temporary, major effect on flow and patterns during construction of the new stream channel. The area should reach a stabilized equilibrium in a relatively short time period following construction.
- b. Velocity - Temporary, major effect on velocities with the removal of instream ponded areas. A permanent positive effect is expected in the flow velocities as a result of the new stream morphology.
- c. Stratification – No effect

3. Normal Water Level Fluctuations – Positive and long term effects are expected from improving channel morphology, providing access to the existing and widened floodplain, and in overall stream function.

4. Salinity Gradients – No effect

5. Actions That Will Be Taken To Minimize Impacts: Construction sequencing

C. Suspended Particulate/Turbidity Determinations

- 1. Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Fill Site: Temporary, major effects during stream and floodplain construction activities. The area should reach a stabilized equilibrium in a

relatively short time period with a positive effect on long term suspended particulates and turbidity levels as a result of stabilizing eroding areas.

2. Effects on Chemical and Physical Properties of the Water Column:
  - a. Light Penetration: Temporary, minor effect.
  - b. Dissolved Oxygen: Temporary, minor effect.
  - c. Toxic Metals and Organics: No effect.
  - d. Pathogens: No effect.
  - e. Aesthetics: Temporary, major effects during the construction period. Site should stabilize quickly and planting plan will be in place for any exposed and graded riverbanks and created wetland areas.
  - f. Temperature: Short term no effect. Long term positive effects following removal of the instream gravel pit causing heating of water. Area of low velocity pooled water will be a free flowing stream maintaining cooler water temperatures. Riparian vegetation will decrease water temperatures over time.
3. Effects on Biota:
  - a. Primary Production, Photosynthesis: Temporary, minor effect on production due to increases in turbidity and reduction of main channel flows during channel construction. The area should reach a stabilized equilibrium in a relatively short time period following construction.
  - b. Suspension/Filter Feeders: Temporary, major effect on production due to increases in turbidity during channel construction. The area should reach a stabilized equilibrium in a relatively short time period following construction.
  - c. Sight feeders: Temporary, major effect on production due to increases in turbidity during channel construction. The area should reach a stabilized equilibrium in a relatively short time period following construction.
4. Actions Taken to Minimize Impacts: The impacts to aquatic resources will be minimized by applying a sequenced channel construction and filling approach.

Channel construction will occur as quickly as possible to minimize the amount of time equipment will need to be in the stream channel or flow alterations are needed. Guidelines and recommendations provided by the resource agencies will be implemented.

D. Contaminant Determinations

1. Environmental testing and evaluation of the soils indicate that no chemical contaminants of concern were encountered in any of the floodplain borings within the project area. No visual evidence of contamination was observed and analytical results indicated there were no chemical concentrations of contaminants above cleanup thresholds.

E. Aquatic Ecosystem and Organism Determinations

1. Effects on Plankton: Temporary, minor effect on production due to increases in turbidity during stream construction. The area should reach a stabilized equilibrium in a relatively short time period.
2. Effects on Benthos: Temporary but permanent effect for those portions of the channel being filled. The area should reach a stabilized equilibrium in a relatively short time period following construction as a result of benthic invertebrate migration from upstream and downstream areas.
3. Effects on Nekton: Temporary and permanent impact in those areas of the channel being filled. Some species are expected to move outside the construction area. The newly stabilized stream channel will likely provide more habitat than the existing conditions and the stream channel is expected to naturally repopulate following construction.
4. Effects on Aquatic Food Web: Temporary, minor effect on overall production in the construction reach. The area should reach a stabilized equilibrium in a relatively short time period following construction and the project is expected to provide for greater species diversity and healthier aquatic food web.
5. Effects on Special Aquatic Sites
  - a. Sanctuaries and Refuges: No Effect
  - b. Wetlands: During the construction process of establishing stream channel sinuosity alignment and modifying floodplain elevations to improve floodplain function, approximately 0.75 acres of permanent floodplain wetland impacts are expected as a result of the project.
  - c. Tidal flats: No Effect

- d. Vegetated Shallows: No Effect
- e. Stream riffle: The existing channel is highly degraded and unstable. The new channel will be of natural design and contain a healthy riffle/run/pool mesohabitat complex.
- 6. Threatened and Endangered Species: No effect
- 7. Other Wildlife: Temporary, minor effects during construction.
- 8. Actions to Minimize Impacts: The construction sequence will be closely coordinated with applicable resource agencies. The project construction will occur as quickly as possible to minimize the amount of time equipment will need to be in the stream channel. All timing windows and erosion control methodologies will be employed, as applicable.

F. Proposed Disposal Site Determinations

- 1. Mixing Zone Determinations: Not Applicable
  - a. Depth of water: Not Applicable
  - b. Current velocity: Not Applicable
  - c. Degree of turbulence: Not Applicable
  - d. Stratification: Not Applicable
  - e. Discharge vessel speed and direction: Not Applicable
  - f. Rate of discharge: Not Applicable
  - g. Dredged material characteristics: Not Applicable
- 2. Determination of Compliance with Applicable Water Quality Standards: A section 401 Water Quality Certificate will be obtained from NYDEC prior to construction of the project.
- 3. Potential Effects on Human Use Characteristics:
  - a. Municipal and Private Water Supply: No anticipated effect.
  - b. Recreational and Commercial Fisheries: Temporary, minor effect during construction. Long term positive effect with improved habitat, stream stability, and access.
  - c. Water Related Recreation: Short term negative effect during construction. Long term positive effect following project completion.

- d. Aesthetics: Temporary, minor effect.
- e. Parks, National and Historical Monuments, National Seashore, Wilderness Areas, Research Sites, and Similar Preserves: Temporary, minor effect on local town park areas.

G. Determination of Cumulative Effects on the Aquatic Ecosystem

No other known significant activities are planned within the project area and region that could potentially cumulatively affect the Livingston Manor project. It is expected that positive cumulative effects, as a result of the floodway, stream, and floodplain restoration in the project area will be realized. In addition, incidental positive cumulative effects from increased public access and recreational use are expected. All negative impacts associated with this project are short-term and minor. As a result, it is anticipated that future environmental benefits in both the Livingston Manor project area and surrounding watershed will be realized with respect to floodwater attenuation, stream stability resulting in reduced sediment loads and increased aquatic habitats, and direct physical improvements in riparian, wetlands, and instream habitats. It has been determined that there will be no cumulative negative impacts as a result of this project and long term positive cumulative impacts will be realized.

H. Determination of Secondary Effects on the Aquatic Ecosystem.

No significant secondary effects are anticipated

III. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

- A. Adaptation of the Section 404(b)(1) Guidelines to this evaluation - No significant adaptation of the guidelines were made relative to this evaluation.
- B. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge Site Which Would Have Less Adverse Impact on the Aquatic Ecosystem - The recommended plan was determined from a detailed evaluation of alternatives to have the least amount of environmental impacts. All practical methods to avoid and minimize impacts on resources in the project area will be developed and applied in cooperation with the resource agencies.
- C. Compliance with Applicable State Water Quality Standards - The recommended plan is not expected to violate any applicable state water quality standards in New York. The State of New York State Department of Environmental Conservation is a cooperating agency and project sponsor.

- D. Compliance with Applicable Toxic Effluent Standards or Prohibition under Section 307 of the Clean Water Act - The proposed discharge is not anticipated to violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.
- E. Compliance with Endangered Species Act of 1973 -The recommended plan will comply with the Endangered Species Act of 1973. Informal Section 7 consultation has been completed with the U.S. Fish and Wildlife Service on this project and they are a cooperating agency in the design of the project.
- F. Compliance with Specified Protection Measures for Marine Sanctuaries Designated by the Marine Protection, Research, and Sanctuaries Act of 1972 - No Marine Sanctuaries, as designated in the Marine Protection, Research, and Sanctuaries Act of 1972, are located within the project area.
- G. Evaluation of Extent of Degradation of Waters of the United States - The proposed project will not result in long term significant adverse effects on human health and welfare, including municipal and private water supplies, and recreational and commercial fishing, plankton, fish and shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and wildlife will be temporarily adversely impacted during construction. No significant adverse impacts on aquatic ecosystem diversity, productivity and stability, and recreation, aesthetics and economic values are expected as a result of the project. The project will increase the riffle/run special aquatic sites and the overall function of the stream and floodplain.
- H. Appropriate and Practicable Steps Taken to Minimize Potential Adverse Impacts of the Discharge on the Aquatic Ecosystem – Work in waters will occur as quickly as possible to minimize the amount of time equipment will need to be in the stream channel. Sequencing of construction activities to minimize impacts and all other practical methods to avoid and minimize impacts on resources in the project area will be developed and applied in cooperation with the local, state and federal resource agencies involved with the project.

## 6.5 References

- Ayers, M.A., Wolock, D.M., McCabe, L.E.H., and Tasker, G.D. 1994. Sensitivity of Water Resources in the Delaware River Basin to Climate Variability and Change. U.S. Geological Survey Water-Supply Paper 2422.
- Bates, B.C., Kundzewicz, Z.W., Wu, S. and Palutikof, J.P. 2008. Climate change and water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, Switzerland.
- Brekke, L.D., Kiang, J.E., Olsen, J.R., Pulwarty, R.S., Raff, D.A., Turnipseed, D.P., Webb, R.S., and White, K.D. 2009. Climate change and water resources management- A Federal Perspective: U.S. Geological Survey Circular 1331, 65 p.  
<http://pubs.usgs.gov/circ/1331/>
- Catskill Regional Invasive Species Partnership (CRISP). 2010. Invasive plant species affecting the Catskill Mountain Region. [www.catskillcenter.org/index.php/crisp](http://www.catskillcenter.org/index.php/crisp)
- Conyngham, J and N. Gillespie. 2003. Final Report Trout Unlimited Beaver Kill-Willowemoc Watershed Initiative 1994-2002; An Assessment of Trout Habitat Using Hydrology and Applied Fluvial Geomorphology. 150 pp. Arlington, VA.
- Conway, John. 2009. Excerpt from *Sullivan County: a Bicentennial History in Images*, the History Press. Retrieved December 2, 2010 from <http://sullivancountyhistory.org/>
- Council on Environmental Quality. 1997. Environmental Justice. Guidance Under the National Environmental Policy Act. December 10, 1997.  
<http://ceq.hss.doe.gov/nepa/regs/guidance.html>
- Custer, Jay F. 1996. *Prehistoric Cultures of Eastern Pennsylvania*, Pennsylvania Historical and Museum Commission.
- Eder Associates. 1997. Test Pit Assessment Report, Falls Poultry, School Street, Livingston Manor, NY.
- Federal Emergency Management Agency (FEMA). 2007. *Selecting Appropriate Mitigation Measures for Floodprone Structures* - FEMA 551.
- Falk, Gerhard. 2012. Jewish Buffalo on the Web. Retrieved December 3, 2012 from <http://jbuff.com/c012612.htm>
- Ferracane, Pat. 2012. Personal Communication. New York Department of Environmental Conservation.

Frisbie, Richard. 1996. *Sullivan County History*. Retrieved December 2, 2010 from <http://www.hopefarm.com/sullivny.htm>

Intergovernmental Panel on Climate Change. 2007. Summary for Policymakers, of Climate Change 2007- Impacts, adaptations and vulnerability, in M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, eds., Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Cambridge, United Kingdom, Cambridge University Press. [www.ipcc.ch/ipccreports/ar4-wg2.htm](http://www.ipcc.ch/ipccreports/ar4-wg2.htm)

New York State Climate Office. 2010. Climate of New York. [www.nysc.eas.cornell.edu/climate\\_of\\_ny.html](http://www.nysc.eas.cornell.edu/climate_of_ny.html)

New York State Department of Environmental Conservation. 1994a. Biological Stream Assessment- Little Beaver Kill, Sullivan County, New York dated 26 July 1994.

New York State Department of Environmental Conservation. 1994b. Biological Stream Assessment- Willowemoc Creek, Sullivan County, New York dated 27 July 1994.

New York State Department of Environmental Conservation. 2010a. Air Quality Index (AQI) Forecast and Current Observations in New York State. [www.dec.ny.gov/chemical/34985.html](http://www.dec.ny.gov/chemical/34985.html)

New York State Department of Environmental Conservation. 2010b. Freshwater Wetlands Mapping. [www.dec.ny.gov/lands/5124.html](http://www.dec.ny.gov/lands/5124.html)

New York State Department of Environmental Conservation. 2010c. Nature Explorer- A Gateway to New York's Biodiversity. [www.dec.ny.gov/natureexplorer/](http://www.dec.ny.gov/natureexplorer/)

New York State Department of Environmental Conservation. 2010d. Climate Smart Communities: Local Action to Combat Climate Change. [www.dec.ny.gov/energy/50845.html](http://www.dec.ny.gov/energy/50845.html)

Richie, William A. 1980. *The Archaeology of New York State*, Purple Mountain Press.

Snow, Dean R. 1980. *The Archaeology of New England*, Academic Press.

Smith, T. A., and C. E. Kraft. 2005. Stream fish assemblages in relation to landscape position and local habitats variables. *Transactions of the American Fisheries Society* 134:430-440.

Sullivan 2020 Volume II: The Toolbox. 2005. [www.co.sullivan.ny.us/Departments/PlanningandEnvironmentalManagement/AboutPlanning/Sullivan2020Toolbox](http://www.co.sullivan.ny.us/Departments/PlanningandEnvironmentalManagement/AboutPlanning/Sullivan2020Toolbox)

Sullivan County, New York. 2010. Planning and Environmental Management - Open Space and Farmland Protection.

[www.co.sullivan.ny.us/Departments/DepartmentsNZ/PlanningandEnvironmentalManagement/OpenSpaceFarmlandProtection/tabid/3257/Default.aspx](http://www.co.sullivan.ny.us/Departments/DepartmentsNZ/PlanningandEnvironmentalManagement/OpenSpaceFarmlandProtection/tabid/3257/Default.aspx)

Sullivan County Division of Public Works. 2010. Draft Multi-Jurisdictional Hazard Mitigation Plan, Sullivan County, New York August 2010.

Sullivan County Historical Society. 2010. County History. [www.sullivancountyhistory.org](http://www.sullivancountyhistory.org)

Treichler, Bill (1991). The Crooked Lake Review, *William A. Ritchie: Archaeologist*. Retrieved from [http://www.crookedlakereview.com/articles/34\\_66/35feb1991/35treichler.html](http://www.crookedlakereview.com/articles/34_66/35feb1991/35treichler.html)

Trout Unlimited. 2003. Beaverkill-Willowemoc Watershed Initiative 1994-2002: An Assessment of Trout Habitat Using Hydrology and Applied Fluvial Geomorphology. Jock Conyngham & Nathaniel Gillespie.

The Weather Channel. 2010. Historic Data- Monthly Averages for Livingston Manor, NY. [www.weather.com/outlook/health/fitness/wxclimatology/monthly/graph/USNY0822](http://www.weather.com/outlook/health/fitness/wxclimatology/monthly/graph/USNY0822)

United States Army corps of Engineers. September 1979. Willowemoc Creek, Little Beaver Kill, and Cattail Brook Flood Control Problem Reconnaissance Report.

United States Census Bureau. 2010. [www.census.gov/census2000/states/ny.html](http://www.census.gov/census2000/states/ny.html)

United States Department of Agriculture (USDA). 1989. Soil Survey of Sullivan County, New York. [www.websoilsurvey.nrcs.usda.gov](http://www.websoilsurvey.nrcs.usda.gov)

United States Environmental Protection Agency (USEPA). 2010a. The Green Book Non-attainment Areas for Criteria pollutants. [www.epa.gov/airquality/greenbk/](http://www.epa.gov/airquality/greenbk/)

United States Environmental Protection Agency (USEPA). 2010b. Technology Transfer Network National Ambient Air Quality Standards (NAAQS). [www.epa.gov/ttn/naaqs](http://www.epa.gov/ttn/naaqs)

U. S. Fish and Wildlife Service. 2010. Planning Aid Letter for the U.S. Army Corps of Engineers Livingston Manor, New York Flood Risk Management and Environmental Restoration Feasibility Study. U.S. Fish and Wildlife Service, New York Field Office (Region 5). 15 pages.

URS Group Inc. 2008. Final Hydrologic Report, Delaware River Basin - Study New York Flood Hazard Data Collection Analysis, Prepared for FEMA-1650-DR-NY. July 18, 2008.

Weitmann, Ed. 2012. Personal Communication. Town Supervisor. Town of Rockland.

Weitmann, Ed. 2013. Personal Communication. Town Supervisor. Town of Rockland.

## **7.0 Cost Apportionment**

Costs for implementation of Section 205 flood risk management projects are shared at a rate of 65 percent Federal and 35 percent non-Federal. Implementation costs for this project will include additional cultural resource investigations, a more detailed real estate plan, preparation of project plans and specifications, project management, and construction. Design and implementation will be managed by USACE. Based on the current cost estimates provided (see Appendix D), the estimated apportionment is \$5.8 M Federal and \$3.2 M non-Federal.

### Sponsor Willingness

The non-Federal sponsor, the NYSDEC is committed to the Upper Delaware – Livingston Manor project and has agreed to execute the Project Partnership Agreement (PPA), contingent upon available funding. Letters of support for the project from the sponsor and the local municipality have been included as Appendix G.

## **8.0 Conclusions**

Based on an evaluation of the various alternatives, including the environmental impacts, design elements, and estimated costs; and in collaboration with the non-federal sponsor (NYSDEC) and the local municipality (Town of Rockland). The Recommended Plan is Plan J which consists of widening the LBK floodway at the Main St. Bridge, installing a 4 X 10 feet box culvert, and stabilizing approximately 1-mile of stream upstream (to the old airport site) of Main St. Bridge. This plan had strong flood damage reduction benefits. The economic results indicate a 2.29 benefit/cost ratio with \$410,000 in annual net benefits to the federal government. In addition, this plan will stabilize approximately 1 mile of stream channel, which will be an important component to achieve the correct sediment transport in the stream to avoid sediment deposits in downtown Livingston Manor, which could lead to community flooding. Plan J is the NED plan. Plan J provided key flood damage reduction benefits to Livingston Manor and Under Plan J, average annual damages from flooding should decrease by approximately \$727,000.

This combination plan provides an array of flood damage reduction measures for the Hamlet of Livingston Manor and this plan provides a cost effective return to both the federal government and our non-federal sponsor, while also providing incidental environmental benefits.

Future recommendations and actions not included in this feasibility study would be:

- Further analysis of potential floodplain storage and ecosystem restoration opportunities at the former Poultry Plant site.
- Further explore and complete a hydraulic analysis of the floodplain storage and restoration potential at the Sewage Treatment Plant as the infrastructure and levee is relocated further away from the Willowemoc Creek.
- Further economic analysis of any potential buyout properties located in the Town that are projected to receive continued damages after project completion.
- Further explore restoration options as stand-alone projects (e.g., Poultry Plant).

**9.0 RECOMMENDATIONS**

I put forward that the recommended plan described in this report be approved and implemented under the USACE's Continuing Authorities Program (CAP), specifically the authority of Section 205 of the Flood Control Act of 1948, as amended, which provides the Corps with authority to plan and implement small flood damage reduction projects. In my judgment, the proposed project is a justifiable expenditure of Federal funds. The total estimated cost of the project is \$ 9 M.

The recommendations contained herein reflect the policies governing formulation of individual projects and the information available at this time. They do not necessarily reflect program and budgeting priorities inherent in local and state programs, or the formulation of a national Civil Works water resources program. Consequently, the recommendations may be modified at higher levels within the Executive Branch before they are used to support funding. However, prior to executing a Project Partnership Agreement, the non-Federal Sponsor will be advised of any modifications and will be afforded an opportunity to comment further.

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Date

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Michael A. Bliss, P.E.  
Lieutenant Colonel, Corps of Engineers  
District Commander