Stream Stabilization Plan

Stone Toe Protection is constructed from cobble-sized rock on the creek edges. It extends to approximately the bankfull level, which will protect the channel banks for flow events that occur every 1 to 2 years or less. The material will extend into the ground to resist scour. Coarse gravel is used to separate the larger rock material from underlying soil. Stone toe protection is typically used in conjunction with revegetation of the upper banks.

Existing Conditions
Fluvial bank erosion is caused by water in the stream moving past the streambanks. The shear stress caused by the flow entrains soil particles into the flow, causing the stream bank to erode away. This is the most common type of erosion that occurs in streams. Virtually all streams experience this type of erosion as their flow path evolves over time. However, the rate of fluvial bank erosion can increase when the stream is out of equilibrium with its watershed. Increased flow from a watershed will increase the rate of fluvial bank erosion. In many cases, it appears to be a part of the natural process of stream evolution. In places where the channel is confined by the valley walls, however, fluvial bank erosion can lead to failure of the high banks. It can also undermine storm sewer inlets.

Section Rendering

Materials
Materials will consist of cobble-sized material with coarse gravel filter layer to provide separation from the underlying soil. Natural fieldstone material will be used.

Stone Toe Protection
Bank Protection

Similar Projects
Stone toe protection has been used extensively in Nine Mile Creek’s Lower Valley, in conjunction with deflector dikes, grade control measures and stabilization of large bank failures. Following the 1987 “Super storm,” the proposed design allowed the stream to continue its course while taking measures to protect areas where water flow was eroding valley walls. The resulting measures have stabilized the stream channel and valley walls while blending seamlessly with the natural environment.
Stream Stabilization Plan

Rock vanes are constructed from boulders on the creek bottom. They function by diverting channel flow toward the center and away from the bank. They are typically oriented in the upstream direction and occupy no more than one third of the channel width. Vanes are largely submerged and inconspicuous. The rocks are chosen such that they will be large enough to resist movement during flood flows or by vandalsim, with additional smaller rock material to add stability. Rock vanes function in much the same way as root wads in that they push the stream thalweg (zone of highest velocity) away from the outside bend. They also promote sedimentation behind the vane, which adds to the toe protection.

Vanex can also be constructed from both banks, forming an upstream-pointing “V.” In this configuration, the vane protects both banks and also provides grade control.

**Materials**

Materials will consist of various gradations of rock, ranging from large, 3-foot boulders to coarse gravel.

Fluvial bank erosion is caused by water in the stream moving past the streambanks. The shear stress caused by the flow entrains soil particles into the flow, causing the stream bank to erode away. This is the most common type of erosion that occurs in streams. Virtually all streams experience this type of erosion as their flow path evolves over time. However, the rate of fluvial bank erosion can increase when the stream is out of equilibrium with its watershed. Increased flow from a watershed will increase the rate of fluvial bank erosion. In places where the channel is confined by the valley walls, however, fluvial bank erosion can lead to failure of the high banks. It can also undermine storm sewer inlets.

**Similar Projects**

Here is an example of a stabilization project designed for a 1,000-foot long, 20-foot high streambank that was severely eroded. The channel was directed away from the bank toe by installing six rock vanes. The bank was planted with native vegetation and protected with erosion control blanket, while the terrace above the bank was graded to redirect surface runoff to a less vulnerable area. The restored streambank withstood significant flooding during 2001, and has become nicely vegetated (see picture above).
Stream Stabilization Plan

Soil Pillows are utilized in a bioengineering method known as Vegetated Reinforced Slope Stabilization (VRSS). The method combines rock, geosynthetics, soil and plants to stabilize steep, eroding slopes in a structurally sound manner. VRSS typically involves protecting layers of soils with a blanket or geotextile material (e.g. erosion control blanket) and vegetating the slope by either planting selected species (often willow or dogwood species) between the soil layers or by seeding the soil with desired species before it is covered by the protective material. In either case, with adequate light and moisture, the vegetation grows quickly and provides significant root structure to strengthen the bank. This method tends to be labor intensive and, therefore, relatively expensive.

SECTION RENDERING

The Mill Creek Restoration Project utilized soil bioengineering design to stabilize 175 linear feet of severely eroding streambanks within the Caldwell Recreation Park in southeastern Ohio. The work included two 25-foot vegetated reinforced soil slope (VRSS) sections, two 50-foot fill bank sections protected with woven coir and direct woody plantings, and a 12.5-foot tie-in on the upstream and downstream end of streambank work area.

MATERIALS

Materials consist of graded rock for the lower layers of the structure and for internal drainage, if necessary. Geotextile fabric is used to wrap the soil. Plants, such as willow or dogwood, or seed mixture is used for planting in and between the soil pillows.

Fluvial bank erosion is caused by water in the stream moving past the streambanks. The shear stress caused by the flow entrains soil particles into the flow, causing the stream bank to erode away. This is the most common type of erosion that occurs in streams. Virtually all streams experience this type of erosion as their flow path evolves over time. However, the rate of fluvial bank erosion can increase when the stream is out of equilibrium with its watershed. Increased flow from a watershed will increase the rate of fluvial bank erosion.

In places where the channel is confined by the steep valley walls, however, fluvial bank erosion can lead to failure of the high banks. It can also undermine storm sewer inlets. For sites where groundwater seepage is a problem and where it is desirable to maintain steep banks, soil pillows are a feasible solution.
Stream Stabilization Plan

Grade control measures are used where channel downcutting has occurred. Various types of weirs are commonly used to provide grade control on streams, particularly in steeper systems. Weirs can be constructed of sheetpiling, concrete, or natural materials such as rock. In most cases, natural rock is used to emulate natural riffles. Large boulders would comprise the core of the structure, with smaller rock material placed on the upstream and downstream sides of the boulders to provide a gradual transition to the channel.

The riffles will serve to raise the surface of the water profile, and will reconnect the stream to its floodplain areas. Following the installation of the riffles, pools will be created upstream of the riffles. However, these pools will fill with sediment over time, which will in effect raise the channel bottom to the desired elevation.

MATERIALS
Materials will consist of various gradations of rock, ranging from large, 3-foot boulders to coarse gravel.

Existing Conditions
Channel incision occurs when there is an imbalance between the sediment supply and the sediment carrying capacity of the stream. Erosion will occur when the sediment carrying capacity of a stream exceeds the sediment supply. In streams with cohesive banks and steep channel slope, the erosion will first occur primarily on the channel bottom because that is where the erosive forces are the strongest. As the channel deepens, the stream will gradually become wider as the banks eventually fail. The stream will gradually return to equilibrium; however, the process can take many years and significant amounts of erosion will occur during the process.

Section/Plan Rendering

SIMILAR PROJECTS
Following the 1987 “super storm,” a rapids was constructed on Nine Mile Creek downstream of the 106th Street Bridge. The rapids was one of several grade-control structures that were installed on a three-mile stretch of creek in the lower valley. The proposal allowed the stream to continue its course while taking measures to protect areas where water flow was eroding valley walls. Protection measures included applying porous deflector dikes, burying sheetpile walls parallel to the creek to prevent undercutting of slopes, installing weirs (rock or capped sheetpiles) to limit stream-bed degradation, and improving storm-sewer outlets.

Constructed Pools
Grade Control

BARR
Stream Stabilization Plan

Culvert Stabilization is somewhat unique to each situation, depending on the site circumstances. Most sites require additional rock placement with a granular filter layer (rather than filter fabric). Some cases may require re-alignment and/or lowering of the outlet to better align with the stream channel. Typically, outlets should be aligned in the downstream channel direction so that flow doesn’t impinge on the opposite bank. It is usually desirable for the culvert to enter the stream at or just above the normal water level in order to minimize the potential for undercutting.

There are many culvert stabilization designs used on various streams and rivers. Because they are often small projects, the work is often performed by local municipalities or completed as part of a larger project.

Erosion is frequently observed at culvert outlets for a variety of reasons, including insufficient erosion protection at the culvert outlet, streambank erosion, and channel downcutting, which leaves the culvert perched above the channel. Filter fabric is often used at culvert outlets to separate riprap protection from underlying soils, however the fabric provides a slippery surface for the riprap, which commonly slides into the channel.

Materials consist of rock materials ranging from graded riprap (either fieldstone, or, for steep slopes, angular) and granular filter material (typically coarse gravel). If necessary, additional pipe, manholes and end sections may be necessary.

Culvert Stabilization
Bank Protection
1. INSTALLATION SUMMARY

Trench design construction will be done in dry weather conditions. After snow and ice have disappeared, the contractor will begin work.

2. SUBGRADE AND FOOTER LOGS

**SPECIFICATION**
- 3" to 4" diameter
- Silver to black

**PLACEMENT**
- Excavate to grade elevation - contractor shall make efforts to preserve topsoil and fill with native material for use in steps or other areas.
- Place footer logs at least 30 degrees from parallel to stream flow with ends starting downhill a 30 to 45 feet, above average stage of 1' above base.
- Footing logs shall be extended 1' above low water elevation.

3. ROOT WADS & LRG WOODY DEBRIS

**SPECIFICATION**
- 10" in diameter
- Length based on design cross section on 10' min.
- Length required
- Ends trimmed to a point

**PLACEMENT**
- Large woody debris should be placed on the bank or in the flow.
- Place 5 to 7 large woody debris logs between root wads on the right side of the stream.

4. WOODY DEBRIS & GRANULAR FILL

**SPECIFICATION**
- Woody debris composed of small limbs and branches, 1" max diameter and smaller
- Stout stumps with debris.
- Uniform granular fill.

**PLACEMENT**
- Fill between root wads and between woody debris.
- No woody debris to be placed above 6" elevation.
- Subgrade granular fill to grade woody debris.
- Woody debris fill to grade.
- Woody debris fill to grade.

5. LIVE CUTTINGS

**SPECIFICATION**
- Tee live cutting detail

**PLACEMENT**
- Tee cutting with a density of 10 cuttings per linear foot.
- End of cutting will point towards channel.
- Tee cuttings should be parallel, leaving no more than 6" exposed.
- Tee cuttings and waterlines.

6. SOIL LIFTS

**SPECIFICATION**
- Tee live cutting detail

**PLACEMENT**
- 30 x 30" tee live cutting detail.
- Size of lift based on design cross section.
- Lifts should be symmetrically placed between root wads.

7. VEGETATION

**SPECIFICATION**
- See vegetation plan for details.

**PLACEMENT**
- See vegetation plan for details.

8. SILL LOGS & TERMINATION

**SPECIFICATION**
- Sill log detail

**PLACEMENT**
- Sill log detail.
- Rock sill on both sides.
- Sill log will meet channel.
- Rock sill 30 degrees.
- Sill log detail.

**TOE WOOD**

**EXAMPLE DETAIL**
CEDAR PILES AND RIPRAP APRON DETAILS

SECTION 1 - CEDAR PILES

- Design Pile Material: Cedar
- Diameter: Round Cedar
- Type: Type B
- Depth: 5 feet
- Spacing: 3 feet

Face of Existing Embankment/Bank Cut

- Face of Existing Embankment/Bank Cut
- 5 ft
- Round Cedar Piles

EXCAVATION

- Excavation for Pile Placement
- Excavation for Foundation

EXCAVATION CONTROL SLOPE

- Control Slope
- Slope 1:3

EXCAVATION TRENCH AND TEES

- Excavation Trench and Tees
- 1 ft

CEMENT CONTENT

- Cement Content
- Amount: 10%
GENERAL NOTES:
1. The engineer must be notified at least 3 days prior to Root Wad installation and must be on site during installation.
2. To the extent possible, root wads should be created from trees that will be removed from the sites within the project area.
3. Construction should proceed from downstream to upstream in areas where more than one root wad will be installed as shown on the drawings.
4. Excavate a trench along the streambank toe for the footer logs.
5. Place the footer logs into the trench, with the tops of the logs at specified elevations for each site.
6. Excavate a trench in which to place the root wad. In soft soils it may be possible to drive the root wad into the bank with equipment after sharpening the end to a point. Care shall be taken not to damage the root wad.
7. The root wad must be placed in the bank so that the back of the root fan rests against the front of the footer log.
8. The root fan must be placed such that the fan is angled upstream as shown and as directed by the engineer.
9. Moving upstream, the process is repeated for each additional root wad as shown on the drawings.
10. Large boulders are placed on either side of the trunk of each root wad.
11. Place back fill over the boulders as necessary with a coarse filter aggregate (WA/Dept Standard Specification 3142.2M) and match existing grade with 6” of topsoil.
12. Reforest and stabilize with erosion control blanket as specified for each site as shown in the drawings and directed by the engineer.
13. Trim the roots that extend above the stream bank to a height slightly below bank height as directed by the engineer.