

**PRELIMINARY RESTORATION PLAN
Bushkill Creek Environmental Restoration
Northampton County, Pennsylvania**

- 1. Project:** Bushkill Creek, Northampton County, Pennsylvania, Section 206 of the Water Resources Development Act (1996). The project is located in Pennsylvania Congressional District 15. PWI number is 169548.
- 2. Location:** Bushkill Creek, a tributary of the Delaware River, has a drainage area of 80 square miles in Northampton County, Pennsylvania. The closest city is Easton, Pennsylvania, at the mouth of the creek.
- 3. Description of the Proposed Project:** The objective of this Section 206 study is to identify cost-effective measures that restore and protect in-stream, primarily brown trout, and riparian habitat at ecologically sustainable levels. The proposed project consists of plugging numerous sinkholes and fractures and the placement of an impermeable liner to restore normal stream flow in an approximately one-mile reach of the stream as shown on Enclosure 1.

The reach under study begins at the Route 33 Bridge and continues past the collapsed state route 2017 bridge (Stockertown-Tatamy Road). Severe subsidence and cover collapse in the streambed and along the banks in this area has disrupted fish habitat. Restoration of trout habitat and other related aquatic species would be achieved by use of geotechnical engineering solutions along with natural channel design and bank stabilization techniques. This includes providing a low flow channel for fish passage, boulders and logs for in-stream cover and feeding areas, and riffle and pool habitat for breeding and resting.

The study area continues downstream to the railroad crossing known locally as the “black bridge” then to the mouth of Little Bushkill Creek past the boundary intersection of Forks Township, Stockertown and Tatamy Boroughs to the Tatamy Bridge. Protection and restoration of trout habitat and other related aquatic species would be achieved by investigating and restoring several areas of cover collapse in and along the creek in this area. Habitat improvement techniques, including providing a low flow channel for fish passage, boulders and logs for in-stream cover and feeding areas, and riffle and pool habitat for breeding and resting would also be investigated.

- a. Existing Conditions:** The stream has been locally degraded by natural and induced subsidence due to human activities that have impacted the creek bed and banks, eliminated riparian vegetation, riffle and pool habitat, removed woody debris, reduced channel flow diversity and low flow channel areas. Stream reaches have been impacted by subsidence activity to a degree that at certain times and in specific areas, no water is observable for base flow conditions.

b. Without Project Conditions: If no action is taken to restore this reach of the stream, the future habitat conditions will continue to deteriorate. These sites will contribute to the continued loss and degradation of valuable brown trout habitat, and Northampton County, four local communities (Palmer and Forks Township, Stockertown and Tatamy Boroughs) numerous property owners and industries will be denied positive environmental, economic, and recreational benefits. Restoration is needed in specific locations throughout this one-mile stream segment in order to protect and restore the abundance and diversity of in-stream and riparian communities.

c. Expected Environmental Outputs and How They Would Be Measured: Existing stream conditions and future benefits will be evaluated using the U.S. Department of Agriculture's (USDA) Stream Visual Assessment Protocol (Technical Note 99-1, 1998). Parameters to be evaluated include stream bed and bank stability, hydrologic alteration, substrate characterization, instream fish cover, morphological diversity and flow conditions, nutrient enrichment, pools, canopy cover, riffle embeddedness, insect and invertebrate habitat, riparian vegetative width, water appearance, and barriers to fish movement. Any macroinvertebrates observed will also be documented. Existing water quality information (chemical and biological indicators) from ongoing university and watershed organization studies and programs will be used to determine post-project improvements in Bushkill Creek.

d. Project Significance: The proposed aquatic ecosystem restoration will contribute significant direct and indirect benefits to Bushkill Creek and larger Delaware River initiatives.

Institutional Recognition: As encouraged by Engineering Circular (EC) 1105-2-214, the proposed project strongly supports and contributes to the North Atlantic Waterfowl Management Plan, Delaware River initiatives and the Clean Water Action Plan.

Public Recognition: Bushkill Creek was historically stocked with brown trout by the Pennsylvania Fish and Boat Commission. The stocking of brown trout no longer occurs due to the overall stream degradation due to human impacts. The significance of this project is that the restoration could improve the habitat conditions suitable for stocking to resume in this portion of the watershed. Conversations with fisheries officials in Pennsylvania indicate that future trout stocking plans include Bushkill Creek if the habitat is restored.

Technical Recognition: The Pennsylvania Natural Diversity Inventory, a cooperative effort between the Bureau of Forestry, the Nature Conservancy, and the Western Pennsylvania Conservancy, describes the locations of state and federally listed endangered, threatened, and rare species, and most outstanding examples of the state's natural community and geologic features. The federally endangered bald eagle, and state endangered king rail and osprey have been sighted in the Bushkill Creek watershed since 1980 and would benefit from trout and riparian restoration. The reproduction, nursery and nesting, and feeding niches would be improved from the lowest to highest trophic levels within this stream ecosystem

e. Lands, Easements, Rights-of-Way, Relocations, and Disposal: The non-Federal sponsor is required to provide all real estate (including lands, easements rights-of-ways,

relocations) necessary for project construction. The restoration site involves several private property owners. All of the property owners are willing to participate in this study and restoration effort. Land acquisition in this portion of Northampton County is approximately \$20,000 per acre and it is anticipated that an average of 3 acres (riparian corridor that is 1 mile by 50 ft. wide) will need to be acquired for an average cost of \$60,000. This cost will be revised, as necessary, during the feasibility phase.

f. Relationship of Proposed Project to Other Projects and Plans:

Delaware River Basin Comprehensive Study (2002): This study will utilize a holistic approach to problem resolution including: ecosystem restoration, protection, and enhancement; water quality control and associated land resources. The study utilizes a comprehensive watershed approach working closely with ongoing initiatives such as Pennsylvania's 21st Century Environment Commission and Growing Greener Restoration Program. The objectives of these efforts are to restore and protect watersheds; preserve open space; adopt sound land use planning practices; make infrastructure investments that do not promote sprawl; and invest in restoring public lands.

Joint Planning Commission (JPC) Lehigh-Northampton Counties, Bushkill Creek Watershed Act 167 Storm Water Management Plan (1992): The purpose of this study was to develop a framework for improved management of storm water runoff impacts associated with the development of land in the watershed. Without an effort to coordinate efforts through a watershed analysis, the fourteen municipalities in the watershed would establish a fragmented system with uncertain results.

g. Study Methodology: The watershed problems were previously identified in the Delaware River Basin Reconnaissance Study, and the site selection process and preliminary alternatives analysis took place during various site visits and conference calls with the stakeholders. The feasibility study methodology will include very focused data collection, alternatives analysis, quantitative and qualitative evaluation of with- and without-project habitat conditions, and limited design preparation.

Data Collection: A field reconnaissance (USDA protocol) will be undertaken on this portion of Bushkill Creek to identify and collect baseline trout habitat information. This will provide pre-project information to be used for comparison during post-project monitoring and ensure that no in-stream features exist (i.e., fish blockages and unsuitable substrate) that could deter trout and other aquatic life from returning to the project area once the habitat is restored. By gathering this information (and existing water quality data) and using reference reaches in the watershed, the biologist will be able to determine habitat structures and functions are degraded and should be restored.

Other factors will be considered during the inventory of natural resources including community size, scarcity, significance, existing wetland location and function, and biodiversity. These factors will also be considered when defining desirable outcomes of the

restoration measures and plans. The data gathered and developed during the inventory process will be used in evaluating alternatives and selecting the best plan.

Quantitative and Qualitative Benefits: The USDA protocol will be utilized to quantify and evaluate the environmental outputs produced by this project. Any adverse impacts will be identified and avoided, minimized, or mitigated, respectively, during the alternatives analysis. It is anticipated that the environmental outputs will consist of a restored brown trout community in the Bushkill Creek watershed.

Alternatives Analysis: Site restoration will include stabilizing the streambed and banks with a natural channel design and in-stream habitat features. This will include incorporating woody debris, a low flow channel, riffle and pool sequences, bank and riparian vegetative plantings (such as sycamore, willow, and alder), significant boulder bank stabilization, and boulder placement to increase habitat niches.

Alternatives that were considered but were not technically feasible, cost-effective, or environmentally beneficial were using only boulder placement in the absence of vegetative plantings or woody debris, “hard” engineering techniques such as concrete, only root wads or vegetation for stabilization, and gabions.

If potential adverse impacts are identified by any proposed restoration plan, then the team will evaluate avoidance and minimization of the adverse impacts during the alternatives analysis. For the in-stream community, the targeted species is brown trout. A holistic approach that attempts to restore a healthy and diverse community, which includes optimal conditions for brown trout, will be used for the purpose of the benefits analysis.

It is anticipated that the project delivery team will deliver a concept design for each reach. The stakeholders have agreed to support the most cost-effective, engineeringly feasible, and environmentally sound restoration techniques; therefore, it is assumed that the environmental and economic benefits will be maximized using these techniques. Alternatives analysis will not be completed for various designs at each site; however, the cost-effectiveness of each site will be evaluated by comparing to unit costs of similar restoration projects in the region by other agencies.

The analysis will conclude with a written justification supporting the selection of the recommended design. The results of this analysis will be used to help select the Federal plan and determine Federal and non-Federal cost-sharing requirements. These reports are expected to be completed in the field as the team proposes engineeringly feasible alternatives for restoration. It is also anticipated that team engineers will complete any necessary hydrologic analyses in the field to verify the projects are technically sound and make recommendations regarding future actions in the area of operation and maintenance.

Design Preparation: Design criteria and performance standards will be established using the evaluation techniques and criteria employed in USDA protocol, or other selected methods used in the feasibility phase. Detailed designs for each of three reaches will be prepared to a level of detail to provide quantities and materials estimates on a unit-cost basis.

At this time, it is anticipated that bioengineering and natural stream channel design techniques will be used to complete the restoration of the stream sites after the foundations have been completed. Comparisons of pre- and post-project environmental outputs and community diversity will be used to assess the projects' success and need for adaptive management and monitoring. The result of this study phase will be detailed designs and a refined cost estimate for plans and specifications and construction. Design analysis will rely extensively upon reference reach techniques to mimic the habitat conditions in the non-impacted stream segments in the immediate vicinity.

Since natural conditions in the watershed are dynamic, it is expected that the design at each reach will also be dynamic and designed to adjust itself to a natural state of equilibrium. This includes evolving and adjusting to a variety of stream flows and will not be static. In contrast, sites that involve existing bridges and stream crossings will be designed to be static, not dynamic. There are two railroad and two vehicular bridges over the creek in this area and stream flow must be conveyed under each structure.

The non-Federal sponsor will be required to acquire all the necessary permits for project construction in accordance with local, state, and Federal regulations.

4. Consistency Statement: Not Applicable.

5. Views of the Non-Federal Sponsor(s):

The Northampton County Commissioners have been advised of the need to submit a letter of intent to the Philadelphia District to act as the non-Federal sponsors for this Section 206 project.

6. Views of Federal, State, and Regional Agencies: Various agencies have been involved in investigating stream restoration alternatives in the Bushkill Creek watershed over the past several years. In addition, the Northampton County Conservation District, the Bushkill Stream Conservancy and the Pennsylvania Fish and Boat Commission and Trout Unlimited have expressed their support for the project.

7. Environmental Compliance Requirements: An environmental assessment and final Finding of No Significant Impact will be prepared for this project.

8. Costs and Benefits: Environmental benefits are expected to be 1 mile of restored trout habitat. Improvements will provide a low flow channel, stream temperature control, feeding and breeding niches, and a diversity of flows. The total project cost has been estimated to be \$5,000,000 that includes the feasibility study, geotechnical investigations, plans and specifications, construction, and real estate costs. Operation and maintenance costs are estimated at \$1500 annually with a projected project life of 20 years.

It is anticipated that habitat restoration at the sites described above would provide significant beneficial improvements within the Bushkill Creek watershed. Providing a natural

streambed would restore in-stream habitat and banks, diversifying the pool-riffle sequences and flow regimes, and creating bank vegetation and a riparian buffer to decrease stream temperatures and increase woody debris inputs.

There may be incidental economic and recreational benefits as a result of additional trout habitat and diversity provided to the area. By improving the stream habitat using bioengineering and natural design techniques, the area may attract more anglers and outdoor enthusiasts. This will be qualitatively described in the feasibility report.

By improving in-stream and riparian habitat, the expected environmental outputs and benefits to the Bushkill Creek ecosystem would be an increase in physical habitat stability, diversified niches, and sustainable flora and fauna communities. This would be a positive benefit to the overall aquatic community structure within the Lehigh River watershed.

9. Schedule:

Item	Duration (months)	Start Date	Finish Date
Environmental Restoration Report	8	12/02	08/03
Plans and Specifications	6	09/03	03/04
Construction	6	04/04	102/04

10. Supplemental Information: Accelerated sinkhole formation in the study area by the infiltration of surface water through the bed and banks of Bushkill Creek into the bedrock below causes piping of soils and subsequent sinkhole formation at the ground surface in the vicinity of the stream. In order to prevent this infiltration, restoration activities that consider sealing the stream bottom or otherwise preventing the infiltrating water from piping or removing overburden soils are required. Because of the highly unstable condition of the study area, the stability of any restoration action will be very difficult to provide, and impossible to guarantee. Possible mitigation concepts and numerous site constraints that potentially prevent success include:

- Stream bottom and bank lining – Using a lining material such as polyethylene, polyvinyl chloride, or concrete to line the stream bottom and banks, theoretically preventing surface water from infiltrating to bedrock. Potential problems include failure of the foundation supporting the liner and the inability to control stream water from entering the subsurface upstream of the liner terminus, in effect “short-circuiting” the restoration effort, causing continued piping of soil and eventual sinkhole redevelopment.
- Cut-off wall installation – Injecting a high-density grout to form a subsurface wall that “cuts-off” or prevents the stream water from migrating laterally from the stream into the subsurface beneath the study area. “Short-circuiting” of water around the wall is possible due to the interconnected and fractured nature of the bedrock, causing piping and subsequent unacceptable sinkhole redevelopment unless large volumes of grout are used to close these pathways. Drilling along the creek banks has also shown a rapidly changing depth to bedrock, making wall anchoring difficult.

The variability and instability of the karst environment beneath the study area makes it impossible to predict or reasonably guarantee the success of any restoration technology at this site. Although short-term successes may be realized, successful long-term restoration is unlikely where a reasonably priced restoration plan is proposed. Restoration plans that may have greater long-term success will likely be at greater cost, and the effectiveness over the duration of time is impossible to gauge. Without restoration, the site conditions along and beneath Bushkill Creek, including the presence of weathered dolomite, saturated, fractured, and weak bedrock and loose, saturated overburden, will continue to provide the mechanism for further karst development.

11. Financial Data:

a. Project Costs (in 1000's)

Item	Project	Non-Federal	Federal	Federal Funding Needs			
				FY	FY+1	FY+2	BTC
Report	\$150	\$0	\$150	\$150	\$0	\$0	\$0
P&S	\$100	\$0	\$100	\$0	\$100	\$0	\$0
Construction	\$4,750	\$1,662	\$1,788	\$0	\$1,375	\$3,375	\$85
Totals	\$5,000	\$1,662	\$1,950	\$150	\$1,375	\$4,750	\$85

NOTE: The Ecosystem Restoration Report, and Plans and Specifications are initially Federally financed, and costs are distributed as part of the non-Federal share of project costs during implementation.

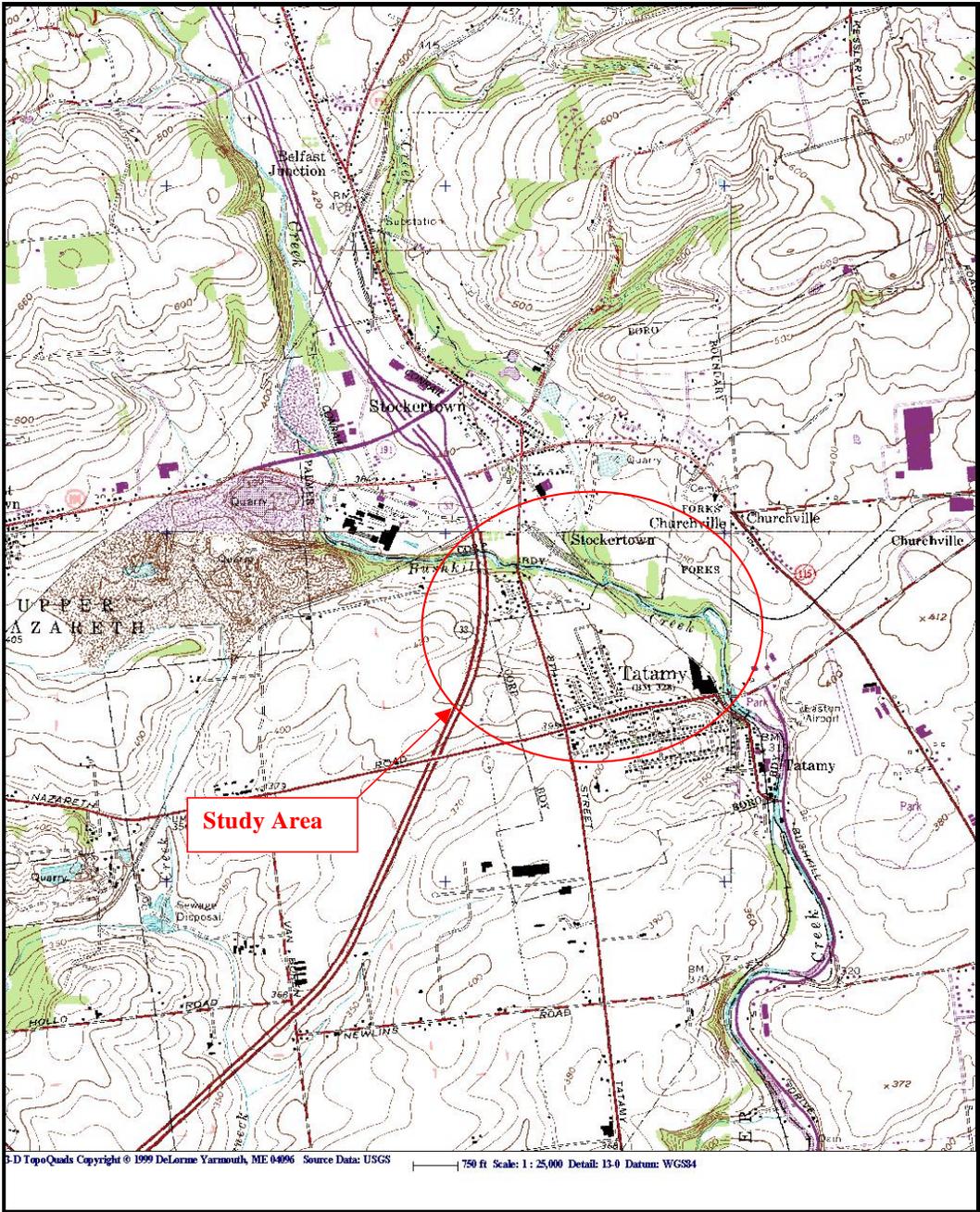
b. Non-Federal Requirements (in 1000's)

LERRD:	\$60
Cash:	\$600
Work-in-kind:	\$1,000
Annual OMRR&R:	\$1.5

c. Fully funded cost as found in the PCA: Not Applicable.

12. Federal Allocations to Date:

Preliminary Restoration Plan:	\$10,000
Environmental Restoration Report:	\$0
Plans and Specifications:	\$0
<u>Implementation:</u>	<u>\$0</u>
TOTAL PROJECT:	\$10,000



Enclosure 1. Project Location Map - Bushkill Creek

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**QUALITY CONTROL REVIEW REPORT
SECTION 206, WRDA OF 1986, as amended
BUSHKILL CREEK, NORTHAMPTON COUNTY
ENVIRONMENTAL RESTORATION PROJECT**

In response to multiple memorandums, CECW-A, 14 April 1995, Subject: Implementation of New Technical and Policy Review Procedures, the following individuals were participants in the formulation and technical elements of the Preliminary Restoration Plan:

PLANNING DIVISION

Study Element	Name/Organization
Special Studies	Richard C. Lockwood CENAP-PL-PS
Environmental	Jerry Pasquale CENAP-PL-E

ENGINEERING & CONSTRUCTION DIVISION

Civil Project Management	Don Martinelli CENAP-EC-MC
Cost Engineering	Jose Alvarez, PE CENAP-EC-EC
Design	Augustus Rambo, PE CENAP-EC-D
Hydrology & Hydraulics	Glenn Stevens, PE CENAP-EC-H

The significant issue involves restoration of portion of Bushkill Creek, a tributary of the Delaware River, to protect and restore stream bank and riparian habitat. We believe that the process required under the mandates of the Planning and Engineering & Construction Divisions has been completed within the extent of a Preliminary Restoration Plan under Section 206 of the WRDA of 1986, as amended.

MINAS M. ARABATZIS
Acting Chief, Planning Division

PETER M. TRANCHIK, PE
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