DRAFT REPORT

Environmental Restoration Report and Environmental Assessment Lower Assunpink Creek Ecosystem Restoration Project - Broad Street Culvert

Prepared for

U.S. Army Corps of Engineers
Philadelphia District
Philadelphia, Pennsylvania

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Acronyms and Abbreviations

µg/m^3	micrograms per cubic meter
DHS	Department of Human Services
DWQ	Division of Water Quality
EPA	U.S. Environmental Protection Agency
F	Fahrenheit
NAAQS	National Ambient Air Quality Standards
NJDEP	New Jersey Department of Environmental Protection
NMFS	National Marine Fisheries Service
NPV	net present value
PM-2.5	particulate matter
ppm	parts per million
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Executive Summary

The U.S. Army Corps of Engineers (USACE), Philadelphia District, has initiated an environmental restoration project for the lower Assunpink Creek area under authority of Section 1135 of the Water Resources Development Act of 1986. As amended, the Act provides authority for modifying the structure or operation of an existing USACE project to improve the quality of the environment in the public interest and for determining if the operation of such a project has contributed to the degradation of the quality of the environment. The City of Trenton, New Jersey, will serve as the non-Federal project sponsor.

The Lower Assunpink Creek Ecosystem Restoration Project study area is located along a 3-mile section of the lower Assunpink Creek in Trenton, New Jersey. Assunpink Creek is 25 miles long, and drains approximately 91 square miles in central New Jersey. The main tributaries that feed Assunpink Creek are Shabakunk Creek and Miry Run. The headwaters begin in Millstone Township, in Monmouth County, and flow into the Delaware River in Trenton. The project area evaluated for this report encompasses a 500-foot section of the lower Assunpink Creek in downtown Trenton where the creek is contained within a buried box culvert known as the Broad Street culvert.

From the Delaware River to the Trenton city limits, several former industrial sites, abandoned bridges, and the Broad Street culvert were identified as candidates for ecological restoration. The Broad Street culvert recently experienced a structural failure, which increased the urgency to implement a restoration action that would also address a public safety hazard. For this reason, this report documents the evaluation of alternatives for removal or "day lighting" of the Broad Street culvert along Assunpink Creek between South Broad Street and South Warren Street. Should there be additional Section 1135 funding available for the Lower Assunpink Creek Ecosystem Restoration Project, the other prospective restoration sites will be discussed in a subsequent report.

The Broad Street culvert is located in the heart of the downtown business district and is on a recovering urban stream that connects various greenway areas and transportation facilities. The proposed day lighting of the stream would occur through removal of the culvert roof structure, allowing the stream to be exposed to natural sunlight. The resulting open channel design will improve anadromous fish migration, as low-light conditions can disorient migrating fish, hindering their ability to spawn upstream. The project will also benefit businesses adjacent to the site, provide recreational options for visitors and local residents, and provide historical and educational opportunities for the community.

SECTION 1

Needs and Objectives of Proposed Action

It has been estimated that, since 1955, more than 100 acres of tidal wetlands and riparian habitat have been lost along the Delaware River and its tributaries, specifically ranging from Trenton, New Jersey south of the Route 1 bridge to the Philadelphia city limits. Much of the loss along the Delaware River can be linked to the Delaware River, Philadelphia to Trenton, Federal Navigation Project, specifically from historic placement of dredged material used to create "fast land". This activity has adversely affected freshwater tidal wetlands and associated riparian habitats, including Assunpink Creek.

The upper reaches of the stream, which include the Assunpink Wildlife Management Area, have been purchased and are earmarked for open space preservation. Downstream, the ecosystem is deteriorated and the riparian habitat is badly degraded. The existing ecosystem along lower Assunpink Creek consists of deteriorated riparian habitat in an urban industrial area. Construction rubble has been haphazardly dumped along the shoreline for stabilization purposes. Abandoned buildings and concrete and asphalt parking lots are adjacent to and landward of the creek's shoreline.

The Broad Street culvert in particular poses a significant barrier for anadromous fish migration from the Delaware River to the headwaters of Assunpink Creek. The September 3, 2006 partial collapse of a 24- by 35-foot section of culvert adjacent to the State of New Jersey Department of Human Services (DHS) building has increased the urgency to address the Broad Street culvert component of the Assunpink Creek restoration plan. An initial assessment of the failure, performed by Birdsall Engineering (Appendix A), attributed the collapse to the failure of the culvert roof deck slabs. Citing the potential for future sudden collapse of remaining roof slabs, the Birdsall report recommended that the entire culvert perimeter be cordoned off to any access. The City of Trenton has taken action to limit access; however, the collapsed deck slabs still remain within the creek, creating an obstruction and potential flooding hazard.

The goal of the Lower Assunpink Creek Ecosystem Restoration Project is to restore migratory fish habitat, enhance recreational opportunities, and improve the overall stream ecology of Assunpink Creek. Project goals will be accomplished through day lighting the Broad Street culvert and creation of an open-channel system. The proposed action evaluated in this report coincides with interstate management plans developed by the Atlantic States Marine Fisheries Commission in 1985 to restore herring stocks in streams experiencing stream blockages. Additionally, restoring the freshwater ecology and creating recreational opportunities for the public will benefit the overall economy of the City of Trenton and the region.

SECTION 2

Alternatives

The Broad Street culvert is a box culvert approximately 500 feet long, with two 9- by 22-foot flumes separated by a 3-foot center wall. The culvert contains a roof structure of 8-inch precast, hollow-core concrete deck slabs that are covered in soil, averaging 3 feet in the center of the culvert to 6 feet near the DHS building. The area over the culvert is mowed turf.

Five alternatives for the proposed ecological restoration at the Broad Street culvert were considered and evaluated, including Alternative Five – a No-Action Alternative. Attachment 1 contains the study area map and conceptual plan and profile drawings for all alternatives, and Attachment 2 contains project location photographs.

The alternatives were developed to address the ecological restoration goal of restoring fish migration within Assunpink Creek. With the exception of the No-Action Alternative, all proposed alternatives will assist the City of Trenton with the remediation of a public safety hazard. The alternatives are also supportive of the recreation objectives outlined in the Delaware Valley Planning Commission publication, Closing the Missing Link on the Assunpink Creek Greenway.

2.1 Alternative One – Removal of Culvert Roof Structure

For this alternative, the roof slabs, center wall, and the fill above the roof slab will be removed. The banks above the walls will be sloped back to match existing elevations. Architectural detail will be applied to remaining concrete walls to mimic the channel upstream of the South Broad Street Bridge and to create a more aesthetically pleasing structure. An overlook platform encroaching into the stream will be added in the current location of the hardscape patio leading from the entrance to the DHS building.

Both banks will be planted with upland trees and shrubs to create an aesthetically pleasing park environment similar to the Mill Hill Park and Greenway immediately upstream. A pedestrian walkway along the southern bank will connect sections of the Assunpink Greenway. Handrails will be added to both sides of the culvert for public safety.

2.2 Alternative Two – Removal of Roof Structure and Southern Culvert Wall

For this alternative, the roof slabs, center wall and the fill above the center wall will be removed. The southern wall of south box will be removed down to heights between 2 and 4 feet as constrained by Factory Street. The north bank above the remaining wall will be sloped back to match existing elevations. The southern bank will be benched to create a flood bench, with the extent of the bench also constrained by Factory Street.

The banks will be stabilized with riparian vegetation supplemented by stone boulders, riprap, or other hardscape material. Stone boulders will be grouted into the remaining bottom slab to provide roughening and to provide a varied flow pattern through the channel. The lower south bank will be planted with riparian trees and shrubs, while the upper banks will be planted with native upland trees to enhance the aesthetics of the park environment. The north bank above the remaining wall will be planted with upland trees. Architectural detail will be applied to the remaining concrete walls to mimic the channel upstream of the South Broad Street Bridge and to create a more aesthetically pleasing structure.

Two overlook platforms encroaching into the existing culvert will be added, one in the current location of the hardscape patio leading from the entrance to the DHS building and the other along the south bank near the South Broad Street Bridge. A pedestrian walkway along the southern bank will connect sections of the Assunpink Greenway. Handrails will be added as necessary for public safety.

2.3 Alternative Three – Removal of Roof Structure, Southern Culvert Wall and Partial Removal of the North Culvert Wall

For this alternative, the roof slabs, center wall and the fill above the center wall will be removed. As with Alternative Two, the south culvert wall will be removed down to heights between 2 and 4 feet as constrained by Factory Street. The southern bank will be benched to create a flood bench, with the extent of the bench also constrained by Factory Street. The north culvert wall will remain where constrained by the DHS building infrastructure; however, upstream from the DHS building the wall will be removed down to heights between 2 and 4 feet as constrained by East Lafayette Street.

The lowered portion of the north bank and the entire south bank will be benched to create a flood bench, with the extent of the benching constrained by East Lafayette and Factory Streets.

Two overlook platforms encroaching into the existing culvert will be added, one in the current location of the hardscape patio leading from the entrance to the DHS building and the other along the south bank near the South Broad Street Bridge.

The banks will be stabilized with riparian vegetation supplemented by stone boulders, riprap, or other hardscape material. Stone boulders will be grouted into the remaining bottom slab to provide roughening and to provide a varied flow pattern through the channel. The lower south bank will be planted with riparian trees and shrubs, while the upper banks will be planted with native upland trees to enhance the aesthetics of the park environment. The north bank above the remaining wall will be planted with upland trees, while the lowered portion will be planted with riparian vegetation. Architectural detail will be applied to the remaining concrete walls to mimic the channel upstream of the South Broad Street Bridge and to create a more aesthetically pleasing structure.

A pedestrian walkway along the southern bank will connect sections of the Assunpink Greenway. Handrails will be added where necessary for public safety.

2.4 Alternative Four – Complete Culvert Removal and Realignment of Creek Channel

For this alternative, the entire culvert structure will be removed and Assunpink Creek will be realigned. The realigned channel will be developed using natural channel design principles that will restore an appropriate channel pattern, dimension, and profile given the land use constraints associated with the study area.

The pattern, or alignment, will be shifted away from the DHS building infrastructure while considering the egress and ingress of the creek to the South Broad Street and South Warren Street bridges. The channel dimension, or cross-section, will generally be narrowed and deepened.

This alternative will incorporate instream structures such as log and rock cross-vanes and J-hooks that center the flow, control the grade, and vary the channel bottom, or profile. The resulting riffles and pools will create habitat for aquatic life. Both banks will be planted with riparian trees and shrubs to enhance the aesthetics of the park environment, in addition to providing bank stability. Biologs and coir matting will provide temporary structural stability until the vegetation becomes well established. A pedestrian walkway along the southern bank will connect sections of the Assunpink Greenway.

2.5 Alternative Five – No-Action Alternative

Under the No-Action Alternative, none of the above alternatives will be implemented. It is assumed that the collapsed portion of the culvert will be repaired; however, it is assumed a failure could occur again in the future. The No-Action Alternative serves as a baseline against which the impacts of the proposed "action" alternatives can be evaluated.

2.6 Alternatives Evaluation

2.6.1 Alternative One

Under this alternative, the roof structure and center wall of the culvert will be removed, architectural detail will be added to the side walls, an overlook platform will be built into the creek to replace the DHS building patio, and landscaping will be added along both banks of the creek.

Structural Stability

This alternative will provide increased structural stability compared to the existing condition because the soil load and suspect roof slabs will be removed from the system.

Maintenance Requirements

The overall requirement for maintenance, after the monitoring and warranty periods, will be incrementally greater than the level required to "maintain" the existing conditions. The slight expected increase in maintenance can be attributed to the introduction of the general public to the land and costs associated with maintaining landscaping. Public impacts from

foot traffic and litter can be managed through education and facilities management (trash cans, signs, bollard fencing).

Cost Estimate

The order-of-magnitude cost estimate is $3,218,159. Please see Attachment 3 for more detailed costing information. This cost estimate was based on standard construction estimating references (such as R.S. Means Cost Data Manuals), previous CH2M HILL project experience, and preliminary price quotes from various suppliers.

Environmental Benefits

Under this alternative, the creek will be day lighted, removing a significant obstacle to fish passage. Removing the roof structure will encourage fish migration upstream, as low-light conditions can disorient migrating fish, hindering their ability to spawn upstream. This will help to create a sustainable anadromous fishery within Assunpink Creek. The area adjacent to the open channel will be planted with native upland trees and developed to enable public access, adding approximately 1.5 acres of parkland to the downtown Trenton area.

2.6.2 Alternative Two

As with Alternative One, this alternative will provide an open channel configuration for the creek. The roof structure and center wall of the culvert will be removed, architectural detail will be added to the side walls, two overlook platforms will be built into the creek, and landscaping will be added along both banks of the creek. Unlike Alternative One, the south culvert wall will be lowered to allow for a "softbank" approach with riparian landscaping along the southern bank of the channel. Instream structures will create riffles and pools and public access will be provided via a footpath and two overlook platforms.

Structural Stability

Alternative Two will provide increased structural stability compared to the existing condition because the soil load and suspect roof slabs will be removed from the system. The north wall will be retained at its existing height and the south wall will be removed to a height between 2 and 4 feet. Riparian landscaping along the south wall will prevent scour during periods of high flow. Biologs and coir matting will provide temporary structural stability until the vegetation becomes well established.

Maintenance Requirements

The overall requirement for maintenance, after the monitoring and warranty periods, will be greater than the level required to "maintain" the existing conditions and greater than Alternative One. The expected increase in maintenance can be attributed to the introduction of the general public to the land and cost associated with landscape management. Public impacts from foot traffic and litter can be managed through education and facilities management (trash cans, signs, bollard fencing).

Cost Estimate

The order-of-magnitude cost estimate is $4,278,688. Please see Attachment 3 for more detailed costing information. This cost estimate was based on standard construction

estimating references (such as R.S. Means Cost Data Manuals), previous CH2M HILL project experience, and preliminary price quotes from various suppliers.

Environmental Benefits

The benefits to the Assunpink Creek fishery achieved through implementation of this alternative are similar to those benefits identified in Alternative One; however, the proposed riparian component and instream structures will offer additional ecological benefits. The restored riparian zone will provide a beneficial transition buffer between existing water and human land uses; improved habitats, including foraging and nesting areas, for various species of birds, small mammals, and aquatic wildlife species; improved runoff water quality by acting as a sediment and pollutant filter; and improved aesthetic and recreational values for the project area. The proposed overlooks will provide recreational fishing opportunities and, in conjunction with placed boulders, will create instream features. The resulting riffles, pools, and varied flow path will create visual interest as well as habitat for macroinvertebrates. By reducing the south culvert wall, this alternative will provide riparian habitat and improved aesthetics when compared to Alternative One. The area adjacent to the open channel will be developed to enable public access and will add approximately 1.5 acres of parkland to the downtown Trenton area.

2.6.3 Alternative Three

As with Alternatives One and Two, Alternative Three will provide an open channel configuration for the creek. The roof structure and center wall of the culvert will be removed, architectural detail will be added to the side walls, two overlook platforms will be built into the creek, and riparian landscaping will be added along both banks of the creek. As with Alternative Two, the south culvert wall will be removed down to heights between 2 and 4 feet. The north culvert wall will remain where constrained by the DHS building infrastructure; however, upstream from the DHS building the north wall will be removed down to heights between 2 and 4 feet.

Structural Stability

This alternative will provide increased structural stability compared to the existing condition because the soil load and suspect roof slabs will be removed from the system. Riparian landscaping along the south wall and lowered portions on the north will prevent scour during periods of high flow. Biologs and coir matting will provide temporary structural stability until the vegetation becomes well established.

Maintenance Requirements

The overall requirement for maintenance, after the monitoring and warranty periods, will be slightly greater than the level required to "maintain" the existing conditions and greater than Alternatives One and Two. The expected increase in maintenance can be attributed to the introduction of the general public to the land and the additional landscaping component. Public impacts from foot traffic and litter can be managed through education and facilities management (trash cans, signs, bollard fencing).

Cost Estimate

The order-of-magnitude cost estimate is $4,598,750. Please see Attachment 3 for more detailed costing information. This cost estimate was based on standard construction estimating references (such as R.S. Means Cost Data Manuals), previous CH2M HILL project experience, and preliminary price quotes from various suppliers.

Environmental Benefits

The environmental benefits that will be achieved from this alternative are greater than benefits identified in Alternatives One and generally equal to Alternative Two. In addition to providing fish passage opportunities, benefits include a restored riparian zone; improved habitats for various species of birds, small mammals, and aquatic wildlife species; improved runoff water quality by acting as a sediment and pollutant filter; and improved aesthetic and recreational value of the project area. By reducing a portion of the north culvert wall, this alternative will increase vegetation and improve aesthetics when compared to Alternatives One and Two. The overlooks will provide recreational fishing opportunities and, in conjunction with placed boulders, will create in-stream features.

This alternative will also provide an improved buffer for stormwater surface runoff sediment control compared to Alternatives One and Two. The area adjacent to the open channel will be developed to enable public access and will add approximately 1.5 acres of parkland to the downtown Trenton area.

2.6.4 Alternative Four

Alternative Four involves the complete removal of the culvert structure and the realignment of the creek into a natural channel. This alternative will provide a structurally sound streambank, while improving on the existing ecological community through in-stream structures and creation of fish spawning habitat. The pattern, or alignment, will be shifted away from the existing DHS building's infrastructure while considering the egress and ingress of the creek to the South Broad Street and South Warren Street bridges. While this alternative is deemed feasible, it is expected to present more significant construction challenges compared to the other alternatives.

Structural Stability

This alternative will generally have less structural stability than the other alternatives because of the incorporation of a complete "softbank" approach for channel stabilization. Structural stability of the streambank will be accomplished through the root structure provided by riparian vegetation and strategic placement of riprap and boulders. The channel dimension, or cross-section, will generally be narrowed and deepened. The project will incorporate instream structures such as log and rock cross-vanes and J-hooks, that center the flow, control the grade, and vary the channel bottom or profile. Both banks will be planted with riparian trees and shrubs to provide stability. Biologs and coir matting will provide temporary structural stability until the vegetation becomes well established. This alternative will provide an enhanced buffer for stormwater surface runoff sediment control, as well as provide an ecosystem that is conducive to sustaining wildlife species.

Maintenance Requirements

The Alternative Four overall requirement for maintenance, after the monitoring and warranty periods, will be greater than the other three alternatives because of the reliance on a complete "softbank" approach and the greater landscaping maintenance involved. This alternative has the greatest vegetative component and will therefore require increased replanting and maintenance. There is also a greater potential for debris to accumulate behind the planned instream structures. Public impacts from foot traffic and litter can be managed through education and facilities management (trash cans, signs, bollard fencing).

Cost Estimate

The order-of-magnitude cost estimate is $5,666,500. Please see Attachment 3 for more detailed costing information. This cost estimate was based on standard construction estimating references (such as R.S. Means Cost Data Manuals), previous CH2M HILL project experience, and preliminary price quotes from various suppliers.

Environmental Benefits

Alternative Four will provide increased environmental benefits compared to the other three alternatives. This is attributable to the complete removal of the concrete slab that serves as the stream bottom under the other three alternatives. Under this alternative, there will be opportunities to create fish-spawning habitat and other aquatic habitat through channel design, instream structures, and creation of pools and riffles. Removal of the concrete bottom slab will also increase fishery migration opportunities by creating a varied substrate and will increase biodiversity through increased macroinvertebrate habitat. Other benefits include a restored riparian zone, providing a beneficial transition buffer between existing water and human land uses; improved habitats, including foraging and nesting areas, for fish-eating birds, small mammals, and aquatic wildlife species; improved runoff water quality by acting as a sediment and pollutant filter; and improved aesthetic and recreational value of the project area. A more-diverse ecosystem conducive to sustaining aquatic and wildlife species will result. The area adjacent to the open channel will be developed to enable public access and will add approximately 1.5 acres of parkland to the downtown Trenton area.

2.6.5 Alternative Five – No Action Alternative

Under the No-Action Alternative, the culvert will remain and is assumed to eventually be repaired. In its assessment of the culvert collapse, Birdsall Engineering concluded that additional failure of roof panels is possible given the site conditions and culvert design. It is likely that once repaired, the entire area over the culvert will remain off-limits to the public because of safety concerns. The collapse also has deposited concrete debris within the channel that under high flows could create a flooding hazard upstream. Under the No-Action Alternative, a significant barrier to anadromous fish migration will remain in place.

2.7 Alternatives Evaluation Summary

The proposed alternatives were evaluated to determine which one most effectively (1) restores the buried stream bank, (2) improves stream ecology and fishery habitats, (3) effectively protects the stream bank, (4) minimizes the amount of long-term maintenance, (5)

enhances recreation opportunities, and (6) minimizes the cost. Table 2-1 summarizes the preliminary evaluation of the alternatives.

TABLE 2-1
Summary of Alternatives Evaluation

Alternative	Cost	Habitat Units[2]	Incremental Cost per Unit of Output[3]	Structural Stability	Maintenance Requirements
Alternative One	$3,218,159	3,148	$8,698	1	1
Alternative Two	$4,278,688	5,667	$421	2	2
Alternative Three	$4,598,750	5,667	n/a	3	3
Alternative Four (Selected Alternative)	$5,666,500	11,167	$ 252	4	4
Alternative Five	No Cost[1]	2,778	n/a	5[3]	5[3]

[1] Does not consider repair cost or costs to replace suspect roof panels.

[2] Refer to Section 5 for Habitat Unit and Incremental Cost per Unit Output calculations.

[3] Assumes potential for future structural failure of roof panels.

The relative ecological benefits of each alternative were quantified through a habitat services analysis. Habitat or ecosystem services are defined as the physical, chemical, or biological functions that one natural resource provides for another natural resource, and thus indirectly provides value to the public. Examples include provision of food for wildlife, protection from predation, and nesting habitat, among others. These services can be quantified into habitat units for comparison purposes. Section 5 contains the habitat benefits analysis and incremental cost analysis completed for the alternatives; a summary analysis is presented in this section.

The amount of habitat units for each alternative was derived using a rapid assessment protocol that evaluates the improvements to instream habitat expected from each alternative, and relates them in percentage terms to a reference stream. These percentages were multiplied by the extent of the proposed action (500 linear feet) to obtain habitat units expressed in stream length. The habitat quality improvements are assumed to remain constant for each year over a 50-year period. Using a 3 percent real annual rate of discount, the habitat units are estimated in terms of discounted stream length years. An incremental cost analysis was conducted to derive the incremental cost per unit of output shown in Table 2-1.

For the evaluation of structural stability and maintenance requirements, each alternative was ranked from one to five (one being the highest). Channel stability under high-flow conditions, scour potential, and landscape maintenance cost were considered for the evaluation.

Alternative Four provides the lowest incremental cost per unit of output with the greatest production of habitat units while fulfilling the project object of restoring migratory fish habitat, enhancing recreational opportunities, and improving the overall stream ecology of Assunpink Creek. Therefore, Alternative Four is the Selected Alternative.

2.8 Selected Alternative - Conceptual Design

Alternative Four was identified as the Selected Alternative based on an evaluation of its ecological benefits, structural stability, expected long-term maintenance requirements, and construction cost estimates. Input received from the New Jersey Department of Environmental Quality, Division of Fish and Wildlife indicates support for the complete removal of the culvert as proposed under this alternative (Appendix B). A conceptual plan and profile for the Selected Alternative is included in Attachment 1.

To enable work to be accomplished with minimal impacts to water quality, stream flows will be diverted into the northern culvert flume. This will allow for the southern flume be demolished under dry conditions and for excavation and grading of the realigned channel. The alignment of the new channel will be shifted south away from the existing DHS building's infrastructure while considering the egress and ingress of the creek to the South Broad Street and South Warren Street bridges. Flows will be diverted into a temporary diversion channel to allow for the demolition of the northern flume.

Structural stability of the streambank will be accomplished through the root structure provided by diverse riparian vegetation and strategic placement of variously sized boulders. A bentonite layer will be added to the stream bed as necessary. The channel dimension, or cross-section, will generally be narrowed and deepened. The project will incorporate instream structures such as boulders, log and rock cross-vanes and J-hooks, that center the flow, control the grade, and vary the channel bottom or profile. Both banks will be planted with riparian trees and shrubs to provide stability. Biologs and coir matting will provide temporary structural stability until the vegetation becomes well established.

A secondary benefit of the restoration of the stream and riparian habitat will be an increase in the recreational and educational potential for this area. To accentuate this, trees and shrubs will be planted in such a way as to create natural travel paths for pedestrians. Features such as access points, signage, and minimal facilities (benches, trash receptacles) will be installed in selected locations to allow easy access from one point of interest to the next. A paved footpath will also be provided in the upland area to provide recreational opportunities and public access. Additionally, recreational fishing opportunities for the public will increase with improved riparian habitat and stream bank restoration.

The construction cost estimate for the Selected Alternative - Conceptual Design is $5,666,500.

SECTION 3

Affected Environment

3.1 Physical Site Characteristics

3.1.1 Topography, Geology, and Soils

The topography of the Trenton, New Jersey area is relatively flat and low-lying. Elevations in this area range from near sea level to just above 100 feet above sea level. The average elevation of the city itself is approximately 95 feet above sea level. Elevations along the Assunpink Creek are below 30 feet above sea level, dropping to near sea level where the creek discharges into the Delaware River. The project area involves a section of the creek that flows through a highly urbanized and developed section of Trenton.

Trenton is underlain by a variety of rock types. The predominant rock types that are found within the project area are amphibolites and gniesses, including a small section comprised of Wissahickon schist towards the northeast corner of the project area. Gabro and Byram gniess can be found immediately north of the creek, and rocks of the Magothy and Raritan formations dominate the area south of the creek.

Soils within the project area are classified as being of the Galestown-Evesboro formation. These soils are characterized as being deep and excessively drained, with nearly level to gently sloping soils that are sandy throughout their depth.

Soils in the Evesboro formation are characterized as deep, loose, excessively drained, sandy soils in the upland region. They contain thick deposits of medium and coarse, highly quartzose sand that is not glauconitic in nature, and have a gradient that is gently or moderately sloping. The surface layer of the Evesboro soil consists of loamy sands that are approximately 18 inches thick. The soil is very dark gray in color in the top few inches, becoming dark yellowish brown in color throughout the rest of the layer. The subsoil is strong-brown, loose, loamy sand that extends to a depth of approximately 36 inches. The Evesboro soil is characterized by rapid permeability to a depth of up to 5 feet.

Soils in the Galestown formation formed in old alluvium that consists of thick deposits of sand or loamy sand along the Delaware River, the lower reaches of Crosswicks Creek south of Trenton, along Millstone Creek, and along Assunpink Creek. Galestown soils are characterized as deep, loose, excessively drained, sandy soils. The gradient of these soils are generally nearly level, or may be gently sloping on terraces along streams. The surface layer of the Galestown soil consists of loamy sand that is approximately 17 inches thick. The upper part of this loamy sand is dark yellowish brown in color, with the lower part being yellowish brown in color. The subsoil is a yellowish-red loamy sand that is approximately 15 inches thick. Galestown soil is characterized as having rapid to moderately rapid permeability to a depth of 5 feet or more and as highly susceptible to wind erosion in the early spring months.

3.1.2 Hydrology and Water Quality

Assunpink Creek flows in a southwesterly direction, emptying into the Delaware River. Areas of East Trenton often experience flood events because of the highly developed and low-lying areas surrounding the creek. A hydraulic model was developed as part of the study to evaluate the flood risk of any proposed modifications to existing bridges and culverts (Appendix C).

Assunpink Creek is classified by the New Jersey Department of Environmental Protection's Division of Water Quality (NJDEP DWQ) as FW2-NT. "FW" indicates that the creek is classified as freshwater, meaning that the water has as salinity of less than or equal to 3.5 parts per thousand at mean high tide. "FW2" indicates that the creek has been given a general surface water classification that has not been designated as FW1 or Pinelands Waters. This means that the creek may be subjected to manmade wastewater discharges or runoff from human activities. A classification of FW2 indicates that the water body has no extraordinary or distinctive characteristics, such as good clarity, color, scenic setting, or other characteristic of aesthetic value, or any ecological, recreational, water supply, or fisheries resource significance. "NT" indicates that Assunpink Creek is not suitable for trout production or trout maintenance because of its physical, chemical, or biological characteristics. However, the creek may be suitable for a wide variety of other fish species, including large mouth bass (*Micropterus salmoides*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), and Alewife herring (*Alosa pseudoharengus*).

The U.S. Geological Survey (USGS) operates several streamgages on Assunpink Creek via the National Streamgaging Network Plan, one of which is found at Trenton:

Station Number	Station Name	Operational Status
01464000	Assunpink Creek at Trenton, NJ	Active

USGS has obtained 37 years of flow records using streamgage #01464000, 30 years of which recorded low-flow conditions in the stream. Streamgage #01464000 has also recorded a mean annual flow of 139 cubic feet per second for Assunpink Creek. The area of the drainage basin that is monitored in part by this streamgage is approximately 90.6 square miles, with a main channel length of 20.5 miles and a slope of 4.84 feet/mile.

The NJDEP Bureau of Water Quality Standards and Assessment conducted a study in 2003 to detect measurable amounts of metals in the state's freshwater bodies. Having taken samples from the Assunpink Creek at Peace Street in Trenton, the water assessment team found that chromium, nickel, and selenium were all present in measurable amounts. Arsenic, copper, lead, and zinc were not found. Insufficient data were collected while trying to detect the presence of cadmium, mercury, and silver.

An ongoing study being performed by NJDEP DWQ shows that in 1999, 94 percent of community water systems had no measurable amount of volatile organic compounds. In the same year, 97 percent of the community water systems had no detectable microbiological contaminants, and 93 percent had no detectable chemical contaminants. These numbers show that the water quality of community water systems is currently much better than the quality that was observed in the mid-1980s.

3.1.3 Air Quality

Six principal pollutants act as indicators of air quality in the United States. The National Ambient Air Quality Standards (NAAQS) are the concentrations of these principal pollutants, above which adverse effects on human health may occur. Areas of New Jersey where air pollution levels consistently stay below these standards are designated "Attainment." Areas where air pollution levels persistently exceed these standards are designated "Nonattainment." If an area was in "Nonattainment" but now attains the standard and has a plan approved by the U.S. Environmental Protection Agency (EPA) to maintain the standard, it is designated a "Maintenance" area. Mercer County is designated by EPA as a "Nonattainment" area for both particulate matter (PM-2.5) as well as 8-hour ozone. Table 3-1 shows the NAAQS that New Jersey has adopted.

TABLE 3-1
National Ambient Air Quality Standards

Pollutant	Concentration
Carbon Monoxide	9 parts per million (ppm)
Lead	1.5 micrograms per cubic meter ($\mu g/m^3$)
Nitrogen Dioxide	0.053 ppm (annually)
Ozone	0.085 ppm (maximum daily – 8 hours)
Particulate Matter (< 10 microns)	50 $\mu g/m^3$ (annually)
Sulfur Dioxide	0.03 ppm (annually)

3.1.4 Climate

Trenton is located in the southern climatic division of New Jersey. The average annual temperature is approximately 52.1° Fahrenheit (F), with an average temperature in the mid- to high 70s in the summer months and in the mid- to low 30s in the winter months. However, temperatures have been known to reach in excess of 100°F and below 0°F. Because of urbanization, Trenton itself is a heat island, trapping heat most often during the summer months. This heat-trapping effect can lead to much higher temperatures within the city limits than surrounding areas.

Trenton receives an average of 44.27 inches of precipitation annually. Snow typically occurs between mid-November and mid-April. Approximately 25 to 30 thunderstorms occur each year. Measurable amounts of precipitation fall about 120 days out of the year. The fall months tend to be the driest months, typically averaging 8 days with measurable precipitation. The rest of the months average 9 to 12 days of measurable precipitation events.

3.2 Fish and Wildlife Resources

Many species of common and migratory fish are known to inhabit Assunpink Creek and the nearby Delaware River. Migratory fish species common to Assunpink Creek include the American eel (*Anguilla rostrata*). Other common species known to occur in or around the project area include several species of sunfish (*Lepomis spp.*), large mouth bass (*Micropterus salmoides*), striped bass (*Morone saxatilus*), pickerel (*Esox spp.*), eastern mudminnow (*Umbra pygmaea*), brown bullhead (*Ameiurus nebulosus*), fallfish (*Semotilus corporalis*), white sucker (*Catostomus commersoni*), perch (*Aphredoderus spp.*), margined madtom (*Noturus insignis*), tessellated darter (*Etheostoma olmstedi*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), and alewife herring (*Alosa pseudoharengus*).

3.3 Aquatic and Terrestrial Habitat

In general, the project area is significantly disturbed as a result of historical land uses, including both industrial and residential development. The creek is currently contained within a buried culvert with mowed turf placed at the surface, limiting aquatic and terrestrial habitat.

3.4 Threatened and Endangered Species

The National Marine Fisheries Service (NMFS) reported that the Federally endangered shortnose sturgeon (*Acipenser brevirostrum)* are known to occur in the Delaware River in the vicinity of Assunpink Creek. Specifically, shortnose sturgeon overwinter in dense sedentary aggregations in the upper tidal reaches of the Delaware River between river mile 118 and river mile 131 reaches. During the late summer months, shortnose sturgeon are more dispersed and are thought to be more widely distributed throughout the river and estuary than in the winter months.

According to NJDEP, the following state and Federally listed species have the potential to occur with ¼ mile of the project site:

TABLE 3-2
Threatened and Endangered Species Potentially within ¼ mile of the Project Area

Common Name	Scientific Name	Federal Status	State Status
dwarf wedgemussel	*Alasmidonta heterdon*	LE	E
green floater	*Lasmigona subviridis*		E
shortnose sturgeon	*Acipenser brevirostrum*	LE	E
yellow lampmussel	*Lampsillis cariosa*		T

LE =formally listed as endangered E = Endangered T = Threatened

According to U.S. Fish and Wildlife Service (USFWS) records, except for transient species, no Federally listed or proposed threatened or endangered species under the jurisdiction of USFWS are known to occur within the project area. Threatened and endangered species correspondence is included in Appendix D.

3.5 Cultural Resources

Cultural resource investigations in the project area were performed by Hunter Research, Inc. in October 2003 in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, 36 CFR 60 and 63- National Register of Historic Places; 36 CFR 800- Advisory Council on Historic Preservation; New Jersey Historic Preservation Office guidelines; and, the New Jersey Historic Preservation Plan. The Phase IA Cultural Resources Reconnaissance Report – Summary and Recommendations section is included as Attachment 4.

3.5.1 Historical Significance of the Assunpink Creek

To a large degree, the Assunpink Creek corridor represents the backbone of historic Trenton. From a historic architectural perspective, a large number of potential resources have been identified, including individual historic buildings and bridges, factory and recreational complexes, and historic districts. Trenton's oldest neighborhoods are in the vicinity of the mouth of the Assunpink. Also, the Mill Hill district is the location of the area's initial industrial development. The southern bank of the Assunpink at Broad Street was the site of Trenton's first industry, where a wooden grist mill was built by Mahion Stacy around 1678. In the 1700s, the Trent Mill (a grist mill owned at one point by Joseph Pierce) was later built on the site of the original Stacy Mill. During the 19th century, a paper mill occupied the same location on the southern bank. As part of Trenton's early paper industry, the paper mill was operated by William McCail and later by Henry M. Lewis.

During the American Revolution, the predecessor of the Broad Street Bridge (then only 16 feet wide and known as King Street Bridge) was the focus of fierce fighting during the Second Battle of Trenton, in which General Washington's troops held the British back. The Battle of the Assunpink was considered a critical defensive battle that resulted in heavy British losses and boosted the morale of the Continental Army.

3.5.2 Archaeological Resources

Various recent archaeological explorations indicate an intensive and widespread Native American presence along the downtown Trenton area of the Assunpink, extending through the Archaic and Woodland periods up to the arrival of the first Europeans. However, very little is known about prehistoric settlement farther upstream.

3.6 Socioeconomic Conditions

Trenton is located approximately 65 miles southwest of New York City, 35 miles northeast of Philadelphia, and 90 miles northwest of Atlantic City. According to the 2000 U.S. Census, the total population of Trenton is estimated at 85,403.

Table 3-2 lists populations, income, and poverty status for both the state of New Jersey, and for the City of Trenton. The median income is lower in Trenton than the state and county median incomes. In addition, the proportion of minorities and the poverty rate are higher in Trenton than the average for the state.

TABLE 3-3
Minority and Low-Income Statistics for New Jersey and the City of Trenton

Demographics / Income	New Jersey	City of Trenton
Total Population	8,414,350	85,403
White	72.6%	32.6%
Black	13.6%	52.1%
American Indian[a]	0.2%	0.3%
Asian	5.7%	0.8%
Pacific Islanders[b]	0.04%	0.2%
Other Race	5.4%	10.8%
Two or more races	2.5%	3.2%
Hispanic or Latino[c]	13.3%	21.5%
Median Household Income	$55,146	$31,074
Poverty Rate[d]	8.5%	21.1%

Source: U.S. Census Bureau, Census 2000, Redistricting Data Summary File, Tables PL1, PL2, PL3, and PL4. 2000 Census of Population and Housing, Summary File 3.

Notes:

[a] Includes Alaska Native.

[b] Includes Native Hawaiian.

[c] Persons of Hispanic origin can be of any race and are counted in those categories also.

[d] Calculated by dividing the population below poverty level by the population for whom poverty status is determined.

3.6 Land Use

The site is comprised of land owned by the City of Trenton and consists of open space covered in mowed turf. The project site is approximately 1,000 feet (2 city blocks) upstream from the Delaware River and is directly downstream of Mill Hill Park, which in turn is approximately 2,000 feet downstream of the Amtrak/New Jersey Transit train station. Directly upstream of the train station, the Assunpink Creek Park has been proposed and will continue upstream another 5,000 feet.

3.7 Recreational Opportunities

Two parks are located adjacent to Assunpink Creek in Trenton. Mill Hill Park is located on Front and Broad Streets, bordering the creek. The park includes restored mill ruins with an overlooking amphitheater and a 500-foot-long gabion retaining wall system along the creek.

Stacy Park is located along the Delaware River; the south end boundary of the park is a short distance upstream of the mouth of the Assunpink.

The Assunpink Creek Greenway Project involves the creation of the Assunpink Creek Park between Monmouth Street and St. Joe's Avenue. The park will include paths for pedestrians and bicyclists along the creek, a community pool, baseball and soccer fields, basketball courts, picnic areas, playgrounds, roller hockey rink, a pavilion, and space for a farmers market and other community events.

Several facilities owned by the City of Trenton border Assunpink Creek. These sites are part of a larger City effort to acquire, assess, and remediate brownfields properties along the Assunpink Creek and turn the area into a greenway. The greenway will increase open space and create a link between neighborhoods, places of work and recreation, and historic sites.

SECTION 4

Environmental Effects

Implementation of the Selected Alternative will result in the restoration of approximately 500 linear feet of the Assunpink Creek stream bank currently contained within a buried concrete box culvert. The Selected Alternative will promote upstream migration of anadromous fish species and will create riparian and upland habitat in an urban park setting

The following section describes the environmental effects of the proposed action. This section is primarily focused on the Selected Alternative (Alternative Four); however, because each of the alternatives involves similar activities, impacts will generally be consistent for Alternatives One, Two and Three.

4.1 Physical Site Characteristics

4.1.1 Topography, Geology, and Soils

By implementing the Selected Alternative, topography within the project area will be altered. As the area over and surrounding the culvert is largely artificial fill, the proposed project would return contours to those more closely resembling the natural condition.

Implementation of the proposed project will not affect the geologic conditions within the project area.

Surficial soils will be disturbed by implementing the Selected Alternative. All materials removed from site for disposal will be disposed of in accordance with all appropriate local, state and Federal rules and regulations.

4.1.2 Hydrology and Water Quality

The proposed project will not significantly affect water quality or the aquatic ecosystem, and has been found to be in compliance with Section 404(b)(1) of the Clean Water Act, as amended (Attachment 5). There will be short-term impacts to water quality in the project area by implementing the Selected Alternative. Short-term impacts from construction activities will result in a temporary increase in sediment for work related to the demolition of the culvert structure. However, during construction stream flows will be diverted to the extent practical to isolate the work area from stream flows and minimize sedimentation.

The long-term benefits to the hydrology and water quality of the stream far outweigh any temporary construction-related impacts. The proposed project should improve water quality both within the project limits and from areas adjacent to the site that contribute stormwater surface runoff. The proposed riparian vegetation will provide uptake and filtering of stormwater surface runoff through the removal of sediment and pollutants.

In addition, the hydrologic model completed for the project did not indicate an increased flooding risk from removal of all or part of the culvert (Appendix C).

4.1.3 Air Quality

Implementation of the Selected Alternative will not have any long-tern adverse effect on air quality. Because Mercer County is designated by EPA as a "Nonattainment" area for both PM-2.5 as well as 8-hour ozone, a conformity analysis is typically required for proposed Federal actions that would cause emissions of criteria air pollutants that are above certain levels. General conformity under the Clean Air Act, Section 176 has been evaluated for the selected alternative according to the requirements of 40 CFR 93, Subpart B. This Alternative is exempt according to 40 CFR 93.153(c)(1) because the proposed actions will not cause emissions of these pollutants or their precursors. Only minor, short-term adverse impacts to air quality may occur as the result of the use of construction equipment and vehicles on the site during the construction and restoration activities. A Record of Non-Applicability (RONA) has been completed and is attached in Attachment 6 in accordance with Part 2 of the Army Technical Guide for Compliance with the General Conformity Rule, documenting the exempt status.

4.1.4 Climate

Implementation of the Selected Alternative will not affect climate.

4.2 Fish and Wildlife Resources

Adverse impacts resulting from implementing the Selected Alternative will be minor and of short duration. Most species that could be found using the project area are mobile and will be temporarily displaced from the project area during construction activities. Following restoration of the project area, it is anticipated that any species displaced during construction activities will return.

Removing the culvert is expected to enhance anadromous migration into the Assunpink Creek from the Delaware River. These species could include large mouth bass (*Micropterus salmoides*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), and alewife herring (*Alosa pseudoharengus*). The recreational fishery for striped bass (*Morone saxatilus*) will benefit from the increase in the aquatic biodiversity and forage fish. Rocks and boulders, as well as other in-stream structures, will also increase fish habitat as well as macroinvertebrate populations. NJDEP's Division of Fish and Wildlife has stated that numerous species of fish will likely take advantage of spawning in Assunpink Creek should the barriers for fish passage (i.e., culvert) be removed (Appendix B).

4.3 Aquatic and Terrestrial Habitat

The project will restore approximately 500 linear feet of stream bank currently contained within a concrete culvert. The project will not result in the discharge of dredged or fill material that will cause or contribute to significant degradation of Assunpink Creek. To the contrary, implementation of the Selected Alternative will improve aquatic and terrestrial habitats.

The project will also create riparian habitat and additional riparian buffer. The proposed creation of these areas will greatly improve the overall function and value of available habitat over the current conditions.

These habitat improvements are expected to have an overall beneficial impact to many aquatic and terrestrial wildlife species, fish-eating birds, passerine birds, and small mammals.

4.4 Threatened and Endangered Species

Implementing the Selected Alternative is not anticipated to have any adverse effects on state or Federally listed threatened or endangered species. Additional dialogue regarding the specifics of the proposed project will continue with NMFS and, if necessary, Section 7 consultation under the Endangered Species Act will be initiated with NMFS to ensure that the project will not adversely impact the Federally endangered shortnosed sturgeon.

The project is not expected to adversely impact the dwarf wedgemussel (*Alasmidonta heterdon*) green floater (*Lasmigona subviridis*), or yellow lampmussel (*Lampsillis cariosa*). Additional dialogue will continue with New Jersey Endangered and Nongame Species Program regarding specifics of the project. If deemed necessary, mussel surveys will be conducted upstream and downstream of the project area to confirm the absence of these species.

4.5 Cultural Resources

From a historical architectural perspective, removing the buried culvert and recontouring the creek banks will have little or no impact on cultural resources or standing buildings and structures eligible for listing on the National Register of Historic Places.

Most of the area in the vicinity of the culvert has been previously disturbed when the culvert was installed in the 1970s. Excavation work will largely involve removal of imported fill that was placed at the time of the culvert construction. The proposed grading and recontouring in the project area could potentially expose archaeological components associated with the Mill Hill Historic District, including the Eagle Cotton Factory. Additional consultations with the State Historic Preservation Office will occur to ensure the proposed excavation and grading work does not adversely affect unknown cultural resources that may remain in the vicinity of the project.

Removal of the culvert will provide pedestrian access to the South Broad Street Bridge and provide an opportunity to educate the public on the historical significance of the area. The planned reconstruction of the South Broad Street Bridge will afford additional educational opportunities.

4.6 Socioeconomic Conditions

4.6.1 Project Construction

Removing the buried culvert will not directly displace existing populations or residents within or adjacent to the Assunpink Creek corridor and will not require any modifications to infrastructure outside of the project site.

Most construction workers needed for this project are likely to come from the local area. Workers in specialized trades may come from farther distances.

4.6.2 Project Operation and Maintenance

Restoration in the project area is anticipated to increase desirability of potential adjacent commercial development. Local businesses will be enhanced by the increased visitation of the public to the area.

This project will not negatively affect low-income or minority populations. In contrast, the residents of the area will benefit from increased access to the restored area.

4.7 Land Use

Implementing the Selected Alternative is not expected to have any significant adverse effects on the land use of the properties that make up the proposed project area. The area is currently mowed turf and is fenced off from the public because of the recent culvert collapse.

In contrast, the proposed project will assist in the revitalization of downtown Trenton and will provide approximately 1.5 acres of public park available for a variety of recreational uses. The project is also consistent with the Assunpink Greenway Project and its stated goal of linking all of the communities along Assunpink Creek through a series of interconnected trails along the streambanks.

4.8 Recreational Opportunities

Implementing the Selected Alternative will not adversely affect recreational opportunities within the project area. As noted earlier, because of the recent culvert roof collapse, the entire area over the culvert has been fenced off, limiting the public access to the area. In contrast, the Selected Alternative will greatly increase the attractiveness of the area and will promote public use for a variety of recreational and educational opportunities, including walking, picnicking, fishing, and nature/wildlife observation in the area.

The project will provide a corridor for wildlife migration, as well as provide scenic value and recreational opportunity in this predominately urban area of Trenton. The multiple-use trail will provide access to the restoration sites by the general public. Additionally, recreational fishing opportunities for the public will increase with improved riparian habitat and streambank restoration.

In addition to the recreational opportunities directly associated with the project, substantially higher benefits are possible through its role as a link in a linear park system. Linking the various public areas from the Delaware River through the end of the proposed Assunpink Creek Park will provide a valuable pedestrian and bicycle thoroughfare more than 2 miles in length, connecting downtown business and historical areas.

SECTION 5

Habitat Benefits Analysis

5.1 Derivation of a Quantitative Measure of Habitat Benefits for the Assunpink Creek Alternatives

Physical habitat is the living space for instream aquatic organisms. It is a spatially and temporally dynamic entity defined by the interaction of structural features of a stream channel and hydrological regime. Physical habitat is particularly critical for healthy fish communities (Maddock, 1999) and has been evaluated using a wide range of standard metrics to link physical habitat characteristics to instream quality indexes (Hall et. al., 1999).

The purpose of this analysis is to assess the likely quality of stream habitat services that each alternative may produce. Most valuation methods have their theoretical foundations in welfare economics, such as benefit-cost analysis, risk-benefit analysis, and cost-effectiveness analysis. Each analysis's framework comes with tools and measurement methods that have their advantages and disadvantages, depending on the decision they are intended to support and the nature of the effects they are attempting to measure. For example, the preferred metric in a benefit-cost analysis is usually dollars, in order to facilitate aggregating across a wide range of effects from alternative policy actions. However, in the case of assessing morbidity or mortality benefits, other metrics, such as reduced cancer risk or statistical lives saved, are often preferred.

To assess ecological value, environmental metrics based on the flows of ecosystem services may be used.[1] Such metrics are preferred over monetary metrics to capture ecological service flows that provide indirect human use benefits. Such basic ecosystem support services are relatively difficult to quantify in dollar terms and yet can be significantly affected by human activities. This is contrast with direct human use benefits from natural resources and the environment, such as recreational fishing and hunting, wildlife observation, nature photography, etc., which are generally quantified in dollar terms using economic valuation tools that rely on observations or verbal statements about recreation behavior. Thus, depending on the problem and the nature of the available data, different metrics may be used to measure, compare, and value the potential benefits from human actions.

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[1] From the DOI (1996) regulations, ..."services include provision of habitat, food and other needs of biological resources, recreation, other products or services used by humans, flood control, ground water recharge, waste assimilation, and other such functions that may be provided by natural resources."

From the OPA (1996) regulations, "Services (or natural resource services) means the functions performed by a natural resource for the benefit of another natural resource and/or the public." NOAA guidance further classifies natural resource services as:

Ecological services - the physical, chemical, or biological functions that one natural resource provides for another natural resource and thus indirectly provides value to the public. Examples include provision of food for wildlife, protection from predation, and nesting habitat, among others: and ,

Human services - the human uses of natural resources or functions of natural resources that provide direct value to the public. Examples include fishing, hunting, nature photography, and education, among others.

Past and present human activities at the Assunpink Creek have affected the environment and the quality and quantity of ecological services being provided. Some of those activities have resulted in a decline or decrease in ecological services, and some have resulted in an increase in ecological services through restoration actions such as habitat enhancement, creation and preservation.

Measuring these changes in services requires an understanding of how these ecological services have changed over time. Services that are produced over time are referred to as service flows. For example, humans consume the flow of services provided by their homes. That is, they consume the shelter and warmth provided by their homes during the course of a year. Similarly, ecological services are provided by a habitat over the course of a year as well. Streams provide habitat and the life requisites (food, cover, water, and breeding habitat) for macroinvertebrates and fish, and it is these stream ecological services (e.g., physical, chemical, or biological functions) that macroinvertebrates and fish consume and are a part of.

To measure service flows, major service flows from the site are identified, and some structural or functional metrics of the ability of the habitat to provide those service flows are then developed. A baseline or reference habitat is specified. This baseline habitat is defined to provide 100 percent of the service flows from a habitat. Using metrics of service flows, the service flows under alternative human activities are compared as a percentage relative to the baseline.

5.1.1 Assessment of Habitat Service Flows

A number of rapid assessment protocols have been developed to evaluate the quality of physical characteristics of instream habitat. This analysis uses the Ohio Qualitative Evaluation Index to assess the potential habitat or ecological service flows associated with the proposed alternatives. Per the Ohio Qualitative Evaluation Index, the expected physical characteristics generated from each alternative over the 500-foot section of the Assunpink Creek were evaluated according to the following metrics:

Substrate: This metric includes two components, substrate type and substrate quality.

- Type: The two most common types are scored, unless one substrate predominates (greater than 75 to 80 percent of bottom area). Substrate types are defined as follows:

    1. **Bedrock:** solid rock forming a continuous surface
    2. **Boulder:** rounded stones larger than 256mm in diameter or large "slabs" longer than 256mm
    3. **Cobble:** stones from 64 to 256mm in diameter
    4. **Gravel:** mixture of rounded coarse material from 2 to 64mm in diameter
    5. **Sand:** materials 0.06 to 2.0mm in diameter; gritty texture
    6. **Silt:** 0.004 to 0.06mm in diameter; fine material that generally feels "greasy" when rubbed between fingers

7. **Hardpan:** particles less than 0.004mm in diameter; usually clay that forms a dense, gummy surface that is difficult to penetrate

8. **Marl:** calcium carbonate; usually greyish-white; often contains mollusk shell fragments

9. **Detritus:** dead, unconsolidated organic material covering the bottom; includes sticks, wood, and other partially decayed plant material

10. **Muck:** black, fine, flocculent, completely decomposed organic matter

11. **Artificial:** substrates such as rock baskets, gabions, bricks, trash, concrete, etc., placed in stream for reasons other than habitat mitigation

12. **Sludge:** a thick layer of organic matter that is of human origin; if originates from point source, not included

- Quality: When scoring quality, **origin** refers to the parent material from which the stream substrate is derived. **Embeddedness** is the degree to which cobble, gravel, and boulder substrates are surrounded, impacted, or covered by fine materials. Substrates should be considered embedded if more than 50 percent of the surface of substrates are embedded (cannot be easily dislodged). This includes substrates that are concreted or "armour-plated". Scoring **Extensiveness** of the sampling area is as follows: **Extensive** is 75 percent of area, **Moderate** is 50 to 75 percent of area, **Sparse** is 25% to 50 percent of area, and **Low** is less than 25 percent of area.

  Silt cover is the extent to which the substrate is covered by silt. **Silt-heavy** means that nearly all the stream bottom is layered with a deep covering of silt. **Moderate** includes extensive coverings of silts, but with some areas of cleaner substrates. **Normal** silt cover includes areas where silt is deposited in small amounts along the stream margin or is present as a "dusting" that appears to have little functional significance. **Silt-free** substrates are those that are exceptionally clean of silt.

Instream Cover: The first half of instream cover is the *type* that is present. Any cover that is in more than 5 percent of the sampling area should be noted, but should not be counted if in areas of the stream that are too shallow (usually <20 cm) to make it useful. Instream cover *amount* can be categorized by: extensive, moderate, sparse, or nearly absent. **Extensive** cover is present in greater than 75 percent of the sampling area. **Moderate** is about 25 to 75 percent; **Sparse** is less than 25 percent; and **Nearly Absent** is when no large patch of any type exists anywhere in the sampling area.

Channel Morphology: Relates to quality of the stream with regard to creation and stability of macrohabitat. This includes: channel sinuosity, channel development, channelization, and channel stability.

- Sinuosity: The degree to which a stream bends. **No** sinuosity means the channel is straight. **Low** sinuosity would have one or two poorly defined bends. **Moderate** has more than two outside bends, with at least one being well-defined. **High** sinuosity would have more than two or three well-defined outside bends with deep areas outside and shallow areas inside.

- Development: Refers to development of riffle pool complexes. **Poor** means no riffles or shallow ones with sand and fine gravel. **Fair** are poorly developed or absent riffles. **Good** implies better-defined riffles with larger substrates. **Excellent** means the riffles are good and pools have a maximum depth of more than 1 meter and deep riffles and runs are present.

- Channelization: Refers to human-made channel modifications. **Recovered** means that the streams were channelized in the past, but have since regained most of their natural characteristics. **Recovering** means the stream was channelized, but is in the process of regaining its former, natural characteristics. **Recent** or **No Recovery** implies the stream was recently channelized or shows no significant recovery.

- Stability: Refers to how stable the channel remains. Channels with stable banks and substrates with little or no erosion are categorized as **High** stability. Artificially stable (concrete) channels also receive the **High** mark. **Moderate** scores are given to channels with stable riffle/pool and channel characteristics, but also exhibit symptoms of instability. **Low** scores go to channels with fine substrates in riffles, unstable (eroding) banks, and high bedload.

Riparian Zone: This metric measures the quality of the riparian buffer zone of floodplain vegetation, including riparian zone width, floodplain quality, and extent of bank erosion. To score each component, one looks downstream and averages both the left and right banks.

- Width of Floodplain: This is the width of the riparian vegetation. Estimates should only be taken for forest, shrub, swamp, and old field vegetation (fairly mature successional field that has stable, woody plant growth).

- Floodplain Quality: The two most predominant floodplain quality types are to be checked. Floodplain refers to areas immediately outside of the riparian zone or greater than 100 feet from the stream, whichever is wider on each side of the stream.

- Bank Erosion: This can have one of five different scorings:

    1. **None**-streambanks are stable and not being changed by water flows or animals

    2. **Little**-streambanks are stable, but slightly changed along the transect line; less than 25 percent of streambank is receiving any stress, is false, broken down, or eroding

    3. **Moderate**-streambanks are receiving moderate alteration along transect line; at least 50 percent of streambank is in natural stable condition; 50 percent is false, broken down, or eroding

    4. **Heavy**-streambanks have received major alterations along transect lines; less than 50 percent of streambank is in stable condition; over 50 percent of streambank is false, broken down, or eroding

5. **Severe**-streambanks along transect lines are severely altered; less than 25 percent of bank is stable condition; over 75 percent of bank is false, broken down, or eroding

Pool Quality: Pool quality consists of three areas: maximum depth of pool or glide, current type, and morphology:

- Depth: This can range from a score of 0 to 6. A pool or glide with maximum depths less than 20 cm is considered to have lost its function and the total metric score is 0.
- Current Type: There are seven possible categories for current type:

    1. **Torrential**-extremely turbulent with fast flow and large waves; water surface very broken with no consistently connected surface
    2. **Fast**-mostly non-turbulent flow with small standing waves in riffle-run areas; water surface partially broken, but some areas of consistent connectivity of surface
    3. **Moderate**-detectable and visible non-turbulent flow; water surface visibly connected
    4. **Slow**-water flow is perceptible, but very sluggish
    5. **Eddies**-small areas of circular current usually formed in pools just downstream from riffle-run areas
    6. **Interstitial**-flow only perceptible in interstitial spaces between substrate particles in riffle-run areas
    7. **Intermittent**-no flow; standing pools separated by dry areas

- Morphology: This category would be checked **wide** if pools are wider than riffles, **equal** if pools and riffles are the same size, and **narrow** if riffles are wider than pools. If morphology varies throughout the site, average the types.

Riffle Quality: If no riffles exist, a 0 should be recorded. If not, riffle quality consists of three areas:

- Riffle Depth: A score from 0 to 4 is to be chosen to describe the depth characteristics of the riffle. If the riffle is less than 5cm deep, riffles are considered to have lost their function and a score of 0 should be recorded.
- Substrate Stability: A score from 0 to 2 is chosen that best describes the substrate type and stability of the riffle habitats.
- Embeddedness: This is the degree that cobble, gravel, and boulder substrates are surrounded or covered by fine material. Substrates are embedded if more than half of the surface of the substrate is embedded in the fine material (are not easily dislodged), including substrates that are cemented. *Extensiveness* of the embeddedness in the area sampled is also recorded: **extensive** is 75 percent of

stream area; **moderate** is 50 to 75 percent of area; **sparse** is 25 to 50 percent of area; **low** is less than 25 percent of area.

5.2 Habitat Services Analysis

CH2M HILL calculated habitat units based on the expected flow of ecological services over time and space from each alternative, using the expected habitat services in percentage terms. Attachment 7 shows the completed assessment sheets used for the analysis. For each alternative, a team of stream design experts assessed each alternative for each metric. The scores were then tabulated and normalized to reflect the percentage of services provided from each alternative.

These percentages were multiplied by 500 linear feet to obtain ecological services expressed in stream length. Those services are assumed to remain constant for each year over a 50-year period. Using a 3 percent real annual rate of discount, the habitat units are estimated in terms of discounted stream length years. The real discount rate used is 3 percent, which represents society's intertemporal rate of preference, or the rate at which society is willing to forgo current consumption of goods and services for future consumption of those goods and services. Table 5-1 shows the percentage of services potentially generated from each alternative.

TABLE 5-1
Percentage of Habitat Services Potentially Generated from each Alternative

Alternative	**Habitat Services** *(in percent)*	**Habitat Units** *(in discounted stream length years)*
Alternative One	19	3,148
Alternative Two	34	5,667
Alternative Three	34	5,667
Alternative Four	67	11,167
Alternative Five	17	2,778

Alternative Five, the No-Action Alternative, is estimated to provide 17 percent of habitat services. Alternative One provides 19 percent, Alternatives Two and Three provide 34 percent, and Alternative Four provides 67 percent of habitat services.

5.3 Incremental Cost Analysis

An incremental cost analysis for the alternatives was conducted. The alternatives are first ranked from lowest to highest in terms of their output (in habitat units). Alternative Three is dropped from the analysis as it produces the same amount of output but at a higher cost

than Alternative Two. Table 5-2 shows the remaining alternatives in terms of their total costs, total output in habitat units, the incremental cost, the incremental output and the incremental cost per unit of increasing output to the next successive level.

TABLE 5-2
Incremental Cost, Incremental Output, and Incremental Cost per Unit of Increasing Output to the Next Successive Level

Alternative	Cost	Output *(in Habitat Units)*	Incremental Costs	Incremental Output	Incremental Cost per Unit of Output
Alternative Five	No Cost*	2,778	n/a	n/a	n/a
Alternative One	$3,218,159	3,148	$3,218,159	370	$8,698
Alternative Two	$4,278,688	5,667	$1,060,529	2,519	$421
Alternative Four	$5,666,500	11,167	$1,387,812	5,500	$252

The incremental cost analysis suggests that Alternative Two has the lowest incremental cost ($1,060,529) of the alternatives considered with Alternative Four having the next lowest incremental cost ($1,387,812). Alternative 4 has the lowest cost per unit of output at $252. Alternative Two has a cost per unit of output of $421 and Alternative One has a cost per unit of $8,698.

SECTION 6

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SECTION 7

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Name	Highest Degree	Project Role
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Steve Miller	M.S., Environmental Engineering	Overall/Engineering – Senior Consultant
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Aditya Tyagi	Ph.D., Biosystems Engineering	Hydraulic Modeling – Engineering Senior Consultant
Mark Rockel	Ph.D., Marine Studies/Economics	Habitat/Recreation Benefits Analysis – Biology Senior Consultant
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Arundhati Bhosle	M.S., Civil Engineering	Cost Assessment
Kate Murphy	B.A., Environmental Studies	Environmental – Biology Task Lead

SECTION 8

References

Atlantic States Marine Fisheries Commission. 1985. *Fishery Management Plan for American Shad and River Herrings*.

Bathymetric data, surveyed Fall 2002 (NAVD88).

Brandywine Conservancy. 2005. "The Restoration of American Shad to the Brandywine River: A Feasibility Study." http://www.brandywineconservancy.org/images/pdf/brandywineShadReport2005.pdf

Delaware Valley Regional Planning Commission. 2000. *Closing the Missing Link on the Assunpink Greenway*. Delaware Valley Planning Commission, Philadelphia, PA.

Federal Emergency Management Agency. 1990. Flood Insurance Study, City of Trenton, Mercer County, New Jersey.

Hall, L.W., Jr., R. P. Morgan II, E. S. Perry and A. Waltz. 1999. *Development of a Provisional Physical Habitat Index for Maryland Freshwater Streams*. Maryland Department of Natural Resources, Chesapeake Bay and Watershed Programs. CBWP-MANTA-EA-99-12.

Maddock, I. 1999. The Importance of Physical Habitat Assessment for Evaluating River Health. *Freshwater Biology* 41: 373-391.

Moser, Mary L. & Terra, Maria E. 1999. *Low Light as a possible Impediment to River Herring Migration.* Center for Marin Science Research, University of North Carolina – Wilmington.

National Oceanic and Atmospheric Administration (NOAA). 1999. *Discounting and the Treatment of Uncertainty in natural Resource Damage Assessment*. Technical Paper 99-1, Damage Assessment and Restoration Program, Damage Assessment Center, Resource Valuation Branch, National Oceanic and Atmospheric Administration, 1305 East-West Highway, SSMC #4, Silver Spring, Maryland 20910. February 19, 1999.

National Oceanic and Atmospheric Administration (NOAA). (1997a) Habitat Equivalency Analysis: An Overview, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program.

National Oceanographic and Atmospheric Administration. 1996. Natural Resource Damage Assessments. *Federal Register* 61(4).

Rankin, E. T. 1989. The Qualitative Habitat Evaluation Index (QHEI); Rationale, Methods and Application. Ohio EPA, Columbus, Ohio.

Robinson, Ridgley; Hansen, William; Orth, Kenneth ; Franco, Samuel, "Evaluation of Environmental Investments Procedures Manual - Interim: Cost Effectiveness and Incremental Cost Analyses", Army Engineer Inst. for Water Resources, Fort Belvoir VA, May 1995, IWR Report 95-R-1.

Thunhorst, G.A. 1993. *Wetland Planting Guide for the Northeastern United States – Plants for Wetland Creation, Restoration, and Enhancement*. Environmental Concern, Inc.

Unsworth, R.E. and R. Bishop. (1993) Assessing Natural Resource Damages Using Environmental Annuities, *Ecological Economics*, 11(1994) 35-41.

U.S. Army Corps of Engineers, Philadelphia District. January 2001. Lower Assunpink Creek Preliminary Restoration Plan.

U.S. Department of Agriculture (USDA), Soil Conservation Service. 1982. *Flood Control Feasibility Study, Lower Assunpink Creek Watershed, Mercer County, New Jersey.*

U.S. Department of the Interior. 1996. Natural Resource Damage Assessments—Type A Procedures. *Federal Register* 61: 20560-20614.

U.S. Environmental Protection Agency. 2000. *Regulatory Impact Analysis Guidelines.* Washington, DC.

U.S. Fish and wildlife Service (USFWS). 1980. Habitat Evaluation Procedures (HEP) ESM 102. U.S. D.I. Fish and Wildlife Service, division of Ecology. n.p.

U.S. Geological Survey (USGS). Average daily flow data at the USGS Gauging Station 01464000 on Assunpink Creek.

SECTION 9

Finding of No Significant Impacts

Overview

The draft Environmental Assessment identifies and evaluates the anticipated environmental impacts and benefits associated with the proposed Ecosystem Restoration project. Goals of the project include the restoration of the Assunpink Creek, restoration of fisheries, and creation of additional riparian communities. Upon completion of the proposed project, a significant obstacle to fish migration will be removed, wildlife habitat value and diversity will be enhanced, riparian buffers will serve to slow, filter and remove sediments and pollutants from stormwater surface runoff, as well as, provide riverfront recreational and educational opportunities in the area. The project will also support the future plans for the Assunpink Greenway project.

Purpose

The proposed "restoration" project, upon completion, will serve to enhance fishery habitat and migration, improve water quality and provide riverfront recreational and educational opportunities for the surrounding community. With the recent partial collapse of the Broad Street culvert roof structure, immediate action is needed to remedy what has become a public safety hazard in addition to an impediment to fish passage.

Specifications

Five alternatives were considered and evaluated for the proposed ecological restoration, including a "No-Action" alternative. These alternatives were evaluated for cost, environmental benefit, structural stability, maintenance requirements, and the ability of each alternative to be incorporated into the future plans for Assunpink Creek.

Alternative Four was selected as the "Selected" Alternative. Alternative Four was chosen based on ecological benefits, structural stability and expected long term maintenance requirements.

Finding of Compliance

An Environmental Assessment has been prepared for the project in order to determine the nature and extent of environmental impacts resulting from the implementation of the selected alternative.

The proposed project will be performed in compliance with the Clean Water Act, the Federal Endangered Species Act, the National Historic Preservation Act, and applicable New Jersey water quality and land use regulations.

Habitat Impacts

The draft Environmental Assessment has been prepared to evaluate the anticipated impacts to existing environmental resources within the project area. Potential impacts were assessed mainly in regard to existing conditions occurring within the project and the anticipated ecological benefits that will result following implementation of the selected alternative. It was determined during the Habitat Benefits Analysis, that each of the proposed alternatives, with the exception of the "No-Action" alternative, will result in significant benefits. The selected alternative provided the best combination of environmental benefits and streambank stabilization without compromising the effectiveness of the restoration.

The draft Environmental Assessment prepared for the proposed project will be forwarded to the United State Fish and Wildlife Service, National Marine Fisheries Service, the United States Environmental Protection Agency, the New Jersey Department of Environmental Protection, the New Jersey Historic Preservation Office, and any other applicable parties. The Environmental Assessment prepared for the proposed project has determined that there will be no adverse impacts to any critical or sensitive habitats or environments, including habitats for State or Federally listed threatened or endangered species, found within or in the vicinity of the proposed project.

Cultural Impacts

Properties and sites within or in the vicinity of the proposed project area that are listed on or are eligible for listing on the National Register of Historic Places have been addressed.

The South Broad Street Bridge is listed on the National Register, but adverse impacts to the bridge will be avoided.

The proposed project will not adversely impact cultural resources.

Recommendations

Because the Environmental Assessment concludes that the proposed project is not a major Federal action significantly affecting the human environment, I have determined that an Environmental Impact Statement is not required.

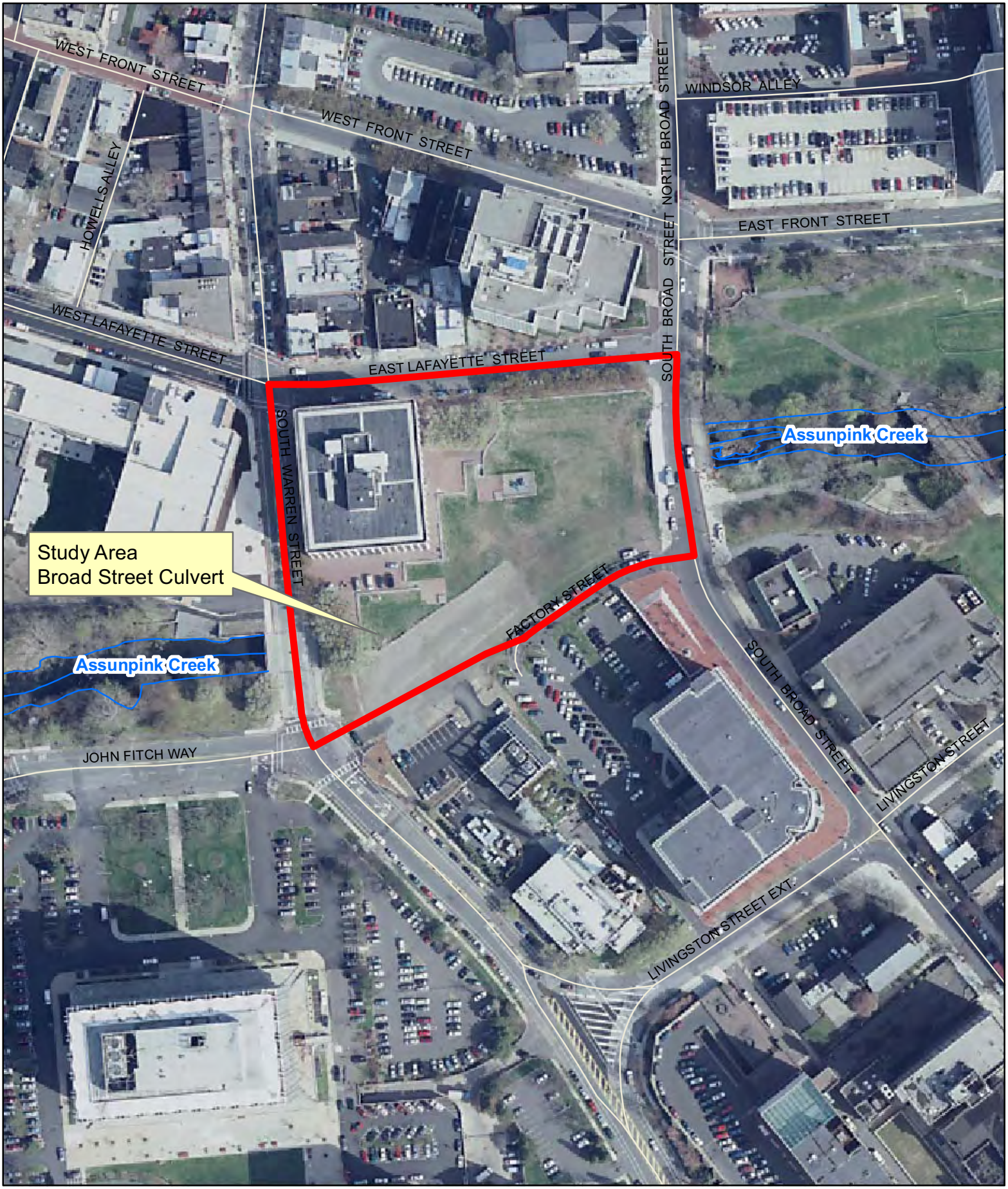
Date

Gwen E. Baker
Lieutenant Colonel, Corps of Engineers
District Engineer

Attachment 1 – Study Area Map and Conceptual Plan and Profile Drawings

CH2MHILL

FIGURE 1
VICINITY MAP
Lower Assunpink Creek - Broad Street Culvert
Environmental Restoration Report

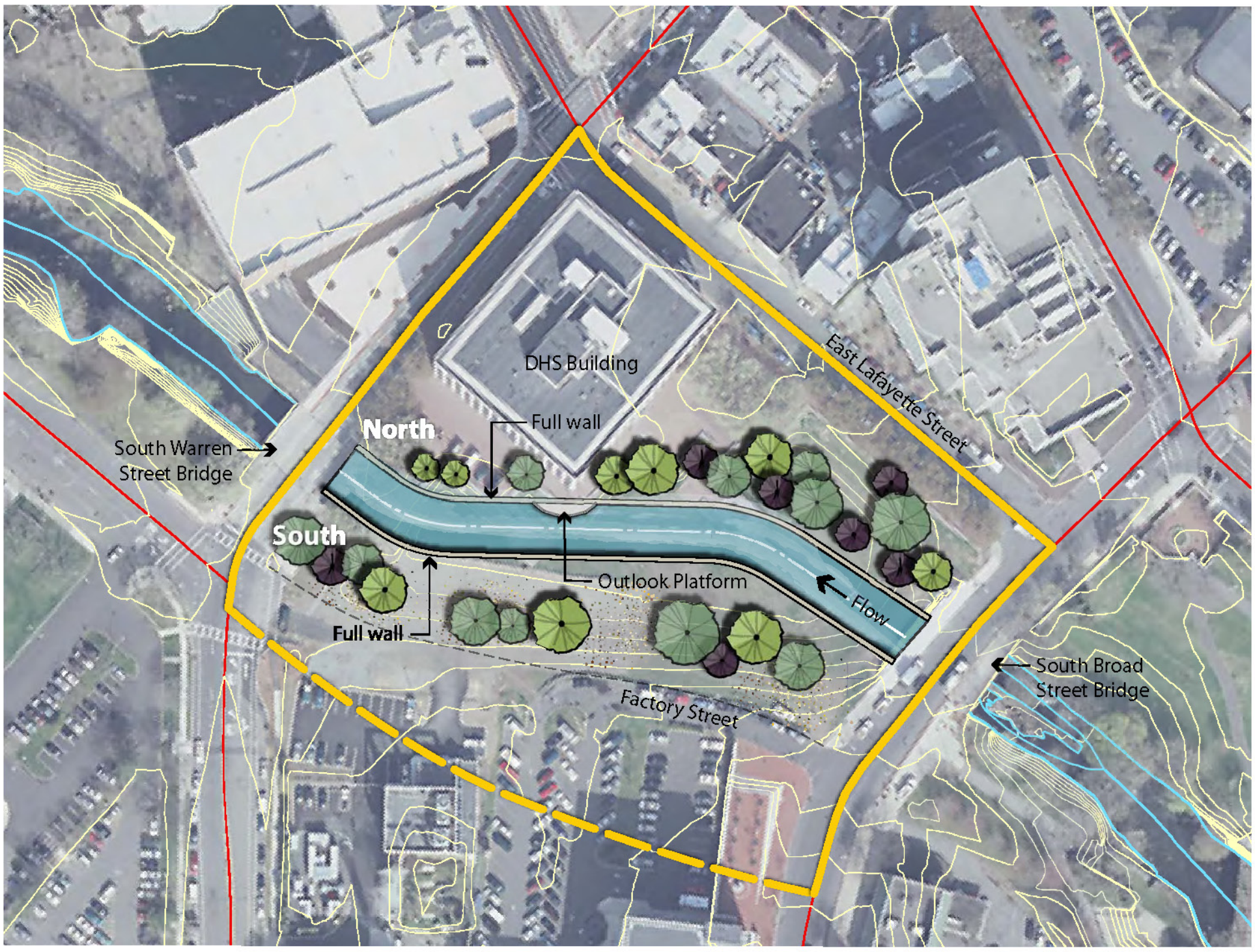


CH2MHILL

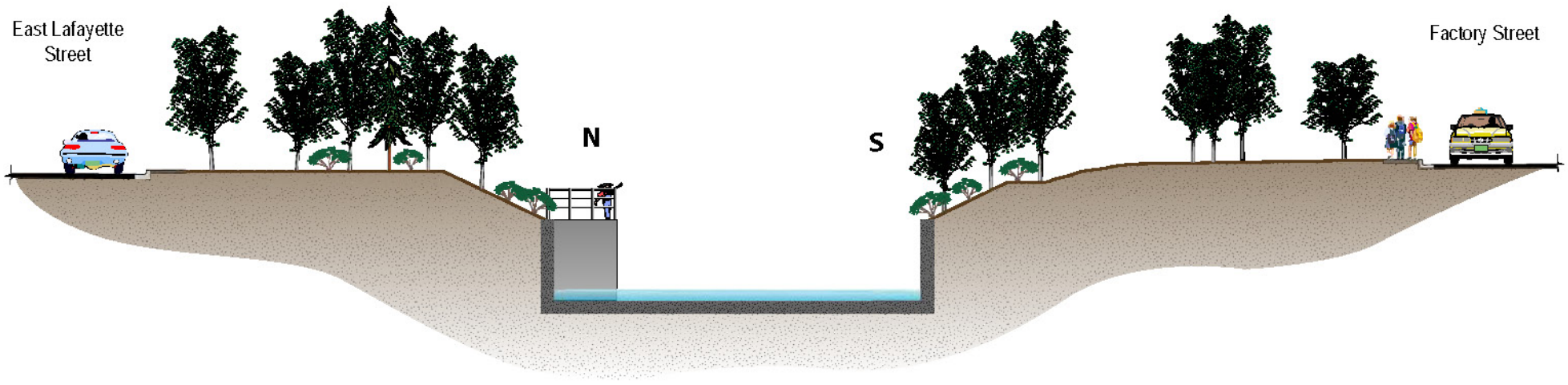
N

500 250 0 500
Feet

FIGURE 2
STUDY AREA
Lower Assunpink Creek - Broad Street Culvert
Environmental Restoration Report



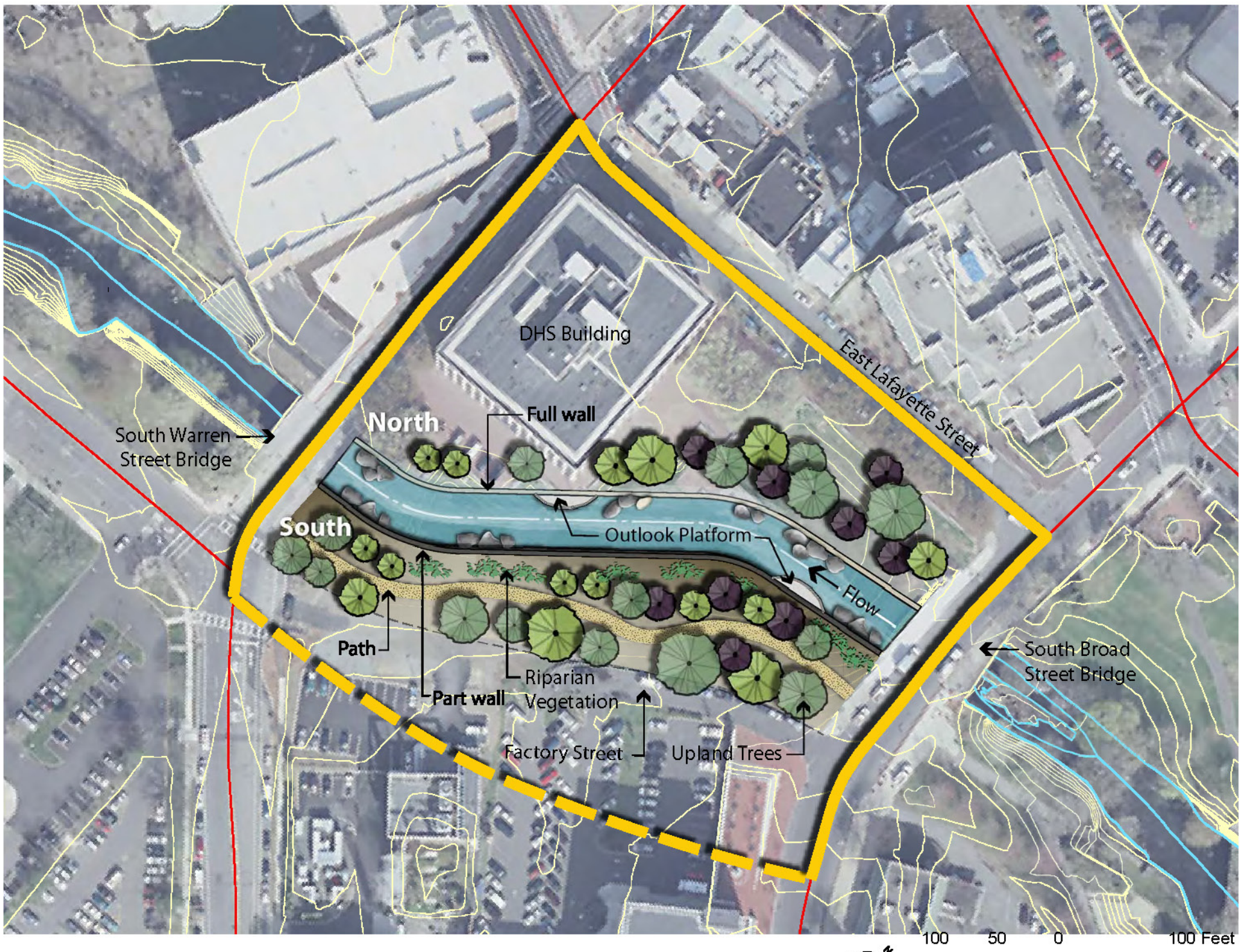
Plan View



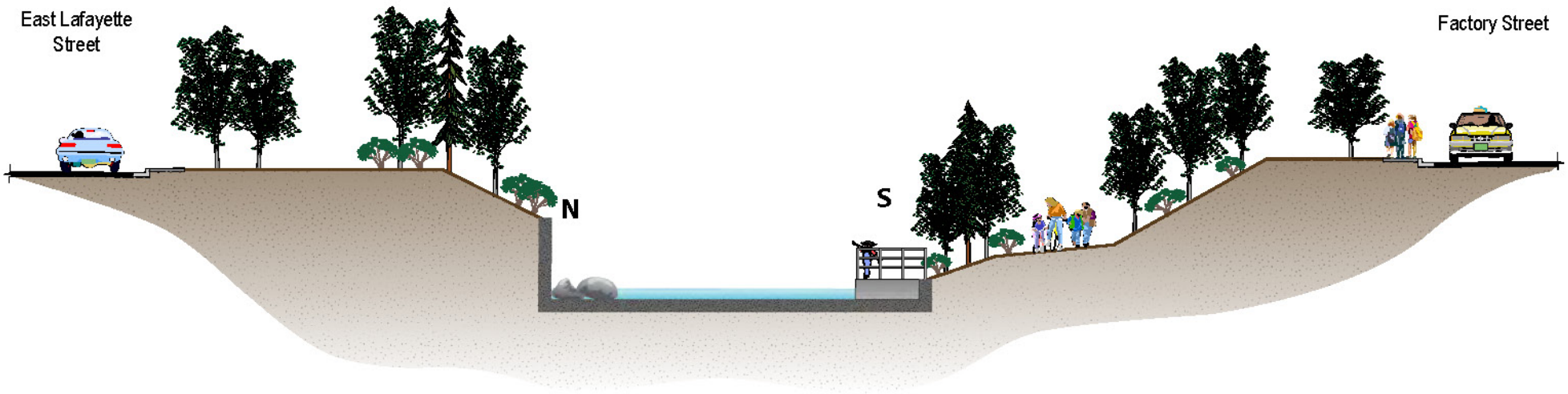
Cross-Section

Assunpink Creek - Broad Street Culvert
Roof Structure and Center Wall
Removed

FIGURE 3 - ALTERNATIVE ONE
CONCEPTUAL CROSS-SECTION AND PLAN VIEW
Lower Assunpink Creek – Broad Street Culvert
Environmental Restoration Report



Plan View

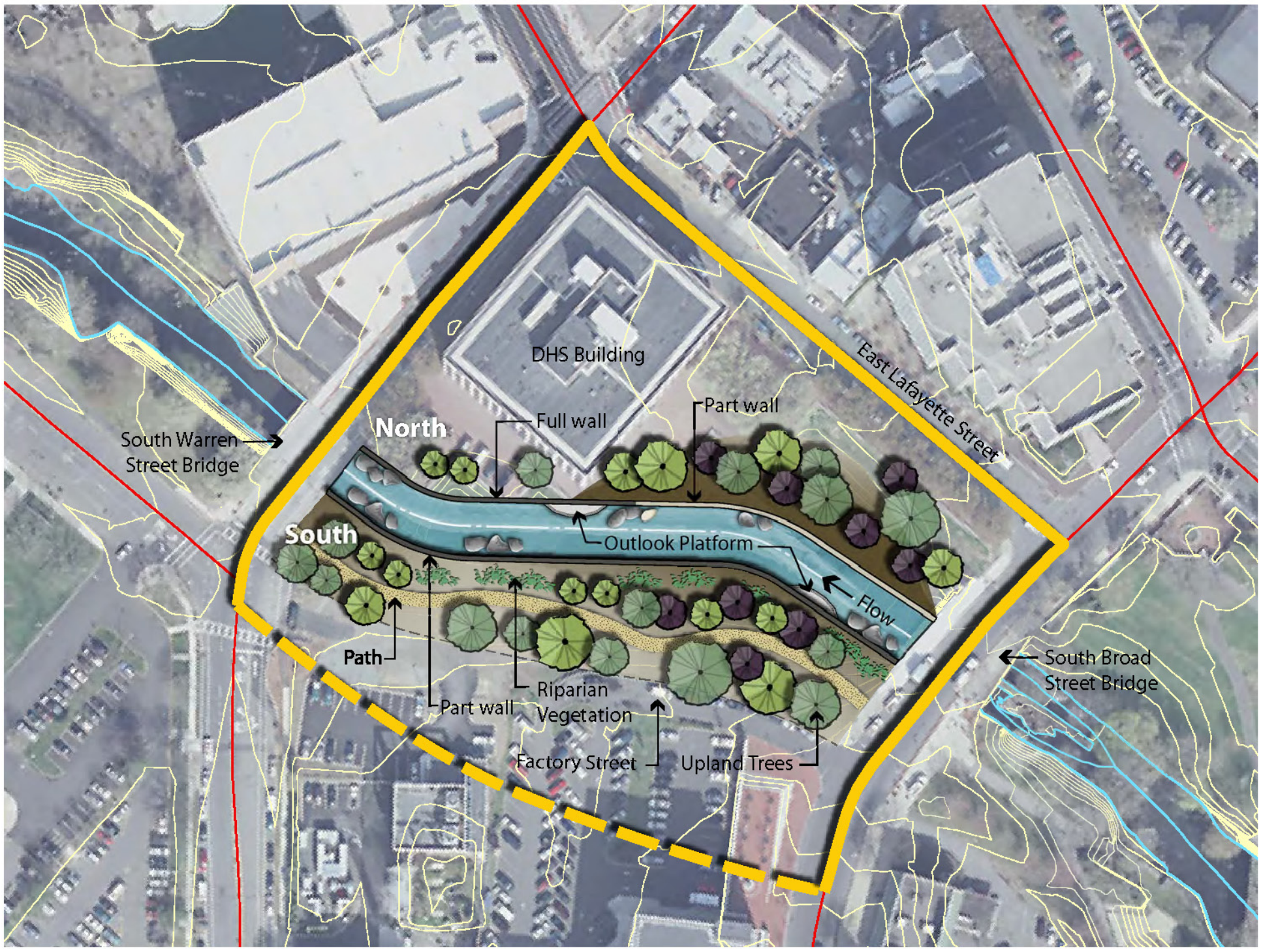


Cross-Section

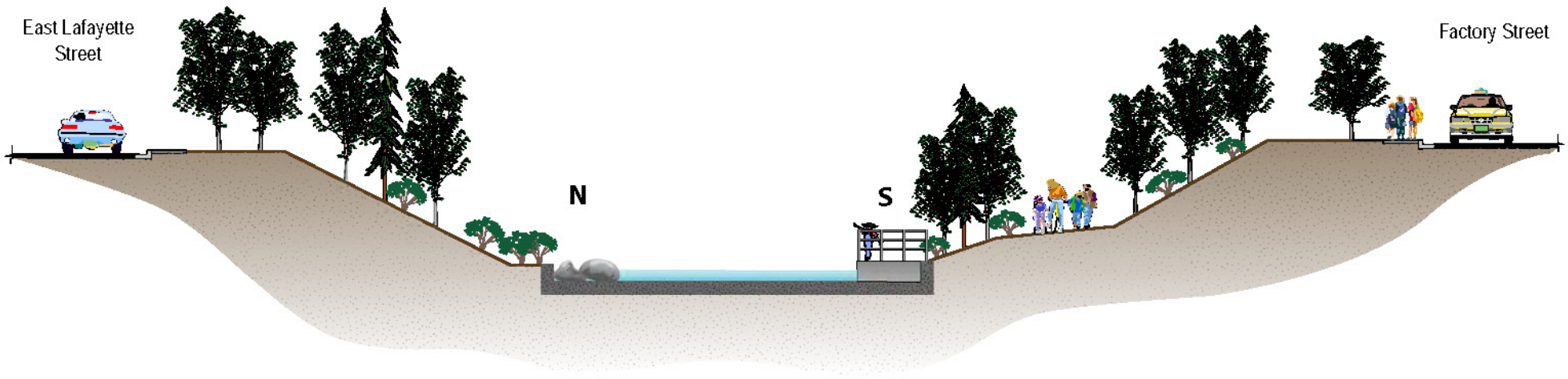
Assunpink Creek - Broad Street Culvert
Roof Structure and Center Wall Removed
South Wall Lowered

FIGURE 4 - ALTERNATIVE TWO

CONCEPTUAL CROSS-SECTION AND PLAN VIEW
Lower Assunpink Creek – Broad Street Culvert
Environmental Restoration Report



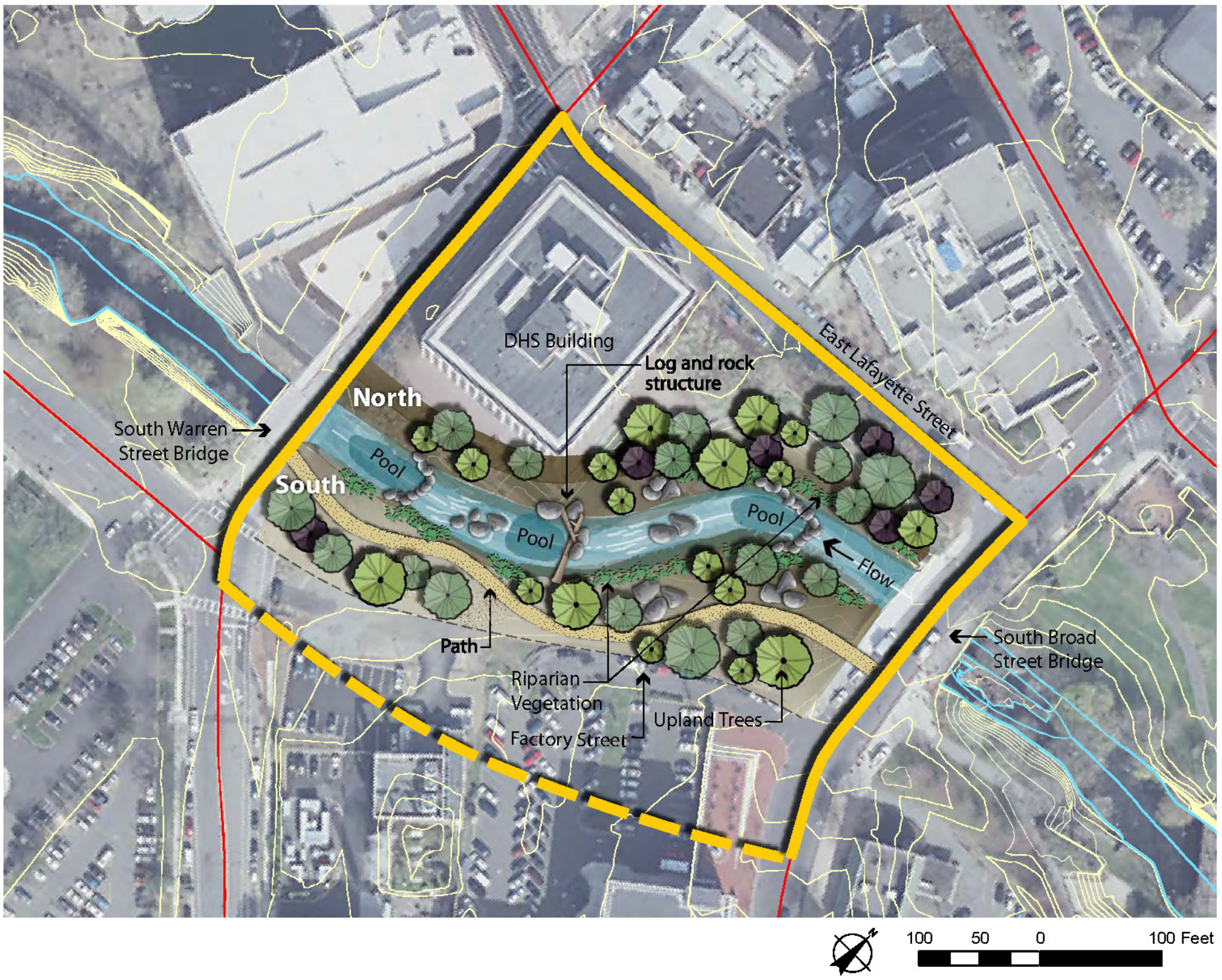
Plan View



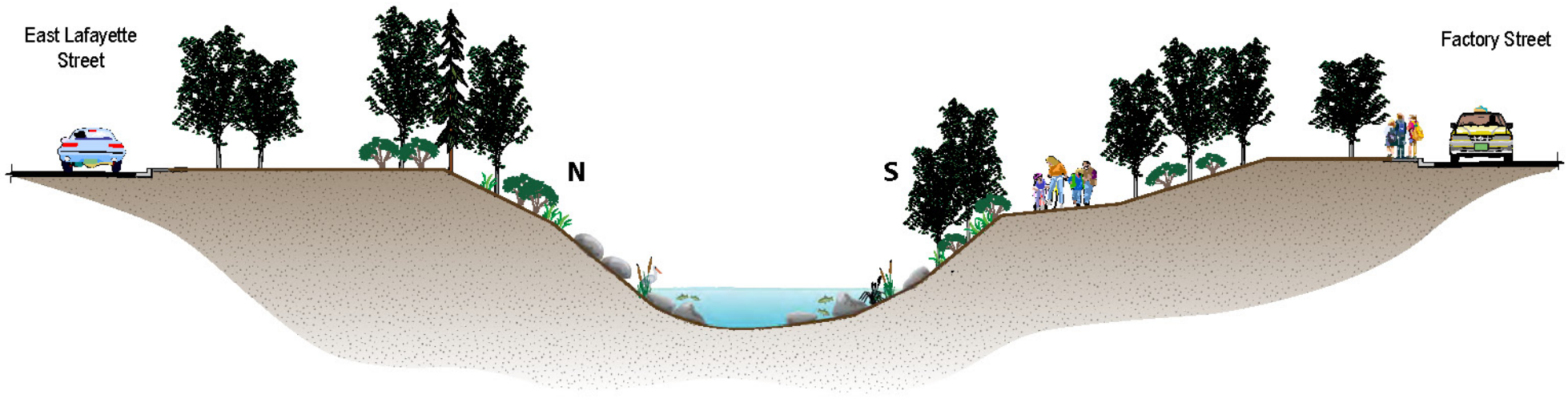
Cross-Section

Assunpink Creek - Broad Street Culvert
Roof Structure and Center Wall Removed
South Wall and Part of North Wall Lowered

FIGURE 5 - ALTERNATIVE THREE
CONCEPTUAL CROSS-SECTION AND PLAN VIEW
Lower Assunpink Creek – Broad Street Culvert
Environmental Restoration Report



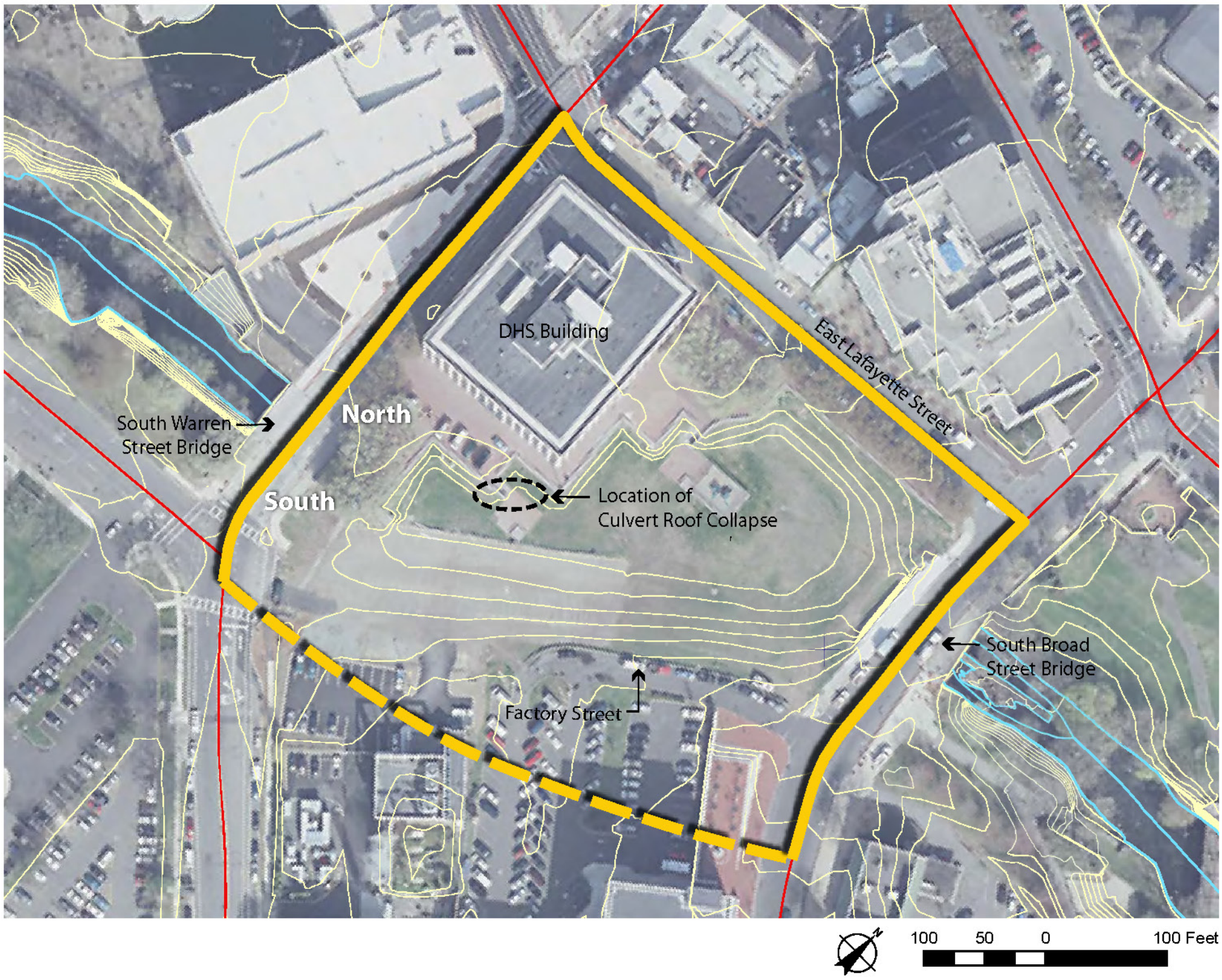
Plan View



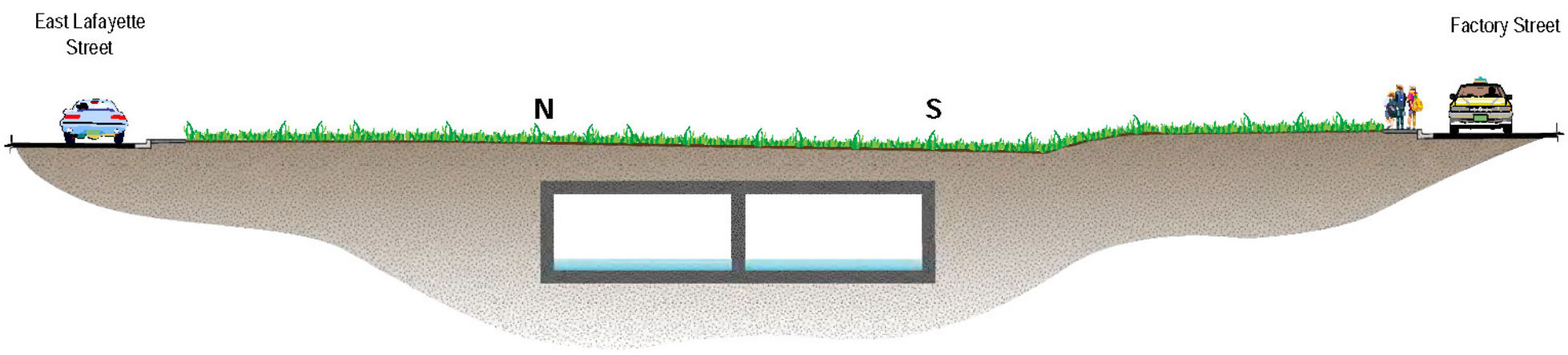
Cross-Section

Assunpink Creek - Broad Street Culvert
Entire Culvert Removed
Creation of Natural Stream Channel

FIGURE 6 - ALTERNATIVE FOUR (SELECTED)
CONCEPTUAL CROSS-SECTION AND PLAN VIEW
Lower Assunpink Creek – Broad Street Culvert
Environmental Restoration Report



Plan View



Cross-Section

Assunpink Creek - Broad Street Culvert
No Action - Buried Culvert Remains

FIGURE 7 - ALTERNATIVE FIVE
Conceptual Cross-Section and Plan View
Lower Assunpink Creek – Broad Street Culvert
Environmental Restoration Report