U.S. Army Corps of Engineers
Philadelphia/Baltimore Districts

Alternate Green Stream Bank Stabilization Methods

Wissahickon Creek, Tannery Run and Rose Valley Creek
Bo-Rit Asbestos Site
Ambler, Pennsylvania

Prepared for

U.S. Environmental Protection Agency
Region III

Prepared by

U.S. Army Corps of Engineers
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I. INTRODUCTION

In 2006, the U.S. Environmental Protection Agency, Region III (EPA) requested that the U.S. Army Corps of Engineers, Philadelphia District (USACE) develop a matrix of possible stream bank stabilization solutions for the Bo-Rit Asbestos Site, which is located in Ambler, PA. The original remedial solutions proposed by the USACE were primarily hardened structures and were presented in the document entitled "Potential Bank Stabilization Methods, Wissahickon Creek, Tannery Run and Rose Valley Creek near the Bo-Rit Site, Ambler, Pennsylvania" (USACE, September 2006). In April 2008, EPA requested that the USACE develop more naturally appearing "greener" solutions to stabilize the eroding stream banks. This report discusses the greener solutions suggested by the USACE.

The project area extends approximately 2,440 feet along the Wissahickon Creek and 775 feet along Rose Valley Creek. Rose Valley Creek is a tributary to the Wissahickon Creek. Tannery Run, which was included and discussed in the 2006 report; has been eliminated in the current reevaluation since EPA has decided to enclose this stream in a culvert within the study area. Therefore, Tannery Run will not be discussed in this report.

Stabilization of the Wissahickon Creek and Rose Valley Creek are required because the existing stream banks, which contain Asbestos Containing Material (ACM), are eroding and the ACM is exposed to stream flow. Both friable and bound ACM (pipes, rings and shingles) are visible along the banks of the streams as they flow adjacent to the asbestos site. The project location is shown on the Site Layout Map in Figure 1.

II. SITE DESCRIPTION

Wissahickon Creek

The majority of the Wissahickon Creek that passes along the western side of the site has a bedrock channel that is approximately 30-40 ft wide within the project area. The left bank is stepped in places with a 2-5 ft high stream bank, a 10–20 ft wide bench and then another 10-15 ft rise beyond the stream. The left bank contour varies due to the random placement and grading of the ACM fill. The right bank did not receive asbestos fill and is adjacent to residential properties (single homes with large back-yards). The right bank is approximately 2-5 ft high. A sanitary sewer runs just behind the right bank.

The upstream portion of the Wissahickon Creek has visible ACM pipes and rings protruding from the bank and sometimes ACM is present in the channel. This material will reportedly be removed and properly disposed during the embankment stabilization process.

Rose Valley Creek

Rose Valley Creek has a bottom width of approximately 10-15 ft. The surficial sediments are predominately sand/gravel and river-rock (cobbles). The banks are approximately 2-5 ft high and nearly vertical at the downstream end. At the upstream end, the banks are approximately 10-15 ft high with slopes that are typically 1H:1V. Both left and right banks contain ACM that is both friable and non-friable (pipes and rings).

III. ASBESTOS CHARACTERISTICS

Review of EPA technical data on the migration pathway of asbestos contamination in air and water indicates that the migration of asbestos contamination from ACM is greatly inhibited by a suitable cover. Asbestos fibers do not significantly migrate through soil, so placing a soil cover of sufficient thickness is an ideal and cost effective containment solution. However, since a soil cover is susceptible to erosion, it must be protected by a suitable erosion control device.

IV. CONSTRUCTION CONSIDERATIONS

Temporary access roads, staging areas for equipment and materials, work areas/pads for equipment working from top of the banks and equipment cleaning area will have to be constructed as part of the mobilization effort on site. These actions will preclude any formal stabilization method work and will help to minimize impacts of equipment disturbance on existing exposed ACM. New fences may have to be constructed along with signage restricting access to anyone not signed in, properly briefed and trained on the site hazards and utilizing the required PPE (personal protective equipment).

It is assumed for cost estimating purposes that all streams will be temporarily diverted using techniques such as water bladder dams, Portadams®, portable coffer dams, or using a pumped diversion system, so that the construction work can proceed under de-watered conditions.

Along the Wissahickon Creek, the stream is generally wide enough so that the water can be diverted to one side, allowing work to be completed from the dewatered stream bed without the use of a pumped diversion system. Heavy equipment will also need to work on the bank above the toe to properly compact the protective fill cover and install erosion control materials over the exposed asbestos containing materials.

Construction at Rose Valley will also have to be performed in the dry, making it necessary to divert the stream flow. Since flow is relatively low in this creek, water could be pumped or otherwise diverted around the work area. Additionally, a temporary construction access road will most likely need to be built along the bank to provide access for construction equipment and to stage the construction.

All methods assume that there will be minimal bank disturbance. Whichever alternative is utilized, the existing bank must be prepared to permit installation of the selected revetment solution. This preparation will include the removal of all ACM from the adjacent streambed and protruding from the face of the slope, regrading of the embankment slope to the requirements of the particular alternative selected, and preparation of the slope surface to support the erosion protection. The preparation of the slope is critical to the long term stability of the erosion control system.

As indicated above, asbestos does not readily migrate through soil. As such, covering any exposed ACM material on the bank with at least one foot of riprap or soil cover, or equivalent combined soil and erosion control cover, should prevent the ACM migration from the soil into the air and prevent lateral migration with the groundwater into the adjacent stream.

V. STABILIZATION METHODS

Stabilization methods will consist of three parts:

(1) the toe that is always submerged,
(2) the area between the toe and the upland that will be submerged during storm events,
(3) the upland area that extends to approximately 10-12 feet up the slope above the water's edge.

Although the goal of the proposed solutions is to be as "green" as possible, they necessarily contain some hardened or semi-hardened features near the toe because "soft" solutions will not withstand aggressive flow velocities. As such, a typical "green" stream bank stabilization project often incorporates some type of biodegradable, semi-biodegradable or semi-hardened structure that protects the submerged toe and supports the growth of water-edge vegetation.

The following section describes stabilization methods for the toe, the zone between the toe and upland section, and for the upland section along the streams at the Bo-Rit site. Each method has been characterized as "non-degradable" or "degradable." Degradable products promote the establishment of vegetation, and will deteriorate over time and thus will no longer provide long term embankment support. These are usually utilized to rehabilitate lake shores or along roadways that are not subjected to aggressive water flow conditions such as in the upland area at the Bo-Rit site. Non-degradable products are used to provide long term stabilization and continual support to vegetation in more aggressive erosion control applications as occur between the toe and upland area along the Wissahickon and Rose Valley Creeks.

(1) Toe Protection: Since aggressive stream flows are expected periodically, a hardened or semi-hardened structure is recommended for the toe. The following methods were considered:

Riprap (non-degradable).
Wissahickon – Possible; Cost estimate will be computed
Rose Valley – Inappropriate due to narrow channel width

Geocells* – filled with stone or natural-looking cemented stone (non-degradable).
Wissahickon – Possible; Cost estimate will be computed
Rose Valley – Possible; Cost estimate will be computed

Stacked Erosion Control Tubes; a.k.a., "Biologs" (degradable).
Wissahickon – Possible; Not recommended due to high velocities
Rose Valley – Inappropriate due to narrow channel width

(2) Between Toe and Upland Protection: A greener erosion protection, reinforced to prevent stream erosion, is recommended above the lower hard protection. This softer protection must be durable enough to remain in place and stable until substantially well-rooted vegetation has an opportunity to take hold and stabilize the upper toe area if degradable material is used. The following methods were considered:

Soil-choked Rip-rap with plantings (non-degradable).
Wissahickon – Possible; Cost estimate will be computed
Rose Valley – Inappropriate due to narrow channel width

Geocells* – soil filled with plantings (non-degradable).
Wissahickon – Possible; Cost estimate will be computed
Rose Valley – Possible; Cost estimate will be computed

Scour-stop mats** (non-degradable).
Wissahickon – Possible; Cost estimate will be computed
Rose Valley – Possible; Cost estimate will be computed

* Geocells are also known as Geoweb®, Confined Cellular System (CCS), etc.
** Scour-stop mats or similar products, such as Scourstop™, high performance TRM (HPTRM), etc.

(3) Upland Protection: The upland area is expected to be dry under normal conditions and only exposed to low velocities during storm events, which will not be erosive enough to fail the protection. Upland protection height will vary depending on the specific site conditions, but is expected to be approximately 10-12 feet upslope on the banks or at a significant break in slope (change from steep slope to flat slope). Asbestos-containing pipes will be crushed and buried under the clean fill. Clean fill will be then be placed over the existing prepared ground. The clean fill should consist of 8 inches common fill

overlain by 4 inches of topsoil. The topsoil shall be seeded and stabilized with one of the following turf reinforcement materials:

Soil Filled Turf Reinforcement Mat (TRM) (non-degradable).
Wissahickon – Possible; Cost estimate will be computed
Rose Valley – Possible; Cost estimate will be computed

Eco Blanket – pneumatically sprayed TRM alternative (degradable).
Wissahickon – Not recommended; May not be as durable as a TRM
Rose Valley – Not recommended; May not be as durable as a TRM

Coir Mat (degradable).
Wissahickon – Possible; Cost estimate will be computed
Rose Valley – Possible; Cost estimate will be computed

A rough cost estimate for selected options is presented in Attachment I. Sample photos of several methods are presented in Attachment II.

VI. RECOMMENDED PLAN

Based on effectiveness, cost and constructability the following plans are recommended:

Wissahickon Creek

All stabilization methods discussed in this report include both the left and right banks. The left bank will be stabilized to contain the asbestos materials and the right bank will be protected to prevent any erosion that may be induced by the required changes in the stream cross section to contain the ACM on the left bank. Only the left bank will receive upland protection. Upland stabilization will utilize a "soft" method since the upland area is expected to be dry under normal conditions and only exposed to low velocity overland flow during storm events which will not be erosive enough to fail the protection recommended. The bench and lower bank area will require a more durable erosion protection as they will be exposed to more aggressive stream velocities.

Toe: Since the toe will always be subject to shear stresses induced by water flow, a hardened structure is necessary. We recommend a riprap toe on the Wissahickon that extends up the bank for approximately 3 feet measured along the slope. This will require a geotextile overlain by 6 inches of bedding material and riprap having a layer thickness of approximately 12 to 18 inches. This protection will be placed on both sides of the Wissahickon. The right bank is uncontaminated and will therefore only receive a riprap toe to prevent any erosion. The protection will encroach into the stream several feet depending on the bank slope. Since the Wissahickon is approximately 30 feet wide and has a non-erodible rock bottom, this is not expected to have any serious effects on flow rate and flooding. However, before a design is finalized, hydraulic modeling should be completed to determine the effects due to the channel and overbank alterations.

Between toe and upland: The area above the toe will be dry under normal flows but will be submerged and subject to erosive forces under storm conditions. As such, the solution for this level should be a combination of an aesthetically pleasing "green" solution with a hardened structure for stability. For this level, we recommend a soil-choked riprap that extends up the bank approximately 4 feet above the riprap toe. Willows and a riverbank mix would be planted so that their root system would further stabilize the banks and also provide a green cover. Right bank protection above the riprap toe is not recommended.

An alternative to soil filled riprap is a proprietary product called "scour-stop mats". This product consists of perforated flexible green mat approximately 1 inch thick that allow vegetation to grow through while providing almost the same shear resistance as riprap. Also, soil-filled geocells with plantings is another stabilization option, but this system will not provide the same level of protection as the soil-filled riprap or scour-stop mats, and is therefore not recommended for the Wissahickon Creek.

Upland: EPA requested that our solution cover approximately 10 to 12 feet upslope on the banks. This area is expected to be submerged infrequently. FEMA's Flood Insurance Study (2001) shows that the 10-year water surface is approximately 7 feet deep based on the channel center. Therefore, the recommended 3 feet of riprap and 4 feet of soil-choked riprap starting near the stream edge exceeds the 10-year water surface. No surveys were available to determine the elevation of the channel center compared to the channel edge. These heights should be adjusted based on surveys. Since this area will be dry most of the time, we recommend a soil-filled, turf reinforcement mat (TRM) be utilized in this area to stabilized the 12" of cover soil. Note that the 12" will be comprised of 8" of common clean fill overlain by 4" of topsoil. The TRM is approximately 1/2-inch thick and would be placed over the 4" of topsoil and then soil filled/seeded.

Rose Valley Creek

Hardened stabilization methods should be used at the toe of the bank to resist the more aggressive flow erosion that may occur there. Since this stream is relatively narrow, it is anticipated that it would be easier and more cost effective to line the channel bed with the same material that will be placed at the toe of the bank rather than to stop at the bed and "key-in" the protection on both sides.

Soft methods are recommended for the upland stabilization. For the purposes of the attached initial rough cost estimate, it was assumed that the same method will be used for both the upstream and downstream portions. However, subsequent analyses performed after more detailed data on the site conditions is collected may determine that more than one method may be required to better address the varying bank slopes along this creek.

Since Rose Valley is only approximately 10 feet wide, riprap cannot be used because it would extend too far into the channel, restricting the flow. Additionally, the overbanks of this stream vary in slope, requiring one solution for steep areas and a different solution for gentler slopes.

For the steeper slopes, we recommend lining the banks and channel with geocells. In the stream, it will be filled with stone or natural looking cemented stone. On the banks, the geocells will be filled with soil and vegetation. The geocells will also have to be anchored at the top of bank slopes using proprietary anchor systems. The anchor systems will be hidden from view, as the cables are internal to the geocells system and the anchors will be buried at the top of slope.

On gentler slopes, we recommend using a geocells in the stream filled with stone or natural looking cemented stone. On the banks of gentler slope areas, a soil-filled turf reinforcement mat capable of withstanding the stream velocities and shear stresses should be used.

These geocells and/or TRM will have less hydraulic impact than riprap. We recommend hydraulic modeling be performed to determine the hydraulic effects of this remedy. The modeling should also be used to determine the water velocities so they can be compared to the allowable velocity or shear stress that the geocells and/or TRM can withstand.

The geocells can be cut to go around existing trees as much as practicable but must be seeded with appropriate vegetation that will grow under shady conditions. We also recommend preventative measures be taken to control invasive species so that the vegetation intended for bank stability is able to flourish and cover the area.

VII. ENVIRONMENTAL/SAFETY CONSIDERATIONS

The USACE suggests that the USEPA provide an ACM control at the site to restrict or minimize exposure to ACM before mobilization effort commences. At a minimum, constant wetting of the surfaces is assumed prudent. Surfaces containing ACM on which equipment will be utilized, such as wheeled or track mounted equipment should be covered with clean soil, mats, or some other type of suitable cover to prevent disturbance of the ACM. This engineered control will help minimize ACM exposure to the workers and the public and may influence minimum level of PPE required to do the work on site.

Continuous area air monitoring and sampling will be required before, during and after construction phase activities onsite; in particular, at the residences, adjacent facilities and at the McDonald’s restaurant nearby. Personal asbestos sampling will be required for contractor employees. The results of which will help determine and verify the appropriate PPE to be used by workers on site. All contractors working for the USACE on behalf of USEPA will also be required to perform all work in accordance with EM 385-1-1 (Safety – Safety and Health Requirements).


Reservoir
Legend
Gate
R5 SEPTA rail line
Tributary
Spillway
Site Boundary
Reservoir
Borit Asbestos Pile
Dirt piles
Tennis court
Source: Modified from U.S. Geological Survey Digital Orthophoto MrSID mosaic for Ambler Quadrangle, Pennsylvania (NAPP II, 1999)
0 100 200 300
Feet
Quadrangle Location – Pennsylvania
Borit Asbestos Tailing Pile Site
Ambler, Montgomery County, Pennsylvania
Figure 1 – Site Layout Map
TETRA TECH EM INC.

Figure 1

ATTACHMENT I

SOLUTION MATRIX WITH COST ESTIMATES

GENERAL REQUIREMENTS COST		
	Wissahickon Creek	**Rose Valley Creek**
See Note Below	**$955K**	**$675K**
TOE PROTECTION		
Riprap	**$1.1M**	NA
Geocells (cement/stone filled)	**$455K**	**$175K**
BETWEEN TOE AND UPLAND PROTECTION		
Soil-Choked Riprap and plantings	**$1.3M**	NA
Geocells (stone/soil filled)	**$400K**	**$168K**
Scour-Stop Mats	**$825K**	**$385K**
UPLAND PROTECTION		
Soil Filled Turf Reinforcement Mat (TRM)	**$110K**	**$30K**
Coir Mat	**$90K**	**$30K**

Notes:
1. General requirements include mobilization, demobilization, care and diversion of water, clearing, erosion control, and typical field overhead items.
2. The cost estimate for the Wissahickon Creek is based upon an assumed remedial length of approximately 2440 feet along the creek. The right bank will only have toe protection.
3. The cost estimate for the Rose Valley Creek is based upon an assumed remedial length of approximately 775 feet along the creek. Both banks will have full protection.
4. The total cost of the project will be the addition of the general requirement cost, the toe protection cost, between toe and upland, and the upland protection cost.

ATTACHMENT II (specific products are noted for identification purposes only)

SAMPLE PHOTOS - TOE PROTECTION

Riprap. Photo shows riprap above water line. Riprap above the waterline at Bo-Rit will be soil-choked and planted.

Erosion control tubes (Filtrexx photo)

Geocells –cement filled

SAMPLE PHOTOS - BETWEEN TOE AND UPLAND PROTECTION

Soil Choked Riprap with plantings

After 1 year

After 2 years

Confined Cellular System (CCS) – gravel filled
Soil will be placed on top of gravel

SAMPLE PHOTOS - UPLAND PROTECTION

Slope Stabilization—Partially Vegetated

TerraGuard™ 45P

Turf Reinforcement Mat (TerraGuard Photo)

Eco Blanket (Filtrexx Photo)

Coir Mat with Willow Plantings