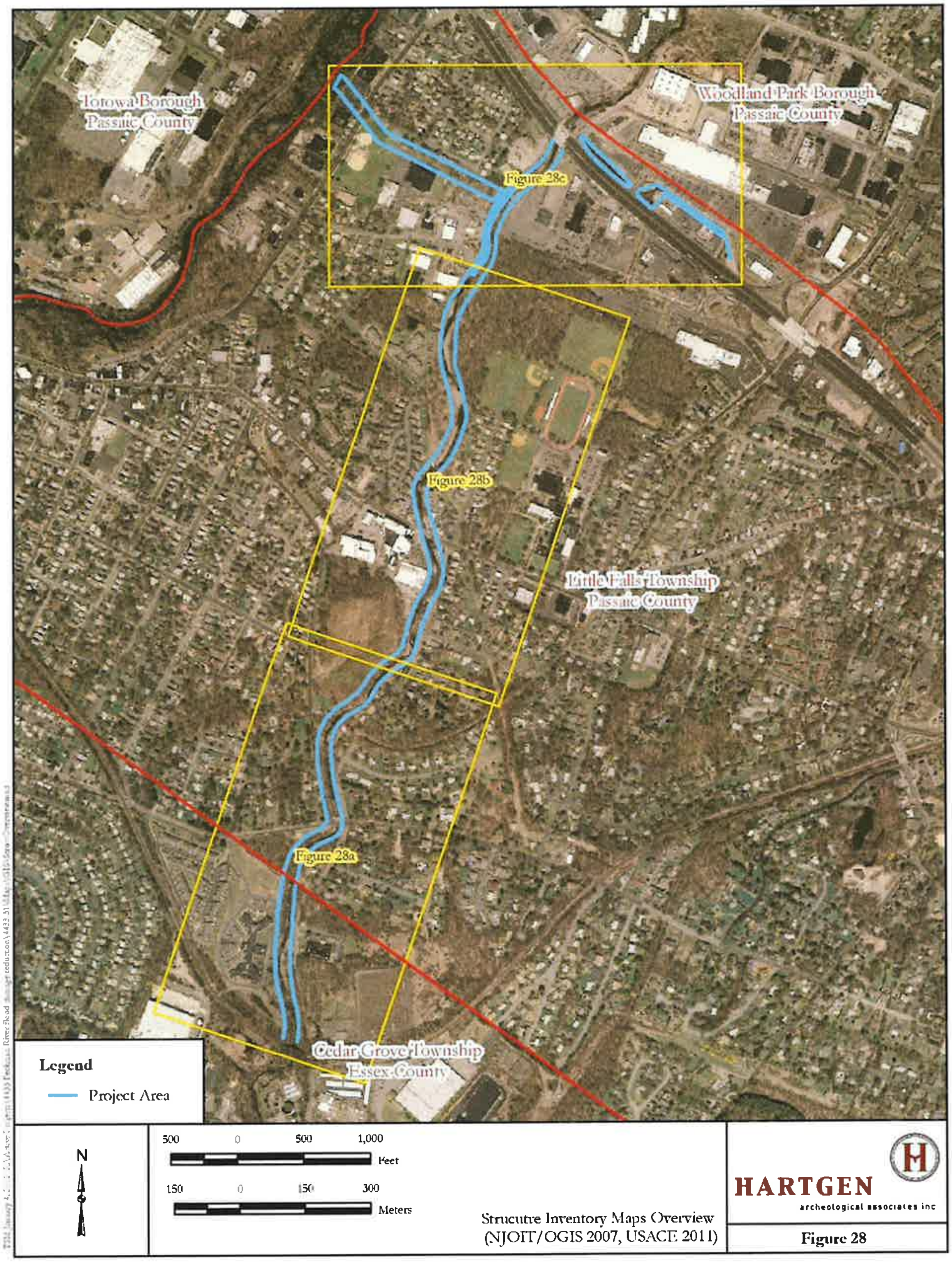

Figure 28. Phase I Archaeological Investigations and Structure Inventory Study Area (HAA 2013)

- The Little Falls Laundry (National Register-eligible): Began in 1912 as the Little Falls Washing Company, it became one of the largest and most modern commercial laundry facilities on the East Coast. It ceased operations in 1970. The complex consists of a main building built between 1917 and 1932, replacing the original 1912 building and two other buildings built in 1915 and 1925. The Laundry building is located at 101 Main Street along the Peckman River.

- The Route 46 Bridge over the Passaic River and Riverside Drive (National Register-eligible): The bridge is a 477 foot long concrete arch bridge built in 1939.

- The Jersey City Water Works Pipeline (National Register-eligible): This property consists of an aqueduct that crosses the Peckman River within the study area just south of Lindsley Road and Francisco Avenue. In the vicinity of the APE, the pipeline consisted of a 72-inch diameter pipe. Gatehouses that controlled the flow of water were found along the waterline at the corner of Lindsley Road and Cedar Grove Road. The pipeline itself extends from Boonton to the west, which is the site of the Jersey City/Boonton Reservoir to Jersey City to the east.

Table 5. New Jersey State Museum archaeological sites within two miles of the APE.

Site No.	Site Identifier	Description	Proximity to Project Area (nearest point)
28-Pa-111	"26-1-6-6-1"	Precontact; no information	8500 ft. (2590 m) west
28-Pa-109	"26-1-6-4-5,6"	Precontact; site findings include "arrowheads, spearheads, axes, pestles and potsherds."	9500 ft. west (2895 m) map has it on north side of river but description places it on south side of river
28-Pa-153	Van Der Kooy	Precontact; site findings include "arrowheads, axes, spears, knives, scrapers, hammerstones, broken bannerstones, and the usual chip materials. No pottery."	10,000 ft. (3048 m) west
28-Pa-110	"26-1-6-2-7"	Precontact; no information	8300 ft. (2530 m) west
28-Pa-108	"26-1-6-1-6"	Precontact; no information	9500 ft. (2895 m) northwest
28-Pa-105	"26-1-6-5-5"	Precontact; no information	8400 ft. (2560 m) west
28-Ex-58	Area 21 Santucci	Precontact: site finds include "broken pottery, arrowheads, fishspears, hammerstones, celt and axes."	11400 ft. (3475 m) west
28- Pa-106	"26-1-6-5-5,6"	Precontact; no information	8100 ft. (2469 m) west
28-Pa-105	"26-1-6-5-5"	Precontact; no information	7000 ft. (2134 m) west
28-Pa-107	"26-1-6-6-1"	Precontact; no information	5200 ft. (1585 m) west
28-Pa-154	Vreeland	Precontact; site findings include "turtle-back scrapers, blades of Coxsackie flint, and jasper chips. A few potsherds"	6000 ft. (1829 m) northwest
28-Pa-155	Vreeland Route 6	Precontact; site findings include "arrowheads, large spearheads, grooved axes, long pestles and other common artifacts, also the usual flake and chip material. Decorated pottery found"	5000 ft. (1524 m) northwest

28-Pa-57	Lower Preakness	Precontact; no information	9000 ft. (2743 m) northwest
28-Pa-114	"26-2-4-2-8,9"	Precontact; no information	1500 ft. (457 m) north
28-Pa-116	"26-2-4-2-5,6"	Precontact; no information	2500 ft. (762 m) north
28-Pa-115	"26-2-4-2-6"	Precontact; no information	3000 ft. (914 m) northeast
28-Pa-117	Little Falls	Precontact; ford across the Passaic	3500 ft. (1067 m) northeast
28-Pa-113	"26-2-4-5-3"	Precontact; no information	1000 ft. (304 m) northeast
28-Pa-169	Dowling	Precontact; Fishing camp with two nearby camps, a fish weir and an eel weir. Site findings from camps include: "fireplaces with a few arrowheads, drills and course pottery,… a few flat net sinkers"	3800 ft. (1158 m) northeast
28-Pa-94	"26-2-4-3-6"	Precontact; ford across the Passaic	2500 ft. (762 m) east
28-Pa-101	"26-2-4-3-3"	Precontact; ford across the Passaic	5500 ft. (1676 m) northeast
28-Pa-44	"26-2-5-2-6"	Precontact; site findings include "hatchets, celts, arrowheads, spear points (large) etc. Black flint chips. No pottery."	9000 ft. (2743 m) northeast
28-Ex-120	New Hospital Center Locus A Site	Precontact; three chert flakes	6500 ft. (1981 m) southwest
28-Ex-121	New Hospital Center Locus B Site	Precontact; tertiary jasper flakes and late stage chert core	6000 ft.(1829 m) southwest
28-Ex-96	"26-2-4-7-9"	Precontact; no information	4000 ft. (1219 m) south
28-Ex-130	Van Reyper/Bond House	Historic: associated with late 19th-early20th century extant house; items include nails, wood, glass.	7500 ft. (2286 m) southeast

Field Investigations

Field investigations carried out for this study resulted in the identification of five additional archaeological resources:

- Little Falls Laundry, Weir, and Headrace: Recently damaged by the flood water, portions of the former weir which diverted water into the headrace still stand. The weir and headrace were likely built in the 1920s as part of the laundry's expansion after the Sindle and Van Ness mills were no longer operational to utilize the water for their mill ponds to power distant mills. The headrace, headwall, and sluice gate mechanisms are still intact.

- Marley Mill Site: This site consists of a stone dam and retaining wall. There is no evidence of the actual mill structure. The mill was built in 1896 and was destroyed in a fire prior to 1907 and not rebuilt. The dam has been breached and most of it has been damaged or destroyed. The retaining wall was likely a later feature built for the nearby roadway and is not part of the site proper. The actual mill site lies under a portion of the St. Vincent nursing facility and has likely been destroyed or deeply buried under fill.

- Morris Canal Aqueduct: The remains identified within the study area include the interior canal walls on the east side of the river. Additional canal walls were also found to the east outside of the study area. No evidence was found of the central pier or the aqueduct's abutment's or canal prism on the west side.

- Seuchlung Slaughterhouse Bridge Abutment: the abutment is located on the west side of the Peckman River. This features did not possess additional research potential archeologically.

- Smalley Street Bridge: A small concrete feature that crosses the Peckman River north of East Main Street. It likely served as a still feature to protect the abutments for this former bridge. There is no evidence of the abutments. This feature does not possess additional research potential archeologically, and it is not considered an archeological site.

Architectural Survey
The architectural survey consisted of a field inspection of 81 properties within the study area. All structures built before 1962 were evaluated using the National Register criteria for significance. The survey determined the Morris Canal Aqueduct, the Little Falls Laundry, and Jersey City Water Works Valve House have retained their integrity and remain listed on or eligible for listing on the New Jersey State and National Registers. The Cedar Grove Railroad Overpass, was identified by this survey as potentially eligible for the New Jersey State and National Registers (Figure 25).

Geotechnical Survey
The results of geotechnical testing in the study area identified varying stratigraphic profiles along the project corridor. The majority of the borings indicated organic silt and soil underlain by fill material. In other areas, particularly in the middle portion of the project area immediately along the Peckman, the borings noted deep deposits of riverine sands and silt, up to eight feet deep in some locations. The sands are likely recent in origin. One area at the western end of the diversion culvert alignment in the location of an extant parking lot between Patterson Avenue and the Passaic River appears to contain deep fill deposits. This area was recommended for further investigations (see Figure 29).

2.16 Recreation
Specific areas supportive of active and/or passive recreational activities within the project area include the Little Falls Recreation Center, the Peckman Preserve, and the Morris Canal Greenway bike/walking trail.

The Little Falls Recreation Center includes a building that provides space for indoor recreational activities such as dance and fitness classes, a playground, two tennis courts, and two baseball fields (known as Duva Field) (Figure 5 in Appendix A-1).

The Peckman Preserve is a 12 acre tract of land along the left bank of the Peckman River that was acquired by Passaic County in 2005. No improvements have been made to the property since its acquisition. However, a study commissioned by the Passaic County Freeholders to evaluate potential improvements included a conceptual plan that consists of the installation of a bike path along the western perimeter of the park within the alignment of an unconstructed portion of the Morris Canal Greenway, and ecological enhancements and a boardwalk with educational signage within the preserve (Edgewater Design, LLC, 2010). In addition, the Passaic County Planning Department is proposing to install a footbridge over the Peckman River to connect the eastern and western spurs of the Morris Canal Greenway (Kelleher, 2017b).

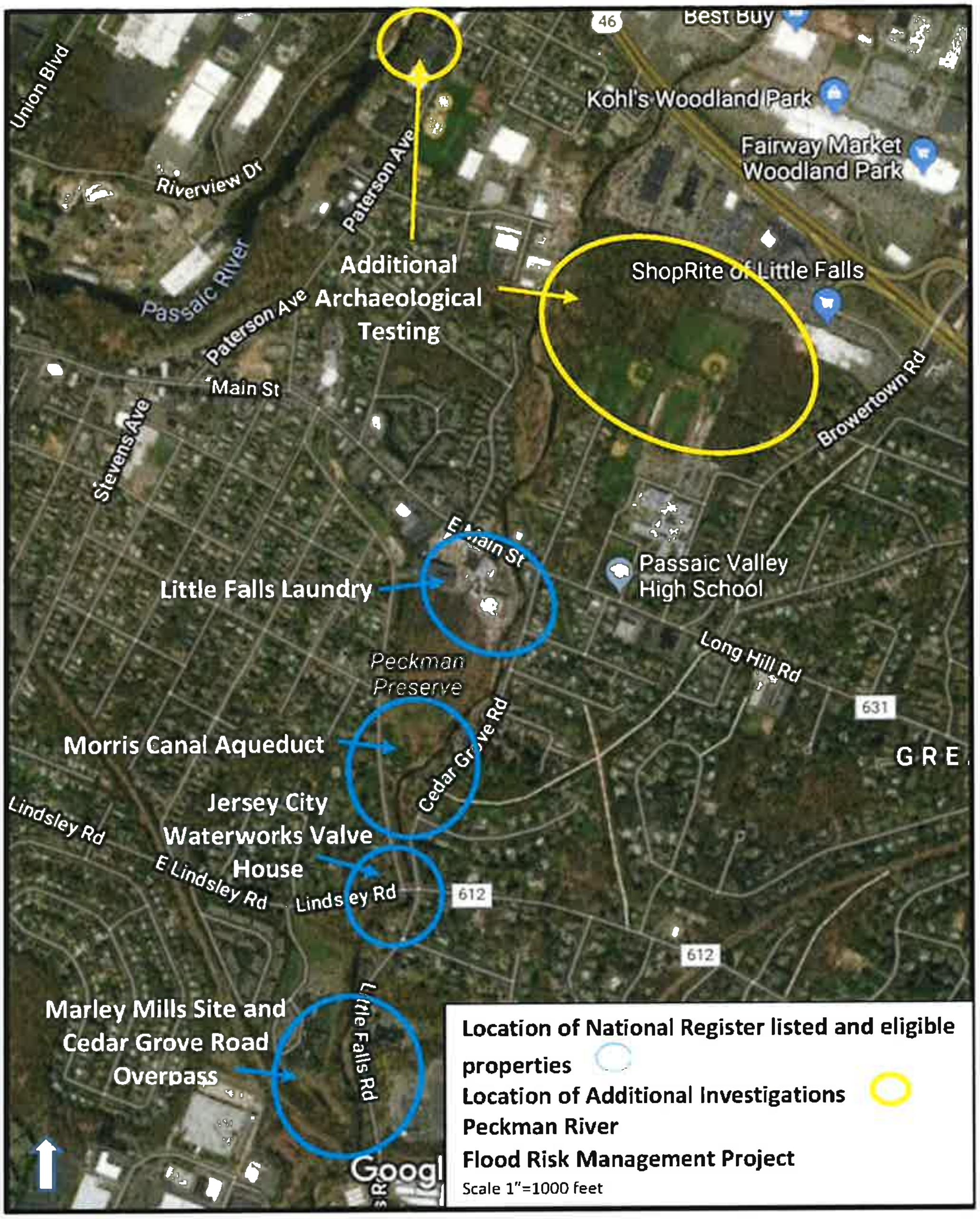

Figure 29. Location of identified historic properties and additional archaeological testing and monitoring (2018 imagery).

The Peckman River itself offers limited water-based recreational opportunities due to lack of public access points.

Great Notch Brook does not offer any water-based recreational opportunities within the project area.

The Passaic River is large and deep enough to provide water-based recreational opportunities although there are no public access areas to the river located within the project area. However, the Suchorsky Park, which is located in Little Falls, but is outside of the project area, has a boat launch to the Passaic River (Refer to Figure 2 in Appendix A-1).

2.16.1 Green Acres Program

The Green Acres Program, created in 1961 and administered by NJDEP, provides funds for the State or local municipalities to acquire and maintain lands for the purposes of recreation.

Under the Green Acres program, lands obtained or developed with Green Acres funding and lands concurrently held by a local government for recreation, open space and conservation purposes, regardless of the source of acquisition funds, must permanently remain in use for recreation, open space and conservation purposes. In general, lands subject to the rules of the program cannot be disposed of or diverted unless it can be demonstrated to the State that the modification will protect or enhance the use of the area. By definition, land that is used for purposes other than recreation, open space and conservation is considered a "diversion" while a "disposal" is the selling, donating, or some other form of permanent transfer of possession of parkland.

A review of the NJDEP Recreation and Open Space Inventory Database (ROSI) indicates that the Peckman Preserve was acquired with Green Acres Program funds. During the review of the 2018 DIR/EA, Green Acres Program staff noted that the parcel that comprises Little Falls Recreation Center including the Duva baseball fields and tennis courts is encumbered under the Green Acres Program. Other parcels noted by NJDEP during their review include a 0.82 acre parcel east of Browertown Road located within the footprint of the Old Morris Canal way that is designated as a bikeway, and 0.28 acre parcel that encompasses the Peckman River and the portion of land on the left bank of the Peckman behind townhomes along Turnberry Court (Appendix A-1 Figure 5).

No other properties encumbered by the Green Acres program are listed in the ROSI database within the project area.

2.17 Aesthetics & Scenic Resources

The aesthetic quality within the project area is influenced by heavy residential and business development. Much of the land along the river shorelines or wetland margins is developed with single-family residential dwellings and local business/industries. The visual setting of the project area is therefore characterized by moderate to high-density development along the Peckman and Passaic Rivers and Great Notch Brook.

There are no scenic byways, National Wildlife Refuges, National Parks, National Forests, National Natural Landmarks, or National Heritage sites within the project area. The Paterson Falls-Garret Mountain National Natural Landmark is located approximately three miles downstream from the project area (see Figure 2 in Appendix A). Neither reaches of the Peckman River, Great Notch Brook, nor the Passaic River within the project area are designated as wild and/or scenic per the Wild and Scenic Rivers Act of 1968.

2.18 Air Quality

2.18.1 Air Quality

The Clean Air Act (CAA), as amended, assigns USEPA responsibility to establish primary and secondary National Ambient Air Quality Standards (NAAQS) that specify acceptable concentration levels of six criteria pollutants: particulate matter (measured as both particulate matter less than 10 microns in diameter (PM10) and particulate matter less than 2.5 microns in diameter (PM 2.5), sulfur dioxide (SO_2), carbon monoxide (CO), oxides of nitrogen (NOx), ozone (O_3), and lead. Short-term NAAQS (1-, 8- and 24-hour periods) have been established for regulated emissions contributing to acute health effects, while long term NAAQS (annual averages) have been established for those emissions contributing to chronic health effects.

Federal regulations designate Air Quality Control Regions (AQXRs) in violation of the NAAQS as nonattainment areas. Federal regulations designate AQCRS with levels below the NAAQS as nonattainment and have been redesigned to attainment for a probation period through implementation of maintenance plans. According to the severity of the pollution problem, ozone and PM10 nonattainment areas can be categorized as marginal, moderate, serious, severe or extreme.

Passaic County located in the New York-New Jersey-Long Island Air Quality Control Region. Similar to most urban industrial areas, emissions from automobiles, manufacturing processes, utility plants, and refineries have impacted air quality in the project area. Based on the NAAQS for this region Passaic County is designated as moderate non-attainment areas for ozone and as a maintenance area for carbon monoxide.

2.19 Noise

Noise is generally defined as unwanted sound. The day-night noise level (Ldn) is widely used to describe noise levels in any given community. The unit of measurement for Ldn is the "A"-weighted decibel (Dba), which closely approximates the frequency responses of human hearing.

The primary source of noise in the project area is vehicular traffic on local roadways and local construction projects that may be underway, and operation of businesses. The project area is characterized as residential and business development, therefore existing sound levels are likely within this range.

Chapter 3: Plan Formulation

Plan formulation is the process of building alternative plans that meet planning objectives and avoid planning constraints. The 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (Principles and Guidelines, or P&G) and USACE Engineering Regulation (ER) 1105-2-100 "Planning Guidance Notebook" lay out an iterative six-step planning process used for all USACE Civil Works studies in developing and evaluating alternatives. This chapter presents a summary of problems and opportunities; inventory and forecast; and plan formulation, evaluation, comparison, selection, and optimization.

A Note About the Contents of this Chapter

Since release of the previous version of this report in May 2018, the Tentatively Selected Plan has been refined based on updated engineering and economic information described in Section 3.13. Much of this chapter describes initial planning activities undertaken through May 2018, the logic and conclusions of which are still valid. This chapter is organized as follows:

- Section 3.1 through Section 3.12 summarize plan formulation, evaluation, and selection undertaken through May 2018.
- Section 3.13 includes a description of plan optimization completed subsequent to release of the May 2018 DIFR/EA, through the October 2019 release of the Revised DIFR/EA.

A description of the Recommended Plan is presented in Chapter 4.

Display of Price Levels: Costs and benefits developed as part of initial plan formulation, evaluation, and comparison are included for historical reference; they do not reflect current price levels because they were calculated in previous fiscal years. They are noted with the price level that reflects previous fiscal years as appropriate. Costs and benefits developed during feasibility-level design (optimization) are shown in the current fiscal year price level.

3.1 Problems & Opportunities

A problem statement is the detailed description of a problem that helps guide the planning process. It informs the identification of the study's goals and objectives, and ultimately plan formulation, comparison, and selection.

Problem Statement: People, infrastructure, and property within the Peckman River Basin, especially in the communities of Little Falls and Woodland Park, experience significant risk to life safety and property flood damages because of flash flooding from the Peckman River and its tributaries, and overbank and backwater flooding from the Passaic River (Figures 30 and 31). The red pedestrian bridge featured in these photos crosses over the Great Notch Brook in the Plaza 46 Shopping Center parking lot in Woodland Park (Figure 32).

Figure 30. Pedestrian Bridge over Great Notch Brook at the commercial retail property, Woodland Park, New Jersey (2017).

Figure 31. Pedestrian bridge over Great Notch Brook pictured in previous figure during the June 30, 2009 storm.

Figure 32. Location of red pedestrian bridge and Plaza 46 shopping center and parking lot.

One of the most damaging floods of record in the basin resulted from Hurricane Floyd on September 16-17, 1999, causing an estimated $12,100,000 (FY19 P.L.) in flood-related losses to towns in the basin. Hundreds of homes and businesses were flooded in Little Falls and Woodland Park. The Woodland Park business district was one of the hardest hit areas, with over three feet of flood water affecting structures. In Little Falls, businesses were inundated with over four feet of water, and the Jackson Park residential area suffered extensive flooding. Hurricane Doria in August 1971 caused an estimated $2,000,000 (FY19 P.L.) in flood-related damages and a severe flood in May 1968 reportedly caused over $18,600,000 (FY19 P.L.) in damages within the basin.

Because of the difference in drainage areas of the Peckman River and Passaic River Basins, and the differing characteristics of rainfall events, the project area is rarely flooded by simultaneous flash flooding from the Peckman River and its tributaries, and overbank and backwater flooding from the Passaic River. Based on a statistical regression analysis of a 30 year record of historical flows on the Peckman and Passaic Rivers, there is no reliable way to predict a flood stage on the Peckman River based on water levels on the Passaic River. The converse is also true in that there is no reliable way to predict a flood stage on the Passaic River based on what is happening on the Peckman River. About two thirds of storms do not cause simultaneous flooding of both rivers. The differences in the flooding mechanisms are explained below.

Flash Flooding

Flash flooding is the rapid flooding of low-lying areas due to heavy rainfall associated with intense thunderstorms, hurricanes, and tropical storms. The Peckman River Basin experiences frequent flash flooding caused by such high rainfall events. Rainfall can produce significant runoff into rivers and streams that can quickly exceed their channel capacity, and that of bridge and culvert openings. Flash flooding is most frequent along the relatively small Great Notch Brook, which is a tributary of the larger Peckman River. Storms with a ten percent annual chance of occurrence typically cause flooding along Great Notch Brook. Water from the Brook drains into the Peckman River, which typically experiences simultaneous high water during large storms (Figure 33). Flooding caused by drainage of flood waters from Great Notch Brook into the Peckman River is exacerbated when rain has saturated soils in the area.

Figure 33. Flash flooding in the Peckman River during Hurricane Floyd near Little Falls, New Jersey (1999).

The right bank of Great Notch Brook receives a portion of Peckman River inundation in the area of the shopping mall parking lot (Figure 28). Great Notch Brook flows into the Peckman River with the confluence on the west end of the parking lot immediately downstream of the Route 46 Bridge. Given the difference in drainage basin size for Great Notch Brook (0.6 square miles) and Peckman River (9.8 square miles) it is possible that more of the inundation may be caused by the Peckman River, but specific contributions of flooding cannot be easily determined.

Because of its larger watershed, flood elevations on the Peckman River typically peak about an hour after peak flood elevations are recorded on Great Notch Brook. Flood waters eventually travel from the Peckman River to the Passaic River. With its larger drainage area, the Passaic River often peaks approximately two or three days after peak flood elevations are recorded on the Peckman River. Flash flooding from Great Notch Brook and the Peckman River typically impact Little Falls and Woodland Park more than other municipalities in the Peckman River Basin.

Backwater Flooding

A description of backwater flooding mechanisms is presented in this section to fully describe all sources of flood risk in the study and project areas. As discussed in Section 1.4, USACE and NJDEP are currently completing an analysis of backwater and overbank flooding from the Passaic River in the region, under the authorization for the Passaic River Basin, New Jersey flood risk management study. Because of this, the scope of this study is limited to addressing flooding caused by the Peckman River and its tributaries.

Backwater flooding occurs when water from a river banks up into tributaries that feed into it, much like a traffic jam caused by road construction on a highway. Like flash flooding and overbank flooding, it is caused by rainfall that exceeds the channel capacity of rivers and streams. The Passaic River is a source of backwater flooding in the project area. Backwater flooding is worsened when rain continues to fall on the land and water piles up in Peckman River and its tributaries, and the tributaries cannot quickly discharge accumulated rainwater into the Passaic River. Backwater flooding from the Passaic River typically impacts areas along the river within Woodland Park. Backwater flooding does not affect Little Falls.

Overbank Flooding

A description of overbank flooding mechanisms is presented in this section to fully describe all sources of flood risk in the study and project areas. As discussed in Section 1.4, USACE and NJDEP are currently completing an analysis of backwater and overbank flooding from the Passaic River in the region, under the authorization for the Passaic River Basin, New Jersey flood risk management study. Because of this, the scope of this study is limited to addressing flooding caused by the Peckman River and its tributaries.

Overbank flooding occurs when waters overtop river banks and inundate areas behind the banks. Like flash flooding and backwater flooding, it is caused by rainfall that exceeds the channel capacity of rivers and streams. The Passaic River is a source of overbank flooding in the project area (Figure 34). Woodland Park and Little Falls are affected by overbank flooding in rare instances during relatively large storms.

Figure 34. Flooded parkway in nearby town of Singac (Little Falls Township, New Jersey) during the March 2011 Passaic River flood (2011).

Opportunities: Manage the risk of fluvial flooding in the Passaic River Basin caused by flash flooding on the Peckman River and its tributaries. Addressing this flooding may:

- Manage flood risks from associated fluvial flood events that impact communities, infrastructure, and the economy
- Support the resiliency of the Peckman River Basin's communities, infrastructure, and the economic consequences to the region and to the nation economy
- Communicate existing and potential future flood risks to local planners and public officials

3.2 Future Without-Project Conditions

The future without-project condition, or the No Action alternative, serves as the base condition to use as a comparison for all the other alternatives. The period of analysis used in the comparison of potential costs and benefits of alternative plans is 2027 through 2076.

In the absence of Federal action, flooding problems in the Peckman River Basin associated with rainfall events are expected to continue. Communities in the basin will continue to experience damages to structures, their contents, vehicles, and infrastructure caused by flash flooding in the Peckman River and its tributaries, and overbank and backwater flooding from the Passaic River. This would likely result in the continued maintenance and reconstruction of infrastructure and facilities, and repairs to houses and roads following storm events. Residents and businesses would be impacted by flooded roads and structures. They would be at continued risk of harm due to direct flood hazards and reduced access by emergency services during storm events.

Changes in global climate and weather patterns may potentially cause changes in rainfall patterns in the future. If climate change causes heavier rainfall events in the future, this may result in an increase in water in the basin, an increase in discharge, and increases in water surface elevations. Future without-project damages may increase in the future in the absence of the project and major changes to existing conditions.

Another future without-project condition is that some parts of Woodland Park will continue to flood from the Passaic River. The study authority for this project focuses only on flooding caused by the Peckman River, so addressing Passaic River flooding is outside of the scope of this study. The goal of the USACE Passaic River Mainstem, New Jersey flood risk management study is to address Passaic River flooding. As of this time, the Passaic River Mainstem study has been suspended, and it is unknown if a recommendation for federal action will be made. Parts of the Peckman River study area flood separately from both the Peckman and Passaic Rivers. Since this study focuses on the Peckman River flooding problem, there is residual risk within the study area for Passaic River flooding. Though the Passaic Mainstem study is currently suspended, there is potential for this study to reassume in the future to address the Passaic River flooding that occurs throughout northern New Jersey, including the Peckman River study area. Local efforts to manage and communicate flood risk may also mitigate flood damages.

3.2.1 Economic Damages

Average Annual Damages (AAD) in the future without-project condition from 2027 - 2076 were calculated at $17,225,000 (FY19 P.L.). Detailed information about the structure inventory, damage calculations, and economic modeling are provided in Appendix B.

3.2.2 Socioeconomic & Community Impacts

The most likely scenario for the future without-project condition would be the continuation of existing social and community conditions and trends, as well as economic growth within the project area. The Peckman River watershed is currently heavily urbanized and developed. Under without-project future conditions, the damage centers in Woodland Park and Little Falls would continue to be subject to flooding.

3.2.3 Land Use

The No Action alternative would not change short term land use, land cover and zoning. However, in the long term, properties along the Peckman River, particularly those in flood prone areas, are likely to sustain continued damage during future storm events. Without proactively addressing flood risks, damages will continue to accrue. Businesses and residences property values may decrease, or development may be prohibited, both which could lead to changes in land use, cover or zoning.

3.2.4 Environmental Resources

Topography, Geology and Soils

The No Action alternative would not result in any change to the topographic and geologic resources within the project area.

Water Resources

Under the No Action alternative, water quality and habitat would remain unchanged unless others take restorative actions to enhance aquatic habitat and water quality. In addition, there would be no changes to wetland communities within the project area.

Vegetation

The No Action alternative would have no effect on the plant communities that occur within the project area. There would be no short or long-term disturbance to any vegetation, and thus upland and wetland communities would remain as they are expect for changes associated with natural disturbance events – including future flooding events – and community succession.

Fish and Wildlife

Under the No Action alternative, fish and wildlife utilization of the project areas would be consistent with current conditions. The same is true for any state and/or Federal endangered, threatened or special concern species that may occur within the project area.

Cultural Resources

Under the No Action Plan, no direct adverse effects to historic properties are anticipated. However, the continued flooding of historic properties, such as the Little Falls Laundry, would likely result in deterioration of historic resources, leading to their loss of integrity and/or demolition.

Recreation

Parks and water dependent recreational opportunities within the project would remain the same under the No Action alternative. However, fluvial storm events could impact usability of the open space/park adjacent to the Peckman River through inundation or deposition of debris that could result in park closures.

Aesthetics and Scenic Resources

Under the No Action Alternative, aesthetic and scenic resources would remain unchanged from current conditions.

Hazardous, Toxic and Radioactive Waste

The No Action alternative would not change HTRW conditions within the project area.

Air Quality

Ambient air quality would remain unchanged under the No Action alternative.

Noise

Under the No Action alternative, noise conditions would remain unchanged when compared to existing conditions.

3.3 Planning Goals & Objectives

Planning goals and objectives were developed to meet the intent of the study authority, and to respond to project-specific problems. Planning objectives were identified based on problems, needs, and opportunities, as well as existing physical and environmental conditions present in the project area.

Planning Goals

Planning goals describe the overarching intent of the project, and helped in creating and evaluating alternative plans. The planning goals are to:

- Manage the risk of fluvial flood damages in the Peckman River Basin due to flash flooding in the Peckman River and its tributaries (Figure 35)
- Contribute to NED by managing the risk of fluvial flood damages in the Peckman River Basin
- Where possible, provide a plan that is compatible with future flood risk management and economic development opportunities

Figure 35. Flooded commercial area in Woodland Park, New Jersey.

Planning Objectives

Planning objectives state the intended purpose of the planning process. They are a statement about what solutions should try to achieve. Objectives are based on problems and opportunities. They are:

- Reduce the risk of fluvial flood damages in the Peckman River Basin due to due to flash flooding in the Peckman River and its tributaries from 2027 through 2076
- Reduce the risk to Peckman River Basin residents' life and safety from 2027 through 2076
- Support community resilience and cohesion in the Peckman River Basin by reducing economic losses from flooding, and maintaining the community and economic base from 2027 through 2076

These planning objectives focus on reducing the impacts of flood damages caused by flash flooding from the Peckman River and its tributaries. The study teams recognizes that the study areas also experiences flood damages due to overbank and backwater flooding from the Passaic River. The scope of this study is limited to addressing flooding caused by the Peckman River and its tributaries. However, the effects of Passaic River backwater flooding on project performance was considered as part of the study. The results of a joint probability analysis that considered the probability and extent of Passaic and Peckman River flooding in the study area is summarized later in this chapter.

3.4 Planning Constraints & Considerations

Unlike planning objectives that represent desired positive changes, planning constraints and considerations represent restrictions that should not be violated or avoided, if possible. The formulation and evaluation of alternative plans are constrained by technical, environmental, economic, regional, social, and institutional considerations.

Constraints

Constraints are restrictions that limit the extent of the planning process. They can be divided into universal constraints and study-specific constraints. Universal planning constraints are the legal and policy constraints to be included in every planning study. Study-specific planning constraints are statements of things unique to a specific planning study that alternative plans should avoid. Constraints are designed to avoid undesirable changes between the with- and without-project conditions. A constraint specific to the study is:

- Critical infrastructure: The community is served by important roads, bridges, and services (e.g., police and fire response). Plans were formulated to avoid major impacts to infrastructure.

Considerations

- The Route 46 bridge that spans the Peckman River was replaced in 2003. Potential ways to avoid or minimize modification to the bridge were considered.
- FEMA sometimes updates Base Flood Elevations (BFEs) for communities based on new technical information. The BFE is the computed elevation to which floodwater is anticipated to rise during a one percent storm, which is a storm with a one percent annual chance of occurrence. The BFE is the FEMA regulatory requirement for the elevation or floodproofing of structures. The relationship between the BFE and a structure's elevation determines the flood insurance premium. A change in BFE for an area may affect floodplain management activities, local building ordinances, and zoning codes. The chance of a significant increase in BFE in the area in the recent future is low, but was nevertheless considered during plan formulation.

3.5 Key Uncertainties

Limitations to the quantity and quality of information results in uncertainties. A noted uncertainty in this phase of the planning process is:

Nonstructural Participation Rate: Per USACE planning guidance, implementation of many nonstructural measures such as structure elevation, floodproofing, flood warning systems, and floodplain development zoning changes/enforcement is voluntarily agreed to with property owners. However, acquisition, relocation, and permanent evacuation are not voluntary and must include the option to use eminent domain. For voluntary nonstructural measures, it was assumed that participation in a voluntary nonstructural project would be popular with many property owners in communities. Based on coordination with non-Federal and local interests, and current building strategies, an at- or near-100 percent participation rate was assumed during initial plan formulation.

3.6 Management Measures

Measures are features or actions that contribute to the planning objectives. Project-specific measures were developed to address problems and to capitalize on opportunities. They were derived from a variety of sources, including prior studies, the public scoping process, and coordination with the non-Federal sponsor.

3.6.1 Nonstructural Measures

Nonstructural features and actions reduce flood risk by removing structures and residents from flood hazards, either temporarily or permanently. They reduce flood damages without significantly altering the nature or extent of flooding. Nonstructural measures considered in the formulation of alternative plans include structure elevation, wet floodproofing, dry floodproofing, acquisition, evacuation plans, flood warning systems, and floodplain development zoning changes/enforcement. Various nonstructural techniques were considered as elements of a comprehensive solution.

Elevating (Raising) Structures. Elevation is the process of raising a structure, typically so that the main living area (main floor) will be above the BFE (Figure 36). In most cases, the process involves separating a structure from its foundation, raising it on hydraulic jacks, and holding it in place with temporary supports while a new or extended foundation is constructed below. The result is the living area is raised and only the foundation remains exposed to flooding. The new or extended foundation may consist of continuous walls or separate piers, piles, and columns, or some combination thereof.

Floodproofing. Floodproofing is the process of making adjustments in the design or construction of buildings to reduce potential flood damages. There are two categories of floodproofing: wet floodproofing and dry floodproofing. Dry floodproofing would provide flood risk management to a building by sealing its exterior walls and providing removable shields at structure openings to prevent the influx of floodwaters. Dry floodproofing is practical only for buildings with structurally-sound walls, and only where flood depths are relatively low. Wet floodproofing refers to the protection of a building in a manner that allows floodwaters to enter and exit freely, in such a way that internal and external hydrostatic pressures are equalized. This equalization of pressures reduces the loads imposed on a structure, and reduces the probability of structural damage or failure. Basement utilities subjected to flooding may be relocated to an above-grade utility room, where space permits, otherwise, the basement utilities may be surrounded by a watertight barrier.

Acquisition (Buy-Outs). Acquisition involves the purchase of property and its structures and/or the purchase of development rights. A buy-out plan would result in the permanent evacuation of the floodplain in areas of frequent and severe inundation. Buy-outs involve the acquisition of a property and its structures, either by purchase or by exercising the powers of eminent domain. Following acquisition, the structure and associated property development is either demolished or relocated. Acquired lands are typically restored to a natural condition and used for recreation or other purposes that would not be jeopardized by a flood hazard.

Figure 36. Example of an elevated home in Keansburg, New Jersey.

Flood Warning System. A flood warning system can afford residents advance warning of flooding and allow them time to make appropriate preparations. While a flood warning system does not prevent flooding and does not reduce damage to property that is left in the path of floodwaters, it can provide an aid in reducing property loss and increasing the safety of individuals. With the use of a flood warning system, property such as motor vehicles can be relocated to higher ground in time to prevent damage from rising waters. In addition, moveable items can be taken to higher floors within structures, where they will not be impacted. Finally, residents will have time to leave the area, if necessary, for their own safety.

Floodplain Development Zoning Changes/Enforcement. Through proper land use regulation, floodplains can be managed to ensure that their use is compatible with the severity of the flood hazard. Several means of regulation are available, including zoning ordinances, subdivision regulations, and building and housing codes. Their purpose is to reduce losses by controlling the future use of floodplain lands and would not be effective in mitigating the existing hazard. It should be noted that zoning is a local issue and is not within the jurisdiction of the Federal government. However, any Federal project will have a floodplain management plan component that includes requirements on the use of flood prone lands.

3.6.2 Structural Measures

Structural measures reduce flood risk by modifying the characteristics of the flood. They are physical modifications designed to reduce the frequency of damaging levels of flood inundation. Structural measures are often employed to reduce peak flows (flood storage); direct floodwaters away from flood prone property (flood barriers); or facilitate the flow of water through or around an area (channel modifications or diversions). Structural measures considered in the formulation of alternative plans include diversion culverts, levees/floodwalls, channel modification, detention basins, road elevation, ringwalls, and clearing and snagging. Any barriers must not increase flooding from interior runoff that becomes trapped behind it. To address these requirements, any structural plan that includes a barrier may also require interior drainage facilities that may include pumps and ponding areas.

Diversion Culverts: A diversion culvert is a structure that allows water to flow under a road, railroad, or similar obstruction from one side to the other (Figure 37). Culverts come in many sizes and shapes, including round, elliptical, flat-bottomed, pear-shaped, and box-like. A diversion culvert can provide a detour for an existing waterbody.

Figure 37. Example of a culvert similar in size to the proposed Peckman River diversion culvert.

Levees: Levees are typically low, wide earthen embankments built to retain floodwater inside a channel (Figure 38). They generally consist of a trapezoidal shaped mound of earth with 1 vertical:3 height vegetated side slopes. Interior drainage facilities, located on the landward side of the levees, would be needed to collect, control, and disperse water trapped behind the barriers. Otherwise, floodwaters would pond behind the barrier and potentially breach the levee.

Figure 38. Example of a levee holding back flood waters.

Floodwalls: Floodwalls are structures composed of steel, concrete, rock, or aluminum (Figure 39). Interior drainage facilities, located on the landward side of the floodwall, would be needed to collect, control, and disperse water trapped behind the barriers. Otherwise, floodwaters would pond behind the barrier.

Figure 39. An example of a permanent floodwall in Middlesex, New Jersey.

Channel Modification: Modification of the cross-section of a channel of water along a length or lengths of that channel can sometimes improve flow and reduce or prevent fluvial flooding (Figure 40). Channel modifications can include dredging, deepening and widening, rechannelization, dam modifications, and elevating or widening bridges.

Figure 40. An example of a sloped grassed bank or trapezoidal channel.

Detention Basins: Detention basins may be used to reduce the peak flood flows by temporarily storing (detaining) floodwater, then releasing it at a substantially reduced flow to reduce peak flood flows. This reduces peak water surface elevations and helps to minimize flood damages downstream.

Road Elevation: Roads could be elevated to heights that would minimize or eliminate the impacts of flooding. Road raisings are often combined with other structural flood risk management measures.

Ringwalls: Ringwalls are intended to reduce the frequency of flooding to one or a group of structures on a small-scale basis. They can be temporary (deployable) or permanent.

Clearing & Snagging: Clearing and snagging includes the removal of vegetation along the bank (clearing) and/or selective removal of snags, drifts, or other obstructions (snagging) from natural or improved channels and streams.

Pumps: Pumps would remove water from the project area. Water would likely be pumped into the Peckman or Passaic Rivers. They would be complementary to other project features.

Ponding Areas: Ponding areas may be used to control water levels in a water body or diversion culvert. They are typically built by deepening an existing area of a waterbody.

3.6.3 Natural and Nature-Based Features

Natural and nature-based features (NNBFs) are habitats or features such as marsh, oyster reefs, and submerged aquatic vegetation that may reduce flood risk while providing ecosystem benefits.

3.7 Plan Formulation Strategy

The general plan formulation strategy is to maximize NED benefits while considering technical feasibility, environmental impacts, economic implications, social consequences, and technical criteria. This included an evaluation of the four P&G accounts of NED, regional economic development (RED), other social effects (OSE), and environmental quality (EQ), as fully described in Section 3.10.

Economic Implications (P&G Accounts NED and RED): Construction costs were estimated for each alternative. These costs were developed for screening purposes only and did not reflect detailed designs and environmental assessments accomplished later for the more developed alternatives. Economic benefits of the alternatives were developed for the with- and without-project conditions. This information was used to compare alternatives.

Social Consequences (P&G Account OSE): The public may experience negative impacts of property acquisitions, environmental impacts, visual aesthetics (floodwalls or levees), and inconvenience due to construction. Over the long term, the minimization of flooding or flood damage will greatly improve quality of life.

Environmental Impacts (P&G Account EQ): Impacts to the environment were evaluated for each alternative. Field data and literature were used to assess existing conditions and potential impacts.

Technical Feasibility: Consideration was given to all feasible nonstructural and structural measures. Sound engineering judgment was utilized in selecting the components for each alternative. Existing topography, wetlands, structures, roadways, and drainage patterns were some of the local features that had to be accommodated in the design process.

Technical Criteria: Alternative plans were developed to manage the risk from storm inundation. Detailed analysis of the alignment features could indicate that variations or uncertainty in some design conditions, such as overtopping, could present a risk of damage below the top elevation of the risk management structures. These uncertainties could combine to reduce the estimated economic benefits.

3.8 Screening & Combination of Measures

3.8.1 Screening of Measures

Management measures were retained for further consideration based on their ability to meet the following measures screening criteria:

1. Does the measure meet the planning objectives?
2. Does the measure avoid the planning constraint?

Measures eliminated from further consideration are shaded in Table 6.

Table 6. Screening of management measures.

Measure	Does the measure...			
	Objective 1: Manage the risk of flood damages	Objective 2: Manage the risk to life safety	Objective 3: Support community resilience and cohesion	Constraint: Avoid impacts to critical infrastructure
Elevating Structures	Yes	Yes	Yes	Yes
Floodproofing	Yes	No	Yes	Yes
Acquisition	Yes	Yes	No	Yes
Flood Warning System	Yes	Yes	Yes	Yes
Floodplain Management	Yes	Yes	Yes	Yes
Diversion Culverts	Yes	Yes	Yes	Likely
Floodwalls	Yes	Yes	Yes	Likely
Levees	Yes	Yes	Yes	Likely
Channel Modification	Yes	Yes	Yes	No
Detention Basins	Yes	Yes	Yes	Likely
Road Elevation	Yes	Yes	Yes	No
Ringwalls	Yes	Yes	Yes	Likely
Clearing & Snagging	No	No	No	Yes
Pumps*	Yes	Yes	Yes	Yes
Ponding Areas*	Yes	Yes	Yes	Likely
Natural and Nature-Based Features*	No	No	No	Likely

* May meet planning objectives and/or avoid the planning constraint in combination with other measures.

Elevating (Raising) Structures: Elevating structures would permanently remove them from flood hazards. It is assumed that homeowners and business owners would support the elevation of their structures. It is acknowledged that elevating structures would not reduce the problems of street flooding, automobile damage, lost income, and adverse effects on homes and businesses that are not elevated. The measure was included for further consideration.

Floodproofing: Floodproofing structures would permanently alter the design of structures. Dry floodproofing involves the sealing of building walls with waterproof compounds, so that the structure is watertight. Shields may be installed to seal off doors, windows, and other openings. Wet floodproofing includes techniques that can reduce flood damage to a building and its contents, while allowing it to flood. This includes actions such as installing flood vents, relocating contents to higher parts of the building, using flood-damage resistant building materials, and installing automatic shut-off valves on sewer and fuel lines. It is assumed that business owners would support this type of action, which would be limited to non-residential structures. It is acknowledged that floodproofing structures would not reduce the problems of street flooding, automobile damage, lost income, and adverse effects on homes and businesses that are not floodproofed. The measure was included for further consideration.

Acquisition (Buy-Outs): Acquisition of flood-prone properties may reduce flood risk throughout by permanently removing structures and residents' from the basin. This would possibly create additional open space that may be used for recreation. However, communities would be dispersed to other areas. It is assumed that acquisition and relocation of a significant portion of floodplain properties would be prohibitively expensive, and that public acceptability of a mandatory plan is unlikely. The measure was included for further consideration.

Flood Warning System: A flood warning system could allow residents to evacuate low-lying areas in advance of flood. The USGS is currently installing water level gages within the Peckman River, as part of a flood warning system. Two gages were installed in Little Falls in May 2017, with a third planned for installation. The flood warning system will provide information about water levels that can inform local leaders and residents about potential flooding in the project area. Because the USFS gages will provide a flood warning system for the community, the measure was dropped from further consideration.

Floodplain Development Zoning Changes/Enforcement: Floodplain management could help promote smart development of the floodplain. Zoning is a local issue and is not within the jurisdiction of the Federal government. However, any Federal project will have a floodplain management plan component that includes requirements on the use of flood prone lands. The measure was included for further consideration.

Diversion Culverts: Culverts could increase the conveyance capacity of the Peckman River and/or its tributaries. It can reduce flood risk by reduce water surface elevations and flood damages throughout the section of basin downstream of Route 46. It was acknowledged that costs for construction, road work, transportation disruption, utility relocation, and acquisition of real estate interests would be significant. Additionally, there is also a potential for impacts to occur to unrecorded cultural and historic resources during the construction period of a diversion culvert. The measure was included for further consideration.

Levees: Like floodwalls and ringwalls, levees may reduce flood risk throughout the basin by providing flood risk management to areas traditionally sustaining flood damages from flash flooding. However, their construction may include for the destruction of wetlands and impacts to jurisdictional waters; this may result in high environmental mitigation costs. In addition, costs for acquisition of real estate interests may be relatively high. The measure was included for further consideration.

Floodwalls: Like levees and ringwalls, floodwalls may reduce flood risk throughout the basin by providing flood risk management to areas traditionally sustaining flood damages from flash flooding. Because of their typically smaller footprint, they may result in less impacts to environmental resources and real estate costs relative to levees. The measure was included for further consideration.

Channel Modification: Channel modification may increase the conveyance capacity of the Peckman River and/or its tributaries. It could reduce channel blockages resulting from high sediment loads and bank material transported during flood events. This in turn would reduce the risk of flood damages by reducing water surface elevations and flood damages throughout the basin. Channel modification may result in destruction of wetlands and impacts to jurisdictional waters. This could result in high environmental mitigation costs. In addition, the costs for acquisition of real estate interests may be relatively high. The measures was included for further consideration.

Detention Basins: Basin may reduce flood risk by reducing water surface elevations and flood damages by temporarily detaining waters upstream of areas traditionally sustaining flood damages. Areas must have the potential to store enough water temporarily to sufficiently reduce water surface elevations and flood damages downstream. Because the basin is highly developed, no such sufficiently large area could be identified. The measure was dropped from further consideration.

Road Elevation: Elevating roads would significantly impact existing infrastructure and thus was dropped for consideration as a stand-alone feature. However, this measure could provide an efficient tie-in location for a structural alignment and to allow unimpeded traffic flow. It has been considered for further consideration as part of a plan with levees and floodwalls.

Ringwalls: Like levees and floodwalls, ringwalls may reduce flood risk throughout the basin by providing flood risk management to areas traditionally sustaining flood damages from flash flooding. Because of their typically smaller footprint, they may result in less impacts to environmental resources and real estate costs less than levees. The measure was included for further consideration.

Clearing & Snagging: Clearing and snagging of the Peckman River and its tributaries could reduce flood risks throughout the basin by increasing the waterbodies' carrying capacity. Minor snagging and clearing would not have a measurable flood management benefits, and thus would not meet Planning Objective #1. The measure was dropped from further consideration.

Pumps: Pumps alone were dropped for consideration as a stand-alone feature because they would not effectively manage flood risk on their own. However, pumps could allow for the efficient drainage of areas behind levees, floodwalls, and other structural measures and were thus considered for further consideration as part of a plan with levees and floodwalls.

Ponding Areas: Ponding areas would function generally in the same way as detention basin as a stand-alone feature, and thus was dropped for consideration on their own. However, they could improve the function and efficiency of a diversion culvert, and were thus considered for further consideration as part of a plan with culverts.

Natural and Nature-Based Features (NNBFs): Due to the relatively limited flood risk management benefits they would provide and the limited space to construct them, NNBFs were dropped for consideration on their own. However, they could improve the function and efficiency of other measures, and were thus considered for further alternative development as part of the alternatives as practicable.

3.8.2 Combination of Measures: Plan Formulation

Measures that warranted continued consideration were assembled into alternative plans. An alternative plan (also known as, "plan" or "alternative") is a set of one or more management measures functioning together to address one or more planning objectives. The remaining management measures were used individually or combined with others to form alternative plans. The following important points informed the scope and location of the alternatives:

- As described in Section 1.4, the scope of the study and thus the alternatives is limited to addressing flash flooding caused by the Peckman River and its tributaries. They do not include features that reduce backwater or overbank flooding from the Passaic River.
- As described in Section 1.6, flood damages in the basin are concentrated in the communities of Little Falls and Woodland Park. It was determined during initial plan formulation, as documented in the January 2002 Reconnaissance Report, that Federal investment in a flood risk management project would not be economically justified in the upstream municipalities of West Orange, Verona, and Cedar Grove.

Route 46 was identified as a logical dividing point in the formulation of structural alternatives. Differences in flooding mechanisms north and south of this point allowed for the development of separate scales of "upstream" and "downstream" (from Route 46) alternatives for comparison. Woodland Park, which is downstream/north of Route 46, experiences backwater flooding from the Passaic River; Little Falls, which is upstream/south, does not experience backwater flooding. In addition, the Peckman River's relatively close proximity (approximately 1,500 feet) to the Passaic River at Route 46 make it a logical geographic location for a diversion culvert. It was acknowledged that a diversion culvert would provide flood risk management benefits only downstream of Route 46. Other, additional measures would be needed to provide risk management to upstream communities for plans that include the diversion culvert.

3.9 Alternative Plans

The following alternatives were developed for initial plan formulation from the remaining management measures identified in Section 3.8.1 to meet planning objectives and avoid the planning constraint while reasonably maximizing NED benefits. These plans do not include the alternatives considered during feasibility-level design; see Section 3.13 for information about these plans. With the exception of the No Action alternative, they are made up of combinations of measures described in Section 3.8.1. For the purpose of comparing the performance of alternatives, the structural components of alternatives were evaluated at two percent flood event. In addition, the nonstructural components of alternatives were assumed to provide a level of performance at the one percent flood event.

- Alternative 1: No Action
- Alternative 2: Nonstructural Plan
- Alternative 3: Peckman River Diversion Culvert
- Alternative 4: Channel Modifications Upstream and Downstream of Route 46
- Alternative 5: Levee/Floodwall System Upstream and Downstream of Route 46
- Alternative 6: Levee/Floodwall System Downstream of Route 46
- Alternative 7: Channel Modifications Downstream of Route 46
- Alternative 8: Channel Modifications Upstream of Route 46 with Peckman River Diversion Culvert
- Alternative 9: Levee/Floodwall System Upstream of Route 46 with Peckman River Diversion Culvert (formerly the LPP)
- Alternative 10a: Nonstructural Measures (two percent floodplain) Upstream of Route 46 with Peckman River Diversion Culvert
- Alternative 10b: Nonstructural Measures (ten percent floodplain) Upstream of Route 46 with Peckman River Diversion Culvert

Varying levels of performance (design levels) of each alternative were considered. For example, different dimensions of the proposed Peckman River Diversion Culvert that would provide capacity for the ten percent, two percent, and one percent floods were considered during plan formulation and comparison. For brevity, the descriptions presented in this section do not fully describe the different scales of each alternative. This detail, as well as figures showing the locations and geographic extent of the alternatives are included in Appendix C-2.

Alternative 1: No Action. This alternative assumes no Federal action, and is the basis for comparison of the alternative plans. It serves to establish the likely existing and future without-project conditions, and reflects the continuation of existing economic, social, and environmental conditions and trends within the project area. Additionally, the No Action alternative acts as a baseline to which all other alternatives are compared, and is a requirement of the NEPA process. The No Action alternative reflects an absence of Federal action to manage flood risk in the Peckman River Basin due to flash flooding of the river and its tributaries.

Alternative 2: Nonstructural Plan. USACE policy requires the identification of an alternative plan consisting of only nonstructural measures. Differing iterations of nonstructural plans that include combination of the nonstructural measures described in Section 3.6.1 were investigated during initial plan formulation. As part of this initial analysis, structures were logically aggregated by their main floor elevations at heights corresponding to the water surface elevation of different flood events. The groupings used include: structures with a main floor elevation less than or equal to the 0.2, 0.4, one, two, four, and ten, 20, and 50 percent still water surface elevations.

All eight plan iterations included nonstructural measures designed to mitigate inundation up to and including the one percent flood event. The USACE National Nonstructural Committee Nonstructural Flood Risk Management Matrix flowchart was utilized to identify appropriate treatment techniques for each structure. The matrix tool has been used for other USACE feasibility studies with nonstructural components, most recently for the Shrewsbury River Basin, Sea Bright, New Jersey, and Raritan Bay and Sandy Hook Bay, Leonardo, New Jersey coastal storm risk management feasibility studies. The tool evaluates the most appropriate nonstructural measure for each structure based on the structure's attributes (i.e., square footage, foundation type, number of stories, building materials). The tool identified structure elevations, wet floodproofing, dry floodproofing, ringwalls, and structure acquisitions (buy-outs) as the most appropriate treatments in the study area.

The target elevation for the first floor of all structures to be elevated will be at a height of one foot above the USACE-modeled one percent flood water surface elevation. USACE determined that the "plus one foot" height accurately reflects uncertainly of wave effects on water surface elevations in the study area. The BFE varies in the project area from +130 feet to +190 feet NAVD88, with the lowest BFEs located at the confluence of the Peckman and Passaic Rivers. Construction of structure elevations, wet floodproofing, dry floodproofing, and ringwalls measures would be implemented on a voluntary basis. That is, property owners would choose to participate in the nonstructural portion of the plan. As described in Section 3.5, an at- or near-100 percent participation rate is likely and thus was assumed for the purposes of initial plan formulation. Based on a preliminary economic analysis of costs and benefits of each of the eight plan iterations, an alternative plan including structures at or below the ten percent still water surface elevation was chosen as Alternative 2. Nonstructural measures were included in other alternatives, as described in this chapter.

Alternative 3: Peckman River Diversion Culvert. A 1,500-foot long, 35-foot wide diversion culvert would be constructed between the Peckman and Passaic Rivers (Figure 41). Its length would run from 550 feet upstream of the Route 46 bridge, northwest to the Passaic River. It would divert floodwaters from the Peckman River to the Passaic River during and after storms. The diversion culvert inlet at the Peckman River would consist of an in-line weir approximately 10 feet high and 130 feet long that would help divert the flow from the Peckman River into the culvert discharging it into the Passaic River. The diversion culvert would significantly reduce downstream peak discharges (i.e., flash flooding), and subsequently, downstream flood elevations and flood damages. The diversion would not reduce flood damages due to Passaic River backwater flooding the lower reaches of the Peckman River basin in Woodland Park. Due to the high velocities along the river and unstable banks, streambank erosion measures would be necessary. Streambank erosion measures include riprap and articulated concrete blocks. Approximately 1,000 feet of channel modifications in the Peckman River near the diversion culvert opening would be made. Approximately 2,500 linear feet of levees and/or floodwalls downstream of the ponding weir to the Route 46 bridge would be built. The levees and/or floodwalls would range in height from 3 to 6 feet above ground elevation. The top elevation of these features would be +139 feet NAVD88 near Route 46, and +150 feet NAVD88 near Browertown Road. Additionally, approximately 3,000 linear feet of levees and/or floodwalls would be built in the lower reach of Great Notch Brook to its confluence with the Peckman River.

Alternative 4: Channel Modifications Upstream and Downstream of Route 46. The Peckman River would be widened and dredged along its entire length in the project area (Figure 42). The sidewalls of the channel would be reinforced with concrete retaining walls and/or riprap. A 60-foot (base) concrete channel with concrete sidewalls would effectively convey flood discharge downstream to the confluence of the Passaic River. The channel modification would require approximately 15,000 feet of retaining walls along the lower reach of the Peckman River. This work may necessitate reconstruction of the Route 46, Lakawanna Avenue, and McBride Avenue bridges. Additionally, approximately 3,000 feet of levees and/or floodwalls would be built in the lower reach of Great Notch Brook to its confluence with the Peckman River. The levees and/or floodwalls would range in height between 5 and 10 feet above ground elevation. The top elevation of these features would be +139 feet NAVD88 near Route 46, and +150 feet NAVD88 near Browertown Road. Pump stations would be needed to ensure sufficient interior drainage of areas behind levees and/or floodwalls.

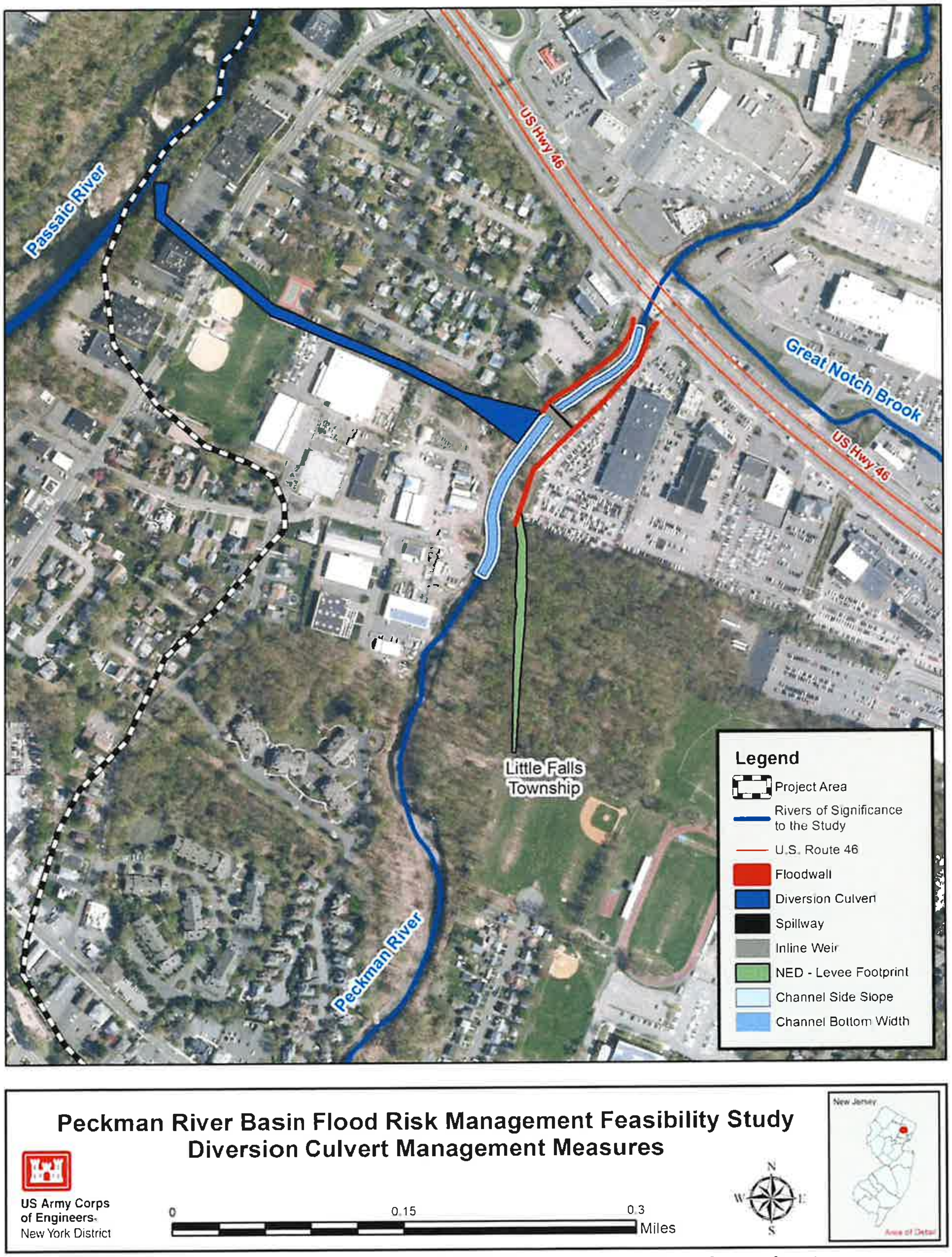

Figure 41. Features associated with the proposed diversion culvert.

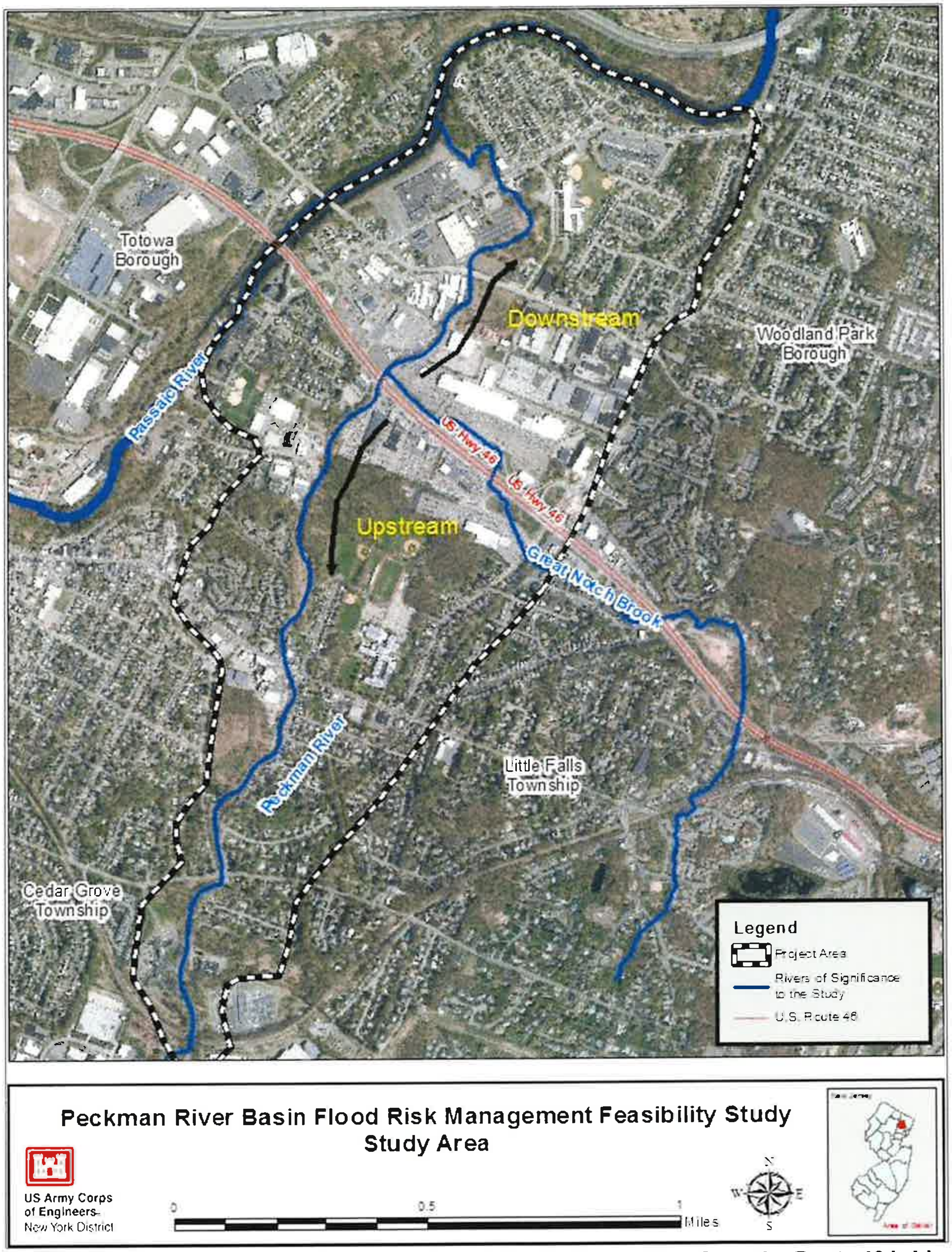

Figure 42. Upstream and downstream reaches of the Peckman River from the Route 46 bridge.

Alternative 5: Levee/Floodwall System Upstream and Downstream of Route 46. Approximately 12,000 feet of levees and/or floodwalls would be built on the Peckman River from the confluence of the Passaic River extending upstream for its entire length in the project area. It is assumed that adequate space is not available on most of the length of the river to construct levees without changing current land uses; floodwalls may be more appropriate for areas with limited space. The average height of the levees and/or floodwalls would be eight feet above ground elevation. Four automobile bridges along the Peckman River would need to be replaced during to this work. This work may also necessitate road closure gates and/or raisings at the Lakawanna Avenue and McBride Avenue bridges.

Additionally, approximately 3,000 feet of levees and/or floodwalls would be built in the lower reach of Great Notch Brook to its confluence with the Peckman River. The levees and/or floodwalls would range in height between five and ten feet above ground elevation. The top elevation of these features would be +139 feet NAVD88 near Route 46, and +150 feet NAVD88 near Browertown Road. Pump stations would be needed to ensure sufficient interior drainage of areas behind levees and/or floodwalls.

Alternative 6: Levee/Floodwall System Downstream of Route 46. Approximately 12,000 feet of levees and/or floodwalls would be built on the Peckman River from the confluence of the Passaic River extending upstream to the Route 46 bridge. The average height of the levees and/or floodwalls would be eight feet above ground elevation. This work may necessitate reconstruction of the Lakawanna Avenue and McBride Avenue bridges.

Additionally, approximately 3,000 feet of levees and/or floodwalls would be built in the lower reach of Great Notch Brook to its confluence with the Peckman River. The levees and/or floodwalls would range in height between five and 10 feet above ground elevation. The top elevation of these features would be +139 feet NAVD88 near Route 46, and +150 feet NAVD88 near Browertown Road. Pump stations would be needed to ensure sufficient interior drainage of areas behind levees and/or floodwalls.

Alternative 7: Channel Modifications Downstream of Route 46. The Peckman River would be widened and dredged from the confluence of the Passaic River extending upstream to the Route 46 bridge. The amount of channel excavation is approximately 80 percent less than that for Alternative 4. The channel modification would require approximately 12,000 feet of retaining walls along the upper reach of the Peckman River. This work may necessitate reconstruction of the Lakawanna Avenue and McBride Avenue bridges.

Alternative 8: Channel Modifications Upstream of Route 46 with Peckman River Diversion Culvert. The features described in Alternative 3 and Alternative 7 would be combined into this plan, excluding the channel improvement features along the Peckman River.

Alternative 9: Levee/Floodwall System Upstream of Route 46 with Peckman River Diversion Culvert (formerly the LPP). The features described in Alternative 3 would be built, in addition to approximately 9,000 feet of levees and/or floodwalls on the Peckman River from the Route 46 bridge extending upstream for the extent of the project area. The average height of the levees and/or floodwalls would be 8 feet above ground elevation. Due to the high velocities along the river and unstable banks, streambank erosion measures would be necessary. Streambank erosion measures include riprap and articulated concrete blocks.

Additionally, approximately 3,000 feet of levees and/or floodwalls would be built in the lower reach of Great Notch Brook to its confluence with the Peckman River. The levees and/or floodwalls would range in height between five and 10 feet above ground elevation. The top elevation of these features would be +139 feet NAVD88 near Route 46, and +150 feet NAVD88 near Browertown Road. Pump stations would be needed to ensure sufficient interior drainage of areas behind levees and/or floodwalls.

Approximately six structures near the bank of the Peckman River would require buyouts to accommodate the levees and/or floodwalls. Due to the high velocities along the Peckman River and unstable banks, streambank erosion mitigation measures would be necessary along the sections of the river. Channel modification is expected in some areas to accommodate riprap and articulated concrete blocks. Large diameter riprap and articulate concrete block are required to eliminate the erosion and possible undermining of the proposed levee and/or floodwall. Lastly, the alternative includes two bridge replacements, Main Avenue East and Lindsley Road, and an automatic hydraulic gate structure at E. Main Street. The gate would close to traffic during extraordinary storm events.

On November 24, 2014 (after the Alternatives Milestone), NJDEP (the non-Federal sponsor) requested that USACE examine Alternative 9 at the one percent flood level of performance, as the LPP. NJDEP favored this alternative because they were interested in providing risk management benefits at this level of performance. Additionally, the LPP offered a greater level of risk management, and provided benefits to a greater number of structures within Little Falls as opposed to the NED plan. Upon conducting this analysis, USACE found that the cost of the project increased from $139,000,000 to $233,000,000 to build to the one percent storm. At this point, the study team determined that this plan had too high of a cost to pursue, based on a comparison of costs and benefits of other alternatives. After this, the NED plan again became the Tentatively Selected Plan.

Alternative 10a: Nonstructural Measures (two percent floodplain) Upstream of Route 46 with Peckman River Diversion Culvert. The features described in Alternative 3 would be built, in addition to the construction of ringwalls that would encircle 51 structures (three residential, 48 non-residential), and implementation of nonstructural measures to structures within the two percent floodplain. A description of the formulation and selection of these nonstructural techniques is summarized in sub-paragraph "Alternative 2." Table 7 summarizes the nonstructural components of the alternative.

Table 7. Nonstructural components of Alternative 10a.

Treatment	Residential	Non-residential	Subtotal
Elevation	71	0	71
Wet Floodproofing	27	2	29
Dry Floodproofing	17	12	29
Total	**115**	**14**	**129**

Ringwalls were individually considered in a last-added analysis. Considering current land uses and the nature of flooding, permanent barriers (vs. temporary barriers) are the most appropriate for the project area. Fifty one ringwalls are included in the plan.

Alternative 10b: Nonstructural Measures (ten percent floodplain) Upstream of Route 46 with Peckman River Diversion Culvert. The features described in Alternative 3 would be built, in addition to the construction of ringwalls that would encircle 47 structures (0 residential, 47 non-residential), and implementation of nonstructural measures to structures within the ten percent floodplain. A description of the formulation and selection of these nonstructural techniques is summarized in sub-paragraph "Alternative 2." Table 8 summarizes the nonstructural components of the alternative.

Table 8. Nonstructural components of Alternative 10b.

Treatment	Residential	Non-residential	Subtotal
Elevation	64	0	64
Wet Floodproofing	3	1	4
Dry Floodproofing	1	2	3
Total	**68**	**3**	**71**

3.10 Plan Evaluation

The alternatives were evaluated and compared based on their economic performance; ability to meet planning objectives and avoid the planning constraint; consideration of the four P&G criteria; and consideration of the four P&G accounts.

3.10.1 Evaluation of Economic Performance

An estimate of Average Annual Costs (AAC) were considered against the Average Annual Benefits (AAB) for the alternatives (Table 9). This allowed for an evaluation of alternatives. The annual costs include interest during construction, which is the interest that accumulates on the construction expenditures until the project is completed and producing benefits.

Table 9. Economic performance of the initial array of alternatives (FY18[1] P.L.).

	First Cost	Average Annual Cost	Average Annual Benefit	Net Benefits	BCR
Alternative 1	N/A	N/A	N/A	N/A	N/A
Alternative 2	$200,928,000	$8,100,000	$17,403,000	$9,303,000	2.1
Alternative 3	$97,609,000	$4,100,000	$16,029,000	$11,929,000	3.9
Alternative 4	$274,231,000	$12,000,000	$16,776,000	$4,776,000	1.4
Alternative 5	$214,372,000	$9,300,000	$17,836,000	$8,536,000	1.9
Alternative 6	$145,499,000	$7,300,000	$6,789,000	($511,000)	0.93
Alternative 7	$106,540,000	$4,500,000	$14,477,000	$9,977,000	3.2
Alternative 8	$213,231,000	$9,400,000	$20,330,000	$10,930,000	2.2
Alternative 9	$267,448,000	$11,148,000	$19,324,000	$8,176,000	1.7
Alternative 10a	$206,812,000	$8,400,000	$20,148,000	$11,748,000	2.4
Alternative 10b	$154,394,000	$6,507,000	$19,363,000	$12,856,000	3.0

BCR: benefit-to-cost ratio / Average annual costs include interest during construction / Interest rate of 2.75 percent from 2027 through 2076 / Discount rate of 2.75 percent from 2027 through 2076

All plans but Alternative 6 provide positive net economic benefits – that is, the economic benefits outweigh the project costs. Of the remaining nine alternatives, some provide two to three times more net economic benefits than others. A relatively ranking of the alternatives by net benefits provided by each plan is shown in Table 10.

Table 10. Relative ranking of net benefits provided by the alternatives.

	Net Benefits	BCR
Alternative 1	N/A	N/A
Alternative 6	($511,000)	0.93
Alternative 4	$4,776,000	1.4
Alternative 9	$8,176,000	1.7
Alternative 5	$8,536,000	1.9
Alternative 2	$9,303,000	2.1
Alternative 7	$9,977,000	3.2
Alternative 8	$10,930,000	2.2
Alternative 10a	$11,748,000	2.4
Alternative 3	$11,929,000	3.9
Alternative 10b	$12,856,000	3.0

[1] Costs and benefits developed as part of initial plan formulation, evaluation, and comparison are included for historical reference; they do not reflect current price levels because they were calculated in previous fiscal years. They are noted with the price level that reflects previous fiscal years as appropriate.

Alternative 10b provides the greatest net economic benefits ($12,856,000) of any plan. Differentiation of benefits provided by the alternatives was considered during plan selection.

3.10.2 Evaluation of Contributions to Planning Objectives & Constraints

Alternatives were judged upon whether or not they make significant contributions to the planning objectives and sufficiently avoid planning the constraint; some do so more efficiently than others. A relative comparison of alternatives was undertaken, and ranked using a "low" (red), "medium" (yellow), "high" (green) system. The three study objectives were used to judge the alternatives: 1) to reduce the risk of flood damages, 2) to reduce the risk to life safety, and 3) to support community resiliency and cohesion. Alternatives that did not meet these objectives were marked as "low" (red) in Table 11, while those that partially met the objectives were marked as "medium" (yellow). Those that were fully successful at meeting the objectives were marked as "high" (green).

The study constraint that was used to judge the alternatives was "to avoid impacts to critical infrastructure." Those alternatives that posed large problems with the constraint were marked as "high" (red), while those that posed small problems with the constraint were marked as "medium" (yellow). Those that fully avoided the constraint was marked as "Low" (green). Note that transportation infrastructure is grouped with critical infrastructure for the purpose of this evaluation.

Table 11. Consideration of planning objectives and constraints.

	Does the plan...			
	Objective 1: Reduce the risk of flood damages	Objective 2: Reduce the risk to life safety	Objective 3: Support community resilience and cohesion	Constraint: Avoid impacts to critical infrastructure
Alternative 1	Low	Low	Low	High
Alternative 2	Medium	Low	Medium	High
Alternative 3	High	Medium	Medium	Medium
Alternative 4	Low	Medium	Medium	High
Alternative 5	Medium	High	Medium	Low
Alternative 6	Low	Low	Low	Low
Alternative 7	Medium	Low	Low	High
Alternative 8	High	High	High	Medium
Alternative 9	Low	High	High	Low
Alternative 10a	High	High	High	Medium
Alternative 10b	High	High	High	Medium

The plans that include the Peckman River Diversion Culvert - Alternative 3, Alternative 8, Alternative 9, Alternative 10a, and Alternative 10b - generally provide more contributions to the planning objectives than other alternatives. Alternative 5, Alternative 6, and Alternative 9 avoid the planning constraint better than other alternatives.

3.10.3 Evaluation of Contributions to the P&G Criteria

The 1983 P&G requires that alternative plans are formulated and compared in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability.

Completeness is the is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planned efforts, including actions by other Federal and non-Federal entities. Project performance of the alternative plans is not dependent upon the completion or function of a project by another government agency or private investment. However, project performance may be affected by large amounts of debris and vegetation that may be present within the river channel, as was witnessed during the August 2018 flood event. Clearing and snagging is the responsibility of local municipalities.

It was acknowledged that nonstructural measures on their own may provide only a small "piece of the puzzle" for risk management in the Peckman River Basin. Because of this, consideration and communication of residual risk is a key component of Alternative 2, Alternative 10a, and Alternative 10b, the plans with nonstructural components.

Effectiveness is the extent to which the alternative plans alleviate the specified problems and achieves the opportunities. The alternatives all achieve the study opportunities to:

- Manage flood risks from associated fluvial flood events that impact communities, infrastructure, and the economy
- Support the resiliency of the Peckman River Basin's communities, infrastructure, and the economic consequences to the region and to the nation economy
- Communicate existing and potential future flood risks to local planners and public officials

Alternatives were judged upon whether or not they make significant contributions to these opportunities; some do so more efficiently than others. In general, Alternative 1 and Alternative 2 would provide risk reduction to a much smaller geographic area than other alternatives. Alternatives that include limited spans of structural measures are less effective at providing risk management as compared to alternatives that include larger spans of structural measures, or combinations of measures.

It is assumed that alternatives that would require little or no change in community services, pathways, and land use would have minimal negative impacts on community cohesion and resilience. It is assumed that alternatives that include levees and/or floodwalls along the Peckman River would have greater impact on the landscape, environment, and land use than other alternatives.

All alternatives are equally effective at providing information for local planners; this study and report meet this opportunity.

Efficiency is the extent to which an alternative plan is the most cost effective means of achieving the objectives. Efficiency was measured through a comparison of benefit-to-cost ratios, reduced damages, and benefits from the project, as described in Section 3.10.1. This comparison showed that of the alternatives, all plans but Alternative 6 provide positive net benefits and thus were deemed economically efficient. The relative ranking of the alternatives by net benefits provided by each plan (Table 10) was used to determine which plans were more efficient than others in providing economic benefits to communities.

Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies. The alternatives were formulated in accordance with applicable laws, regulations, and policies. The alternative plans are equal in that there are no known issues with laws, regulations, and policies that would preclude their implementation. Any proposed plan would require complete environmental compliance and coordination with resource agencies prior to construction. The alternatives were formulated in accordance with applicable laws and regulations. Therefore, they are equally acceptable.

Table 12 shows a summary of to what degree each alternative meets the P&G criteria on a subjective scale of Low-Medium-High.

Table 12. Summary of contribution of alternatives to the P&G criteria.

	Completeness	Effectiveness	Efficiency	Acceptability
Alternative 1	Low	Low	Low	High
Alternative 2	Low	Low	Medium	High
Alternative 3	High	Medium	High	High
Alternative 4	Medium	High	Low	High
Alternative 5	Medium	High	Medium	High
Alternative 6	Medium	Medium	Low	High
Alternative 7	Medium	Medium	Medium	High
Alternative 8	High	Medium	High	High
Alternative 9	High	High	Low	High
Alternative 10a	High	High	High	High
Alternative 10b	High	High	High	High

Alternative 8, Alternative 10a and Alternative 10b contribute highly to at least three of the four P&G criteria. Alternative 1, Alternative 2, Alternative 5, Alternative 6, and Alternative 7, do a poor job of contributing highly to at least two of the four P&G criteria.

3.10.4 Evaluation of Contributions to the P&G Accounts

The 1983 P&G requires that alternative plans are formulated and compared in consideration of four accounts:

- NED (National Economic Development): changes in the economic value of the National output of goods and services. To define which alternatives maximized the NED account, the net benefits of each alternatives (Tables 9 and 10), were ordered from lowest to highest. The four alternatives with the lowest net benefits were assigned a ranking of "low", the three next lowest alternatives were marked as "medium", and the four alternatives with the highest net benefits were marked as "high."
- RED (Regional Economic Development): changes in the distribution of regional economic activity that result from each alternative plan. The economic benefits presented in Table 13 were used to define which alternatives maximized the RED account. The four with the lowest net benefits were marked as "low", the three next lowest were marked as "medium", and the four alternatives with the highest net benefits were marked as "high."
- OSE (Other Social Effects): effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts. The Other Social Effects account includes things like environmental justice, community cohesion, and structural divisions through communities that could impact open communication between residents. Each alternative was marked as low, medium, or high on a case by case basis. Alternative 1 was marked as the only low alternative, because following the no-action alternative, the communities of Little Falls and Woodland Park would continue to flood and endure catastrophic damages. Alternatives 2, 3, 6, 7, 10a, and 10b were marked as "medium" because they address flooding problems primarily in Woodland Park and leave a substantial amount of residual risk in Little Falls. Alternatives 4, 5, 8, and 9 were marked as high because they offer structural solutions to both communities of Woodland Park and Little Falls, leaving very little residual risk of flooding.
- EQ (Environmental Quality): non-monetary beneficial effects on significant natural and cultural resources. The low, medium, high rankings of the alternatives in this account is a summary of the environmental analysis presented in Tables 14 and 15. Any alternatives that had a significant and unavoidable (SU) impact to environmental resources were marked as "low." Any alternative that has a Less Than Significant with Mitigation (LTSM) was marked as "medium." Alternative 1 was marked as "medium" because it neither has positive or adverse effects on environmental resources..

The accounts were the basis for the plan formulation strategy, as described in Section 3.7. Table 13 shows a summary of to what degree each alternative meets the P&G accounts on a subjective scale of Low-Medium-High. The levels of low, medium, and high represent the team's subjective, relative ranking of alternatives in how successful they are in each P&G account. Alternatives that did not meet the accounts were marked as "low" (red) in Table 12, while those that partially met the accounts were marked as "medium" (yellow). Those that were fully successful at meeting the accounts were marked as "high" (green).

Table 13. Summary of contribution of alternatives to the P&G accounts.

	NED	RED	OSE	EQ
Alternative 1	Low	Low	Low	Medium
Alternative 2	Medium	Medium	Medium	Medium
Alternative 3	High	High	Medium	Medium
Alternative 4	Low	Low	High	Low
Alternative 5	Medium	Medium	High	Low
Alternative 6	Low	Low	Medium	Medium
Alternative 7	High	High	Medium	Low
Alternative 8	Medium	Medium	High	Low
Alternative 9	Low	Low	High	Low
Alternative 10a	High	High	Medium	Medium
Alternative 10b	High	High	Medium	Medium

Alternative 3, Alternative 4, Alternative 5, Alternative 8, Alternative 9, Alternative 10a, and Alternative 10b contribute highly to at least two of the four P&G accounts. Alternative 1, Alternative 2, and Alternative 7, do not contribute highly to at least one of the four P&G accounts.

3.10.5 Evaluation of Environmental and Socioeconomic Benefits & Impacts

This section builds upon the EQ "non-monetary effects on significant natural and cultural resources" P&G account by further classifying the magnitude of impacts the preliminary alternatives are likely to have on the environmental and socioeconomic resources. Table 14 and Table 15 summarize the environmental impacts of each alternative.

For the purposes of the preliminary screening of the alternatives, the magnitude of impacts are categorized as:

- No Effect (No Effect): no noticeable adverse effect on the environment would occur.
- Less Than Significant (LTS): The impacts of the project do reach or exceed the defined threshold/criteria of significance or the effects are not adverse. No mitigation measures are required for a LTS impact.

  An example of this type of impact is air quality, where construction emissions from flood risk management projects such as have historically been below the de minimis values established for criteria pollutants. For other environmental resources such as water, vegetation, and fish and wildlife, this impact type is assumed when the area being affected by the action has undergone such significant anthropological modifications that the effect of the proposed action would not further decrease the function of the resource to a level where mitigation is necessary.
- Less Than Significant with Mitigation (LTSM): Mitigation measures in the form of avoidance, minimization, reducing the impact over time, and/or compensation are identified to reduce the potentially significant impact to less than significant level.

An example of a LTSM impact is moving a floodwall/levee further out of wetlands to avoid or minimize impacts, or compensating for the impacts through the purchase of wetland mitigation credits or creating, restoring, or enhancing wetlands.

- Significant and Unavoidable (SU): SU is applied to actions that cause substantial permanent adverse changes to any of the physical conditions within the area affected by the proposed action. Although implementation of mitigation measures may reduce the significance of the effects, they will not reduce the impact to a less than significant level. Unavoidable is defined as the impact is necessary in order for the proposed action to achieve its stated goal, in this case flood risk management.

The Water Resource column for Alternative 7, Alternative 8, and Alternative 9 in Table 14 is an example of this type of impact. The channel modifications and levees/floodwalls will significantly permanently change the character and function of the Peckman River, but is necessary to provide flood risk management.

Table 14: Summary of impacts of alternatives to environmental resources.

	Water Resources	Vegetation	Fish and Wildlife	Cultural Resources	Air Quality
Alternative 1	No Effect	No Effect	No Effect	No Effect	No Effect
Alternative 2	No Effect	LTSM	No Effect	LTS	LTS
Alternative 3	LTS	LTSM	LTSM	LTS	LTS
Alternative 4	SU	SU	SU	SU	LTS
Alternative 5	SU	SU	SU	SU	LTS
Alternative 6	LTSM	LTSM	LTSM	LTS	LTS
Alternative 7	SU	SU	SU	LTS	LTS
Alternative 8	SU	SU	SU	SU	LTS
Alternative 9	SU	SU	SU	SU	LTS
Alternative 10a	LTSM	LTSM	LTSM	LTSM	LTS
Alternative 10b	LTSM	LTSM	LTSM	LTSM	LTS

Table 15: Summary of impacts of alternatives to socioeconomic resources.

	Recreation	Aesthetics	Env. Justice	Transportation	Noise
Alternative 1	No Effect	No Effect	No Effect	No Effect	No Effect
Alternative 2	No Effect	LTS	No Effect	LTS	LTSM
Alternative 3	LTS	LTS	No Effect	LTS	LTSM
Alternative 4	LTSM	SU	No Effect	LTS	LTSM
Alternative 5	LTSM	SU	No Effect	LTS	LTSM
Alternative 6	No Effect	LTSM	No Effect	LTS	LTSM
Alternative 7	No Effect	LTS	No Effect	LTS	LTSM
Alternative 8	LTSM	LTSM	No Effect	LTS	LTSM
Alternative 9	LTSM	SU	No Effect	LTS	LTSM
Alternative 10a	LTS	LTS	No Effect	LTS	LTSM
Alternative 10b	LTS	LTS	No Effect	LTS	LTSM

3.11 Plan Comparison

The study team considered how well each alternative performed relative to others as related to economic performance, planning objectives, the planning constraint, the P&G criteria, and the P&G accounts. Table 16 summarizes the relative performance relative to these selection criteria on a subjective scale of Low-Medium-High. Note that those alternatives that avoided constraints very well were rated "high."

Table 16: Summary of performance of the alternative plans.

	Economic Performance	Meets Planning Objectives	Avoids Planning Constraints	Contributes to P&G Criteria	Contributes to P&G Accounts
Alternative 1	Low	Low	High	Low	Low
Alternative 2	Medium	Low	High	Low	Low
Alternative 3	High	High	Medium	Medium	Medium
Alternative 4	Low	Medium	High	Medium	Medium
Alternative 5	Medium	Medium	Low	Low	Medium
Alternative 6	Low	Low	Low	Low	Low
Alternative 7	Medium	Medium	High	Low	Medium
Alternative 8	High	High	Medium	High	High
Alternative 9	Low	Medium	Low	Medium	Medium
Alternative 10a	High	High	Medium	High	High
Alternative 10b	High	High	Medium	High	High

The alternatives were grouped by flood management strategy for the purposes of plan comparison.

Strategy 1: Plans Focusing on Diverting Floodwaters to the Passaic River

Alternative 3, Alternative 9, Alternative 8, Alternative 10a, and Alternative 10b include the Peckman River Diversion Culvert. These plans generally do a better job of meeting planning objectives and contributing to the P&G criteria than other alternatives. Alternative 3, Alternative 8, Alternative 10a, and Alternative 10b provide greater net economic benefits than all other plans. Because of the Peckman River floodwalls included in Alternative 9, the plan provides relatively little economic net benefits relative to other culvert alternatives.

Strategy 2: Plans Focusing on Channel Modifications in the Peckman River

Alternative 4, Alternative 7, and Alternative 8 include modification of the Peckman River channel. Alternative 8 also includes the Peckman River Diversion Culvert. Alternative 8 provides the most economic net benefits of this group. Alternative 7 provide relatively moderate net economic benefits, while Alternative 4 does a relatively poor job of providing net economic benefits. They generally avoid constraints better than other alternatives, because channel modifications would be limited to within the Peckman River.

Strategy 3: Plans Focusing on Levees and Floodwalls along the Peckman River

Alternative 5, Alternative 6, and Alternative 9 include the construction of levees and floodwalls along the Peckman River The alternatives provide relatively low net economic benefits. Construction of levees and floodwalls would require land use changes that may not be acceptable to the community. The study team determined that this would be a major obstacle during plan implementation.

Strategy 4: Plans Focusing on Nonstructural Strategies

Alternative 2, Alternative 10a, and Alternative 10b are largely or totally composed of nonstructural measures. Alternative 2 provides moderate net economic benefits and avoids the planning constraint satisfactorily. However, they does not contribute as much to the P&G criteria and accounts compared to the other alternatives. The benefits and impacts of Alternative 10a and Alternative 10b are generally from the Peckman River Diversion Culvert, which are discussed previously in this section.

3.12 Plan Selection

The study team considered the costs, benefits, and trade-offs related to each alternative. It was agreed that plans that include the Peckman River Diversion Culvert provide the most economic and social benefits; acceptably avoid significant impact to the environment and communities; and contribute the greatest to the P&G criteria and accounts, as previously presented in this chapter. Because of this, all plans but Alternative 3, Alternative 9, Alternative 10a, and Alternative 10b were screened from consideration.

Of the four alternatives that include a diversion culvert, Alternative 9 was found to be the least acceptable alternative. The plan provides the least amount of net economic benefits. In addition, the plan's extensive levees and floodwalls along the Peckman River, have greater environmental and social impacts than the other plans. Because of this, the plan was screened from consideration.

Finally, Alternative 3, Alternative 10a, and Alternative 10b were compared (Table 17). The first cost of Alternative 3 is significantly less than Alternative 10a and Alternative 10b. Alternative 10a and Alternative 10b have relatively high costs due to the inclusion of nonstructural measures upriver of the Peckman River Diversion Culvert in Little Falls. The three plans provide similar net economic benefits, though Alternative 10b provides more than the other two plans. However, the nonstructural measures included in Alternative 10a and Alternative 10b reduce residual risk and risk to life safety. This is displayed as "with-project (residual) damages" in Table 17; Alternative 10a and Alternative 10b significantly reduce residual risk more than Alternative 3. For this reason, Alternative 3 was screened from consideration.

Table 17: Plan comparison: Alternative 3, Alternative 10a, and Alternative 10b ($1,000s, FY18 P.L.).

Alternative	First Cost	Without Project Damages	With Project (Residual) Damages	Annual Benefits	Net Benefits	Benefit-Cost Ratio
Alternative 3	$97,609	$20,626	$4,597	$16,029	$11,929	3.9
Alternative 10a	$206,812	$20,626	$478	$20,148	$11,748	2.4
Alternative 10b	$154,394	$20,626	$1,263	$19,363	$12,856	3.0

First cost includes interest during construction at 2.875 percent. Annual cost includes annual OMRR&R costs.

The first costs and net economic benefits of Alternative 10a and Alternative 10b were then compared. The first cost for Alternative 10a is approximately 34% more than Alternative 10b. In addition, Alternative 10a provides less economic benefits than Alternative 10b. For these reasons, Alternative 10b was identified as the Tentatively Selected Plan. In summary, the alternative provides the most economic and social benefits; acceptably avoids significant impact to the environment and communities; and contributes the greatest to the P&G criteria and accounts, as described in Section 3.10 (Figure 43). The plan is a combination of a diversion culvert connecting the Peckman and Passaic Rivers; levees and floodwalls; channel modifications; ringwalls; and nonstructural measures within the ten percent floodplain upstream of Route 46. The structural features are designed to manage flood risk up to the two percent flood event. The project will reduce the risk of flooding for those flood events that have up to a two percent chance of occurring in a given year. The plan provides the greatest NED benefits of any alternative ($12,856,000 in FY18 P.L.), with a BCR of 3.0.

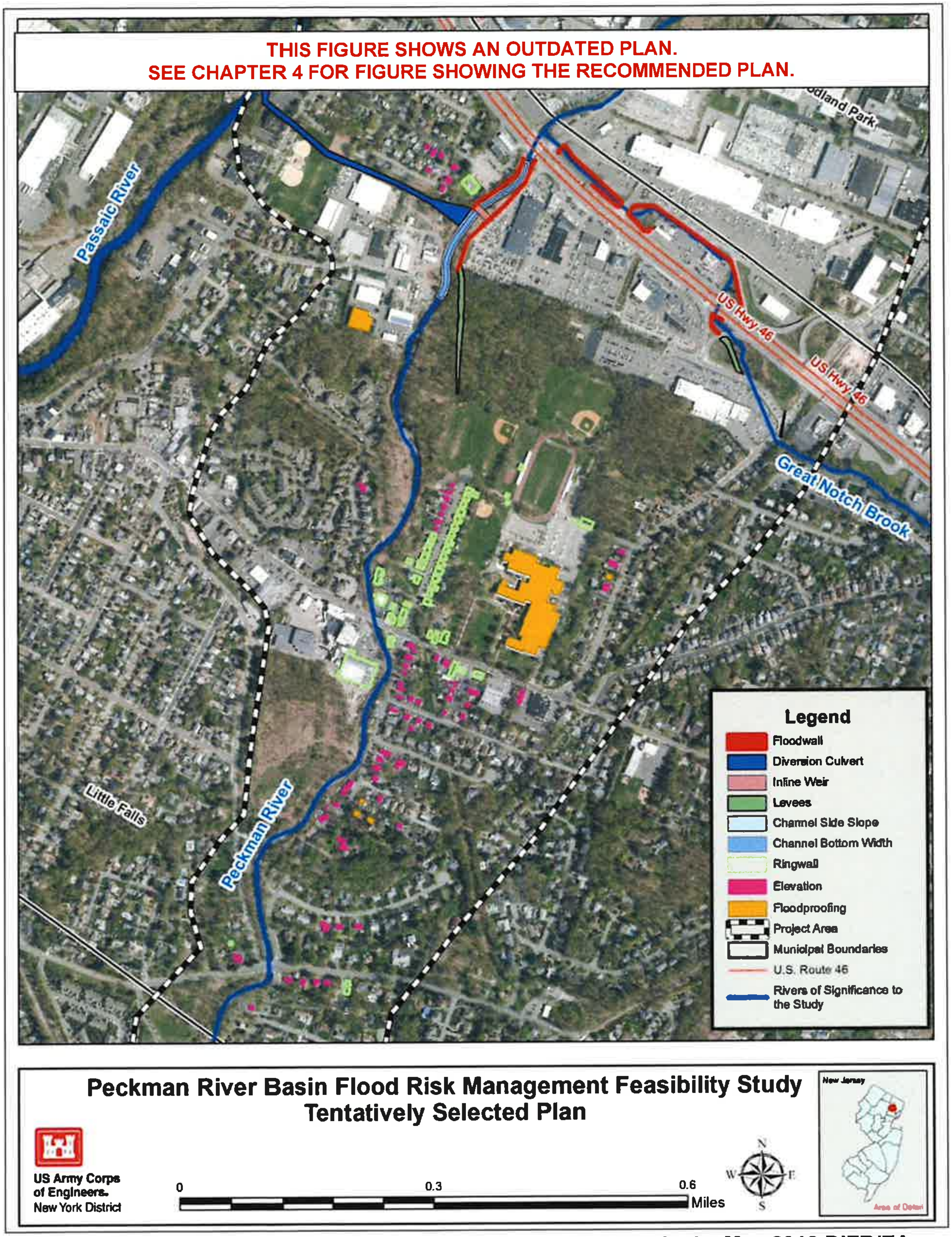

Figure 43. Components of the Recommended Plan presented in the May 2018 DIFR/EA.

3.13 Feasibility-Level Design (Plan Optimization)

Since release of the DIFR/EA in May 2018, additional engineering modeling, economic analysis, and detailed design and cost estimating were completed to reduce risk and uncertainty. This feasibility-level design effort, or "plan optimization," improved the definition of project costs, economic benefits, residual risk of flooding, and impacts to the environment. The results of initial plan evaluation and comparison summarized in Section 3.10 and Section 3.11 are still valid. Alternative 10b was refined as a result of feasibility-level design, as summarized in this section. The optimized plan is fully described in Chapter 4.

3.13.1 Engineering (Hydraulic) Modeling

An one-dimensional steady state USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) hydraulic model was used during initial plan formulation and selection, to understand existing and expected future flooding in the study area. During feasibility-level design, a two-dimensional unsteady state HEC-RAS model was used to further analyze flood dynamics in the study area. The two-dimensional HEC-RAS modeling results have led to a better understanding of existing and expected flood dynamics. A summary of the HEC-RAS modeling effort is found in Appendix C-2.

As described in Section 3.1, the study area experiences flood damages due to flash flooding from the Peckman River and its tributaries, and overbank and backwater flooding from the Passaic River. The scope of this study is limited to addressing flooding caused by the Peckman River and its tributaries. However, it was acknowledged during feasibility-level design that project performance may be affected by the effects of backwater flooding from the Passaic River. Specifically, backwater flooding into the Peckman River through the diversion culvert may affect project performance. To better understand the effects of Passaic River backwater flooding on project performance, backwater flooding was incorporated into the model; overbank flooding was not included, as it doesn't have a similar effect on project performance. In addition, a joint probability analysis was completed to calculate the likelihood and effects of simultaneous flooding of the Peckman and Passaic Rivers flooding the study area.

The two-dimensional HEC-RAS model results showed nuances of existing and expected flood water levels in Little Falls and Woodland Park. They showed that floodwaters on the right (east) bank of the river, downstream (north) of the East Main Street bridge flow overland more than previously understood. Consequently, the assumed efficiency of the diversion culvert's ability to capture floodwaters was reduced. Refinements to the plan were made to enhance project performance, as described in Section 3.13.2.

3.13.2 Plan Refinement

The two-dimensional HEC-RAS model results were the basis of refinements made to the plan. The following changes were made based on the better understanding of existing and expected flood dynamics. Appendix C-2 includes detailed information about plan refinements.

- Great Notch Brook levees and floodwalls. More overland flooding occurs downstream (north) of the East Main Street bridge flow occurs than was previously understood. The levees and floodwalls along the Great Notch Brook are not effective in reducing this overland flooding. Accordingly, the features were removed from the plan.
- Extension of right (east) bank levees near Little Falls High School. The modeling also showed the need to divert overflow floodwaters more efficiently into the Peckman River, and eventually the diversion culvert, near the East Main Street bridge. To achieve this, levees and floodwalls north of Little Falls High School between the track and baseball field were added to the plan.
- Peckman River channel modifications. The model results provided information about the need for additional spans of channel modifications upriver (south) of where initially located.
- Nonstructural measures and ringwalls. Changes to the structural components of the plan required refinement of the nonstructural components. The economic efficiency of different combinations of nonstructural measures, including the incremental economic justification of differing groupings of measures and structures was investigated. This resulted in changes to the number and location

of structures to be elevated or floodproofed. The number of structures to be elevated or floodproofed decreased due to the results of this analysis. In addition, all ringwalls were removed from the plan because they were found to not provide the most effective and appropriate flood risk management as previously thought.

Other plan refinements include changes to the number and dimension of diversion culvert weirs, and Peckman River levees and floodwalls associated with design refinements.

3.13.3 Economic Optimization Analysis

The study team focused an economic optimization analysis on the sizing of the diversion culvert, which is the most prominent and costly feature of the plan. Costs and benefits were calculated for two plans with different culvert sizes: 35-foot wide, and 40-foot wide. The Tentatively Selected Plan presented in the May 2018 DIFR/EA included a 35-foot wide diversion culvert, and is denoted as Alternative 10b-35. It includes the design refinements described in Section 3.13.2. A plan that includes a 40-foot wide diversion culvert (Alternative 10b-40) was considered to investigate the efficiency of a plan that could convey a greater volume of floodwater over time to the Passaic River. It includes the design refinements described in Section 3.13.2 as slightly modified to reflect the difference in culvert size. Appendix C-2 includes detailed information about these refinements.

A plan with a narrower diversion culvert was not considered. There is an inverse relationship between culvert width and levee height. The inclusion of higher levees in any plan was calculated to significantly increase project cost, and thus would not economically perform as well as plans with narrower culvert sizes.

The economic analysis reflects the two-dimensional HEC-FDA modeling results that reflect Passaic River backwater flooding on project performance. Because of this, the with-project (i.e., residual) vary from those developed and used for plan formulation and comparison (Table 9 of Appendix B). Project costs, and economic damages benefits for Alternative 10b-35 and Alternative 10b-40 were developed and compared as part of the economic optimization analysis (Table 18). The economic damages and benefits reflect the effect of Passaic River backwater flooding on project performance, as described in Section 3.13.1.

Table 18: Summary of economic optimization analysis ($1,000s, FY19 P.L.).

Alternative	Total Implementation Cost	Annual Cost	Without Project Damages	With Project Damages	Annual Benefits	Net Benefits	Benefit-Cost Ratio
10b-35	$84,690	$3,526	$17,225	$9,375	$7,849	$4,323	2.22
10b-40	$82,735	$3,449	$17,225	$9,459	$7,465	$4,316	2.25

Total implementation cost includes interest during construction at 2.875 percent. Annual cost includes annual OMRR&R costs.

The results of the economic optimization analysis illustrated that Alternative 10b-35 and Alternative 10b-40 provide very similar net economic benefits (Table 18). Typically, the plan with the greatest net economic benefits is selected as the preferred plan. However, USACE guidance allows the selection of a plan of lesser cost when the net economic benefits are similar. Because the plans provide very similar net economic benefits, Alternative 10b-40, as the less costly plan, was selected as the optimized Tentatively Selected Plan.

3.13.4 Detailed Design & Cost Estimating

Detailed design of Alternative 10b-40 was completed in order to improve accuracy of implementation costs, engineering effectiveness, and economic performance. Detailed project design and costs are presented in Chapter 4. The design of the project will be refined during PED based on detailed site-specific information.

3.13.5 Summary of Plan Changes

Table 19 summarizes changes to the Recommended Plan made since May 2018.

Table 19: Summary of feasibility-level design plan refinements.

Feature	Alternative 10b (May 2018)	Alternative 10b-40 (October 2019)
Peckman River Diversion Culvert	35-foot wide, 1,500-foot long covered culvert located approximately 550 feet upstream of the Route 46 bridge	40-foot wide, 1,500-foot long covered culvert located approximately 550 feet upstream of the Route 46 bridge
Peckman River Diversion Culvert Weirs	One 6-foot wide by 2-foot high weir	Two weirs: 1) 19.25-foot wide by 6.5-foot high, and 2) 24-foot wide by 12.25-foot high
Peckman River Levees and Floodwalls	2,500 linear feet of levees and floodwalls	2,170 linear feet of levees and floodwalls
Peckman River Channel Modifications	1,000 linear feet of riprap and articulated concrete blocks	1,848 linear feet of riprap, articulated concrete blocks, and armoring
Great Notch Brook Floodwalls	3,000 linear feet of levees and/or floodwalls	Not included in plan
Little Falls High School Levees and Floodwalls	Not included in plan	1,207 linear feet of levees and floodwalls
Nonstructural Measures	Up to 71 structures in the ten percent floodplain upstream of Route 46	Up to 58 structures in the ten percent floodplain upstream of Route 46
Ringwalls	7 ringwalls around up to 47 structures	Not included in plan

Stated linear feet of diversion culvert, levees, floodwalls, and channel modification dimensions are approximate. Design details will be refined during PED.

3.13.6 Confirmation of Plan Selection

After release of the October 2019 version of this report, Alternative 10b-40 was confirmed as the Tentatively Selected Plan and is now documented as the Recommended Plan. The details of Alternative 10b-40 are found in Chapter 4.

Chapter 4: Recommended Plan: Alternative 10b-40*

4.1 Plan Components

The plan is a combination of a diversion culvert connecting the Peckman and Passaic Rivers; associated weirs; levees and floodwalls; channel modifications; and nonstructural measures within the ten percent floodplain upstream of Route 46 (Figure 44).

Figure 44. Recommended Plan: Alternative 10b-40.

Project performance. The plan is designed to manage flood risk up to the two percent flood event. The project will reduce the risk of flooding for those flood events that have up to a two percent chance of occurring in a given year. Details about project performance can be found in Chapter 7 of Appendix B "Economics."

Diversion Culvert. Upstream of Route 46, floodwaters would be diverted from the Peckman River to the Passaic River through a 1,500-foot long culvert located approximately 550 feet upstream of the Route 46 bridge. The 40-foot wide double box diversion culvert would be constructed using a "cut-and-cover" approach (Figure 45). The culvert inlet consists of two weirs that would divert the flow from the Peckman River into the culvert, discharging it into the Passaic River. The weirs would be 19.25-feet wide by 6.5-feet in height, and 24-feet wide by 12.25-feet in height. The diversion culvert would significantly reduce downstream peak discharges (i.e., flash flooding), and subsequently, downstream flood elevations and flood damages. Nearly all flood risk management benefits from the diversion culvert would be in Woodland Park. The culvert would not reduce backwater or overbank flooding from the Passaic River.

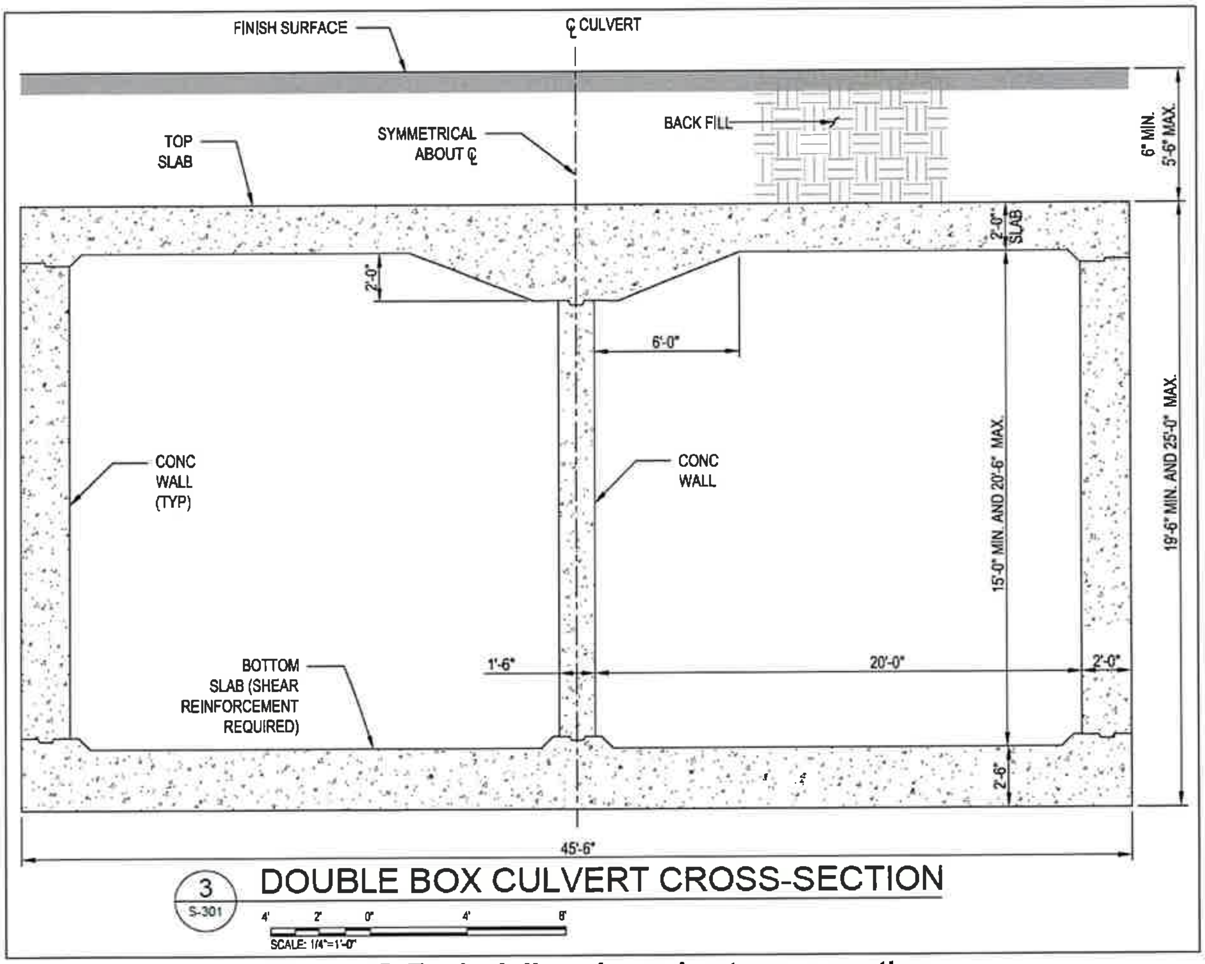

Figure 45. Typical diversion culvert cross section.

Levees & Floodwalls. Approximately 2,170 linear feet of levees and floodwalls would be constructed along the Peckman River downstream of the ponding weir to the Route 46 bridge (Figures 46 and 47). Approximately 1,207 linear feet of levees and floodwalls would also be built north of Little Falls High School between the track and baseball field.

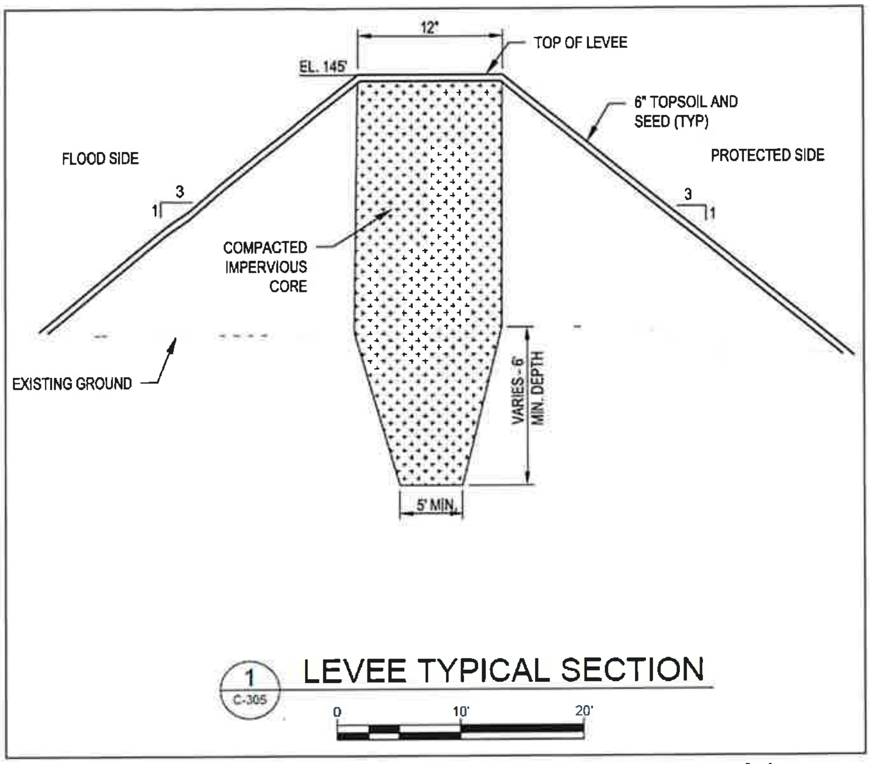

Figure 46. Typical levee cross section (not to scale).

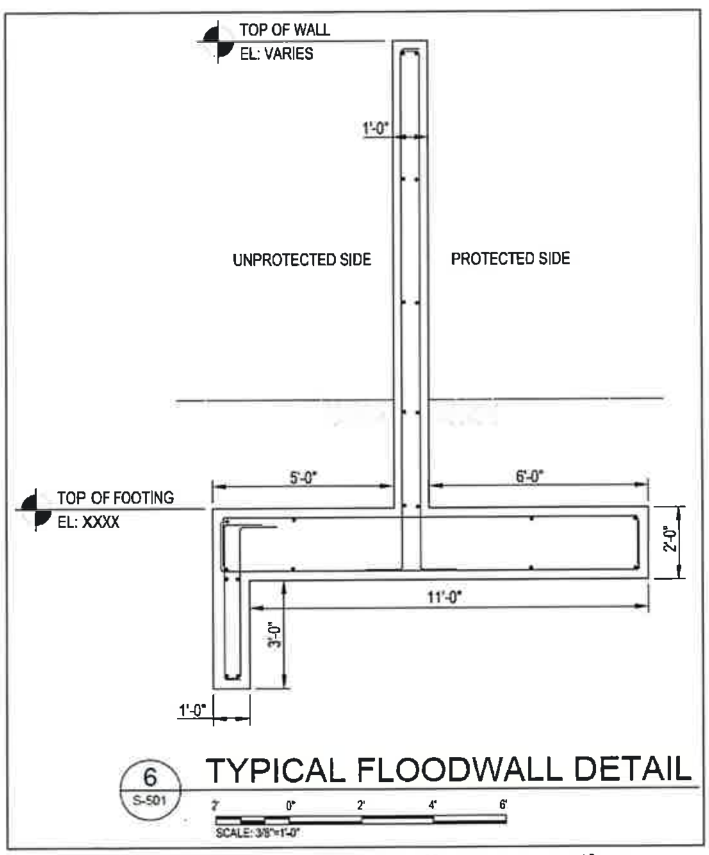

Figure 47. Typical floodwall cross section.

Channel Modifications. Due to the high velocities along the Peckman River and unstable banks, streambank erosion mitigation measures are necessary along the sections of the river. Channel modification is expected along 1,848 linear feet of shoreline to accommodate riprap. Large diameter riprap would eliminate the erosion and possible undermining of the proposed levees and floodwalls.

Nonstructural Measures. Up to 58 structures in Little Falls located in the ten percent floodplain near the Peckman River would be elevated or floodproofed (Table 20). The main objective of the nonstructural measures is to reduce flood damages through modifications of the existing structures. Structure elevations involve lifting structures so their first floor elevation is above the base flood elevation (also known as the one percent flood water surface elevation). The most appropriate wet floodproofing measures for the subject structures include elevating air conditioning and heating units, and filling basements so that they are not subject to flooding. Dry floodproofing measures would include making structures watertight by sealing walls and openings (i.e., doors and windows) with permanent or temporary shields.

Table 20. Nonstructural components of Alternative 10b-40.

Treatment	Residential	Non-residential	Subtotal
Elevation	16	0	16
Wet Floodproofing	29	9	38
Dry Floodproofing	4	0	4
Total	**49**	**9**	**58**

A detailed field assessment of each of the 58 structures included in the plan will be completed as part of PED to confirm the appropriateness of these nonstructural measures. Implementation of the nonstructural measures is based on the voluntary participation of property owners. As such, Table 20 presents the maximum scope of nonstructural measures included in the plan. Per USACE practice, it is assumed that Federal contracting vehicles will be used by the New York District to construct nonstructural measures. Based on the relatively small amount of structures in the plan, it is assumed that a single contractor will handle the work. Temporary real estate easements would be needed for construction, as detailed in Appendix E. Best practices promulgated by the USACE National Nonstructural Committee will be considered during design and construction. The New York District will continue coordination with the Committee through PED and construction.

Compensatory Mitigation. Mitigation is required due to unavoidable temporary or permanent environmental impacts to forested wetland, riparian habitat, and stream restoration. The following habitat types and extents will be permanently, directly impacted by the project: a) 1,848 linear feet of freshwater riverine system equaling to approximately 1.7 acres of open water; b) 0.48 acres of forested wetlands; c) 0.77 acres of riparian zone; d) 0.85 acres of streambank vegetation; and d) 1.5 acres of upland forest. Approximately 0.71 acres of forested wetlands and 1.37 acres of riparian zone will experience temporary impacts as a result of construction activities. These areas will be restored on site following construction completion.

In order to compensate for the permanent direct impacts approximately 1,848 linear feet of river equaling to approximately of 1.7 acres of open water habitat and 0.85 acres of native streambank vegetation will be restored. Included in the compensatory mitigation is 0.77 of riparian zone restoration. Based on USACE policy, no compensation for the loss of 1.5 acres of upland forest is proposed. The details of the mitigation plan are included in Appendix A-9.

Risk Communication. As described in Section 4.5.2 and Section 4.5.6, the project will not eliminate all flood risk to life and property. Because of this, it is essential that flood risk be communicated to residents. USACE, NJDEP, and local municipalities will work together to communicate flood risk, especially residual flood risk, as described in Section 4.5.6.

4.2 Plan Benefits

Benefits were calculated as the difference in damages for the without- and with-project conditions. Benefits were then amortized over a 50-year period (2027 through 2076) to identify equivalent annual benefits using the FY 20 P.L. and an interest rate of 2.75 percent. The plan would provide $9,440,000 in Average Annual Benefits (AAB), while incurring an Average Annual Cost (AAC) of $6,184,000 (FY 20 P.L.). The average annual net benefits of the plan are $3,292,000, with a BCR of 1.5 (FY 20 P.L.). The with project (residual) annual damages are $10,021,000 Equivalent Annual Damages (EAD) (FY 20 P.L.).

4.3 Plan Costs

The project costs were developed using the Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) program (Table 21, Table 22, and Table 23). The MII cost estimate used RSMeans, MII Cost Libraries, and vendor quotations. Moreover, the cost contingencies were developed through a standard Cost and Schedule Risk Analysis (CSRA). The summary of the results of this risk analysis, and more detail on the cost estimate, can be found in Appendix D.

The initial project cost is $146,188,000, with total annual costs of $6,184,000. The plan would be cost shared as 35 percent Non-Federal and 65 percent Federal. The project cost estimate is broken out by cost component (Table 21), annual costs (Table 22), and costs and benefits (Table 23) all costs presented at October 2019 price level. This includes planning, engineering and design, construction management, interest during construction, and operation and maintenance (contingencies are included). The real estate cost of the project is estimated to be $5,273,000. The project would necessitate the acquisition of 12.2 acres of property. Permanent easements totaling 11.35 acres, and 6.20 acres of temporary easements would also be required. In some instances, more than one estate may be required to be obtained over the lands of the same owner. Required Lands, Easements, and Rights-of-Way (LER) total 23.39 acres.

Table 21. Recommended Plan cost estimate (FY 20 P.L.).

Cost Component	Cost ($)
Lands and Damages	$4,777,000
Relocations	$496,000
Fish & Wildlife Facilities	$2,376,000
Channels & Canals	$21,627,000
Levees & Floodwalls	$11,437,000
Floodway Control & Diversion Structure	$65,067,000
Cultural Resource Preservation	$2,387,000
Buildings, Grounds & Utilities	$11,580,000
Planning, Engineering & Design	$17,245,000
Construction Management	$9,197,000
Total	**$146,188,000**

Table 22. Project annual costs (FY 20 P.L.).

Fully Funded Total Project Cost	$176,598,000
First Cost Total Project Cost	$146,188,000
Interest During Construction (32 month construction at 2.75%)	$5,246,000
Net Investments	**$151,434,000**
Annualized (2.75%, 50 years)	$5,609,000
Annual OMRR&R	$575,000
Total Annual Cost	**$6,184,000**

Average annual costs include interest during construction / Interest rate of 2.75 percent from 2027 through 2076

Table 23. Costs and benefits of the Recommended Plan (FY 20 P.L.).

Total First Cost	$146,188,000
Average Annual Cost	$6,184,000
Average Annual Benefits	$9,440,000
Annual Net Benefits	$3,292,000
Benefit-to-Cost Ratio	**1.5**

Average annual costs include interest during construction / Interest rate of 2.75 percent from 2027 through 2076 / Discount rate of 2.75 percent from 2027 through 2076

4.4 Operation, Maintenance, Repair, Replacement & Rehabilitation Considerations

Although the diversion culvert is self-sustaining for the most part, some periodic maintenance to remove accumulated sediment from the upstream side of the diversion weir and within the culvert will be required. The channel and culvert must be maintained to ensure that the hydraulic capacity of the project is preserved. Also, access to the project must be maintained for inspection and maintenance purposes. The project and areas immediately upstream and downstream would be inspected annually and the removal of debris, particularly from bridges before and after a storm event, would be performed.
To maintain the hydraulic capacity of this project, shoals, debris, encroachments and heavy vegetation should be removed from the channel by the non-Federal sponsor.

The culvert should be inspected yearly for cracks, damages, and sediment accumulation. Large sized sediment or significant volumes of sediment should be removed as soon as possible. Vegetation should be removed from the walls and drainage openings. No improvements or changes shall be made over, under, or through this project without prior determination by the New York District Engineer that the requested improvements or changes would not adversely affect the function of the improved channel and culvert.

4.5 Risk & Uncertainty Analysis

4.5.1 Economic Risk & Uncertainty

Risk and uncertainty has been explicitly factored into the economic analysis of this project (Appendix B). A statistical-risk based damage model, Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA), was used in this study to formulate and evaluate the project in a life-cycle approach. HEC-FDA integrates the engineering and economic analyses and incorporates uncertainty in both physical parameters and storms, which enables quantification of risk with respect to project evolution and economic costs and benefits of project implementation (Appendices B and D). The analysis indicated that equivalent annual project benefits can range from $5,744,000 to $12,727,000 and BCRs could range from 0.9 to 2.1, based on the results of modeling with inclusion of uncertainties in the economic and engineering inputs.

The hydrologic and hydraulic performance of a project may be described by annual exceedance probability, long-term risk and assurance, or conditional non-exceedance probabilities. The Recommended Plan effectively reduces almost certain probability of annual exceedance in virtually every reaches compared to the Without condition. In the future without project condition, long term risk in the 10 to 50 year range, exceedance is almost certain in all reaches. With the Recommended Plan in place, the probability of the target stage being exceeded at least once in a 10 year period is decreased by approximately 23 percent on average for all reaches. The Recommended Plan contains the specific event of exceedance for all reaches compared to not having a plan in place. Project performance is detailed in Appendix B "Economics."

4.5.2 Residual Risk

Flood risk to people and structures at any location in a floodplain is the function of flood hazard at the location, and their exposure and vulnerability to the flood hazard. Residual risk is the flood risk that remains after the selected plan is in place. It is the exposure to loss remaining after other known risks have been countered, factored in, or eliminated. The project will not eliminate all flood risk to life and property. Flood damages from fluvial flooding will not be totally prevented, only reduced. Equivalent annual benefits are $9,440,000. While there would still be properties and infrastructure that is vulnerable to fluvial flood damages, flood damage from the Peckman River would be significantly reduced with plan implementation. Post-disaster assistance and aid for owners of these properties may come from other Federal agencies, such as FEMA and USHUD, or from programs run by the State of New Jersey.

In the areas of Little Falls where elevations and floodproofing would be implemented, the fundamental risk associated with the proposed plan is that access routes would still become inaccessible due to flooding since the plan would not alter the floodplain and thus not reduce street flooding in the Township. This would result in the stranding individuals who choose not to evacuate when directed to prior to storms. Emergency services would likely not be able to reach stranded residents who are in need during high water events. Access to transportation routes and emergency services in Woodland Park would be improved through reduction of the floodplain due to construction of the diversion culvert and Great Notch Brook floodwall system. However, parts of Woodland Park would still be subject to flooding from the Passaic River.

The plan complements other ongoing efforts in the basin to manage flood risk. Local municipalities are currently implementing a flood warning system to warn residents in advance of high water events in the Peckman River. In addition, new construction is built to an elevation at least one foot above the BFE in accordance with local floodplain management regulations. Elevated homes are at less risk of damage from flooding from storms.

As mentioned in Section 3.2, some areas of Woodland Park will still be subject to Passaic River flooding even after the project is constructed. This is because the Peckman study is designed to only address flooding from the Peckman River, and not the Passaic River, even though some parts of the study area are flooded from both rivers. There is a separate USACE study (the Passaic Mainstem study) that was designed to address Passaic River flooding, but this study is currently suspended. If this study is to resume, there is potential for a recommendation to be made to improve flood risk management on the Passaic River that would have impacts in the Woodland Park section of the Peckman River study area. If this action is to occur, it would improve residual risk in the Peckman study area.

4.5.3 Risk to Life Safety

Communities in the Peckman River Basin have always experienced flooding from the Peckman and Passaic Rivers (Figures 48 and 49). Residents generally understand the severe implications of staying in harm's way when a storm is forecasted to affect the area. Because there is typically two to seven days' notice prior to major storms (e.g., hurricanes and tropical storms), residents are given sufficient warning to evacuate. However, residents typically have only a few hours warning before the arrival smaller storms and rain events that cause flash flooding on the Peckman River. Residents should evacuate prior to storms to avoid being stranded, which could pose a danger for their welfare. Emergency vehicles may not be able to reach residents in distress due to the flooding of roads and homes. In addition, there is an increased risk of fire in communities due to the potential compromising of electrical and natural gas systems. Loss of life can only be totally prevented by evacuating people well before expected flood events. The inherent erratic nature and unpredictability of a storm's path and intensity requires early and safe evacuation. A policy of early, total evacuation should be continued even with the project in place.

Section 7.2.1 of Appendix B "Economics" includes supplemental information about risk to life safety.

Figure 48. Closed road and traffic congestion as an effect of Hurricane Floyd (1999).

Figure 49. Flooding in Little Falls (2011).

4.5.4 Induced Flooding

The project includes the diversion of flood waters from the Peckman River into the Passaic River. The amount of flood water that will be diverted, even during large storm events, is relatively small in comparison to the Passaic River and its watershed. The project is not expected to induce flooding in communities along the Passaic River that are located downriver of the culvert outfall. Modeling results show no adverse impacts upstream and downstream of the project area.

4.5.5 Climate Change Adaptation and Resilience

Consistent with the objective of Engineering and Construction Bulletin (ECB) 2018-14 "Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects," a qualitative analysis for inland hydrology was conducted using the best available data for the Peckman River Basin. The quantitative analysis was conducted in three phases as specified within the ECB; Chapter 5 of Appendix C-1 "Hydrology" includes details of the work. The analysis indicates that projected moderate increases precipitation and peak streamflow, as well as increases in storm frequency and intensity in the future. However, due to lack of quantitative information the impact of climate change to the project hydrology is inconclusive. Increases and storm frequency and intensity in the future may lead to increases in stream flow and instances of elevated river stages in the Peckman River, which may lead to more frequent overtopping instances of the levee feature in the future. The design of the proposed diversion culvert is robust enough to handle larger storm events and is expected to perform as designed in the future.

4.5.6 Risk Communication

As described in Section 4.5.2, the project will not eliminate all flood risk to life and property. Flood damages from fluvial flooding will not be totally prevented by the project, only reduced. In addition, some areas of Woodland Park will still be subject to Passaic River flooding, as described in Section 3.2. This is because the project is designed to only address flooding from the Peckman River, and not the Passaic River. Because of this, it is essential that flood risk be communicated to residents. Risk communication is the process of informing people about potential hazards to their person, property, or community.

USACE, NJDEP, and local municipalities will work together to communicate flood risk, especially residual flood risk. Currently, local floodplain managers and emergency managers lead risk communication in their communities. USACE will provide these local managers with information about project effectiveness and residual flood risk to disseminate through existing channels. Other efforts may supplement ongoing and planned risk communication to enhance its effectiveness.

4.5.7 Nonstructural Participation Rate Uncertainty

Participation in the nonstructural components of the plan (elevations and floodproofing) is voluntary; therefore there is inherent uncertainty of benefits actually exceeding costs. A sensitivity analysis for participation rates for nonstructural measures was conducted to determine the economic feasibility of participation rates at hypothetical 25 percent, 50 percent, 60 percent, 75 percent, and 100 percent probabilities. Structure records were randomly selected to obtain the targeted number of individual records to match each rate, and thus the selection process is unbiased. Table 24 shows the results of a sensitivity analysis using a random selection of residential structures. For scenarios with up to a 50 percent participation rate, the net benefits are negative. However, net benefits are highly positive at and above a 60 percent participation rate. It is important to note that the costs used in determining net benefits and benefit-cost ratios include the costs of structural components of the plan. If costs were evenly split between structural and nonstructural measures there would be all positive net benefits for each probability and higher benefit-cost ratios. Based on coordination with non-Federal and local interests, and current building strategies, an at- or near-100 percent participation rate is likely.

Table 24. Nonstructural participation rate sensitivity (in $1,000s, FY 20 P.L.)

Participation Rate	Total FWOP	Total FWP	Annual Damage Reduced	Annual Cost*	Net Benefits	BCR
25%	$39,083.38	$33,136.18	$5,947.20	$6,183.00	-$235.80	0.96
50%	$68,212.33	$62,606.49	$5,605.84	$6,183.00	-$577.16	0.91
60%	$99,228.15	$70,772.92	$28,455.23	$6,183.00	$22,272.23	4.6
75%	$116,307.03	$79,194.02	$37,113.01	$6,183.00	$30,930.01	6.0
100%	$146,602.67	$82,308.59	$64,294.08	$6,183.00	$58,111.08	10.4

** Annual cost estimates include structural measures*

4.6 Economic, Environmental, and Other Social Effects

The 1983 P&G presents four accounts to facilitate evaluation and display of effects of alternative plans, as described in Section 3.7: NED, EQ, RED, and OSE. In reducing damages from future storm and flood events, the proposed project would contribute to NED if water levels do not exceed the final design height of the measures. The nonstructural components of the plan neither contributes to nor detracts from the EQ and RED accounts. As detailed in Chapter 5, there would be no significant environmental impacts due to implementation of the plan. The project will not have significant long-term impact on endangered, threatened and or special species of concern. Restrictions on tree and vegetation clearing, as well as in-water construction will help minimize impacts. Permanent impacts to forested wetlands and riparian habitat will be mitigated through the use of either mitigation banks or the use of the existing Peckman Preserve, in accordance with the Preserve's master plan. There is the potential for adverse effects to the Little Falls Laundry, a National Register-eligible property by proposed nonstructural measures as well as the potential to encounter intact archaeological sites along the diversion culvert alignment and floodwalls and levees along the Peckman River. The District will work in coordination with the NJHPO to avoid, minimize, or mitigate any determined adverse effect. Any other impacts would be minor and temporary.

4.6.1 Community Cohesion

Community cohesion refers to the aspect of togetherness and bonding exhibited by members of a community. This includes features such as a sense of common belonging or cultural similarity. There is a shared interest among residents of the Peckman River Basin to reduce fluvial flooding while maintaining their communities and connections. To support this goal, the municipal governments in Little Falls and Woodland Park are working with Federal and state agencies to help residents elevate their homes, move to higher ground, and create pocket parks. The Recommended Plan is consistent with residents' goals and actions to reduce flooding, and thus will support community cohesion in Little Falls and Woodland Park.

4.6.2 Community Resilience

Community resilience is the measure of the sustained ability of a community to utilize available resources to respond to, withstand, and recover from adverse situations (Figures 50 and 51). The proposed project would contribute to community resilience, as structures included in the plan would not be damaged as frequently or as severely as others in the area, and the community would be able to recover quickly after storms if water levels do not exceed the final design height of the measures. People would not be displaced for months or years because their homes were severely damaged by flooding. Businesses would be able to return quickly if they are not flooded, and people would be able to return to work.

Since only a subset of the Peckman River Basin is included in the plan, some property owners who experience flood damages and need help would not receive it via the proposed project. Other sources of Federal and non-Federal assistance for property owners are available via FEMA, USHUD, the State of New Jersey, and nonprofit organizations.

Figure 50. Residents clean up damaged homes after Hurricane Floyd (1999).

Figure 51. Flood damage in Little Falls after Hurricane Irene (2011).

4.7 Executive Order 11988

EO 11988 "Floodplain Management" requires Federal agencies such as USACE, when taking an action, to avoid short- and long-term adverse effects associated with the occupancy and the modification of a floodplain. The agency must avoid direct and indirect support of floodplain development whenever floodplain siting is involved. In addition, the agency must minimize potential harm to development in the floodplain and explain why the action is proposed. USACE implementation guidance for EO 11988 was issued as ER 1165-2-26 "Water Resources Policies and Authorities, Implementation and Executive Order, Engineer Regulation 11988 on Flood Plain Management."

The wise use of floodplains concept, as described in EO 11988, was incorporated as a life safety consideration as part of the study. This approach was based on study objectives of applying qualitative rather than quantitative analysis; use of existing data/inventory; and professional judgment. The eight-step evaluation process outlined in EO 11988 is included here, with a discussion of how it was considered during plan formulation and selection.

Step 1: Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year, i.e., one percent flood). The Proposed Action is within the defined base floodplain.

Step 2: Conduct early public review, including public notice. USACE has coordinated with NJDEP, local municipalities, and the public during the course of the study. The October 2019 DIFR/EA allowed for a formal public review of the proposed action. This FIFR/EA presents the USACE's recommendation for Federal action.

Step 3: Identify and evaluate practicable alternatives to locating in the base floodplain, including alternative sites outside of the floodplain. All practicable alternatives were identified by following the USACE six-step planning process. A wide range of measures and plans using available information, engineering analysis, professional judgment, and risk-informed decision-making were evaluated. Practicable alternatives considered, and the reasons they were screened from consideration are presented in Chapter 3.

Step 4: Identify impacts of the proposed action. As detailed in Chapter 5, there would be no significant environmental impacts due to implementation of the plan. The plan would support community resilience and cohesion by reducing flood risk to residents, businesses, and infrastructure.

Step 5: If impacts cannot be avoided, develop measures to minimize the impacts and restore and preserve the floodplain, as appropriate. The proposed project is the plan that maximizes NED benefits while being consistent with the requirements of EO 11988. The plan would avoid short-term and long-term adverse effects associated with the occupancy and modification of the existing floodplain.

Step 6: Reevaluate alternatives. Plan formulation, evaluation, comparison, and selection are detailed in Chapter 3.

Step 7: Present the findings and a public explanation. This FIFR/EA presents the USACE's recommendation for Federal action.

Step 8: Implement the action. NJDEP is willing to enter into a PPA with the Federal government for implementation of the plan.

4.8 Environmental Operating Principles

The Environmental Operating Principles is an essential component of the USACE's risk management approach in decision making, allowing the organization to offset uncertainty by building flexibility into the management and construction of infrastructure. The Environmental Operating Principles are:

- Foster sustainability as a way of life throughout the organization
- Proactively consider environmental consequences of all USACE activities and act accordingly
- Create mutually supporting economic and environmentally sustainable solutions
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE, which may impact human and natural environments
- Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs
- Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE's actions in a collaborative manner
- Employ an open, transparent process that respects views of individuals and groups interested in USACE activities

Plan selection took into account these principles to ensure the sustainability and resiliency of the NED plan while considering the environmental consequences of implementation. In addition to construction best management practices to maintain water quality standards, other opportunities to implement sustainable measures and/or materials (e.g. low volatile organic paint, recycled industrial materials) that are cost effective and comply with USACE construction standards will be further evaluated in the PED phase. Planting plans will utilize native vegetation that support pollinator species, have a lower susceptibility to disease or pests, and are more adaptable to climate change. In addition, the ability to potentially recycle/re-use material such as excavated material from the channel on-site where feasible for on-site restoration and/or proposed compensatory mitigation activities will be evaluated during the PED phase. The study team considered avoiding and minimizing adverse impacts to existing environmental resources and cultural resources within the project area to the extent practicable during the plan formulation process. Where impacts to these resources are unavoidable, compensatory mitigation will be performed. Continuous coordination with NJDEP, the Township of Little Falls, the Borough of Woodland Park, and the public will occur throughout the feasibility study to ensure an open and transparent process that respects views of individuals and groups. The project will be constructed in compliance with all applicable environmental laws and regulations.

4.9 Compliance with the National Flood Insurance Program

Communities participating in a flood risk management project with USACE are required to participate in FEMA's National Flood Insurance Program (NFIP) and to comply with the land use requirements of the program. The communities of Woodland Park and Little Falls participate in and are in compliance with the NFIP. They adhere to the 2010 Passaic County Hazard Mitigation Plan (Passaic County, 2010), in addition to promulgating their own land use zoning rule, and building codes.

Because the plan would manage flood risk it will inherently support the communities' compliance with the NFIP. All structure elevations and floodproofing would be completed in compliance with Federal, state, and local guidelines and requirements related to NFIP participation. The target elevation for the first floor of all structures to be elevated will be at a height of one foot above the USACE-modeled one percent flood water surface elevation. USACE determined that the "plus one foot" height accurately reflects uncertainly of wave effects on water surface elevations. Coincidentally, the target height is approximately one foot above the BFE, which the minimum standard for building in the one percent floodplain within Woodland Park and Little Falls. USACE has coordinated with FEMA Region II about the proposed project. It will notify FEMA Region II once the project is authorized for construction by the Congress. FEMA could update flood maps and flood profiles to depict post-project conditions, which may affect flood insurance rates for homeowners and business owners who would benefit from the project. It is important to note that flood insurance rates are not set by USACE or the State of New Jersey.

Chapter 5: Effects of the Recommended Plan*

This chapter discusses the potential positive and adverse environmental consequences of the Recommended Plan. The effects of the Recommended Plan are directly compared against the baseline future without-project / No Action alternative conditions as described in Chapter 3.

In summary, the Recommended Plan will permanently impact the following types of habitat: a) 1,848 linear feet of freshwater riverine system equaling to approximately 1.7 acres of open water; b) 0.48 acres of forested wetlands; c) 0.77 acres of riparian zone; d) 0.85 acres of streambank vegetation; and d) 1.5 acres of upland forest. Approximately 0.71 acres of forested wetlands and 1.37 acres of riparian zone will experience temporary impacts as a result of construction activities. These areas will be restored on site following construction completion.

In order to compensate for the permanent direct impacts, the District is proposing to restore approximately 1,848 linear feet of river equaling to approximately of 1.7 acres of open water habitat via the installation of three bendway weir fields along the outer bends of the river where severe bank erosion is occurring, and 0.85 acres of native streambank vegetation. Included in the compensatory mitigation is 0.77 of riparian zone restoration. Based on USACE policy, no compensation for the loss of 1.5 acres of upland forest is proposed.

For reference purposes, bendway weirs are rock structures that are embedded within and perpendicular to streambank along the outer bend of river meanders to help deflect flow away from the bank in order to reduce erosion. They do not extend across the entire width of the channel, but in a manner that redirects the channel thalweg more to the center of the channel. In addition to providing bank protection, bendway weirs provide in-channel aquatic habitat. Typically, a series of bendway weirs are used along a set the length of the effected streambank to maximize effectiveness. These series of weirs are often referred to as fields. For cost estimating purposes, it was assumed that four bendway weirs would make up one bendway weir field. As three bendway weir fields are proposed, a total of 12 individual bendway weirs were included in the cost estimate presented in Account 06 of the Cost Engineering Appendix (Appendix D). Refer to Appendix A-8 for a photo of the structures.

Compensation of permanent wetland impacts will be achieved through the purchase of mitigation credits at an approved mitigation bank or through the creation/restoration of 0.96 acres of wetland habitat. Construction of the Recommended Plan is expected to take approximately 2.5 years.

As mentioned in Chapter 2, streambank orientation is referred to as left or right based on a downstream viewpoint.

5.1 Topography, Geology & Soils

5.1.1 Geology & Topography

Grading may be required around individual building foundations or potentially the entire lot for the construction of nonstructural measures. The topographical changes are expected to be negligible.

Construction of the diversion culvert will employ a "cut and cover" method. This construction method is utilized for shallow tunnels where a section is first excavated and then covered over with enough overhead support system strong enough to carry the load of what is to be built over the tunnel. As the area will be returned to normal grade after construction, no changes to the topography of the area will occur. There are no topographical changes related to the channel modifications within the Peckman River; any excavation proposed is limited to a depth necessary to keep the riprap and articulated concrete block at the current riverbed elevation.

The topography in the location of the proposed levee is generally flat. The levee will have an average height of six feet with a side slope grade of 3:1. Therefore, the construction of the levee will change the topography in the immediate project areas. The modification to the topography in this area will be limited to the immediate footprint of the levee and is required to provide the necessary project performance.

The off-site compensatory vegetated streambank mitigation may require some topographical changes in the form of grading/filling to restore eroded streambanks and facilitate replanting. In addition, the District may perform wetland off-site mitigation if the purchase of mitigation credits is not an option. It can be expected that topographical modifications in the form of excavation may occur within any proposed mitigation areas to establish or enhance hydrological conditions conducive to supportive wetlands. These topographical modifications will be necessary to ensure success of the mitigation and are not expected to have long term adverse effects.

No short or long term adverse impacts to geology from implementation of the proposed action is anticipated.

5.1.2 Soils

No significant impacts to soils will occur as a result of implementation of the nonstructural measures in the Township of Little Falls.

The installation of the concrete weir within the Peckman River and the precast concrete culvert will constitute the conversion of natural soils to concrete. The channel modifications within the Peckman River will involve the excavation and fill of the channel bottom and substrate in order to install the riprap. These measures are meant to prevent scouring and erosion of soil during high flow events. In addition, the portion of the Passaic riverbed and right stream bank in the footprint of the stilling basin at the diversion culvert will be excavated and lined with concrete and rip rap to prevent scouring and erosion of soils.

The interior of the proposed levee will be constructed with an impermeable clay core to prevent seepage. Compacted fill material is typically used for the levee exterior. The in-situ soil will likely not meet the geotechnical specifications for levee construction and soil meeting the specifications will be imported from an approved, permitted, off-site source. Although the importation of soils will represent a change in the existing soil type within the immediate footprint of the levee, no changes to the soil beyond the levee footprint are proposed.

The bendway weir fields and vegetated streambanks proposed for compensatory mitigation will reduce erosion of the streambanks to which they are applied. Therefore, the compensatory mitigation will have a positive effect on soils.

Prime Farmland

The proposed action occurs in an urbanized setting that does not include any additional land uses related to agriculture or silviculture. Therefore, adverse impacts to Prime Farmland soils will not occur.

Hydric Soils

A portion of the levee is located within areas that have soils that meet hydric soil criteria. Because there are specific requirements for the type of soil used to construct potential levees, fill material that meets the construction specifications will be imported to construct the levee. This will constitute a change in soil type and will impact hydric soils. However, this impact is limited to the footprint of the levee as is necessary to achieve the desired project performance. No adverse impacts to hydric soils beyond the levee footprint are expected.

Mitigation

An erosion and sediment control plan will be developed and coordinated with the Hudson-Essex-Passaic Soil Conservation District prior to the construction of the proposed project. Best management practices including, but not limited to, silt fence, turbidity curtains and temporary seeding will be implemented to reduce soil erosion within the project footprint. Following completion of modifications and structures, temporary work locations will be restored to pre-construction conditions.

5.2 Land Use & Zoning

The proposed action will have a short term impact on residential and commercial land use around temporary workspaces during construction. Such impacts include restricted or limited access to specific locations on the property where construction is occurring. For example, during construction of the diversion culvert, there will be a temporary loss of use of the tennis courts and the baseball fields at Little Falls Recreation Center. The loss of use is expected to be approximately eight months. In addition, it is expected that there will potentially be a full loss of parking space in the parking lot at the office building near the discharge location for approximately four to six months during construction. The construction method being employed is a cut and cover method. Therefore, once construction is completed, the land use will be returned to pre-construction conditions.

With the exception of the parcels that comprise the Passaic Valley High School, the majority of the proposed levee and floodwall is situated on several properties in a manner that is not expected to interfere with their existing use. In the instance of the high school, the levee and floodwall alignment is situated between the southern boundary of the track and northern boundary of a baseball field. In order to maintain access to the baseball field, a closure gate will be installed that will remain open under normal conditions.

For safety reasons, it is expected that there will be a loss of use of the track and the two baseball fields during construction. Additionally, there will be a temporary loss of parking spaces in the portion of the High School parking lot near the levee alignment during construction. Construction of the levee and floodwall on the high school property is expected to take approximately seven months. Prior to construction, the District will coordinate with high school officials and the municipality to determine a construction schedule that will provide the least amount of disruption to school operation. In the long term a gate will be installed in the floodwall to allow access to the back baseball field.

Implementation of the channel modifications is not expected to modify existing land use. Permanent easements will be obtained to perform post construction inspection and maintenance.

Temporary construction easements will be acquired and the property owners will be compensated fair market value for the easements obtained. There will be no significant permanent changes in land use once construction is completed.. Properties on which the floodwalls and levees are located will be required to maintain a 15-foot vegetation free zone per USACE Engineering Technical Letter (ETL) 1110-2-583 Guidelines for Landscape Planting and Vegetation Management at Levees, Embankment Dams and Appurtenant Structures. In addition, the ETL 1110-2-583 also requires certain restrictions from property owners from installing permanent structures (e.g. sheds, above ground/underground pools) within the 15-foot vegetation free zone. In addition any portion of land used for riverine and riparian habitat mitigation will be subject to conservation easements that restricts use and development in perpetuity. Permanent easements for maintaining the vegetation free zone and habitat mitigation will be acquired and the landowner will be compensated fair market value for the easement obtained.

In general, the implementation of the proposed action will likely produce long term benefits by reducing flood risk and future damage to residential, manufacturing/ industrial, commercial/ office, transportation/ utilities land uses located within the project area.

The District is proposing to perform offsite stream restoration, and riparian mitigation, and possibly off-site wetland mitigation to compensate for wetland and riparian impacts associated with construction of the floodwalls and levee along the Peckman River and the outlet of the diversion culvert if the mitigation credits cannot be purchased. The District is proposing to use Peckman Preserve to conduct the riparian mitigation, some of the streambank vegetation mitigation and for potential wetland mitigation if mitigation bank credits are unavailable for purchase. The NJ Green Acres Rules typically consider the use of Green Acres encumbered lands for habitat mitigation sites as a change in land use unless the master plan for the subject property includes habitat restoration, creation and/or enhancement. The master plan developed for the Peckman Preserve focuses on passive recreation and includes the creation/restoration of wetlands within the park to enhance such recreational opportunities. Therefore any compensatory wetland and/or riparian mitigation conducted on this site of the project is in conformance with the anticipated land use of the park and is not in conflict with the NJ Green Acre Rules.

Mitigation

Disturbed areas will be restored and returned to pre-construction conditions through grading and native vegetation. A closure gate will be installed in the portion of floodwall located on the high school property to allow access to the baseball field behind the track. Any wetland and/or riparian mitigation performed within the Peckman Preserve will conform to the parks master plan. Property owners will be compensated for any temporary and permanent easements acquired to construct, operate and maintain the project.

5.3 Socioeconomics

The proposed action is not expected to adversely impact the socioeconomic environment of the area. During construction of the diversion culvert and the levee/floodwall, some of the property owners within the project area may be unable to fully utilize their property. Temporary easements will be required for construction and permanent easements will be required for maintenance, inspection and operational requirements. Property owners will be compensated for easements at their market value for the effect on the property.

Long term benefits achieved by the project include flood risk management benefits such as reduced damages to properties including business and residential structures; improved public health and safety; reduced traffic delays; and improved emergency access for the fire department, medical personnel and police protection.

5.3.1 Demographics

Long-term changes to population and demographics are not expected by construction of the proposed action. Residents and businesses located in the structures to be elevated or floodproofed may be temporarily relocated during construction. Residents of the one structure to be acquired will likely be relocated within the local area. Long-term changes to demographics will likely follow state and national trends.

5.3.2 Environmental Justice

Based on the cursory analysis, environmental justice considerations are not applicable to either the Township of Little Falls or the Borough of Woodland Park. Further, analysis of existing available data and coordination with the local stakeholders, have not identified any environmental justice micropopulations within the project area. Therefore, no adverse impacts to environmental justice populations will result from implementation of the project.

5.4 Existing Water Resource Projects

Local stakeholders within the project area have implemented efforts on their own to reduce flood risks. The Township of Little Falls is in the process of buying out residential structures within the municipality. However, these structure buyouts are impacted by Passaic River overbank flooding, not Peckman River flooding. Implementation of the Recommended Plan therefore have no effect on this effort as it is unrelated to Peckman flooding and these structures are not historically flooded by Peckman River overbank flooding.

The Borough of Woodland Park has bought out several properties within its municipality due to flooding from the Peckman River. Implementation of the Recommended Plan may reduce the need for future buyouts related to Peckman River flooding within Little Falls and Woodland Park.

There have been a few clearing and snagging efforts within the Peckman River within Little Falls and Woodland Park over the years. The Township of Little Falls and Borough of Woodland Park have received a $150,000 grant to buy an excavator to allow Little Falls and Woodland Park to conduct their own snagging and clearing of the Peckman River, subject to engineering approval and the necessary permitting. The next snagging and clearing effort is currently being planned. Implementation of the Recommended Plan would have relatively minimal effects upon shoaling and the buildup of debris requiring clearing and snagging within the Peckman River.

5.5 Infrastructure

The proposed action will produce short term minor adverse impacts on the availability of infrastructure. There are minor impacts associated with construction traffic, construction induced changes to traffic flow and other inconveniences caused by the construction activities. Access to critical infrastructure such as emergency medical services, fire stations and schools will not be blocked due to the plan. Electric power, gas, water, and sewage service (as well as any other utilities) would be temporarily taken out of service during construction periods at individual building sites. This would be in accordance with local and utility codes for community/construction worker safety and fire prevention. Utilities would be returned to normal working conditions as soon as possible after construction completion at each of the proposed structures.

There would be a positive long term impact on infrastructure as a result of the proposed action. Because of the reduction in flood risk, damages to infrastructure would be minimized. Recovery from outages of services and utilities would be quicker due to reduced damages.

5.6 Transportation

Traffic will likely increase during construction as a result of the transportation of construction equipment and materials being transported to the site, as well as workers commuting to the project area.

As a portion of the nonstructural measures are located in residential areas, neighborhoods could experience a short duration of limited on-street parking. Businesses receiving nonstructural measures could experience limited parking space in on-site parking lots as well as on-street parking.

Given that the diversion culvert will cross under Paterson Avenue, a partial or full closure of the road may be required during construction. The construction contractor will develop a traffic plan that will be coordinated with the Township of Little Falls and Borough of Woodland Park to minimize impacts and disruption to traffic to the extent possible.

The nonstructural measures proposed within Little Falls only provide flood risk management to structures. Therefore, roads will continue to be subject to flooding as they are now. This could lead to road closures and detours that could cause traffic delays.

Mitigation

In order to minimize impacts to traffic during construction, traffic control and operations strategies that may be implemented during construction may include:

- Preparing a comprehensive construction traffic management plan. This plan will be developed by the contractor in the Construction phase and will be coordinated with the appropriate municipal and/or county officials and affected property owners as necessary

- Routing and scheduling construction vehicles to minimize conflicts with other traffic
- Strategically locating localized staging areas to minimize traffic impacts
- Establishing detours and alternate routes when it is important to close the work area to perform certain construction tasks or when diverting traffic will substantially reduce traffic volumes

5.7 Water Resources

5.7.1 Surface Water

The implementation of nonstructural measures in the Township of Little Falls will have no impacts to the Peckman River or associated tributaries.

Approximately 1,848 feet of the Peckman River will be modified through channel modifications related to the installation of the diversion culvert weir. Approximately 100 feet of the Peckman River will be converted to concrete as a result of the installation of the concrete weir itself. The remaining 1,748 feet of the Peckman River will be modified through the installation of riprap. In total, up to approximately 1.7 acres of open water within the Peckman River will be impacted. Excavation will be performed to accommodate the riprap and maintain existing bed elevation. There will be minimal excavation along the river banks to create a bank slope of 1V:2.5H, however the average top width of the Peckman River within the footprint of the channel modifications will not be significantly increased.

Base flow conditions were analyzed and confirmed that post construction water depths in the portion of the modified channel will not appreciably change from pre-construction conditions. The Recommended Plan will alter the hydrology of the Peckman River, however, by redirecting flows into the culvert during flood events and discharging the flow approximately 0.6 miles upstream from the Peckman River's natural confluence with the Passaic River. The weir will contain a two foot by six foot orifice to maintain normal baseflows and velocities.

In addition, the District is proposing to, the restoration of approximately 1,848 linear feet of river equaling 1.70 acres of open water habitat via the installation of three bendway weir fields along the outer bends of the river where severe bank erosion is occurring and 0.85 acres of native streambank vegetation. The proposed compensatory mitigation will provide fish and wildlife habitat while providing reducing erosion and sedimentation through bank stabilization. As the compensatory mitigation site is immediately upstream of the , ancillary benefits to its function and overall maintenance requirements may be achieved due to the reduction in erosion and sedimentation. The location of proposed mitigation is immediately upstream of the Recommended Plan footprint. Refer to Appendix A-8 for further information.

In order to minimize sedimentation to the Peckman River during construction activities of the Recommended Plan and compensatory mitigation, cofferdams will be installed so that work can be conducted in dry conditions.

Approximately 0.11 acres of substrate of the Passaic River will be modified as a result of the installation of rip rap at the discharge location of the diversion culvert. There will be no significant changes to the current patterns and flow to the Passaic River as a result of the implementation the diversion culvert.

Mitigation

Discussions of water resources mitigation, monitoring, and adaptive management are described in Section 5.7.2.

5.7.2 Water Quality and Aquatic Habitat

Implementation of the nonstructural measures in Little Falls will not have any impacts on water quality or aquatic habitat.

The diversion culvert will have negligible impacts on water quality and habitat.

Construction of the channel modifications associated with both the implementation of the flood risk management feature and compensatory riverine mitigation in the Peckman River will create short term, minor water quality impacts. With the installation of Best Management Practices, the impacts will be limited to the immediate project area. The existing substrate within the approximate 1,848 feet of channel will be replaced with riprap. The portion of the Peckman River in the vicinity of where the weir is proposed is relatively uniform with no distinct riffle and pool complexes. Uniform flow within the modified channel after construction is expected. However, it is anticipated that the river may form some in-stream meanders and pools as it recovers from the disturbance and the natural sediment deposition process occurs. The time it takes for pool and riffle complexes to re-form after a disturbance is dependent on the system and can range from months to years.

Overall, the significance of long term adverse impacts to water quality and aquatic habitat from implementation of the proposed action is somewhat lessened due to the amount of previous disturbance that the project area has experienced. As an example, approximately 55% of total length of river within the Recommended Plan footprint has undergone some type of alteration in the form of retaining wall and/or riprap installation along the river banks.

The proposed compensatory riverine mitigation comprising of bendway weirs and streambank vegetation will provide foraging, spawning and resting habitat as well as cover. Surveys conducted within the Mississippi River by the USACE St. Louis District in 1997 found higher densities and diversity of fish species within bendway weir fields than in natural, degraded reaches of the River (USACE, 1997). Surveys conducted by others also found that the structures can improve fish and aquatic invertebrate habitat through the establishment and maintenance of pools (Kinzil and Myrick 2009). The streambank vegetation will provide shade, cover and detritus used as food sources and spawning substrate for aquatic species.

The proposed stilling basin will have negligible impacts on aquatic habitat in the Passaic River. The diversion culvert discharges approximately 0.5 miles downstream of the water treatment plant and will not adversely affect the use of the Passaic River as a water supply.

Mitigation

During construction, standard erosion and sediment control Best Management Practices will be implemented to minimize adverse and significant impacts to water quality and aquatic habitat during in-stream work.

For the weir proposed in the Peckman River, a two foot by six foot orifice will be installed to maintain normal baseflows and fish passage.

In accordance with the USACE Civil Works Planning Policy, during optimization of the Recommended Plan, the District utilized the Environmental Protection Agency Rapid Bioassessment Protocols (EPA RBP) stream assessment worksheet to further inform the extent of impacts the Recommended Plan have on the functional value of the affected water resources and to identify the scope of compensatory mitigation required to reduce the magnitude of the impacts to below a significant level.

The EPA RBP stream assessment worksheet is an integral component of the New Jersey High Gradient Macroinvertebrate Index (NJ HGMI) and Northern New Jersey Fish Index of Biological Integrity models that were approved for regional use by the USACE Ecosystem Restoration Planning Center of Expertise in February 2014. Stream restoration measures that were evaluated during optimization include stabilization of eroded streambanks with native vegetation and the installation of in-channel structures called bendway weirs that are used to create pool and riffle complexes and direct flow away from streambanks to reduce erosion. Based on the incremental cost analysis, the most cost effective plan identified the restoration of 1,848 linear feet of freshwater riverine system to include 0.77 acres of riparian zone.

Refer to Appendices A-8 and A-9 for further discussion regarding compensatory mitigation alternative selection process for water resources.

Monitoring and Adaptive Management

NJDEP, as the administering authority of Section 404 of the Clean Water Act, requires a minimum monitoring period of five years of any compensatory mitigation constructed. Therefore, the District will conduct monitoring for a minimum of five years not to exceed 10 years. Refer to Appendix A-10 for monitoring protocols and potential adaptive management measures.

5.7.3 Wetlands

The implementation of nonstructural measures in the Township of Little Falls, will have no adverse impacts on wetland resources.

The District has not conducted formal wetland delineation surveys in the project area and will not be conducting delineations until the PED phase. In absence of such surveys, the District utilized wetland mapping available on New Jersey Geoweb, U.S. Fish and Wildlife National Wetland Inventory mapping and a wetland delineation conducted by the Town of Little Falls on a tract they own within the levee alignment. to determine potential wetland impacts.

Approximately 0.48 acres of forested wetland will be permanently adversely impacted through direct fill to construct the channel modifications and levee. This impact will be compensated for to reduce the impact to insignificant. Further discussion of the compensatory mitigation is below in the Mitigation section. Approximately 0.71 acres of forested wetlands will be temporarily impacted as a result of levee/floodwall construction and the channel modifications related to implementing the Recommended Plan. The 0.71 acres will be restored following construction completion. Therefore, adverse impacts are minor.

Based on field investigations and a review of the topography overlain on the Township of Little Falls commissioned wetland delineation, the wetlands are hydrologically connected to a tributary of Great Notch Brook and are not hydrologically connected to the Peckman River. Therefore, indirect adverse impacts to the wetland complex as a result of the levee are not expected.

Approximately 0.85 acres of streambank vegetation will be removed during construction of the channel modification and will not be restored in order to maintain project function, maintenance and inspection. The majority of the vegetation is comprised of invasive species such as Japanese knotweed and tree of heaven. Off-site compensatory mitigation in the form of 0.85 acres of restoring native vegetation to streambanks will reduce the impact to insignificant. Refer to the Mitigation section below for further discussion.

Mitigation

During optimization, the location of the levee was moved closer to the Peckman River to reduce the direct impacts to the forested wetland complex within the tract of land behind the high school.

The temporary impacts to wetland resources during construction will be mitigated through on-site restoration by re-establishment of native vegetation and vegetation supportive of pollinator species (e.g. bees, monarch butterfly), and restoration of topography to maintain the hydrology of the site.

To compensate for the permanent loss of the 0.48 acres of forested wetland habitat the District will either purchase mitigation credits from a New Jersey State approved wetland mitigation bank, conduct off-site compensatory mitigation, or use a combination thereof. The Pio Costa wetland mitigation bank currently operates within the service area in which the Peckman River is located. The District will purchase mitigation credits from the bank during the PED phase pending availability.

In the event that forested wetland mitigation credits are unavailable for purchase from either the Pio Costa wetland mitigation bank or from another state approved mitigation bank, the District is proposing to conduct off-site compensatory mitigation.

Federal mitigation rules typically require wetland compensation to be consistent with a minimum of 1:1 ratio based on functional value using ecological models. However, as the anticipated wetland impacts will be less than one acre, as coordinated within HQUSACE, the District will utilize ratios to determine the compensatory mitigation amount. The NJDEP is the administering authority of the Section 404 of the Clean Water Act and utilizes a ratio based system of compensatory wetland mitigation.

Therefore, should off-site compensatory mitigation option be necessary, the District will follow the NJDEP ratio of 2:1 to create/restore 0.96 acres forested wetland habitat within the Peckman River Watershed. The District had proposed utilizing the Peckman Preserve in the May 2018 DIFR/EA based on initial coordination with NJDEP Green Acres staff. The NJDEP submitted a letter dated June 5, 2018 commenting on the May 2018 DIFR/EA (Appendix A-7), which included a reaffirmation for the possible use of the Peckman Preserve provided that Passaic County as the landholder submit for a Change in Use. Subsequently during the review of the October 2019 Revised DIFR/EA, the NJDEP submitted updated comments via a letter dated November 27 2019 letter (Appendix A-7) stating that after Departmental review of the current New Jersey Freshwater Wetland Rules, it was determined that the Rule prohibit the use of Green Acre encumbered lands for wetland mitigation. As a result, should a mitigation bank not be available at the time mitigation is required, the District will work with NJDEP to identify an appropriate site that complies with all state rules and meets the objectives of wetland mitigation.

Regarding mitigation for streambank vegetation, an incremental cost analysis (ICA) determined that restoring 0.85 acres of streambank with native vegetation is the most cost effective plan. Refer to Appendices A-8 and A-9 for further discussion on mitigation and the ICA process.

Monitoring and Adaptive Management

Monitoring of the on-site mitigation for temporary wetland disturbances and any off-site compensatory mitigation will be conducted on a bi-annual basis for a minimum of five years. Criteria evaluated to determine success includes evaluating hydrological and soil conditions, measuring tree and shrub growth, and comparing percent areal coverage of native vegetation with invasive vegetative species. Depending on the results of the monitoring efforts, adaptive management techniques will be employed to ensure success of the mitigation. Refer to Appendix A-10 for the full description of the monitoring procedures and potential adaptive management measures that could be used to achieve mitigation success.

5.8 Vegetation

5.8.1 Uplands and Riparian Zone

Upland Vegetation

During construction of the nonstructural measures, any clearing of vegetation will be limited to what is necessary to construct the specific measure. Therefore, vegetation immediately adjacent to the structure receiving non-structural treatments may need to be removed. This impact is expected to be negligible and no mitigation is proposed. The disturbed area will be reseeded with native grass species following construction completion.

Approximately one to 1.5 acres of upland forest will be cleared to construct the levee along the Peckman River and the 15 foot vegetation free zone on either side of the levee. As the upland vegetation being impacted does not serve as an immediate transition area to wetlands and the USACE does not have a policy requiring the compensation of loss of upland vegetation, no compensatory mitigation is proposed.

Riparian Zone Vegetation

Approximately 2.14 acres of riparian zone vegetation will be removed during construction of the floodwalls along the Peckman River and the channel modifications. Approximately 1.37 acres of the impacted riparian zone will be restored on-site following completion of the channel modification construction. The remaining 0.77 acres will be compensated through offsite restoration at the Peckman Preserve.

Mitigation

Upland Vegetation

Any temporary disturbance to upland vegetation will be compensated through general on-site restoration of native plantings and plantings that support pollinator species where appropriate.

Riparian Zone

New Jersey Flood Hazard Area Control Act (NJFHACA) requires mitigation for impacts to riparian zone resources. The 2008 Final Rule for Federal Compensatory Mitigation for Losses of Aquatic Resources and the USACE's Civil Works Planning Guidance Notebook provide pathways for riparian zone mitigation as part of an overall watershed approach. The District will evaluate the appropriate level of compensatory riparian zone mitigation that may be required during optimization of the Recommended Plan. Per the NJFHACA Rules, riparian zone mitigation can consist of the following:

- Removal of any impervious surface within 100 feet of streambank
- Herbicide application for invasive species management
- Clearing/grubbing of invasive plant species
- Planting native trees and shrubs within 100 feet of streambank

Approximately 1.37 acres of riparian zone will be restored on-site after construction of the channel modifications. For the remaining 0.77 acres that cannot be mitigated for on-site, the District completed an ICA that determined that restoring 0.77 acre of riparian zone meets the no net loss objective. Refer to Appendices A-8 and A-9 for discussions of the impact and mitigation assessment and the ICA. The District is proposing to perform the off-site compensatory riparian mitigation within the Peckman Preserve.

The State also allows for the purchase of riparian zone credits from state approved mitigation banks. There are currently no riparian mitigation banks that operate within the service area in which the project is located. However, the District will evaluate the status of such banks during the PED phase.

Monitoring and Adaptive Management

As no compensation for upland vegetation is proposed, any vegetation planted as part of general site restoration will be subject to the USACE's standard one year contractor warranty period. During this time, the construction contractor will be required to perform activities such as watering and weeding to ensure survivability of the plant material. The District will inspect the vegetation for successful establishment and the contractor will be required to replace any plant material that has not survived during this one year warranty period. As the replanting is part of general site restoration and not compensatory mitigation, no other post construction monitoring or adaptive management actions are proposed.

For compensatory riparian mitigation, in addition to the one year contractor warranty period, vegetation the District will monitor the vegetation biannually in the spring and fall for a minimum of five years as required by the NJDEP. Monitoring will not exceed 10 years. Refer to Appendix A-9 for full description of the monitoring procedures and potential adaptive management measures that could be employed to achieve mitigation success.

5.8.2 Wetlands

Given that none of the nonstructural measures proposed in the Township of Little Falls will occur in wetlands, there will be no adverse impacts to wetland vegetation.

The construction of the levee and the 15 foot vegetation free zone along the Peckman River and installation of the stilling basin along the right bank of the Passaic River may convert approximately 0.48 acres of mature forested wetland vegetation to maintained lawn and rip rap. Approximately one acre of forested wetland vegetation may be cleared for construction of the levee along the Peckman River. This would be considered a temporary impact.

Mitigation

As mentioned in Section 5.7.3, compensatory wetland mitigation options include either the purchase of wetland mitigation credits or off-site compensatory mitigation through the creation and/or restoration of forested wetlands. Should the District construct an off-site compensatory wetland site, native wetland vegetation will be used. Refer to Appendix A-9 for full description of proposed mitigation.

Monitoring and Adaptive Management

In addition to one year contractor warranty period, vegetation planted as part of wetland mitigation will be monitored by the District for a minimum of five years not to exceed 10 years. Monitoring and adaptive management of wetland vegetation is discussed in Appendix A-8.

5.8.3 Invasive Species Management

Within the project area, Japanese knotweed is the dominant invasive plant species and will require a comprehensive management plan to prevent its unintended spread to other locations outside the immediate project footprint during construction.

The comprehensive management plan will be developed during the PED phase and will outline measures to be taken immediately before, during and after construction. Types of measures that will be assessed include: 1) herbicide applications followed by mowing and/or excavation of Japanese knotweed before initiating construction; 2) implementing proper disposal techniques such as bagging waste containing plant parts; and 3) inspection and removal of any plant parts on equipment to prevent the accidental dispersal of it to other construction sites.

The non-Federal sponsor is ultimately responsible for the long term management of the mitigation site to assure its success once the District has determined that the mitigation site has achieved the mitigation objectives and concludes its involvement with the site. During the PED phase, the District will work with the non-Federal sponsor to identify potential local environmental groups that could assist the non-Federal sponsor in continuing any necessary monitoring and management of invasive plant species.

During the post construction monitoring period of the open water and wetland mitigation, it is assumed there will also be adaptive management actions such as herbicide applications occurring to ensure success of the mitigation.

5.9 Aquatic Resources & Wildlife

5.9.1 Fishery Resources

Implementation of the nonstructural measures in Little Falls will have no temporary or permanent beneficial or adverse impacts to fishery resources.

The construction of the weir and channel modifications within the Peckman River is expected to have temporary adverse impacts to fishery resources due to noise and turbidity from equipment operating in the stream and along the banks. The turbidity caused by construction activities could hinder predation efficiency of sight feeding fish within the river. However, any juvenile or adult fish within the project area are expected to be mobile enough to leave the area. In addition, the initial loss of aquatic macroinvertebrate species resulting from channel modifications will eliminate a food source for fish until the area is recolonized by macroinvertebrate species.

During flood events, fish may be carried into the diversion culvert. The diversion culvert is sloped to facilitate complete drainage, therefore it is not expected that fish will become trapped in the culvert as the water level recedes once in the culvert following storm events.

The majority of species caught during fish surveys are tolerant of degraded water quality and habitat. Subsequent of construction completion, the species most tolerant of impaired conditions are expected to be the first to utilize the area. In addition, although the substrate of the Peckman River is predominantly comprised of cobble and gravel with areas of boulders, the uniform nature of riprap is expected to cause a shift in the type of species that inhabit the channel modification segment to those that are more adapted to hard substrate. Such species include bluegill, sunfish and white sucker, and largemouth bass (Fischenich, 2009) (Wang and Reyes, 2008).

Construction of the riverine mitigation is expected to have similar temporary adverse effects to fish as the construction of the Recommended Plan channel modification. However, long-term benefits to fish species are anticipated from the implementation of the riverine mitigation.

The stilling basin located at the culvert outlet in the Passaic River is not expected to have any long term negative adverse impacts on fishery resources.

Mitigation

The use of erosion and sediment control best management practices will minimize sedimentation and turbidity that can negatively impact fish species and their habitat. In addition, an in-water work restriction from May 1 through July 31 as recommended by the New Jersey Division of Fish and Wildlife will be observed. The in-water work restriction will be extended to April 1 through July 31 if pickerel are present. This determination will be made by pre-construction fish surveys that will be done as part of creating baseline conditions to determine the success of riverine compensatory mitigation measures. A two foot by six foot wide orifice will be installed within the weir to maintain fish passage.

The bendway weirs and streambank vegetation proposed as compensatory riverine mitigation will enhance foraging, resting and spawning habitat for fish species. Further discussion of the mitigation measures are located in Section 5.7.2 and Appendix A-8.

Monitoring and Adaptive Management

The District will monitor the recovery of fishery resources annually for a minimum of five years using the NNJ FIBI as described in Section 5.7.2 and in Appendix A-9.

5.9.2 Benthic Resources

Implementation of the nonstructural measures in Little Falls will not have any adverse impacts on macroinvertebrate species.

Construction of the channel modifications within the Peckman River will have moderate impacts to benthic species. Mortality of aquatic macroinvertebrates as a result of the excavation of the channel and the installation of the riprap along the channel bottom and side slopes will occur. Temporary increases in turbidity and suspended sediments near and downstream of the construction activities could cause direct mortality or indirect decreased reproductive success in benthic species of the short-term. The conversion of the channel bottom and side slopes to riprap and In addition, loss of streambank vegetation, however modest, will represent a loss in food supply, cover and spawning material.

Recolonization of disturbed river channels by aquatic invertebrates is site specific and is dependent on factors such as the proximity of a source of colonizers, the stability of the substrate and other physical conditions. Typical colonization methods include oviposition, drift or crawling and in general can occur within a few months to one year (Giller, 1998)(Simpson, Keirn, Matter and Guthrie, 1982). As the riverine compensatory mitigation site is immediately upstream of the channel modification and will also need to undergo recolonization following construction, the recruitment process for the channel modification is expected to take closer to the one year timeframe. Although the substrate of the Peckman River is predominantly comprised of cobble and gravel with areas of boulders, the uniform nature of riprap is expected to cause a shift in the type of species that inhabit the channel modification segment to those that are more adapted to hard substrate. Such species include midges and caddisflies (Miller and Bingham, 1991)(Fischenich, 2009).

As with the construction of the channel modifications, mortality of aquatic macroinvertebrates will result from excavation and fill activities related to construction of the bendway weir fields as well as the streambank vegetation. The recolonization process within the compensatory mitigation site is expected to occur within a few months due to recruitment from undisturbed portions of the mitigation site.

Mortality of benthic species within the immediate footprints of the stilling basin within the Passaic River is expected during construction activities. However, this impact is expected to be negligible.

Mitigation

The use of erosion and sediment control best management practices will minimize sedimentation and turbidity that can negatively impact benthic resources and their habitat. In addition, the in-water work restriction from May 1 through July 31 required by NJDEP to protect fishery resources will provide similar protection to any benthic resources that also spawn during this timeframe. During optimization, the District will evaluate ways riprap can be installed to create habitat for aquatic macroinvertebrates. For example, riprap may be sized and placed in a manner to create interstitial spaces that these species use to as refuge during flood events. The bendway weirs and streambank vegetation proposed as compensatory riverine mitigation will enhance foraging, resting and spawning habitat for benthic resources.

Monitoring and Adaptive Management

The District will monitor the recovery of aquatic macroinvertebrates on an annual basis for a minimum of five years using the NJ High Gradient Macroinvertebrate Index as described in Section 5.8 Water Quality and Habitat. A survey will be conducted prior to construction to establish baseline conditions. Adaptive management measures related to macroinvertebrate habitat are also described in Appendix A-9.

5.9.3 Birds

The construction of the Recommended Plan and any associated mitigation will create short-term minor adverse impacts to migratory bird species. However, since bird species are highly mobile, they are expected to move away from the project area during construction. Furthermore, outside the breeding season these species do not permanently remain in any one location. Implementation of vegetation clearing restrictions will benefit ground and tree-dwelling migratory birds during the breeding season. Therefore, adverse impacts to migratory bird species are expected to be short term and minor, limited to