Eighteenmile Creek Restoration Project
Town of Newfane
Niagara County, New York

FINAL
Restoration Monitoring Plan for the Eighteenmile Creek Habitat Restoration Project

May 3, 2005

Prepared For:
Niagara County Department of Economic Development

Prepared By:
Ecology & Environment, Inc.

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Restoration Monitoring Plan Table of Contents

1 Introduction/Background

A properly designed monitoring system and associated maintenance activities are vital to the success of riparian and stream ecosystem restoration efforts. The success and benefits realized from restoration activities are closely related to the projects goals and objectives. Because of their importance, project objectives should be stated in quantifiable and measurable terms. The purpose of this report is to describe the project goals and objectives of the Eighteenmile Creek project, describe how they were implemented, and present techniques to monitor the stability and functionality of the restoration measures, in order to determine functionality of the habitat restoration efforts.

The Eighteenmile Creek Habitat Restoration Project originated when the Niagara County Department of Economic Development (County) had been the recipient of several grants for restoration activities on Eighteenmile Creek (the creek), in Niagara County, New York. The U.S. Environmental Protection Agency (EPA) and the International Joint Commission (IJC) have identified the creek as an Area of Concern (AOC). As a result, a remedial action plan (RAP) document was completed to investigate and assess the various sources of pollution affecting the sediments and water quality within the creek. The RAP listed three beneficial use impairments (per IJC definitions) and four other use categories that require further investigation. The beneficial use impairments include: restrictions on fish and wildlife consumption, degradation of benthos, and restrictions on dredging activities (www.epa.gov/glnpo/aoc/eighteenmile.html). The four categories that require further investigation include: degradation of fish and wildlife populations, fish tumors and other deformities, bird or animal deformities or reproduction problems, and degradation of phytoplankton and zooplankton populations. The project summary, as presented by the County, indicates that there has been a loss of habitat for trout and salmon in Lake Ontario tributaries, which threatens the long-term sustainability of the lake fishery. Consequently, restoration activities will focus on "applying ecosystem management techniques", leading toward the establishment of a sustainable fish community, and improving public access to the creek. The County received the grant funds to improve habitat for cold-water fisheries, improve angler access, create environmental education displays, and restore the greater riparian ecosystem in the creek.

The Eighteenmile Creek Habitat Restoration Project study area is located in the Town of Newfane, northern Niagara County, New York near Lake Ontario. The project study area extended from the base of Burt Dam (a barrier to fish migration) to the Fisherman's Park Access point (approximately one quarter-mile downstream) (Figure 1). The access point is approximately 1.5 miles upstream from Lake Ontario. Within this area, the project includes areas in the stream channel and the eastern side of the streambank. The project area is a component of a large NWI and NYSDEC mapped wetland. Wetland NW 3 is a Class 1 wetland system and 66.9 acres in size and is mapped within almost the entire riparian zone from the Burt Dam to the NYS Route Eighteenmile Creek Bridge in Olcott.

This monitoring plan is subdivided into restoration techniques, which were used in the project area to improve public access and enhance aquatic habitat. As presented, this document outlines the restoration measures used and provides techniques to monitor the condition and habitat function of the individual measures used on the Eighteenmile Creek Habitat Restoration project. In addition, maintenance measures are presented for each of the objectives to ensure that any potential failures or limitations of the restoration activities can be modified or rectified to ensure that damage does not occur and the restoration activities continue to benefit the Eighteenmile Creek system.

1.1 Elements of a Monitoring Plan

In recognition of the serious environmental and economic losses occurring throughout the United States as a result of streambank erosion, the Environmental Protection Agency (EPA) contracted with the U. S. Army Engineer Waterways Experiment Station (WES) to develop a streambank protection manual (USACE 1997). This document was developed to present a comprehensive manual covering a wide range of techniques and guidance for design that can be used to undertake streambank protection projects that are large or small. According to the WES Stream Investigation and Streambank Stabilization Handbook (USACE 1997), the primary elements of a monitoring and maintenance plan may include:

- <u>Site inspections</u> – Photo-monitoring on a seasonal basis allows the detection and tracking of bank erosion, channel scour, and/or displacement of armored material. The photos should be taken to allow for a clear picture of how the restoration measures are functioning. Photos taken during the summer allow for documentation of the success of plantings, while spring photos may capture the functionality and stability of the restored bank during high flow events.

- <u>Site surveys</u> – Topographic surveys provide the most detailed documentation of the elevations and slope of the toe, lower bank slope, and channel to determine the displacement or migration of bank structures. The post-construction survey establishes work control points throughout the restoration work area, in order to monitor the stability of the restoration work.

- <u>Geomorphic observations</u> – Changes in channel alignment can alter hydrologic and sediment transport, which can subsequently threaten the stability of any restoration work.

- <u>Hydrologic and hydraulic data</u> – Hydrologic and hydraulic monitoring provides information on the flow rates and water velocities. Comparing this hydrologic data to background information can indicate the potential instability of the streambanks or other restoration measures, if the restoration measures affected the hydrologic regime.

- <u>Geotechnical data</u> – Geotechnical monitoring can be used in complex areas, where geotechnical conditions have the potential to impact restoration measures. A visual inspection of the surface features may be sufficient, or a more detailed analysis of subsurface conditions, via piezometers and slope stability indicators.

- Environmental aspects – Environmental parameters, such as those listed in Section 3 (i.e. hydraulic cover stones, locked limbs, rooted stock plants, etc.) should be routinely monitored to determine the stability of the feature, as well as the functionality of the design. Vegetative monitoring is an important component to ensure that the restoration vegetation is surviving and providing the intended function of the restoration measure. This method is the principal technique that was used for the Eighteenmile Creek Restoration Project.

The timing and frequency of monitoring are additional important considerations in the post-construction restoration process (USACE 1997). There are two critical time periods: the first two years post-construction, and after the first major flood flow. Monitoring during the first two years post-construction will identify potential needs for additional restoration project measures. Examining the restoration measures during high flows can identify attack angles of the current, which have the potential to degrade the stability of the streambank. Examining the restoration measures during low flows will present the opportunity to examine portions of the restoration work that are not visible from the surface during high flow events, as well as vegetative growth during the growing season. For bank stabilization measures, monitoring efforts should focus on the toe of the protection and bank keys, because scour failures in these areas can be most devastating to bank stabilization measures. Additional signs of bank instability include: evidence of bank erosion, displacement of armor material, and condition of vegetation.

1.2 Eighteenmile Creek Restoration Measures

Depending upon the availability of money and the nature of the restoration activities of the project, some or all of these techniques can be used to monitor the restoration project. Often with restoration projects, all of the money is used upfront to plan, permit, and construct the project. Once the project is complete, there are no funds to monitor and maintain the restoration features of the project. Therefore, in developing a monitoring plan, it is important to establish appropriate monitoring techniques/requirements given the post-restoration funding and project support available.

For the Eighteenmile Creek project, the grant funding required that restoration monies be spent by a specific time period. Fortunately, this time period overlapped with one-year post-construction. Future grant funding may be acquired, but for the purposes of this document, it is assumed that limited additional restoration grant funding may be available. Therefore, the majority of the restoration measures in this report were designed to provide low-cost, volunteer-based activities to maintain the functional enhancements of the project to the project area.

The Eighteenmile Creek AOC currently has a RAP Coordinator position deployed out of the Niagara County Soil and Water Conservation District. The RAP Coordinator will be responsible for implementing various monitoring and research efforts to the lead to the ultimate remediation and restoration of the Eighteenmile Creek AOC. The RAP

Coordinator will conduct annual field surveys to assess the condition of the Eighteenmile Creek restoration measures.

Long-term maintenance will be conducted by the town of Newfane, since the town has an easement on the site, and currently maintains the parking area. In addition, the town operates a daily entrance fee during the peak fishing time (i.e. September to December). These monies will assist in the upkeep and maintenance of the facility.

If future annual monitoring efforts indicate that the overall restoration measures are not functioning as designed, a meeting between the New York State Department of State and Department of Environmental Conservation will be held in order to discuss potential resolutions.

2 Restoration Goals and Objectives

Since the Eighteenmile Creek below Burt Dam is designated as a Great Lakes AOC, the restoration project goals and objectives centered on restoring the health and integrity of a component of the AOC that would lead to improvements of the entire AOC area. The County specifically received grant funds to improve habitat for cold-water fisheries, improve angler access, create environmental education displays, and restore the greater riparian ecosystem in lower Eighteenmile Creek. This would be accomplished by the implementation of habitat improvements below Burt Dam with development of a comprehensive watershed plan and feasibility study for restoring the entire watershed as viable habitat for aquatic species with improved public access. Additionally, the enhancements of Eighteenmile Creek from this grant will be used to leverage other funding sources to improve access points along the watershed for environmental education, birding, boating, and fishing; continue habitat restoration work throughout the watershed; and implement the watershed management plan recommendations. The RAP designation was the first step in restoring the Eighteenmile Creek watershed. The work from this restoration project will initiate actual habitat enhancements that will improve the structure and function of a portion of Eighteenmile Creek, as well as increase the public opportunities to learn and enjoy the natural environment in Niagara County.

2.1 Project Goals

As stated in the grant proposal, the primary goal of the restoration project is to begin the restoration of the chemical, physical, and biological integrity of the Eighteenmile Creek AOC. This goal was designed to provide direct improvements to the AOC, and at the same time provide a framework to draw attention to the area in order to build a strong case to attain additional grant monies to ultimately clean-up the entire watershed and eventually remove Eighteenmile Creek from the list of Great Lakes AOC's.

In conjunction with the stream restoration, a prominent goal of the Eighteenmile Creek Restoration Project is to provide safe access to the thousands of visitors that are attracted to Fisherman's Park and the stream reach below Burt Dam and enhance the existing riparian corridor.

2.2 Project Objectives

For the purposes of this plan, the project objectives are described in terms that allow the development of measurable factors, which indicate the success of the restoration work. These "success criteria" will include a combination of factors related to a visual assessment of the surrounding area, as well as, where applicable, more scientifically based interpretation.

The project objectives for the Eighteenmile Creek Restoration Project include:

1. Improving the stability of the streambank along a severely eroded section;
2. Improving the safety and condition of the existing creek access trail to minimize future bank erosion from seasonally intense human-use of the project area; and

3. Enhance the existing aquatic habitat by improving riparian and aquatic habitat for coldwater fish species.

Some of these measures (e.g. safety of a trail) can be described in terms that allow a general interpretation of conditions based on visual assessment, versus long-term quantitative monitoring (e.g. indexing accident records at the site). Other measures involve a more quantitative assessment of site conditions (i.e. stepped wall stability), to ensure that potential displacement or movement of the structure would not compromise the safety and integrity of the site trail. This plan is based on monitoring the stability of the various measures and determining their associated habitat function.

It is important to develop restoration-monitoring measures that adequately reflect the restoration goals and objectives. For instance, if a restoration objective is to improve bank stability, some measure of the integrity of the streambank is needed. If monitoring activities do not detect a streambank losing its integrity, then the stabilization measure may fail and cause further damage to the system.

The restoration measures discussed below were developed to specifically address the project objectives to attain achievement of the project goal. These measures will provide a more stable streambank, improve the safety and integrity of the trail, and provide for an enhanced aquatic ecosystem.

3 Restoration Measures and Designed Function

The overall concept in the design and construction phases of the project was to "do no harm". Essentially, this involves the documentation of existing natural functions within the project area and to ensure that no action is taken that would result in the degradation of the stream or adjacent riparian zone. The following construction techniques and restoration measures were conducted within the restoration work area to enhance aquatic and terrestrial habitat, and improve the safety and integrity of the existing hiking trail and fishing access. The first three techniques described are attributed to Dave Derrick, a stream restoration specialist with the USACE Waterways Experiment Station in Vicksburg, Mississippi. Mr. Derrick was instrumental in providing input and direction on the bioengineering aspects of this project. Derrick's mantra is "function-based design" and subsequently the project design was based in part by structures and conditions in a "reference reach", located in a portion of the restoration work area. The restoration measures were designed to provide low maintenance measures to minimize long-term maintenance and funding requirements.

The restoration measures used in the project are listed below and are described in detail in the subsequent sections:

1. Locked Limb/Locked Logs
2. Instant Shade/Extreme Instant Shade
3. Stump Habitat

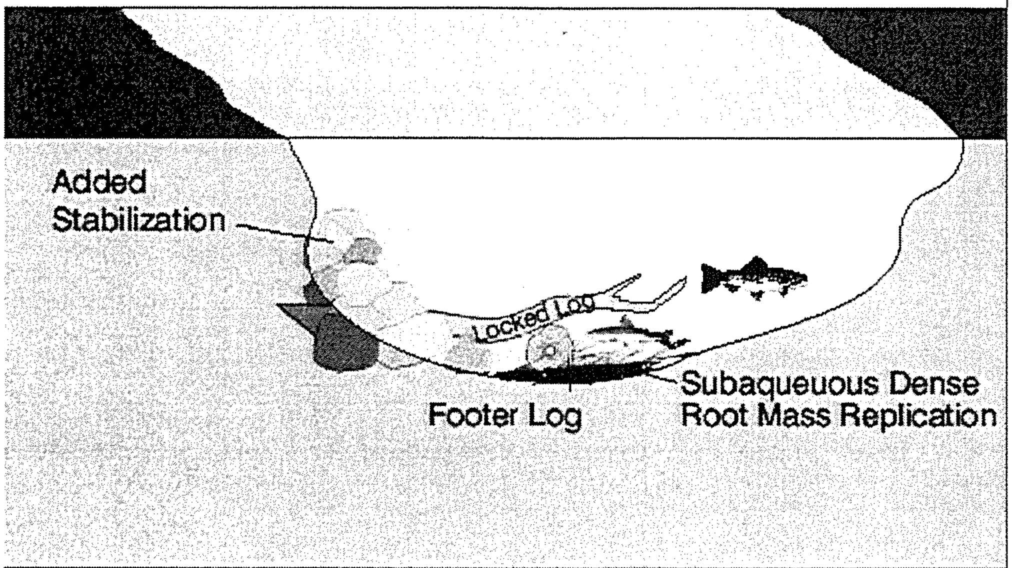
4. Pole Planting in Riprap and Stepped Wall
5. Live Stakes
6. Rooted Stock Plants
7. Grass Seeding of Disturbed Areas
8. Dense Root Mass Replication
9. Brush Layering
10. LUNKERS
11. Hydraulic Cover Stones
12. Trail Enhancements
13. Stepped Wall
14. Placed Rock Riprap

3.1 Locked Limb/Locked Log

This method consists of placing small trees and/or small woody debris along the streambank to simulate natural carbon loading to the stream system. In addition, the locked limbs/logs provide additional aquatic habitat for juvenile fish and aquatic invertebrates. Limbs with leaves, sections of small tree trunks, and treetops that were cut for trail clearing were anchored along the toe of the bank and within the stream channel. The limbs/logs were set into the streambank to protrude into deeper scoured areas to provide in-stream cover, vertical and horizontal structure, and refuge areas for fish and other aquatic species. Locked limbs are typically less than 2" inches in diameter; locked logs are greater than 2 inches in diameter (Derrick personal communication).

These structures were placed into the channel so they were entirely submerged at mean water level. The structures are not easily distinguishable from the shoreline, but provide an ideal fish holding area and consequently a productive fishing "hole" for anglers of warm and cool season game species. In addition, locked limbs/locked logs provide stabilization to loose bank materials and can improve bank stability.

Locked Limbs/Logs with Footer Log and Subaqueous Dense Root Mass Replication



Inspection and Performance

May 10, 2004

All locked logs were intact and functioning as constructed. The subsurface bank with stone stabilization was in the constructed position. The stabilized locked log had collected some submerged plant and small woody debris, but appeared to be functioning properly. There was no obvious alteration of flow beyond a slight reduction of velocity with a calm water zone near the base of the locked log. Small fish were observed in this area, indicating that this restoration measure was functioning as designed.

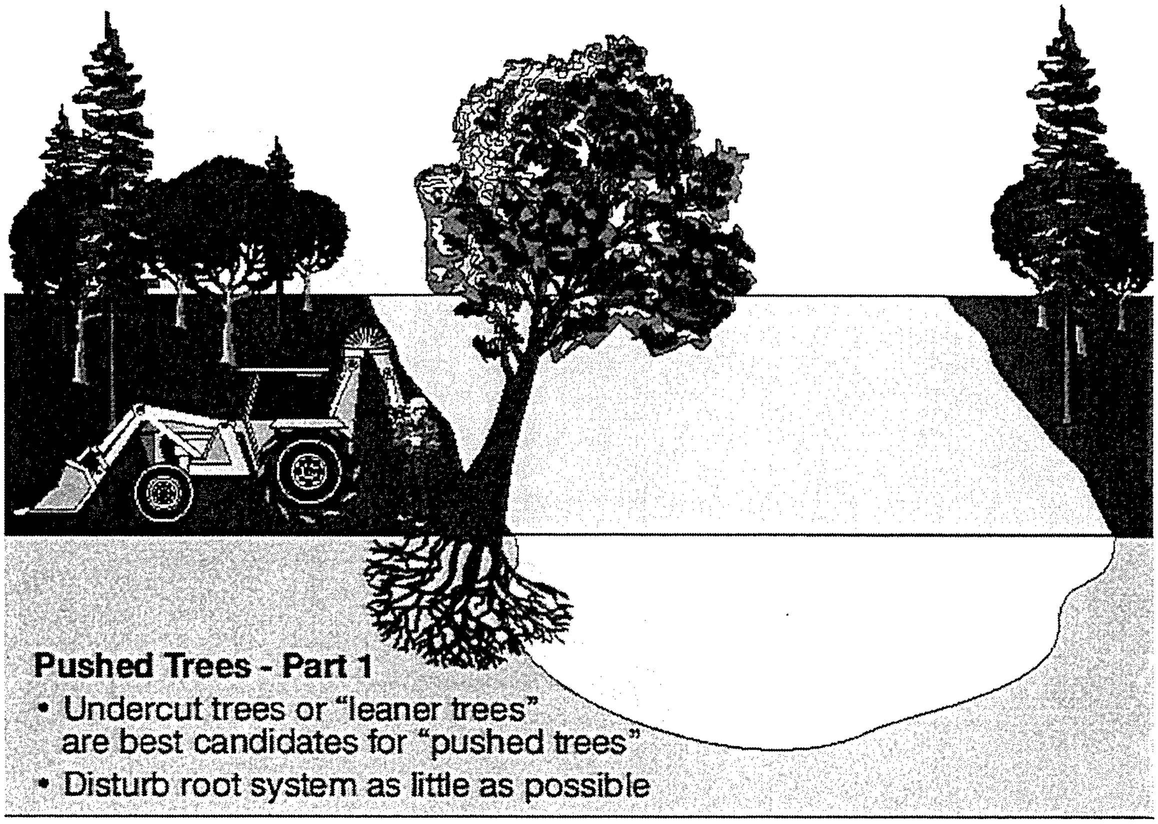
July 13, 2004

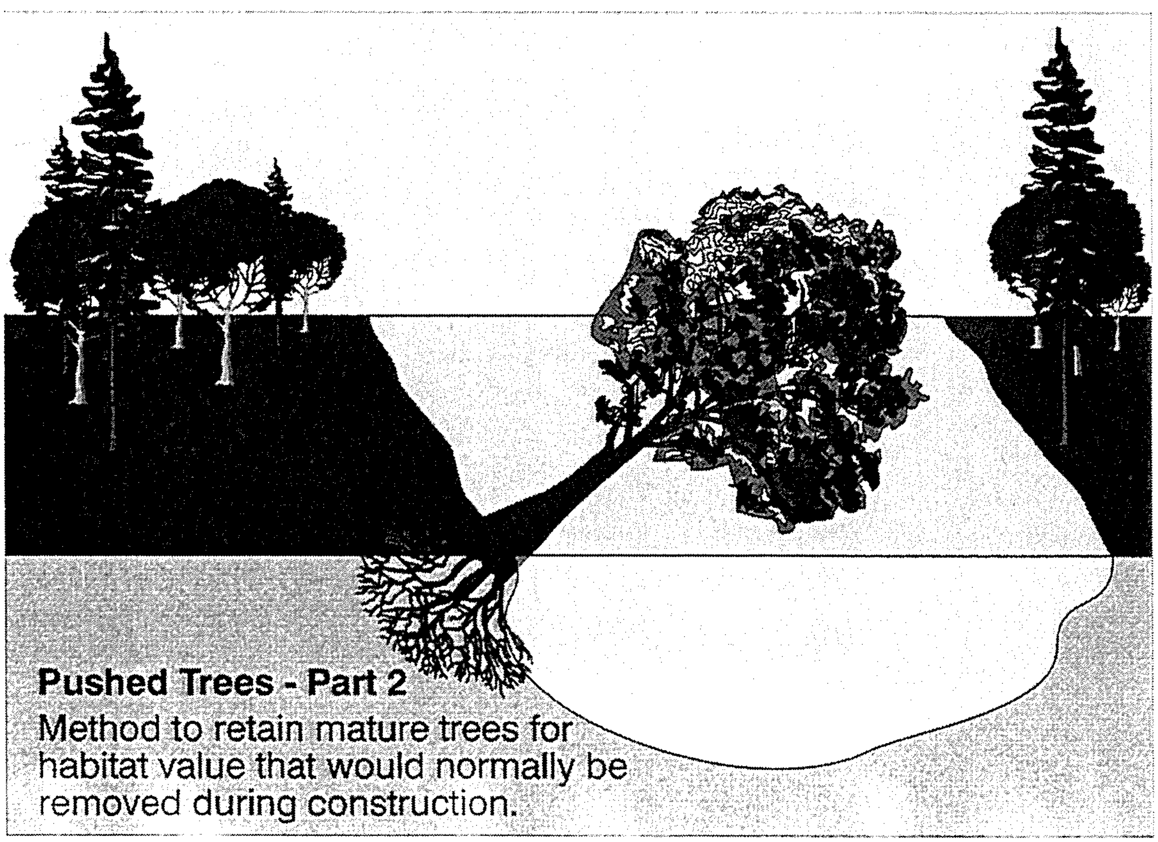
All structures were intact and functioning as constructed. Some water celery grass was observed growing in substrate below the locked logs and foliage approximately 18" long was flowing with current above log structure forming a vegetative curtain. No small fish were observed. However, given that the structures remained in place and aquatic vegetation was growing adjacent to the structures, this restoration measure was still providing adequate function to diversify the aquatic habitat.

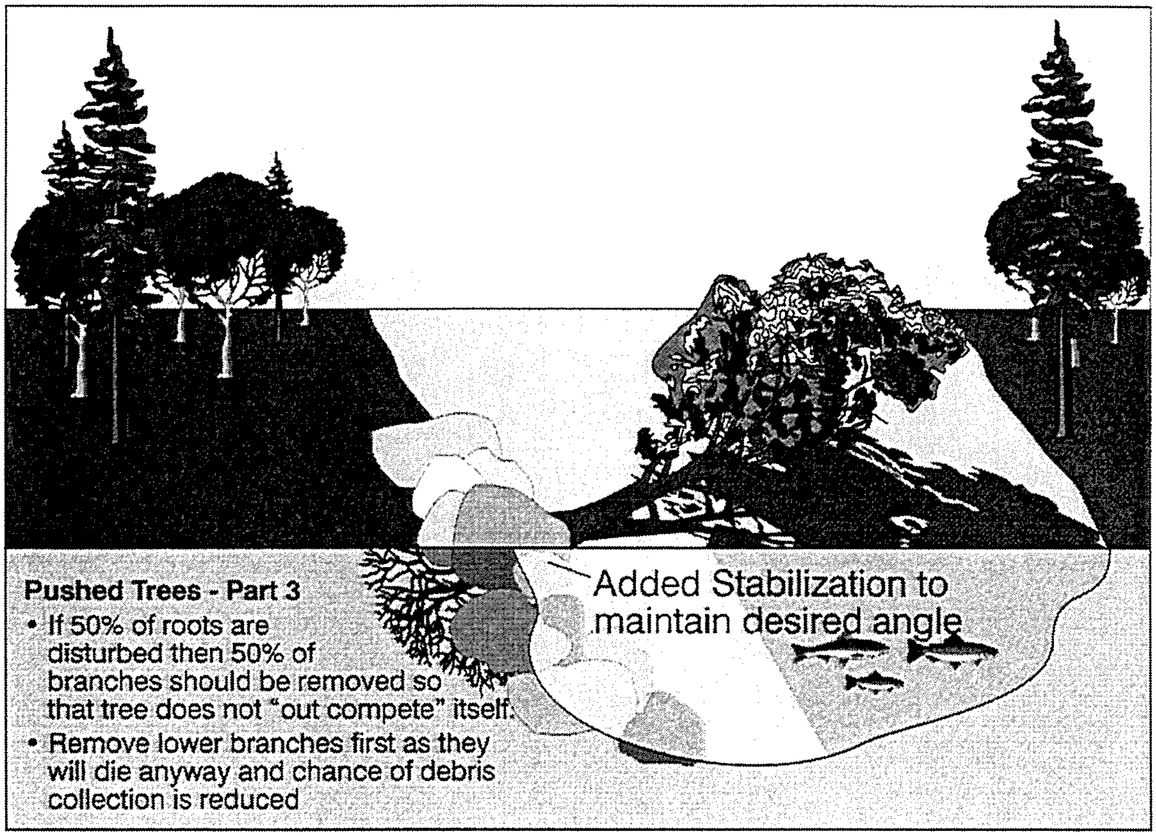
3.2 Instant Shade and Extreme Instant Shade

Suitable species of black willow (*Salix nigra*), box elder (*Acer negundo*), and American elm (*Ulmus Americana*) were located within the designed trail corridor, and identified for clearing and grubbing during the early stages of the project. Prior to construction, trees along the streamside were flagged and protected wherever possible. The bases of some trees were located within the construction haul road and access trail area. To maintain function of these trees (i.e. shading of the water surface, input of terrestrial prey, bank stability), the trees were pushed into a near horizontal position over the water surface and buttressed near the root zone with stone to prevent them from falling into stream channel, and backfilled with topsoil. An appropriate amount of foliar mass (i.e. approximately ½) especially on the underside, or waterside, of the "pushed trees" was removed in relation to root mass loss as a result of being pushed over, to encourage recovery by reducing excessive transpiration. The rootwad and lower trunk of the "pushed trees" were stabilized with rock to prevent the "pushed trees" from collapsing into water column. If these shade trees eventually fall into the channel they will provide additional aquatic habitat in the stream channel, but the goal of the instant shade technique is to provide shading of the stream channel.

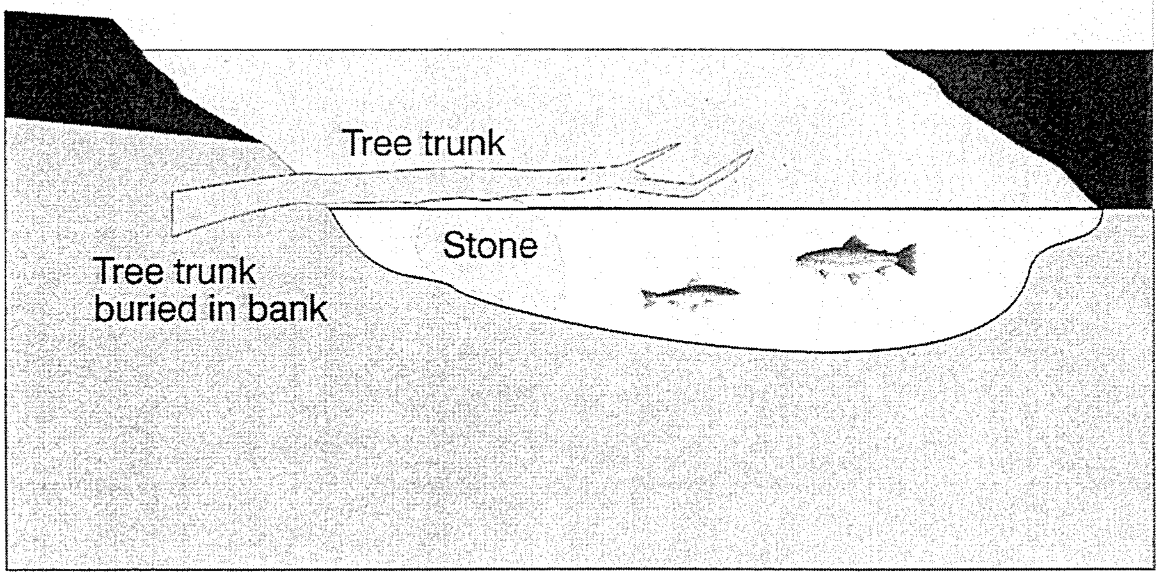
An "extreme instant shade" (Dave Derrick terminology) method was implemented using a particular black willow as a reference tree located on the opposite side of the stream in the project area. It appeared that some time ago, the mature reference tree had fallen into the channel on top of a log in an area of the stream that is approximately 18 inches deep. The willow in time had grown horizontal, but formed a dense foliar mass in the shape of an umbrella, which provided dense shade over the stream channel and provided an ideal source for terrestrial insects into the stream channel. The project team salvaged a number of 20-foot sections of black willow cut from the new trail corridor. The poles were approximately 6 to 8 inches in diameter. The butt ends were keyed into cavities excavated at streamside within the moist soil zone in areas that were already eroded or disturbed. The poles extended 12 to 15 feet into the stream where they rested above water level on a placed boulder. Both shade methods require careful positioning and stabilizing over the water column to prevent trash or debris buildup that could cause stress or dislodge the feature from the stream bank as a result of excessive discharge.


Pushed Trees - Part 1
• Undercut trees or "leaner trees" are best candidates for "pushed trees"
• Disturb root system as little as possible


Pushed Trees - Part 2
Method to retain mature trees for habitat value that would normally be removed during construction.


Pushed Trees - Part 3
• If 50% of roots are disturbed then 50% of branches should be removed so that tree does not "out compete" itself.
• Remove lower branches first as they will die anyway and chance of debris collection is reduced
Added Stabilization to maintain desired angle

Extreme Instant Shade with Footer Stone



Inspection and Performance
May 12, 2004

The leaner trees (*Acer negundo* – box elder) Instant Shade features were observed to be in place as positioned during construction. Bolster stones to support trees in an upright angle above the water surface were in place and stable. The bank and topsoil backfill around the disturbed root systems of the leaner trees were stabilized with erosion control mats and there was evidence of some persistent grass and forb seedlings emerging from the Fall 2003 seeding.

The trees exhibited a flush of early growth from primary and secondary branches. There was minimal dieback of smaller branches during the dormant season near the tree branching system extremities. Some primary branches were cut or broken and damaged by anglers who attempted to open the overhanging structure and gain better access to surface water. At this time this damage does not appear to be life threatening to the tree. If this feature survives a second dormant season, it is expected that the tree will adjust and continue to grow in its altered position. Maintenance of this feature includes periodic or annual removal of damaged branches that enter water to prevent debris buildup.

As the trees remained alive and intact, the trees were functioning as designed. The designed function of the trees leaning over the water column enhanced the ability to shade the creek channel and provide terrestrial prey items on to the water surface.

July 13, 2004

Leaner Trees/Instant Shade features were intact and functioning as constructed. Tree trunks were suspended over the water surface at the level that was designed during construction. Foliage was abundant and healthy from primary and secondary branches. Northern water snakes were observed basking on the portions of tree trunks that provide full sun exposure. Thus, the instant shade features were functioning as designed and enhancing the aquatic habitat conditions in the creek (i.e. providing additional shading of the creek channel).

Extreme Instant Shade

Inspection and Performance

May 11, 2004

The Extreme Instant Shade cut poles were in place above the water surface in the constructed position. The bank at the point of insertion was firm and stabilized with erosion control mats. Erosion control grasses seeded in Fall 2003 were damaged and non-existent in some places in this area due to heavy foot traffic from anglers. The tree poles exhibited abundant new growth along portions of the trunk. Some sprouts and foliage were damaged from anglers walking or sitting on the horizontal poles, but the poles were functioning as designed.

July 13, 2004

Extreme Instant Shade poles were in their original position. New growth was sparse and it appears that many sprouts visible on May 11 were damaged or missing. All poles were alive but exhibited approximately 50% less foliage than was observed 60 days earlier. Continued monitoring of the extreme instant shade trees will occur to determine if the potential death of the tree would compromise bank stability. If signs of bank instability occur, the trees will be removed or cut and additional erosion control mats and seeding will occur to stabilize the banks.

3.3 Stump Habitat

Large stumps and root wads were cut and removed from the route of the new trail corridor. These large structures were placed in the stream channel close to the bank so that they are partially submerged. It is expected that these structures will not only provide habitat for fish, but also encourage colonization of aquatic plant species thereby encouraging beneficial insects as well as producing in stream structure and habitat for a variety of benthic and other aquatic organisms.

Root wads used in the project area were not subject to excessive velocity or flow-related shear stress. Anchoring was not necessary in this application due to the controlled flow regime dictated by the Burt Dam. In other systems, appropriate positioning and anchoring measures are required to hold the feature in place and to prevent bank erosion by excessive velocities redirecting toward the streambank. Boulders and logs with root masses attached placed appropriately in and on streambanks will provide streambank stabilization, trap sediment, and improve habitat diversity. The rootwad placed in Eighteenmile Creek was designed to provide additional aquatic habitat through velocity breaks, wood for aquatic invertebrates, and additional in-channel cover.

Inspection and Performance

May 10, 2004

The root-wad (stump) feature was observed to be in place and orientated in the channel as placed during construction. There was minor accumulation of woody debris on the upstream side of the root wad. Seedling aquatic plants were visible on the root wad above and below water line. Small fish and minnows were observed downstream of the root wad in calm water. Therefore, the rootwad was functioning as designed and is continuing to provide additional aquatic habitat diversity for the Eighteenmile Creek system.

July 13, 2004

The root-wad feature was in place as observed on May 10, 2004. Water celery was observed growing at the base and water snakes were observed basking on the exposed portion of the root-wad. Thus, the rootwad was continuing to function as designed.

3.4 Pole Planting in Riprap and Stepped Wall

Streamco willow (*Salix purpurea)* poles were harvested from a donor site in 20-foot plus lengths prior to construction. Although it is recommended to propagate cut poles during the dormant season, it was decided to utilize the available poles because of the construction timeline. An innovative method that involved cutting apical growth and presoaking wrapped poles for a minimum of 10 days was used to increase survivability.

The poles were placed in cavities along the stepped wall in appropriate locations with butt ends driven into the moist soil zone at water level. The cavities were back filled with topsoil. Within a few weeks of planting, the poles had sprouted new growth. Root growth was anticipated as well. Monitoring of the pole plantings began in Spring 2004. Success of this method may be dependent on the off-season harvest and pre-planting treatment. The pole planting are designed to provide additional shading of the stream channel and additional sources for terrestrial insects into the stream channel.

Inspection and Performance

May 10, 2004

Streamco willow poles 12 to 18 feet long were harvested in August of 2003 and prepared for planting into the stepped wall interstices in late September. The planting method was essentially the same as the dormant season pole or lives stake material. The butt end of the pole was deeply inserted into the saturated soil zone and in some holes below mean water level in stream. Poles exhibited a flush of growth before dormancy but failed to produce foliage in Spring of 2004. Half of the poles were broken or cut down above the wall level by anglers. Although, it is possible that the below soil portions of the poles may be alive and producing roots, no foliage was observed above soil level at the time of inspection.

July 13, 2004
Two remaining poles in stepped wall exhibited no signs of growth. There was no indication of growth at soil level. Lack of survival is partially related to vandalism, and may be related to off-season harvest and planting of this species. Thus, the pole plantings were not functioning as designed.

However, the pole plantings were placed in a high-use area within the stepped rock wall. Thus, the survival of the poles would not affect streambank stability. In addition, since the poles were likely cut by anglers, long-term survival of this type of restoration measure is not expected. No further monitoring of these structures is planned.

3.4.1 Interstices or Stepped Wall Joint Planting

The extensive use of stone in the stepped wall area was necessary to stabilize the severely eroded slope and provide safe access for the public. The design of this feature reflects the need to address impacts of the intense use of the area and the lack of space in the canyon-like project area. This area will now safely accommodate up to 500 fishermen who routinely visit the area daily during the peak fishery activity from October through March.

Restoration planting in this area was designed to increase plant species diversity and habitat as well as attenuate heat loads from sun exposure during warm weather months. All cavities in the Stepped Wall feature were filled with topsoil. Selected species of erosion control grasses and forbs were planted in a combination of seed and plug form. Only native species were selected for use in this area for their durability and habitat value.

Inspection and Performance

May 10, 2004
All interstices in stepped wall were filled with topsoil from a point above high-water where there streamside erosion was not anticipated. Warm-season grasses (200 plugs) and a native grass and forb seed mix were scheduled for planting in mid-May.

July 13, 2004
Grass and forb seed mix was sown in late May. Plug planting was completed in early June 2004. Planted and seeded interstices exhibited growth 6" to 12" and approximately 90% cover. Thus, the initial performance of the interstice planting was functioning as designed. The development of these plantings will lead to long-term stability and shading of the stepped rocks.

3.5 Live Stakes

Donor sites were identified for harvest of dormant live stakes to supplement purchase from vendors in the early of Spring 2004 (Phase II) planting. Buttonbush (*Cephalanthus occidentalis*), silky dogwood (*Cornus amomum)*, red osier dogwood (*C. stolonifera*), and silky willow (*Salix sericea*) were planted in areas corresponding to their wetland indicator ranking.

The Live Stake method is especially effective on project sites like Eighteenmile Creek where suitable wetland soils and hydrology are in-place. The live stakes will increase the extent of the riparian zone and provide additional benefits from shading, streambank stability, and additional sources for terrestrial insects into the water column. This method is easily integrated with all other bioengineering methods and techniques used to restore riparian vegetation and streamside habitat. Twenty-five live stakes approximately 3' in length and ½" in diameter were driven into soil substrate to a depth where approximately 80% of stake is below ground and 20% is above ground.

Inspection and Performance

May 10, 2004

Half of the approximately 25 live stakes were either pulled out or damaged by foot traffic during the peak of the cool season fishing activity. Approximately 70% of all remaining live stakes planted in Spring of 2004 had visible foliage.

July 13, 2004

All live stakes that exhibited foliage in May were alive and healthy. Thus, the live stakes were functioning as designed, except for the ones damaged by vandalism. The development of the live stakes will increase the extent of the riparian zone and provide the associated benefits to the creek, discussed above, from a properly functioning riparian zone. The areas where the live stakes were damaged will not be replanted, but future monitoring efforts will include monitoring these areas for bank stability.

3.6 Rooted Sock Plants

Buttonbush (*Cephalanthus occidentalis*), silky dogwood (*Cornus amomum)*, red osier dogwood (*C. stolonifera*), and silky willow (*Salix sericea*) were harvested as Live Stakes during spring of 2003 at a length of approximately 36 inches and 3/8 inch in diameter. Dormant cuttings or live stakes were propagated in burlap fabric tubes filled with artificial soil in controlled moisture conditions. This method of propagation of restoration plants will produce a rooted plant ready for transplanting in approximately 3-months. The finished product is also referred to in the trade as "Rooted Sock Plants".

"Rooted Sock Plants" were planted in the Fall of 2003 in rip-rap interstices and in wetland soils along the trail at streamside. Approximately 100 of these plants were held over in a dormant state and planted in Spring of 2004 prior to over seeding with warm season grass and forb mix. The rooted sock plants provide similar aquatic habitat enhancements to the other riparian plantings discussed above.

Inspection and Performance

May 11, 2004

Approximately 40% of Rooted Sock Plants planted in the Fall of 2003 had been pulled out or destroyed and excessive foot traffic was evident in the planting areas along the stream. The majority of this vandalism occurred near the base of Burt Dam. The remaining plants were in excellent condition and exhibited 2 to 4 inches of new growth primarily at the apex of the stem. The Sock Plants planted in early May of 2004 were alive and in good condition. Growth was limited to shoots 2 to 4 inches in length.

July 13, 2004

All surviving Rooted Sock Plants were healthy with some dogwood species having flowered and developed fruit. Thus, the rooted sock plants were functioning as designed. The one area near Burt Dam where all of the sock plants had been pulled exhibited a dense growth of grass. Thus the absence of shrubs in this area did not appear to effect the stability of the slope. Due to the intensive nature of the fishery in this area, the likelihood of sock plantings surviving in this area near the dam is doubtful. However, the lack of survival of the sock plants in this area does not appear to affect the integrity of the bank slope. Future monitoring will include checking the stability of the grass plantings. If portions of the slope become unstable or appear to loose vegetation, additional grass seeding will occur.

3.7 Native Grass and Forb Seeding of Disturbed Areas

Equipment staging and mobilization, clearing and grubbing operations, the creation of a trail corridor, stabilized slopes and the construction of the stepped wall caused surface soil disturbance within the project area. Recontoured slopes, rip rap placement, staging areas, and trail apron were reseeded with selected native plant seed mixes based on their position in the landscape. Warm season grasses and perennial forbs were selected for use in full exposure locations such as the stepped wall interstices and slope between the trail and the top of wall. Native plant species were selected for individual areas based on their durability, longevity, habitat value, and sustainable characteristics in hostile environments. All selected species will withstand heavy foot traffic associated with the 11,000 plus anglers that visit the project area during the peak months of the cool season fishery from October through March each year.

In fall of 2003, a coir fiber erosion control mat was installed over all disturbed soil areas and a cool season stabilization grass mix was seeded under the mat to temporarily hold soil in place. Final seeding and planting was done in Spring of 2004.

Inspection and Performance

May 12, 2004

Approximately 50% cover of annual ryegrass was observed from the late October 2003 seeding of a temporary late season erosion control mix. It appears that this was the result of some Fall-sown annual ryegrass seed that remained in a dormant state until Spring 2004, when soil temperature induced germination. All disturbed soil areas and surfaces where erosion control mats were installed had been seeded in late April 2004. There was approximately 90% cover consisting of annual ryegrass and oats nurse crop components of the native species seed mix. Some areas were damaged due to late season anglers using the streamside areas to access stream. However the majority of the grass plantings were intact.

July 13, 2004
There was 100% cover of a combination of the nurse crop component sown in the Fall of 2003 and the native grass and forb seed mixes sown in late April 2004. Nurse crop grass was 8 inch to 14 inch tall with forbs and native grasses visible at ground level. Thus, the grass plantings were functioning as designed, and providing the designed function of bank stability of associated benefits of native plants in riparian areas.

3.8 Dense Root Mass Replication

This method refers to the fine, fibrous root development of root masses from trees and shrubs growing along stream banks. Obligate wetland plant species such as black willow are abundant in mature forms along Eighteenmile Creek. The rhizosphere of this species is often partially within the stream's water column, which causes fibrous root adaptation. This root mass is suspended in water and provided refugia for many aquatic organisms beneficial to the fishery and in-stream habitat.

The stream channel in the project area provides little woody debris and organic matter to the waterway because of the dam immediately upstream. To replicate this feature in the project work area, small branches and whips approximately 0.25 inch to 0.38 inch in diameter from cleared trees and shrubs were bundled into 4 to 6 foot lengths. The bundles were submerged at streamside and anchored in place. It is expected this feature will eventually decompose and be released into the system much the same as natural carbon loading would occur without the dam in place.

Inspection and Performance

May 12, 2004
All brush bundles packed and placed under water and weighted with logs and stone were observed anchored in their placed position at the time of construction. Small woody debris and some organic matter was trapped on the upstream side of the feature. Small minnows and aquatic insects were observed within the water column inside the cover of the brush bundle. Thus, the root mass replications were functioning as designed.

July 13, 2004
All brush bundles were in place. Some aquatic vegetation (water celery) was growing at the base of the feature along each side. Due to the continued integrity of the root masses and the use by fish two months earlier, the root mass replications were functioning as designed.

3.9 Brush Layering

Live and dead brush was salvaged from clearing operations in the travel corridor for use as brush pile structures on land and in the periodically inundated zone along the stream bank. Logs and brush structures were installed in the lower portion of streambanks to enhance fish habitat, encourage food web dynamics, prevent streambank erosion, and provide shading for aquatic and semi-aquatic organisms.

This feature was designed to create a natural, structural environment for insects and other organisms to provide an additional food source for aquatic saprophytes and riparian wildlife. Eventual decomposition will add organic matter and nutrients to the existing silt clay soil and gravel soil surfaces. By creative design and use of woody debris, there was no need to remove cleared vegetation from the project work area. In addition placement locations were chosen to channel foot traffic and stream access away from muck substrate or unstable soils along the stream.

Inspection and Performance

May 12, 2004

Brush piles along the stream bank in the northern end of the project area were in place. Some compression from decomposition and snow accumulation over the winter was noticeable. Vines (Virginia Creeper), songbirds, and numerous insects were observed in the brush piles.

July 13, 2004

Brush Pile features were intact. Little change was observed in the period of time between the May 12 inspection with the exception of additional vine growth on some parts of the feature. Based on the two site visits the brush files were providing the intended habitat enhancement, additional habitat for riparian wildlife species.

3.10 LUNKERS

"LUNKERS" is an acronym for "Little Underwater Neighborhood Keeper Encompassing Rheotactic Salmonids". This constructed wooden feature was used beneath the toe stone in the stepped wall. Open cells were constructed of heavy white oak planks, which were imbedded under sections of the toe stone layer at a depth beneath mean water level. This feature provides covered compartments for fish shelter, habitat, and opportunities for anglers.

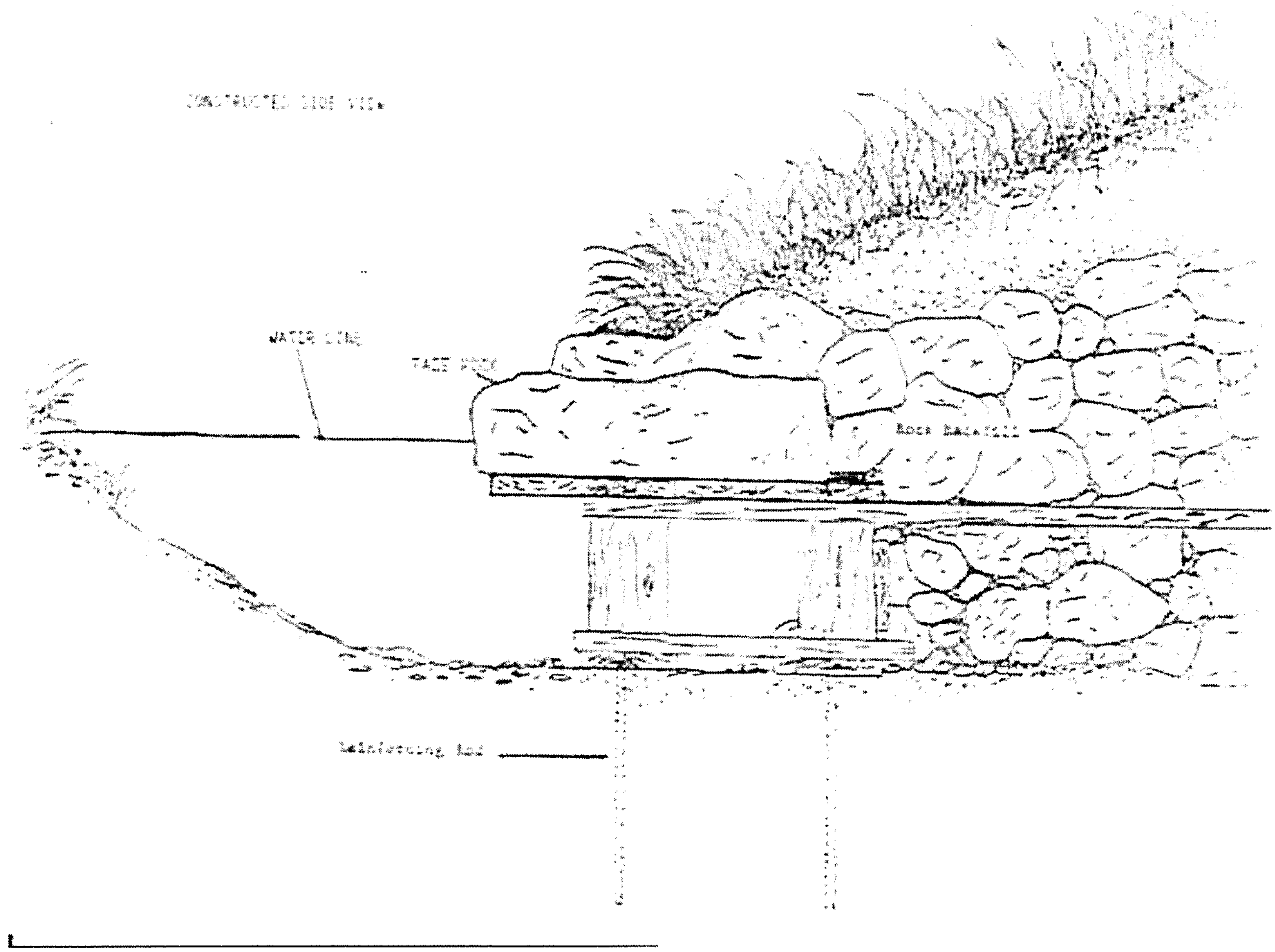
Inspection and Performance

May 12, 2004

All LUNKERS were observed in the original placement and were completely submerged in the stream channel. Water was approximately the same level as at the time of construction in 2003. Minnows were observed inside the LUNKER cavities. Flow and velocity was adequate to prevent sediment or debris buildup at the base of the cavity.

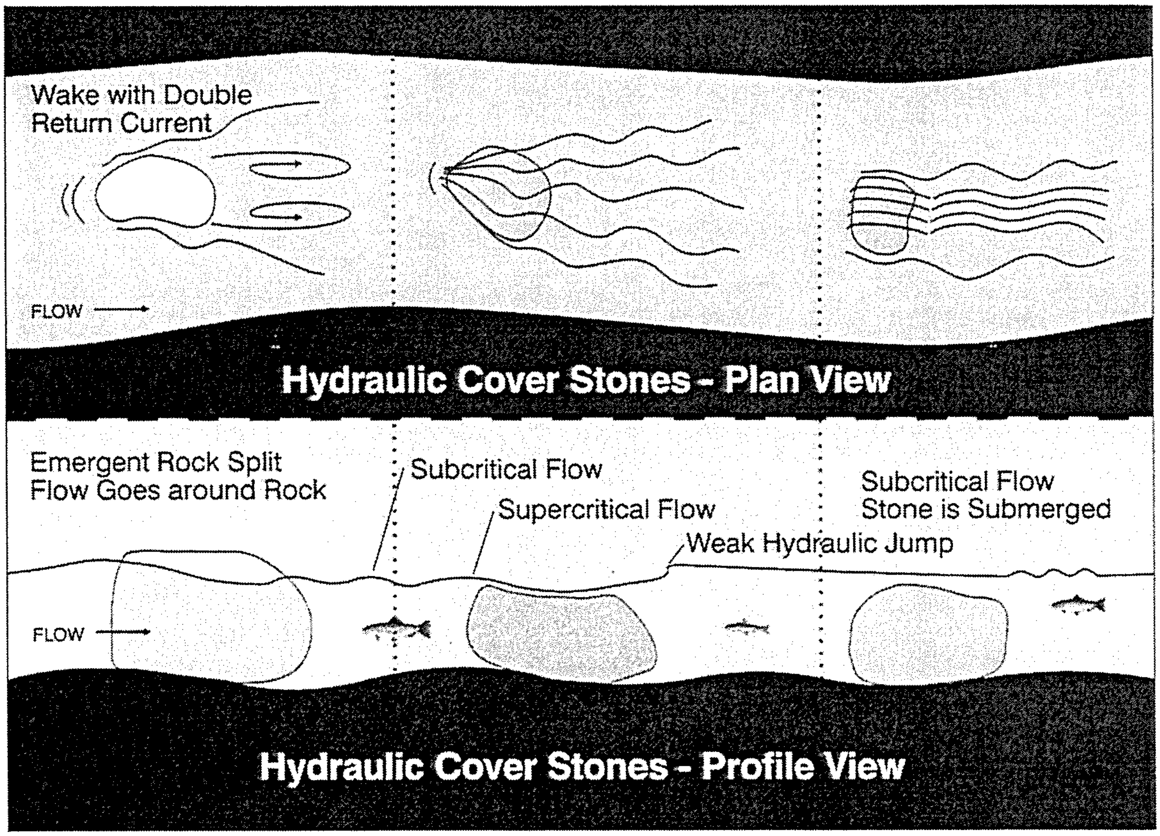
July 13, 2004

All LUNKER structures were observed to be in place. Water level 6 inch higher than observed at time of the May 12 inspection. Based on these two site visits, the LUNKERS were functioning as designed. To completely document use of the structures, actual surveys would need to include the use of more sophisticated fish sampling gear (i.e. snorkeling, underwater video, etc.). Since the basis of the monitoring is to allow for a half-day to full-day site visit to the area to determine success of the aquatic habitat enhancements, no formal fish sampling is planned. Future assessments of the LUNKERS will be limited to stability and placement.



3.11 Hydraulic Cover Stones

Hydraulic Cover Stones were selected for use on the project to provide additional aquatic habitat diversity in mid-channel areas. Hydraulic Cover Stones were placed in the flowing channel with the top of the stone set at an elevation slightly lower than the typical base-flow water surface elevation. When sited correctly, the accelerated flow over the tops of the stones will change from sub critical to supercritical flow, and further downstream back to sub critical (usually with a weak hydraulic jump). Downstream of the stones standing waves and a V-shaped wake will form. This constant movement and rippling of the water results in a type of hydraulic cover, masking fish location from the view of predators. The stones also provide resting areas and in-channel refugia for fish during high energy, high-flow events. The hydraulic jump can also help to entrain air and aerate the stream.



Inspection and Performance

May 12, 2004

All Hydraulic Cover Stones were observed in the approximate original placement and were partially submerged in the stream channel. The cover stones were providing hydraulic surface cover and were functioning as designed.

July 13, 2004

All Hydraulic Cover Stones were observed in the approximate original placement and were almost completely submerged in the stream channel. The cover stones were providing hydraulic surface cover and were functioning as designed. Based on these two site visits, the Hydraulic Cover Stones were functioning as designed. Similar to the LUNKERS, actual surveys of these areas would involve the use of more sophisticated fish sampling gear (i.e. snorkeling, underwater video, etc.). Future monitoring of these structures will be limited to a visual assessment of placement in the creek channel.

3.12 Trail Enhancements

The former hiking trail was in primitive condition with variable width that had several locations with unstable conditions and safety concerns. Safety concerns were significant as a result of the intense use of the area during the fall fishing season (i.e. greater than 10,000 people). This intense use of the trail by people is believed to have facilitated some of the severe erosion and trail lapses. Portions of the trail were severely eroded as a result of the high density of people accessing the stream channel.

The most severe pre construction trail conditions within the project work area were:

- Narrow, sloped trail tread raging from 5 feet to < 1 foot;
- Inundated sections in warm seasons and frozen sections in winter;
- Eroded slope drainage channels across the trail up to 3 feet deep;
- Severe bank conditions (< 1:1 slope) in the narrowest trail sections approximately 10 feet above mean water level; and
- Narrow to non-existent trail apron < 2 feet between toe of slope and stream bank or water's edge.

The trail enhancements served two purposes. First, a widened trail was necessary to provide equipment access for the trail improvements and restoration activities. The second purpose was to improve the safety and integrity of the existing trail. The trail was to be widened in severely eroded areas, and lined with a layer of crushed stone. After restoration construction activities were complete, a gravel base was spread on the trail to provide a large stable trail for river access and other recreation opportunities. In conjunction with the restoration activities, the Town improved the conditions of the steep access trail from the parking lot to the river, and added a staircase for improved elderly and children access to the creek.

Inspection and Performance

May 12, 2004

Trail section 1 (0 to 200 feet) immediately south of the access staging area.
Trail tread (crusher run stone surface) was in place but worn by foot travel. A slope drainage channel crossed a small section of trail. Water bars placed under the slope trail above the access area conveyed water to the vegetated slope east of the trail. A severe snowmelt/rain event occurred during the spring of 2004. This resulted in slope erosion, which eroded soil to bedrock in some areas along the slope. One section of the fisherman's trail was eroded and incised about one foot deep.

Trail Section 2 (200 feet to 500 feet)
The trail tread surface was in place with minimal wear due in part to elevation, graded pitch, and drainage patterns along the vegetated riparian area to the trail apron.

Trail Section 3 (500 feet to end of stepped stone wall)
The trail tread surface was intact and dry due to elevated grade and slope. The culvert installed in this section to convey slope drainage under the stepped wall to the creek was intact and functioned well during the spring snowmelt event.

Trail section 4 (south end of stepped wall to Burt Dam)
The trail tread surface was intact and only slightly worn due to foot traffic. The trail apron was stable in all areas, especially where the key to the stepped wall was constructed into slope. Some minor erosion of stone surface was evident immediately south of wall in lowest trail section due to high water and slope drainage.

July 13, 2004

Trail section 1 (0 to 200 feet)
The trail tread stone surface was replaced and/or dressed with new crusher run material. A new culvert was installed at the point of incision due to trail run-off generated by water bars in the slope trail.

Trail Section 2 (200 feet to 500 feet)
The trail surface was dressed and graded with new stone material.

Trail Section 3 (500 feet to end of stepped stone wall)
The trail tread stone surface had been hand-raked and graded in worn areas.

Trail section 4 (south end of stepped wall to Burt Dam)
The lowest portion of the trail section was resurfaced to replace eroded stone due to high water and erosion related to foot traffic.

3.13 Stepped Wall

The severely eroding bank was stabilized with a stepped wall with vegetation placed along the top of the bank and interspersed within the riprap rock bank. Other sections of the eroding bank were stabilized with large rock and vegetation. The restoration techniques used included a combination of "hard" (i.e., rock/armoring) and "soft" (i.e., vegetative plantings/bioengineering) techniques to maximize the success and benefits of the project to the ecosystem. The primary aquatic habitat enhancement of the stepped wall was to improve the stability of a portion of the bank that was severely unstable and exposed to a substantial amount of fishermen traffic.

The stepped wall utilized a bioengineering approach featuring innovative techniques to integrate vegetation into the stone armoring design. Planting pockets were created to cover portions of the exposed stone and boulders. The plantings ultimately will reduce heat loading and vegetate portions of the stepped wall, providing the function of a partially forested riparian zone.

Inspection and Performance

May 12, 2004

The stepped wall construction was in place and stable. No evidence of settling, shifting or movement of the stone-wall or substrate foundation was evident. There was some minor settling of the soil-choked interstices. Some cavities had settled over six inches but most all had receded only a few inches. This was an expected condition due to the limited ability to compact the soil mix used to fill the voids in the wall.

All areas of disturbed soil were secured with a course weave coir erosion control blanket. Seeding and plantings installed in 2003 were healthy and well established in all but a few areas of heavy foot traffic. First year seedlings and established plants were in good condition and exhibited healthy early season growth. Some plants and seeded areas were damaged by foot traffic and vandalism. Those areas are expected to fully recover with minimal replanting and seeding during the growing season.

July 13, 2004

The stepped stone wall was stable and in place. No shifting or movement was observed. All interstices that settled were filled with soil and seeded as necessary. All plantings except in high traffic areas were healthy and growing well. High traffic areas will be modified by placement of shrub islands or large stone barriers to modify traffic patterns and direct visitors to established trail sections. Based on these two site visits, the stepped wall was functioning as designed. The stepped wall provided access to the thousands of fishermen which use the area, as well as maintained stability of the bank in a severely eroded section.

3.14 Placed Rock Riprap

The stone used in trailside and streambank rip-rap armoring was selected and placed to provide interstices and designed cavities for addition of soil and plants. This application was similar in function and value to the stepped wall, but less engineered because it did not require structural stability or support needed by the wall feature. The design objective was to provide a vegetation cover for exposed stone, enhance wildlife habitat, and provide bank erosion control.

Inspection and Performance

May 12, 2004

All riprap placed stone features were in place and stable. All erosion control blankets in disturbed soil areas around placed riprap were in place and functioning. All cavity or interstitial plantings were healthy and appeared to have over-wintered well. Some fringe shrub plantings and seeded areas were vandalized or damaged by visitors presumably to get better access to water, but the overall stability of the banks in these areas was intact.

July 13, 2004

All placed riprap was in place and stable. Some detritus and waterborne organic debris was deposited on riprap at water's edge. Species recruitment was evident by seedlings growing in algae and organic matter deposits. Additional soil was added to placed rip-rap cavities. Damaged plants and seeded areas exhibited new growth due to the lack of visitor pressure during the warm season. Based on these two site visits, the placed rock riprap was functioning as designed. The banks in these areas were stable and additional vegetation growth in these areas was evident, thus these structures were intact and functioning as designed (i.e. the stability of the streambank in the areas was improved).

4 Maintenance Actions

Monitoring information provides an indication if the restoration measures are functioning as designed. In addition, monitoring allows the opportunity to assess the condition of various measures and determine if potential maintenance of the measures is necessary to prevent future damage to the restored system.

One of the limiting factors in restoration projects can be the designation of project funding to support long-term maintenance actions. Depending upon the nature of the restoration work, this may or may not be feasible. Nonetheless, methodology for maintenance measures should be developed with any restoration project to prevent the potential disturbance of various features.

There are two approaches that can be taken for long-term maintenance of more sophisticated restoration measures. One approach is to take action when signs of instability become prevalent. The second approach involves taking no action until major damage or repair appears inevitable. These approaches primarily relate to large-scale bank stabilization measures (i.e. the stepped wall area) that have the potential to cause significant damage to the system.

Signs of potential concern at the stepped wall area would include shifting of the toe stones or evidence of erosion at the key. The design of the stepped wall included pinning the toe stones into bedrock. There were several design components of the stepped wall that were included to minimize long-term maintenance of the wall. These include: keys (continuing the rock into the bank at an appropriate angle) on the upstream and downstream ends of the wall, the size of the stone, and the pinning of the toe stone. These measures should provide long-term stability to the wall. However, monitoring of the restoration work should include documentation of the toe and the greater wall to ensure stability.

Monitoring of the restoration measures may also indicate instability or improper functioning of other smaller-scale measures. Maintenance of these measures is more dependent upon local project support (i.e. environmental stewardship programs). One of the interesting components of the Eighteenmile Creek project was the Environmental Fair and tours of the sight by local school children. Local interest has been expressed to make the environmental fair an annual event. As this program evolves, workshop activities could include minor maintenance of the restoration work. For example, students could participate in placing fibrous root masses into the stream. This effort would promote carbon-loading and increase the diversity of streamside habitats. Additional plantings of trees and shrubs could also occur depending upon the survival of the existing plant community.

Depending upon the degree of environmental stewardship that may be developed for the Eighteenmile Creek area, simple maintenance actions are available to maintain the majority of the restoration measures used on the Eighteenmile Creek project (Table 1). If future monitoring efforts indicate that certain measures are not working, other restoration measures that are properly functioning may be substituted based on success of the measure (i.e. additional cover stones, more LWD, additional riparian plantings in the event that instant shade is not properly functioning).

Niagara County Soil and Water Conservation District has established a RAP Coordinator position for the Eighteenmile Creek AOC. Environmental stewardship of the greater Eighteenmile Creek watershed should be a priority action, to maintain the work discussed in this report, as well as additional remediation/restoration activities that need to take place throughout the watershed.

Long-term maintenance and upkeep of the site will be conducted by the town of Newfane, since the town has an easement on the site, and currently maintains the parking area. In addition, the town operates a daily entrance fee during the peak fishing time (i.e. September to December). These monies will assist in the upkeep and maintenance of the facility.

If future annual monitoring efforts indicate that the overall restoration measures are not functioning as designed, a meeting between the New York State Department of State and Department of Environmental Conservation will be held in order to discuss potential resolutions.

5 Summary

The objectives of the Eighteenmile Creek project included: improving the stability of the streambank in severely eroded areas, improving safety and condition of the existing trail, and enhancing the existing aquatic habitat of Eighteenmile Creek. Monitoring surveys indicated that the severely eroded areas of the trail were stable after the first spring high flow event post-construction. The overall integrity of the hiking trail was in good shape during the monitoring period. However, one location of the hiking trail was eroded, after a spring snowmelt/rain event. Maintenance actions (i.e. additional culvert installation) were taken to stabilize the eroded area and provide adequate drainage to the area for future high runoff events. The majority of the aquatic habitat measures were in place and properly functioning.

Post-construction monitoring did reveal that certain aquatic habitat enhancement measures were destroyed by fisherman, indicating incompatibly of certain restoration measure (i.e. trees and shrubs in casting areas) in locations of intense fishing pressure. Even though signage and a local restoration workshop were completed to help promote the benefits of the project, the high volume of fisherman and the likely beliefs of certain anglers curtailed the success of certain restoration measures.

Overall the Eighteenmile Creek Restoration project has been a great success. The severely eroding bank has been stabilized and designed to withstand a high volume of anglers during annual fish migrations. The hiking trail has been enlarged and provides safe access along the creek. The majority of the aquatic habitat enhancement measures are in place and functioning as designed.

Table 1. Restoration Measures, designed function, and potential maintenance measures of the Eighteenmile Creek Habitat Restoration project.

Restoration Measure	Function	Maintenance Measure
Locked Limb/Locked Log	Stability/Habitat	If the structures are pulled out and local bank instability is occurring, measures could include replacement or additional placement of rock for stabilization.
Instant Shade and Extreme Instant Shade	Habitat	If the trees do not survive, do not disturb, and allow the trees to become woody debris in the creek channel. If dead trees are causing bank instability, then cut the trees.
Stump Habitat	Habitat	None needed, if the stump moves downstream, no habitat degradation is expected to occur. Stump will continue to function as potential aquatic habitat.
Pole Planting in Riprap and Stepped Wall	Stability/Habitat	If the pole plantings do not survive, or are cut, no maintenance is necessary. With the high use of the area by anglers on a seasonal basis, the likelihood of pole plantings functioning/surviving in the stepped wall area is low.
Live Stakes	Stability/Habitat	If live stakes do not survive in areas which are devoid of plants, additional placement of suitable live stakes (i.e. willow, dogwood) should occur during the spring or fall.
Rooted Stock Plants	Stability/Habitat	If rooted stock plants do not survive in areas which are devoid of plants, additional placement of suitable rooted stock plants should occur during the spring or fall.
Grass Seeding of Disturbed Areas	Stability/Habitat	If previously disturbed areas become barren and begin to erode, additional seeding of the disturbed areas should occur to stabilize the area. Seeding should occur during the spring or fall.
Dense Root Mass Replication (DRMR)	Habitat	Dense root mass replication is a temporary measure to provide carbon-loading and habitat into the creek system. Yearly/seasonal placement or DRMR would provide additional aquatic habitat.

Table 1. Restoration Measures, designed function, and potential maintenance measures of the Eighteenmile Creek Habitat Restoration project.

Brush Layering (BL)	Stability/Habitat	BL is another technique that provides temporary to short-term habitat and stability in near-shore areas, and long-term riparian function if vegetation survives. Replacement is not necessary unless signs of bank failure are prevalent.
LUNKERS	Stability/Habitat	LUNKERS should provide habitat for long periods of time. If LUNKERS become unstable, or appear to be moving or failing, additional rock or replacement should be considered to prevent instability to the toe of the stepped wall area
Hydraulic Cover Stones	Habitat	If hydraulic cover stones move, no maintenance is necessary. If the stones become grouped together and begin to degrade other areas of the channel, maintenance should include separation of the stones to prevent further damage
Trail Enhancements	Stability	Trail enhancements should be monitored to ensure the safety and integrity of the trail is maintained. Additional measures could include, reapplication of crushed stone along path, replacement of culverts, if necessary, and maintenance of drainage ditches to prevent erosion of the trail.
Stepped Wall	Stability	Maintenance of the stepped wall will be necessary if any of the toe stones become unstable or move significantly. Maintenance of the wall could include replacement of toe stones, or placement of suitable rock to stabilize the area.
Placed Rock Riprap	Stability	Maintenance of the placed rock areas may be necessary if significant portions of the riprap areas become unstable or appear to be undermined. Maintenance of these areas could include replacement of missing rocks, or placement of suitable rock to stabilize the area.

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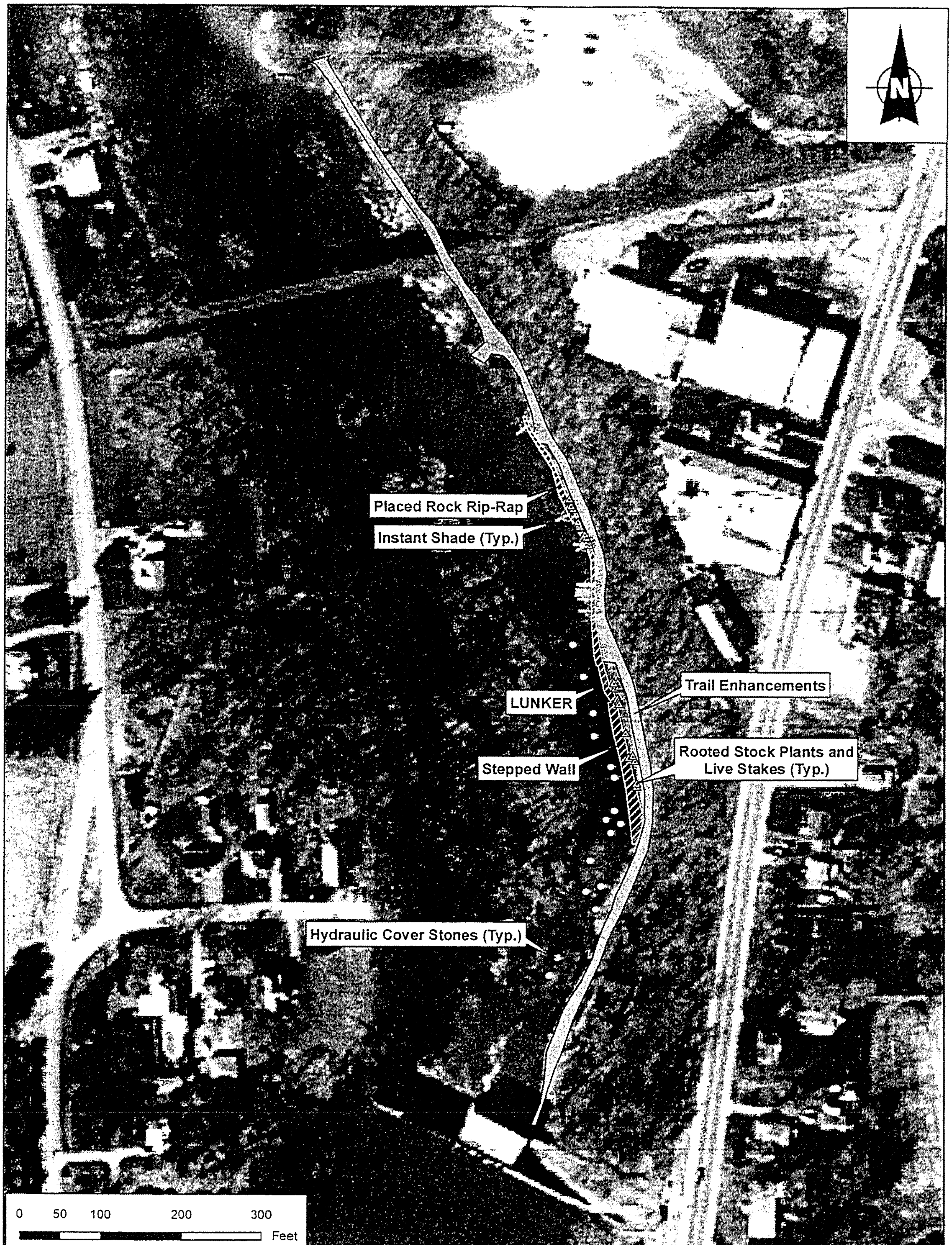


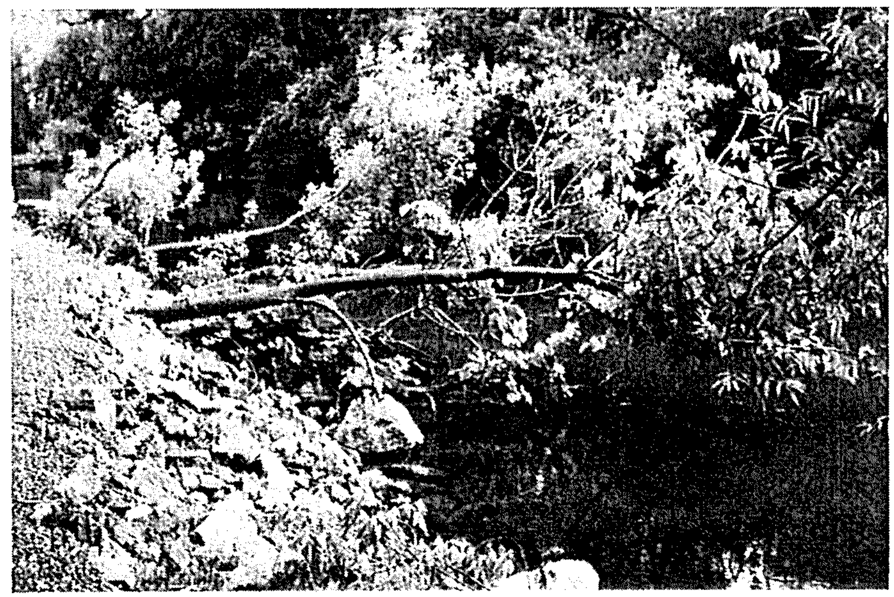
Figure 1
Restoration Measures at Eighteenmile Creek
Niagara County, New York

Appendix A.

1. Instant Shade (Restoration Measures 3.2)
2. Stepped Wall Cavity Planting (Restoration Measures 3.4, 3.7, and 3.13)
3. Stepped Wall Slope Planting (Restoration Measures 3.5, 3.6, 3.7, and 3.13)
4. Modified Rip-Rap Planting (Restoration Measures 3.5, 3.6, and 3.14)
5. Hydraulic Cover Stones (Restoration Measures 3.11)

Instant Shade

Before



After

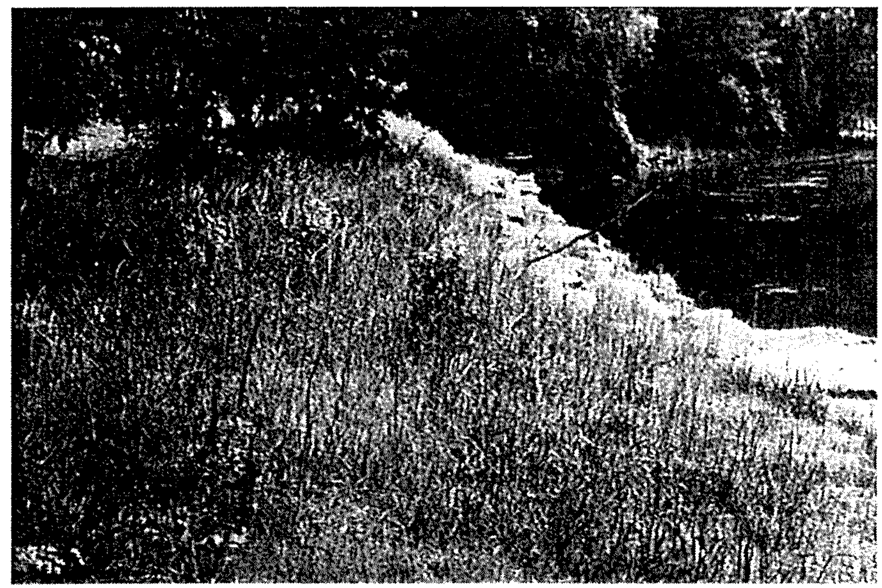
Stepped Wall Cavity Planting


Before


After

Stepped Wall Slope Planting

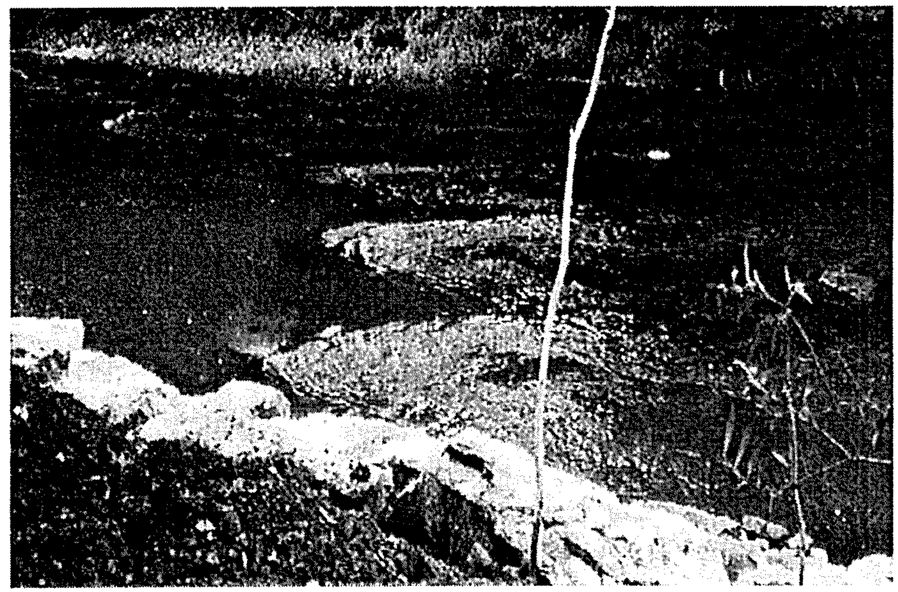
Before



After

Hydraulic Cover Stones


Before


After

Modified Rip-Rap Planting

Before

After