

I. Detailed alternatives for stabilization

The following discussion is organized by location within each reach, referred to as “stabilization sites.” The stabilization sites for the entire project area are shown in Figure I-1. Potential stabilization alternatives for each reach are summarized in Figure I-2 through Figure I-4 and in Table I-1. Sites within each reach that have similar characteristics and stabilization alternatives (Sites 10 and 11) are discussed together.

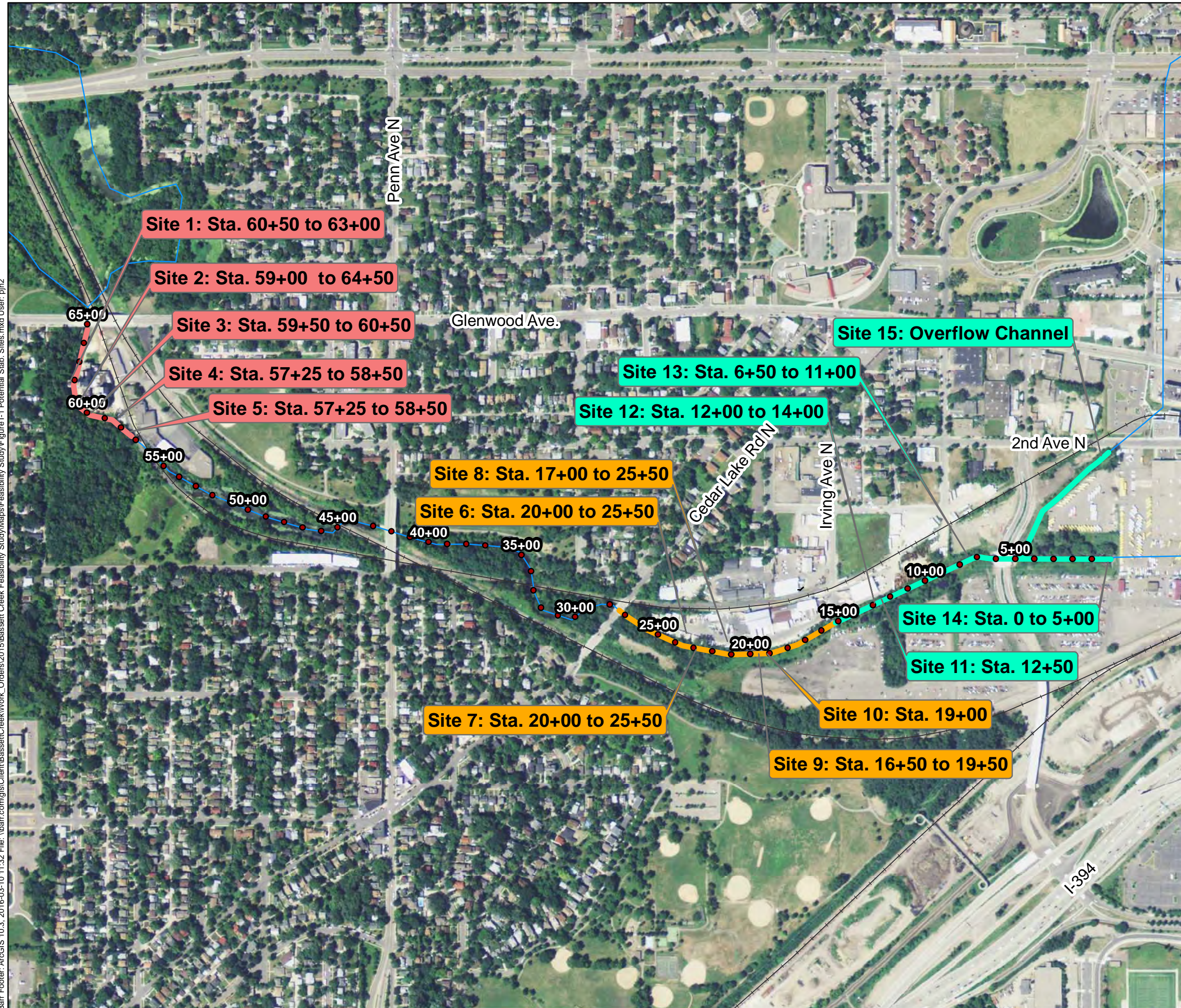
For each stabilization site (or group of sites), the following discussion includes:

- A brief description of the site characteristics.
- The issues to be addressed.
- Potential feasible alternatives for stabilization, with the advantages and disadvantages of each.
- A brief description of alternatives deemed infeasible after consideration.

A variety of factors or combinations of factors may make a “do-nothing” option viable for an individual site; however, that approach may not be cost-effective—particularly if the site may require stabilization in the near future. If a “do-nothing” approach is ultimately chosen for a particular site, the potential need for future stabilization should be evaluated. This evaluation should consider whether likely access routes to the site could damage the measures already installed.

Although the sites for stabilization are discussed individually, final project design will likely result in a nearly continuous implementation of stabilization techniques through all three stream reaches. The stabilization sites identified in Figure I-1 generally abut and overlap one another; however, not all stream banks within each reach need stabilization and recommended techniques may differ between adjacent sites.

Barr Footer: ArcGIS 10.3, 2016-03-10 11:32 File: \\barr.com\gis\client\BassettCreek\Work_Orders\2015\BassettCreek_Feasibility_Study\Figure I-1 Potential Stab. Sites.mxd User: pjh2



Legend

- Reach 1
- Reach 2
- Reach 3
- Non-Project Area Streams
- 100-ft Creek Stationing

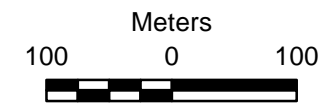
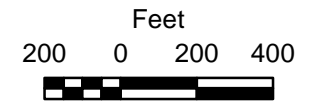


Figure I-1

**BASSETT CREEK POTENTIAL
STABILIZATION SITES**
Bassett Creek Erosion Repair Feasibility Report
Bassett Creek Watershed
Management Commission





Reach 1

Issues: Concrete and limestone armoring on east bank in varying states of repair. Foot path on west bank being eroded in places, submerged at high flows.

Constraints: Water level control must remain at the historic dam site. Historic rock and brick walls must remain. Narrow valley and infrastructure limits meandering potential. Potential soil contamination due to history of industrial use.

Legend

-  Pedestrian Bridge
-  Outfall

Note: Individual alternatives are defined as a, b, or c for many of the sites. One or more alternatives will be chosen for each site.

(*) Indicates recommended alternative

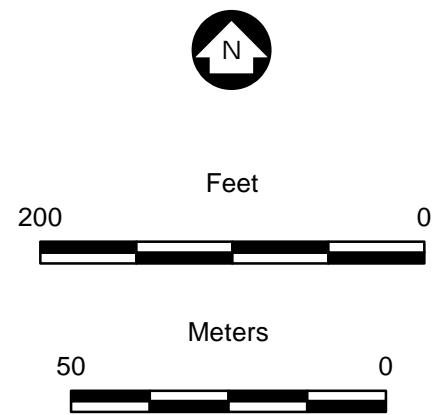


FIGURE I-2
BASSETT CREEK REACH 1 ALTERNATIVES
REACH 1 - FRUEN MILL SITE
 Bassett Creek Erosion Repair Feasibility Report
 Bassett Creek Watershed Management Commission

I.1 Site 1

Site 1 includes a segment of the MPRB walking trail that runs along the west bank of Bassett Creek opposite the Fruen Mill complex, extending from Station 60+50 to 63+00 on Figure I-2. The trail runs adjacent to the stream throughout this site and is inundated at bankfull and flood flows; portions of the trail occasionally experience minor erosion. To the west of the walking trail are several segments of historical brick retaining walls at the base of a steep slope. Photo 1 in Appendix A shows a typical portion of this site.

Alternative 1A—Abandon trail and move to higher elevation

Alternative summary: Adjust the trail alignment so that it runs at a significantly higher elevation and is not adjacent to the stream. Stabilize the existing trail location with vegetation capable of surviving infrequent periods of inundation.

Advantages: Abandoning the trail will reduce the impact of any minor bank migration and reduce the erosion caused by foot traffic. Moving the trail up the hillside will not require any special measures to protect or restore the historical retaining walls.

Disadvantages: Clearing a new trail will create a significant disturbance within Minneapolis Park and Recreation Board (MPRB) land and be more costly than leaving it in place. The public perception of the trail and its natural amenities may also be altered if the trail no longer runs directly along the stream bank, and foot traffic may continue along the abandoned trail.

Feasibility: This alternative is feasible due to a recent land exchange that provides the MPRB with continuous land ownership along a potential trail realignment route.

Alternative 1B—Design trail for submergence at high flows

Alternative summary: Retain the trail in its current position adjacent to the low-flow stream channel, but design its surface and edges to be stable when submerged. Stabilize the in-stream trail edge with riprap and the walking surface with plastic geoweb.

Advantages: The trail can be stabilized in-place without disturbing the historical stone walls or clearing a corridor across the hillside. The trail will retain its access to the stream and provide natural amenities for park users.

Disadvantages: The trail will be impassable for periods when stream flows are significantly above average. Additional maintenance of the improved trail will be required to address any damage following high-flow events. Significant changes to the trail width or elevation will not be feasible and hydraulic modeling will be required during final design to ensure the flood profile is not impacted.

Feasibility: This alternative is feasible provided that acceptable trail surface materials can be identified during final design (i.e., materials capable of withstanding stresses during high flows without increasing flood elevations). Adjustments to the trail width will likely be contingent on grading on the opposite channel bank (see Site 2) to maintain the existing channel cross section.

Infeasible alternatives

Significant changes to the trail width or elevation along its current alignment are not considered feasible. These approaches would cause impacts to the historical retaining walls (likely not permitted by SHPO policies) and would likely increase flood elevations (not permitted by BCWMC policies).

Adjustments to the sheet pile and riprap structure at the Fruen Mill Dam could reduce the frequency with which the walking trail is inundated at this location and reduce flood elevations. Adjustment or removal of the structure is not considered feasible because a lowered water surface elevation would cause the upstream channel to disconnect from the floodplain, potentially eroding stream banks and undercutting historical retaining walls.

Recommendations

Alternative 1B is recommended to address the erosion of the existing foot path, provided that grading on the opposite channel bank allows for maintenance of the existing channel cross section. Stabilization of the narrow walking trail within the stream bank will not preclude the MPRB from moving the trail to a higher elevation in the future, if desired. This recommendation is consistent with plans previously permitted by SHPO.

I.2 Site 2

The entire eastern bank of Bassett Creek through the Fruen Mill complex is identified as Site 2 (Station 59+00 to 64+50 on Figure I-2). The eastern stream bank through this site is fully armored with a combination of historical limestone blocks and concrete; some of the armoring materials are failing or have collapsed into the stream. Photo 2 in Appendix A shows a typical portion of this site.

Alternative 2A—Grade and vegetate stream bank

Alternative summary: Remove the failing concrete slabs (and the limestone blocks if possible) and grade the stream bank to a stable slope (3 feet horizontal to 1 foot vertical [3H:1V] or flatter). Establish vegetation along the stream bank to provide long-term stability.

Advantages: Removing the concrete and establishing vegetation will create a more natural stream bank and improve access to the stream from the Fruen Mill complex when it is redeveloped. If removal and repurposing of the limestone blocks is permitted, they will provide architecturally pleasing materials for landscaping the site. Grading and revegetation could potentially be coordinated with development landscaping activities to reduce project costs and minimize site disturbance.

Disadvantages: Permitting challenges associated with disrupting and/or removing the limestone blocks may make this alternative infeasible. If the limestone blocks must be left in place, it may be difficult to remove only the concrete and grade stable slopes in the vicinity. Depending on the design of future landscaping and stream access, foot traffic may trample grading and natural vegetation and facilitate erosion. In addition, removed soil will likely require landfill disposal because of the potential for contamination.

Feasibility: This alternative is feasible, especially if the limestone blocks can be removed and repurposed. Construction of this alternative would slightly increase the channel cross section, allowing construction of Alternative 1B on the opposite bank.

Alternative 2B—Install riprap toe protection

Alternative summary: Install additional riprap along the eastern banks and adjust existing riprap to prevent additional failure of bank armoring materials.

Advantages: Riprap is relatively inexpensive, effective at reducing bank erosion, and if properly designed can be resilient to large flood events. Leaving the concrete and limestone block in place will reduce permitting challenges and prevent future erosion from foot traffic.

Disadvantages: Stabilizing the stream channel with additional hard armoring may be less aesthetically pleasing. Hard armoring does not encourage vegetative growth and does not appear natural or provide quality in-stream habitat. If erosion occurs around or behind the riprap, maintenance costs tend to be higher than for bioengineering techniques. Due to the existing hard armor on the stream bank, excavation will be limited and the addition of riprap may impact flood elevations.

Feasibility: Provided the design of the stream channel can maintain existing flood elevations, this alternative is feasible.

Recommendations

Alternative 2A provides an opportunity to restore natural stream bank vegetation and the potential to coordinate with development activities to reduce project costs and minimize site disturbance. This alternative is recommended and would enable construction of Alternative 1B on the opposite bank. If possible, coordinate stabilization activities with grading or landscaping performed during redevelopment of the Fruen Mill site.

I.3 Site 3

Site 3 is a short section of the western stream bank opposite the Fruen Mill complex (Station 59+50 to 60+50 on Figure I-2). Rock riprap has been placed along the bank upstream of the Fruen Mill Dam to protect the walking trail, which is near the creek's bankfull elevation. There is bank erosion in several locations between the upstream end of the riprap and an historical limestone block wall (submerged during high flows). Photo 3 in Appendix A shows a typical portion of this site.

Alternative 3A—Extend riprap to tie into historical wall

Alternative summary: Install riprap from the upstream end of the existing riprap to tie into the historical stone wall.

Advantages: Riprap is relatively inexpensive, effective at reducing bank erosion, and if properly designed can be resilient to large flood events. Adding to the existing riprap toe protection will maintain visual continuity around the stream bend, protect the walking trail, and preserve the retaining wall.

Disadvantages: Adding riprap along the stream bank will not reduce the high shear stress generated around the outside of the meander bend.

Feasibility: This alternative is feasible only if there is no net decrease in the stream cross section.

Alternative 3B—Install boulder or log vanes

Alternative summary: Install boulder or log vanes around the eroding bend to direct flow to the center of the stream. Vanes could be installed instead of or in addition to the riprap in Alternative 3A.

Advantages: Boulder or log vanes will reduce the erosive stress on the outer bank, reduce bank erosion, and protect the walking trail. Vanes also create mid-channel scour pools that can increase habitat diversity.

Disadvantages: Depending on their design, vanes can increase the upstream flood profile; hydraulic modeling will be required during final design to ensure that flood impacts are acceptable. Adding vanes to the outer banks will require more detailed design and construction oversight to achieve the desired flow patterns.

Feasibility: This alternative is feasible.

Infeasible alternatives

Existing hard armoring (riprap and historical retaining walls) and the presence of the walking trail make installation of bioengineering measures infeasible. Bioengineering measures (vegetated banks or root wads) are most successful when they can be installed continuously through a stream section, not used to “patch” gaps in other stabilization measures.

Recommendations

Alternative 3A is recommended to maintain continuity with the in-place stabilization measures and to simplify stabilization of this site. The riprap toe protection for this site should tie into the riprap toe associated with the walking trail improvements in Alternative 1B. This recommendation is consistent with plans previously permitted by SHPO.

I.4 Site 4

Downstream of the Fruen Mill Dam, a concrete swale directs surface runoff from the paved areas east of Bassett Creek into the stream (Station 58+50 on Figure I-2). Because the swale is on the outside of the meander bend, high flows are gradually eroding the bank under the swale. This site also includes the east bank of the creek from the swale to the downstream railroad bridge (Station 57+25 to 58+50 on Figure I-2). Photo 4 in Appendix A shows a typical portion of this site.

Alternative 4A—Replace swale with catch basin, culvert, and flared-end section

Alternative summary: Remove the existing swale and install a catch basin and culvert to convey surface runoff to the stream. Install a flared-end section (FES) to direct flow into the stream at the low-flow elevation and pointed downstream.

Advantages: A catch basin and FES will effectively stabilize the stormwater outfall to the creek, preventing erosion. In addition, a sump catch basin will provide an opportunity for retention of some sediment or debris and a small improvement in water quality.

Disadvantages: Over time, the stream bank around the FES may become eroded and need additional stabilization. Replacing the structure will not reduce the high shear stress generated around the outside of the meander bend.

Feasibility: This alternative is feasible.

Alternative 4B—Install boulder cross vane

Alternative summary: Install a boulder cross vane at the eroding bend to direct flow to the center of the stream and away from the stormwater outfall. A cross vane could be installed instead of or in addition to the stormwater improvements in Alternative 4A and could be one of several vanes installed in Alternative 5A.

Advantages: A boulder cross vane will reduce the erosive stress on the outer bank, reduce bank erosion, and protect the stormwater outfall. A cross vane will also create a mid-channel scour pool that can increase habitat diversity and maintain flow vectors centered along the stream channel.

Disadvantages: Depending on their design, cross vanes can increase the upstream flood profile; hydraulic modeling will be required during final design to ensure that flood impacts are acceptable. Adding a vane to the outer bank will require more detailed design and construction oversight to achieve the desired flow patterns.

Feasibility: This alternative is feasible, provided that hydraulic modeling shows no impacts to flood elevations.

Alternative 4C—Install riprap toe protection around swale and downstream

Alternative summary: Install riprap toe protection along the eastern stream bank from the upstream side of the existing swale, extending downstream to the railroad bridge. Grade the stream bank to provide additional cross-sectional area to offset area occupied by the riprap and stabilization measures selected for Site 5.

Advantages: Riprap is relatively inexpensive, effective at reducing bank erosion, and if properly designed can be resilient to large flood events. Riprap toe protection along the stream bank will prevent erosion around the concrete swale on the upstream and downstream sides.

Disadvantages: Adding riprap along the stream bank will not reduce the high shear stress generated around the outside of the meander bend and around the concrete swale.

Feasibility: This alternative is feasible if there is no net decrease in the stream cross section.

Infeasible alternatives

Due to concerns about shallow groundwater quality and the potential for contaminated soils at the Fruen Mill site, installation of a stormwater infiltration basin instead of a direct stormwater discharge is not considered feasible.

Recommendations

Alternative 4C is recommended to stabilize the stormwater swale location as well as the downstream bank.

I.5 Site 5

Site 5 is located downstream of the Fruen Mill Dam and upstream of the railroad bridge, along the west bank of Bassett Creek (Station 57+25 to 58+50 on Figure I-2). Photo 5 in Appendix A shows a typical portion of this site. The majority of the stream flow is along the opposite (east) bank, but the downstream railroad bridge causes a flow constriction and backwater along the west bank. Highly turbulent flows have eroded the toe of the west bank and created a cut bank up to 7 feet tall in places.

Alternative 5A—Install boulder or log vanes

Alternative summary: Install boulder or log vanes and reshape the channel bottom to narrow the low-flow channel and maintain downstream flow vectors while maintaining the overall channel cross section.

Advantages: Narrowing the channel and directing flow downstream will reduce erosive stress on the stream bank and will improve habitat by deepening the channel during low flows.

Disadvantages: Narrowing the channel during low and average flows will transfer the high flow velocities farther downstream and may cause erosion downstream. Hydraulic modeling will be required during final design to ensure that flood impacts are acceptable.

Feasibility: This alternative is feasible, provided that hydraulic modeling shows no impacts to flood elevations.

Alternative 5B—Install composite rock/wood bankfull bench

Alternative summary: Install composite rock/wood bank protection—stone toe with protruding logs, topped with vegetated-reinforced soil slope (VRSS)—along the eroding bank to increase roughness of the lower banks and establish a vegetated bench at the toe of the high, eroding banks.

Advantages: Using a combination of natural materials and hard armoring, composite rock/wood bank protection is effective in reducing stream bank erosion. This site contains significant amounts of rock riprap, which can be reshaped to create a narrow vegetated bench separating the area of high erosive stress from the steep bank.

Disadvantages: Installation of composite rock/wood bank protection is more challenging than hard armoring and will require additional construction oversight to achieve the desired flow patterns.

Narrowing of the low-flow cross section to create the vegetated bench will necessitate hydraulic modeling during final design to ensure that flood impacts are acceptable.

Feasibility: This alternative will make use of existing materials on the site and is feasible if hydraulic modeling shows no impacts to flood elevations. Potential impacts on historical wall segments adjacent to the railroad bridge will need to be considered during detailed design.

Alternative 5C—Install VRSS and riprap toe protection

Alternative summary: Install riprap toe protection and bioengineering in the form of VRSS to establish a vegetated bench at the toe of the high, eroding banks.

Advantages: VRSS is aesthetically pleasing after the vegetated banks begin to thrive and uses renewable materials. If properly designed and installed, VRSS can be resilient in large flood events. Riprap can be resilient to large flood events and can protect the vegetation from undercutting during high flows.

Disadvantages: Due to the shady conditions, suitable species will need to be selected; site preparation, seeding, and maintenance to establish vegetation will need to be tailored to the site. VRSS is more costly to install than hard armoring. During high or turbulent flows the toe of the VRSS may be susceptible to erosion, especially prior to full vegetation.

Feasibility: Shade-tolerant species are available and the VRSS area can feasibly be vegetated, though relatively frequent maintenance may be required to establish the vegetation.

Infeasible alternatives

Bassett Creek through Site 5 is constrained on the upstream end by the flow over the sheet pile structure at the historical dam location and on the downstream end by the railroad bridge crossing. Significant changes to the channel alignment or profile, such as lengthening the stream channel by installing a new meander bend, are considered infeasible due to the constraints.

Recommendations

Alternative 5C is recommended because it will allow for long-term stabilization of the high, eroding west bank while using existing rock riprap. Any re-shaping of the low-flow channel required to install the bankfull bench should be coordinated with the riprap toe stabilization recommended in Alternative 4C to verify that flow patterns are appropriate and that there is no increase in flood levels.



Reach 2

Issues: Historically straightened and brick-lined; banks are steep and eroding in places. Stream bed is a mixture of native and imported materials

Constraints: Narrow valley and infrastructure limits meandering potential. Adjacent land use on north bank limits potential for buffering with vegetation. Adjacent soils are likely contaminated, especially on the south side, due to history of industrial use and dumping.

Legend

- Pedestrian Bridge
- Culvert Outfall

Note: Individual alternatives are defined as a, b, or c for many of the sites. One or more alternatives will be chosen for each site.

(*) Indicates recommended alternative.

N

Feet

200 0

Meters

50 0



FIGURE I-3
BASSETT CREEK REACH 2 ALTERNATIVES
 Bassett Creek Erosion Repair Feasibility Report
 Bassett Creek Watershed Management Commission

I.6 Site 6

Site 6 is located along the northern bank of Bassett Creek, downstream of Cedar Lake Road in Reach 2 (Station 20+00 to 25+50 on Figure I-3). The stream bank throughout this site is approximately 6 feet tall and steep, with areas of undercutting visible on the bottom 2 feet of bank. In many areas the undercutting appears to follow a layer of bricks into the stream bank; these bricks are thought to be from the channelization of Bassett Creek in the 1930s. Although the stream bank is vegetated with trees of varying sizes, many are undercut and in danger of falling into the stream. Logs, fencing, and other debris are present along the upper banks; in some locations the debris is prevented from falling into the stream only because it is caught on overhanging trees. The adjacent industrial facility maintains a trailer storage and parking lot near the top of the existing stream bank. Photo 6 in Appendix A shows a typical portion of this site.

Alternative 6A—Grade stream bank and vegetate

Alternative summary: Remove the leaning/undercut trees and debris and grade the stream bank to a stable slope (3H:1V or flatter). Establish vegetation along the stream bank to provide long-term stability. Install riprap toe protection to prevent erosion and undercutting along the lower stream bank.

Advantages: Removing the debris, grading the bank, and establishing vegetation will create a more natural and stable stream bank that is less prone to erosion at the toe. Riprap toe protection is relatively inexpensive, effective at reducing bank erosion, and if properly designed can be resilient to large flood events.

Disadvantages: Due to the long history of industrial use and filling at this site, soil contamination is likely. The removed soil will likely require landfill disposal because of the potential for contamination. In addition, grading the stream bank to a stable slope will require a significant number of tree removals and move the top of the stream bank into the existing parking lot.

Feasibility: This alternative is feasible only if the existing landowner allows shifting of the stream bank and a reduction in the size of the parking lot.

Alternative 6B—Install VRSS

Alternative summary: Install bioengineering in the form of VRSS to stabilize the stream bank and encourage vegetative growth. Install riprap toe protection to prevent erosion and undercutting along the lower stream bank.

Advantages: VRSS is aesthetically pleasing after the vegetated banks begin to thrive and uses renewable materials. If properly designed and installed, VRSS can be resilient to large flood events. VRSS is also able to remain stable at steeper slopes than soil and vegetation alone and would maintain a bank slope more similar to the existing conditions. Less soil removal and landfilling is required for VRSS compared to bank grading. Riprap toe protection is relatively inexpensive, effective at reducing bank erosion, and if properly designed can be resilient to large flood events.

Disadvantages: Due to the shady conditions, suitable species will need to be selected; site preparation, seeding, and maintenance to establish vegetation will need to be tailored to the site. VRSS is more costly to install than grading or hard armoring alone.

Feasibility: Shade-tolerant species are available and the VRSS area can be feasibly vegetated, though relatively frequent maintenance may be required to establish the vegetation.

Alternative 6C—Install boulder wall

Alternative summary: Install hard armoring in the form of a boulder wall to stabilize the stream bank.

Advantages: A boulder wall will stabilize the stream bank and prevent further erosion while maintaining a bank slope as steep as the existing conditions. Less soil removal and landfilling is required for boulder wall construction compared to either bank grading or VRSS.

Disadvantages: Hard armoring does not encourage vegetative growth and does not appear natural or provide quality in-stream habitat. If erosion occurs around or behind the boulders, maintenance costs tend to be higher than for bioengineering techniques.

Feasibility: This alternative is feasible if bioengineering alternatives are not feasible.

Infeasible alternatives

Due to the adjacent private property and land use that must be maintained, as well as the high potential for soil contamination along the stream, significant changes to the channel alignment (e.g., creation of new meander bends) are considered infeasible. The costs associated with the required soil correction and property acquisition are beyond the scope of this stabilization project.

Recommendations

Alternative 6B is recommended to establish native vegetation and protect the stream bank toe from future erosion.

I.7 Site 7

Site 7 is located along the same portion of Bassett Creek as Site 6 (Station 20+00 to 25+50 on Figure I-3), but comprises the stream bed rather than the banks. The bed consists of a mixture of natural and imported materials, including rock riprap, concrete blocks, and bricks. The stream slope through this site is steeper than the surrounding areas of Bassett Creek. Photo 7 in Appendix A shows a typical portion of this site.

Alternative 7A—Install fieldstone riprap to create a riffle-pool structure

Alternative summary: Remove imported bed materials and create a riffle-pool bed structure using riffles constructed from fieldstone riprap. Anchor the riffle material into the stream banks as needed, but do not otherwise adjust the stream banks.

Advantages: Establishing natural stream bed materials and structure will create in-stream habitat diversity while maintaining a stable stream bed. If properly designed, the riffles and pools will be self-maintaining and resilient to large flooding events.

Disadvantages: Removing the existing (imported and potentially historical) bed materials may require additional testing for contamination or additional permitting. In addition, the steep stream slope and high velocities in this site may require large and costly materials to maintain channel stability. Hydraulic modeling will be required during final design to ensure that flood impacts are acceptable.

Feasibility: Providing that the design of the riffles can maintain existing flood elevations, this alternative is feasible.

Alternative 7B—Install boulder or log vanes to create a step-pool structure

Alternative summary: Remove imported bed materials and create a step-pool bed structure using constructed boulder or log vanes. Anchor the vanes into the stream banks as needed, but do not otherwise adjust the stream banks.

Advantages: A step-pool bed structure may be better able to withstand high flow velocities at this site than constructed riffles. Disturbance of the stream bed associated with vane construction will be more localized than with riffle construction and require less material testing or disposal.

Disadvantages: A self-maintaining step-pool structure may be difficult to establish at this site due to the stream slope; some pools may experience sedimentation, especially downstream. Hydraulic modeling will be required during final design to ensure that flood impacts are acceptable.

Feasibility: Providing that the design of the vanes can maintain existing flood elevations, this alternative is feasible.

Infeasible alternatives

Similar to Site 6, significant changes to the channel alignment or profile (e.g., creation of new meander bends) are considered infeasible. The costs associated with the required soil disposal and property acquisition are beyond the scope of this stabilization project.

Recommendations

Alternative 7B is recommended to minimize the disturbance of the stream bed, create a stable stream bed, improve in-stream habitat, and retain or improve navigability of the creek for recreational uses.

I.8 Site 8

Site 8 is located along the same portion of Bassett Creek as Sites 6 and 7 (Station 17+00 to 25+50 on Figure I-3), but includes the overbank areas on the north side of the stream rather than the stream bed or banks. This area, which extends nearly to the top of the existing stream bank, is on private property used for trailer storage and a parking lot. Debris from the industrial operation at the site can be blown down the stream banks, and runoff from the parking lot enters the stream either as sheet flow or through one of several storm sewer outlets. Stabilization of Site 8 will be designed to complement and tie in to whichever

stabilization alternative is selected for the stream banks in Site 6. Photo 8 in Appendix A shows a typical portion of this site.

Alternative 8A—Remove debris and stabilize top of bank

Alternative summary: Remove debris from the top of the stream bank and stabilize the immediate top of the bank with a row of trees approximately 3 feet wide.

Advantages: Removing the debris and establishing vegetation will help prevent erosion from overland flow and debris from entering the stream. Beyond any bank grading required for stabilization of the stream banks in Site 6, this alternative will require only minor additional acquisition of easements or land from the property owner.

Disadvantages: Vegetative plantings at the immediate top of the bank will have limited ability to filter overland flow. The narrow width of the vegetated area at the top of the bank may not create a sufficient visual buffer and may be susceptible to damage due to parking lot use, snow plowing, or compaction.

Feasibility: This alternative is feasible if the existing landowner allows a small reduction in the size of the parking lot.

Alternative 8B—Install buffer strip at top of bank

Alternative summary: Remove debris and install a 20-foot-wide vegetated buffer along the top of the stream bank.

Advantages: A vegetated buffer will filter sediment and debris out of overland flow from the surrounding parking lot and will capture wind-borne debris before it enters the stream. A buffer zone will also prohibit large vehicles from parking immediately adjacent to the stream bank, reducing the risk of mass bank failure when soils become saturated and overloaded after flooding events.

Disadvantages: Due to the long history of industrial use and filling at this site, soil contamination is likely. Removed soil will likely require landfill disposal because of the potential for contamination, therefore the vegetated buffer will need to be over-excavated for surface-soil correction. The buffer will also require a significant easement or land acquisition and reduce the size of the existing parking lot.

Feasibility: This alternative is feasible only if the existing landowner is willing to grant an easement and allow a reduction in the size of the parking lot.

Recommendations

Alternative 8A is recommended to minimize the need for property or easement acquisition, although significant maintenance may be required if plantings are damaged through use of the adjacent parking lot. The establishment of this narrow vegetated buffer is contingent upon the approval of the landowner and operator of the Pioneer Paper facility.

I.9 Site 9

Site 9 is located along an undercut southern bank of Bassett Creek, downstream of the heavily wooded section of Reach 2 (Station 16+50 to 19+50 on Figure I-3). Although the upper bank is well-vegetated with grasses, the lower banks do not have extensive root mass or surface protection. Photo 9 in Appendix A shows a typical portion of this site.

Alternative 9A—Grade stream bank and vegetate

Alternative summary: Remove the existing small trees and grade the stream bank to a stable slope (3H:1V or flatter). Establish vegetation along the stream bank to provide long-term stability.

Advantages: Grading the bank and establishing vegetation will create a more natural and stable stream bank that is less prone to erosion at the toe.

Disadvantages: Due to the long history of industrial use and filling at this site, soil contamination is likely. The removed soil will likely require landfill disposal because of the potential for contamination. Grading the stream bank to a stable slope will move the top of the stream bank south, perhaps by 5 feet or more.

Feasibility: This alternative is feasible.

Alternative 9B—Install root wads

Alternative summary: Install root wads around the eroding outer bend to direct flow to the center of the stream.

Advantages: Root wads will reduce the erosive stress on the outer bank, reduce bank erosion, and allow vegetation to become established. Root wads also create scour pools and cover that can increase habitat diversity within the stream. Several trees will likely need to be removed to gain access to these banks; these trees would be used for the root wads.

Disadvantages: Root wads will require tree removal; the bank in this location is heavily not wooded and tree removals are not expected to provide all the material needed for root wads. Adding root wads to the outer banks will require more detailed design and construction oversight to achieve the desired flow patterns.

Feasibility: This alternative is feasible provided root wads will not require tree removals that would not otherwise be necessary.

Alternative 9C—Install riprap toe protection

Alternative summary: Install riprap along the outer bank to reduce the sediment loading and loss of bank.

Advantages: Riprap is relatively inexpensive, effective at reducing bank erosion, and if properly designed can be resilient to large flood events. Riprap toe protection will require less grading and soil correction than a vegetated slope or VRSS installation.

Disadvantages: Hard armoring does not encourage vegetative growth and does not appear natural or provide quality in-stream habitat. If erosion occurs around or behind the riprap, maintenance costs tend to be higher than for bioengineering techniques.

Feasibility: This alternative is feasible if bioengineering alternatives are not feasible.

Alternative 9D—Install willow stakes and live fascines

Alternative summary: Use willow cuttings harvested from adjacent locations on Bassett Creek to create live stakes and fascines. Install fascines along the stream bank toe and live stakes along the top of the bank.

Advantages: Willows are fast-growing and create robust root networks that help stabilize stream banks. Improving the vegetation will improve aesthetics of the stream corridor and minimize erosion from the bare banks; the fascines will reduce undercutting while the vegetation becomes established. Using a vegetation-only approach will not require contaminated soil management.

Disadvantages: Improving stream bank vegetation will not help create in-stream pools for habitat diversity and energy dissipation.

Feasibility: This alternative is feasible, especially given the large stands of willows at various locations within Reaches 2 and 3.

Recommendations

Alternative 9D is recommended. This approach will result in a stand of thick-growing willows along the southern bank to aid in screening the City of Minneapolis Impound Lot from view from neighborhoods to the north.

I.10 Sites 10 and 11

Sites 10 and 11 consist of stormwater culverts protruding from the stream banks and elevated above the channel bottom. Flow obstruction, created by the culvert outlets during periods of high flow, has created erosion at both outlet locations. Photo 10 and Photo 11 in Appendix A provide typical views of these sites.

Alternatives 10A and 11A—Lower culvert

Alternative summary: Adjust the final section or sections of pipe so that the culvert enters Bassett Creek at the channel bed.

Advantages: Lowering the culverts will prevent local bed and bank erosion by reducing flow obstruction during periods of high flow and direct the culvert water more efficiently into Bassett Creek during periods of low flow.

Disadvantages: Depending on the culvert design, a stormwater manhole may need to be installed adjacent to the stream bank to provide the necessary drop in flow elevation. Due to the long history of industrial use and filling at this site, soil contamination is likely. Excavation for the culvert or manhole will need to include contaminated soil management.

Feasibility: This alternative is feasible.

Alternatives 10B and 11B—Shorten culvert and add riprap

Alternative summary: Shorten the culvert at Site 10 so it does not protrude from the stream banks, and add riprap below both culvert outlets to prevent erosion during low-flow conditions.

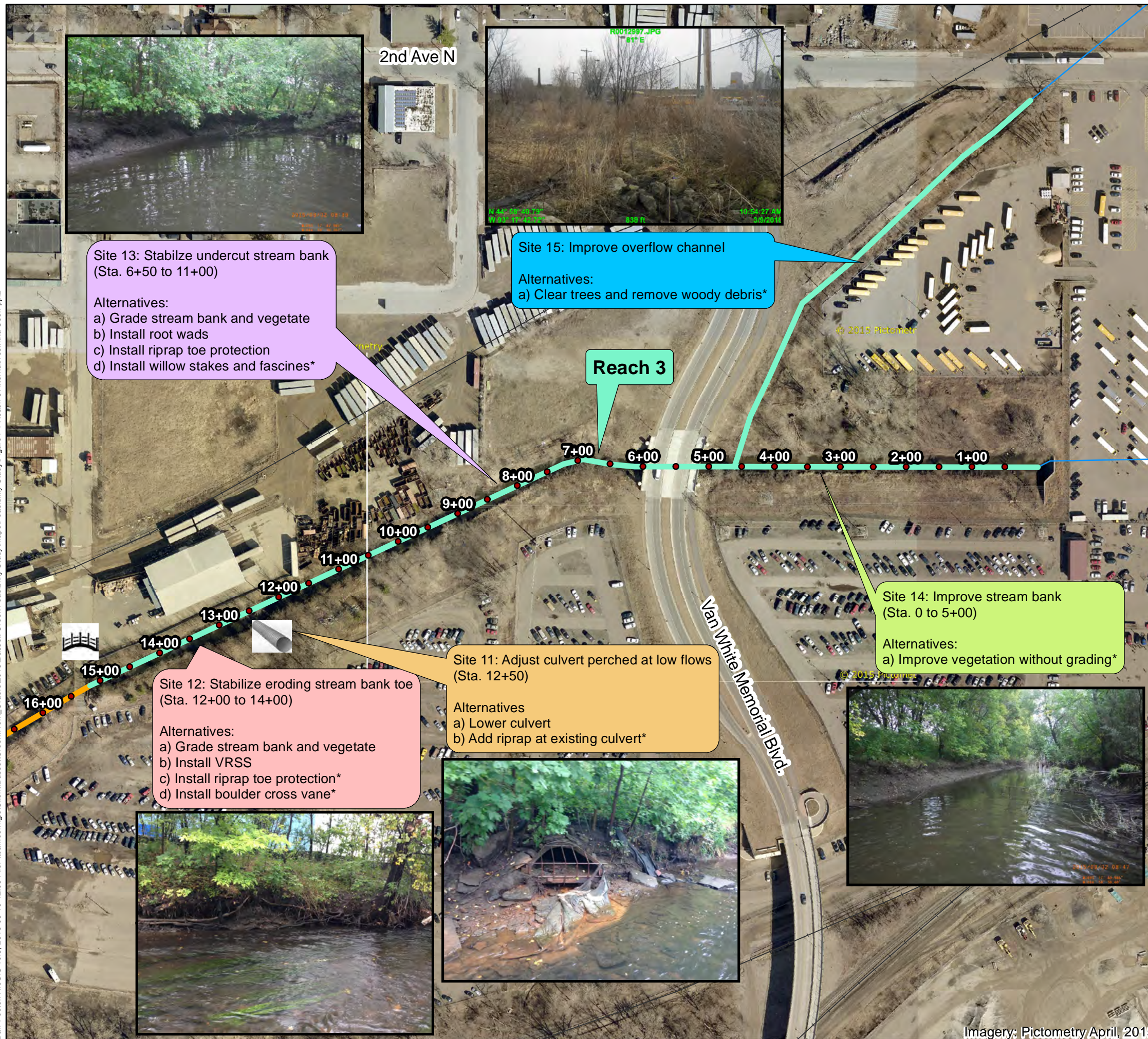
Advantages: Shortening the culvert at Site 10 will prevent local bed and bank erosion by reducing the flow obstruction during high-flow conditions while requiring minimal excavation of the stream banks. Maintaining the length of the culvert at Site 11 will reduce costs and achieve stabilization through riprap additions alone.

Disadvantages: If culverts are significantly elevated above the channel bottom, culvert flows will still create a potential for erosion during low-flow conditions.

Feasibility: This alternative is feasible.

Recommendations

Shortening the culvert at Site 10 and adding riprap at both culverts is a low-cost solution that will not require installation of additional structures; therefore, Alternatives 10B and 11B are recommended.





Reach 3

Issues: Historically straightened and brick-lined; banks are steep and eroding in places. Stream bed is a mixture of native and imported materials

Constraints: Narrow valley and infrastructure limits meandering potential. Adjacent land use on north bank limits potential for buffering with vegetation. Adjacent soils are likely contaminated, especially on the south side, due to history of industrial use and dumping.

Legend

-  Pedestrian Bridge
-  Culvert Outfall

Note: Individual alternatives are defined as a, b, or c for many of the sites. One or more alternatives will be chosen for each site.

(*) Indicates recommended alternative

N

Feet

200 0 200

Meters

50 0 50



FIGURE I-4
BASSETT CREEK REACH 3 ALTERNATIVES
 Bassett Creek Erosion Repair Feasibility Report
 Bassett Creek Watershed Management Commission

I.11 Site 12

The bed and banks of Bassett Creek downstream of the Irving Avenue Bridge are lined with rock riprap for approximately 150 feet. The toe of both banks is eroding immediately downstream of the riprap due to high-velocity flow exiting the riprap-lined section. Site 12, in Reach 3, includes both stream banks from Station 12+00 to 14+00 (see Figure I-4). Photo 12 in Appendix A shows a typical portion of this site.

Alternative 12A—Grade stream bank and vegetate

Alternative summary: Remove the existing small trees and grade the stream bank to a stable slope (3H:1V or flatter). Establish vegetation along the stream bank to provide long-term stability.

Advantages: Grading the bank and establishing vegetation will create a more natural and stable stream bank that is less prone to erosion at the toe.

Disadvantages: Due to the long history of industrial use and filling at this site, soil contamination is likely. The removed soil will likely require landfill disposal because of the potential for contamination. In addition, grading the stream bank to a stable slope will move the top of the stream bank towards the existing parking lot on the north side of the stream.

Feasibility: This alternative is feasible only if the existing landowner allows shifting of the stream bank and a reduction in the size of the parking lot.

Alternative 12B—Install VRSS

Alternative summary: Install bioengineering in the form of VRSS to stabilize the stream bank and encourage vegetation.

Advantages: VRSS is aesthetically pleasing after the vegetated banks begin to thrive and uses renewable materials. If properly designed and installed, VRSS can be resilient to large flood events. VRSS is also able to remain stable at steeper slopes than soil and vegetation alone and maintain a bank slope more similar to existing conditions. Less soil removal and landfilling is required for VRSS compared to bank grading.

Disadvantages: Due to the shady conditions, suitable species will need to be selected; site preparation, seeding, and maintenance to establish vegetation will need to be tailored to the site. VRSS is more costly to install than grading or hard armoring alone. During high or turbulent flows the toe of the VRSS may be susceptible to erosion, especially before vegetation is fully established.

Feasibility: Shade-tolerant species are available and the VRSS area can be feasibly vegetated, though relatively frequent maintenance may be required while the vegetation becomes established.

Alternative 12C—Install riprap toe protection

Alternative summary: Install riprap along the outer banks to reduce the sediment loading and loss of bank.

Advantages: Riprap is relatively inexpensive, effective at reducing bank erosion, and if properly designed can be resilient to large flood events. Riprap toe protection will require less soil removal and landfilling than a vegetated slope or VRSS installation.

Disadvantages: Hard armoring does not encourage vegetative growth and does not appear natural or provide quality in-stream habitat. If erosion occurs around or behind the riprap, maintenance costs tend to be higher than for bioengineering techniques.

Feasibility: This alternative is feasible if bioengineering alternatives are not feasible.

Alternative 12D—Install a boulder cross vane

Alternative summary: Install a boulder cross vane at the downstream end of the existing riprap toe to direct flow to the center of the stream and away from the stormwater outfall. A cross vane could be installed either instead of or in addition to Alternatives 12A through 12C.

Advantages: A boulder cross vane will reduce the erosive stress on the banks. A cross vane will also create a mid-channel scour pool that can increase habitat diversity within the stream and maintain flow vectors centered along the stream channel.

Disadvantages: Depending on their design, cross vanes can increase the upstream flood profile; hydraulic modeling will be required during final design to ensure that flood impacts are acceptable. Adding a vane will require more detailed design and construction oversight to achieve the desired flow patterns.

Feasibility: This alternative is feasible.

Recommendations

Alternatives 12C and 12D are recommended in combination to stabilize the stream bank toe and allow energy dissipation and improved in-stream habitat in the pool downstream of the cross vane.

I.12 Site 13

Site 13 is located along the northern bank of Bassett Creek, upstream of Van White Memorial Boulevard in Reach 3 (Station 6+50 to 11+00 on Figure I-4). The northern stream bank throughout this site is undercut and the lower banks do not have extensive root mass or surface protection, although the bank is not high. Construction access to the site is challenging in several locations due to fencing and trees near the top of the stream bank. In addition, a restrictive covenant for chlorinated VOCs in soil and groundwater is in place for a portion of the site; the covenant requires that site not be disturbed or intruded into at depths greater than or equal to 1 foot below ground surface without prior written approval of MPCA. The covenant documentation reports that seeps have been observed along the creek bank, and they may contain contaminated groundwater. Photo 13 in Appendix A shows a typical portion of this site.

Alternative 13A—Grade stream bank and vegetate

Alternative summary: Remove the existing small trees and grade the stream bank to a stable slope (3H:1V or flatter). Establish vegetation along the stream bank to provide long-term stability.

Advantages: Grading the bank and establishing vegetation will create a more stable, natural stream bank, less prone to erosion at the toe.

Disadvantages: Due to the long history of industrial use and the existing restrictive covenant at this site, soil contamination is likely. The removed soil will likely require landfill disposal because of the potential for contamination. Grading the stream bank to a stable slope will move the top of the stream bank towards existing fencing.

Feasibility: This alternative is feasible only if the existing landowner allows shifting of the stream bank and a reduction in the size of the fenced areas. In addition, the alternative is only feasible if MPCA approves of stream bank grading that may expose seeps of contaminated groundwater.

Alternative 13B—Install root wads

Alternative summary: Install root wads around the eroding outer bend to direct flow to the center of the stream.

Advantages: Root wads will reduce the erosive stress on the outer bank and allow vegetation to become established. Root wads also create scour pools and cover that can increase habitat diversity. Trees will likely need to be removed to gain access to these banks; this tree material would be used for the root wads. Installing root wads will require less soil removal and landfilling compared to bank grading, although contaminated groundwater seepage may still be encountered.

Disadvantages: Tree removal will be required to create the root wads; however, accessing the banks will likely necessitate tree removal, regardless of the technique chosen. Adding root wads to the outer banks will require more-detailed design and construction oversight to achieve the desired flow patterns.

Feasibility: This alternative is feasible provided root wads will not require tree removals that would not otherwise be necessary. In addition, the alternative is only feasible if MPCA approves of stream bank excavation that may expose seeps of contaminated groundwater.

Alternative 13C—Install riprap toe protection

Alternative summary: Install riprap along the outer bank to reduce the sediment loading and loss of bank.

Advantages: Riprap is relatively inexpensive, effective at reducing bank erosion, and if properly designed can be resilient to large flood events. Riprap toe protection will require less soil removal and landfilling than a vegetated slope or VRSS installation.

Disadvantages: Hard armoring does not encourage vegetative growth or appear natural and does not provide quality in-stream habitat. If erosion occurs around or behind the riprap, maintenance costs tend to be higher than for bioengineering techniques.

Feasibility: This alternative is feasible if bioengineering alternatives are not feasible, and would be more likely to be approved by the MPCA due to the minimal grading requirements.

Alternative 13D—Install willow stakes and live fascines

Alternative summary: Use willow cuttings harvested from adjacent locations on Bassett Creek to create live stakes and fascines. Install fascines along the stream bank toe and live stakes along the top of the bank.

Advantages: Willows are fast-growing and create robust root networks that help stabilize stream banks. Improving the vegetation will improve aesthetics of the stream corridor and minimize erosion from the bare banks; the fascines will reduce undercutting while the vegetation becomes established. Using a vegetation-only approach will not require soil excavation and will be the least likely to encounter seepage of contaminated groundwater.

Disadvantages: Improving only the stream bank vegetation will not help create in-stream pools for habitat diversity and energy dissipation.

Feasibility: This alternative is feasible, especially given the large stands of willows at various locations within Reaches 2 and 3.

Recommendations

Alternative 13D is recommended due to the existing soil contamination and the low likelihood of encountering contaminated groundwater if no excavation is performed. This approach would improve in-stream cover and help to stabilize undercut banks, which will improve the in-stream habitat quality, while minimizing disturbance of potentially-contaminated soils.

I.13 Site 14

Site 14 represents the final 500 feet of Bassett Creek (Station 0+00 to 5+00 on Figure I-4), downstream of the Van White Memorial Bridge before the creek enters the Bassett Creek Tunnel. The lower stream banks through this site are largely bare, but have significant clay content and do not appear to be actively eroding. The water levels at this site frequently appear to be controlled by debris buildup on the Bassett Creek Tunnel inlet structure. Photo 14 in Appendix A shows a typical portion of this site.

Alternative 14A—Improve vegetation without grading

Alternative summary: Improve stream bank vegetation by adding willow cuttings harvested from adjacent locations on Bassett Creek and/or groundcover.

Advantages: Willows and similar species are fast-growing and create robust root networks that help stabilize stream banks. Improving vegetation in the area will improve aesthetics of the stream corridor and minimize erosion of the bare banks.

Disadvantages: Improving only the stream bank vegetation will not help create a natural stream bed profile or cross section.

Feasibility: This alternative is feasible.

Infeasible alternatives

Due to the downstream and upstream constraints on this site represented by the Bassett Creek Tunnel inlet and the Van White Memorial Bridge, respectively, adjustments to the stream pattern and cross section are not considered feasible.

Recommendations

Alternative 14A is recommended.

I.14 Site 15

Site 15 is located along the abandoned channel that connects to the old Bassett Creek tunnel. This channel conveys water only during high-flow events; during the 100-year event, an estimated flow of 50 cfs would be diverted here from the main stem of Bassett Creek. There are several small trees growing on the lower banks of the channel and woody debris within the channel. The nature of the problem at this location is a maintenance issue rather than a stabilization issue and will be addressed as such.

Alternative 15A—Clear trees and remove woody debris

Alternative summary: Remove existing small trees and woody debris from the abandoned channel.

Advantages: Removing debris will allow the overflow channel to function as designed, prevent flow blockage, and reduce flooding potential.

Disadvantages: Removing woody debris will decrease the effective roughness of the abandoned channel and may cause increased flow velocities. In the absence of other restoration or stabilization measures, increased flow velocities could increase bank erosion.

Feasibility: This alternative is feasible.

Recommendations

Alternative 15A is recommended, provided that any disturbed areas are stabilized and vegetated.

Table I-1 Bassett Creek feasibility study alternatives summary

Reach	Site	Alternative	Alternative Description	Advantages	Disadvantages	Rec.?
Reach 1	Site 1	Alternative A	Abandon trail and move to higher elevation	Future bank migration will not erode the trail.	Access to the stream from the trail will be lost; sig. disturbance of hillside.	N
Reach 1	Site 1	Alternative B	Design trail for submergence at high flows	Trail will still be an access to the lower portion of the right bank.	Trail impassable at high flow; regular maintenance required.	Y
Reach 1	Site 2	Alternative A	Grade stream bank and vegetate	Naturalizes the bank and improves access to the stream.	Requires coordination w/ redevelopment; may be difficult to permit. May require soil correction.	Y
Reach 1	Site 2	Alternative B	Install riprap toe protection	Stabilizes the bank.	Not aesthetically pleasing; may cause flood impacts.	N
Reach 1	Site 3	Alternative A	Extend riprap to tie into historic wall	Stabilizes the bank using existing erosion control structure and preserves historic wall.	Does not reduce shear stress.	Y
Reach 1	Site 3	Alternative B	Install boulder or log vanes	Contributes to habitat and reduces shear stress.	Sedimentation can occur and stream conveyance could be reduced.	N
Reach 1	Site 4	Alternative A	Replace swale with catch basin, culvert & FES	Effectively stabilizes outfall from erosion and improves water quality.	Water can undercut new structure again; does not reduce shear stress.	N
Reach 1	Site 4	Alternative B	Install boulder cross vane	Contributes to habitat and reduces shear stress. Protects stormwater outfall.	Sedimentation can occur and stream conveyance could be reduced.	N
Reach 1	Site 4	Alternative C	Install riprap toe protection	Stabilizes the bank, extends stabilization downstream.	Does not encourage vegetation establishment.	Y
Reach 1	Site 5	Alternative A	Install boulder or log vanes	Contributes to habitat and reduces shear stress.	Transfers high velocities downstream.	N
Reach 1	Site 5	Alternative B	Install composite rock/wood bankfull bench	Improves habitat and utilizes materials generated on site	May cause flood impacts, more expensive to install than hard armoring.	N
Reach 1	Site 5	Alternative C	Install VRSS and riprap toe protection	Stabilizes the bank and improves aesthetics.	Shorter life span than hard armoring and more expensive to install.	Y
Reach 2	Site 6	Alternative A	Grade stream bank and vegetate	Stabilizes the bank.	Requires significant soil correction, landowner consent for parking lot reduction.	N
Reach 2	Site 6	Alternative B	Install VRSS and riprap toe protection	Improves water quality and aesthetics. Requires less soil correction.	Shorter life span than hard armoring and more expensive to install.	Y
Reach 2	Site 6	Alternative C	Install boulder wall	Stabilizes the bank. Requires less soil correction.	Does not encourage vegetation establishment.	N
Reach 2	Site 7	Alternative A	Install fieldstone riprap to create riffle-pool structure	Reduces bed erosion with self-maintaining structure.	May require significant testing & disposal.	N
Reach 2	Site 7	Alternative B	Install boulder and/or log vanes to create step-pool structure	Contributes to habitat and reduces shear stress. Requires less bed disturbance and testing.	Aggradation could be developed downstream of the step-pool structure.	Y
Reach 2	Site 8	Alternative A	Remove debris and stabilize top of bank	Reduces erosion from overland flow and debris entering stream.	Limited ability to filter overland flow.	Y
Reach 2	Site 8	Alternative B	Install buffer strip at top of bank	Filters overland flow and reduces risk of bank mass failure after flooding events.	Requires landowner consent for significant parking lot reduction.	N
Reach 2	Site 9	Alternative A	Grade stream bank and vegetate	Stabilizes the bank.	Requires significant soil correction.	N
Reach 2	Site 9	Alternative B	Install root wads	Contributes to habitat and utilizes materials generated on site.	Requires additional tree removals to produce root wads.	N
Reach 2	Site 9	Alternative C	Install riprap toe protection	Effective at reducing bank erosion, resilient to large flood events.	Does not encourage vegetation establishment.	N
Reach 2	Site 9	Alternative D	Install willow stakes and live fascines	Improves bank erosion resistance and aesthetics, uses on-site materials.	Does not create in-stream pools.	Y
Reach 2	Site 10	Alternative A	Lower culvert	Prevents local bed erosion.	May require manhole installation, requires more soil correction.	N
Reach 2	Site 10	Alternative B	Shorten culvert and add riprap	Prevents local bed erosion, requires minimal excavation.	Culvert remains elevated at low creek flows.	Y
Reach 2	Site 11	Alternative A	Lower culvert, add catch basin	Prevents local bed erosion.	May require manhole installation, requires more soil correction.	N
Reach 2	Site 11	Alternative B	Add riprap at existing culvert	Prevents local bed erosion, requires minimal excavation.	Culvert remains elevated at low creek flows.	Y
Reach 3	Site 12	Alternative A	Grade stream bank and vegetate	Stabilizes the bank.	Requires significant soil correction.	N

Table I-1 Bassett Creek feasibility study alternatives summary

Reach	Site	Alternative	Alternative Description	Advantages	Disadvantages	Rec.?
Reach 3	Site 12	Alternative B	Install VRSS	Improves water quality and aesthetics. Requires less soil correction.	Shorter life span than hard armoring and more expensive to install.	N
Reach 3	Site 12	Alternative C	Install riprap toe protection	Effective at reducing bank erosion, resilient to large flood events.	Does not encourage vegetation establishment.	Y
Reach 3	Site 12	Alternative D	Install boulder cross vane	Contributes to habitat and reduces shear stress.	Sedimentation can occur and stream conveyance could be reduced.	Y
Reach 3	Site 13	Alternative A	Grade stream bank and vegetate	Stabilizes the bank.	Requires significant soil correction.	N
Reach 3	Site 13	Alternative B	Install root wads	Contributes to habitat and utilizes materials generated on site.	Requires additional tree removals to produce root wads.	N
Reach 3	Site 13	Alternative C	Install riprap toe protection	Effective at reducing bank erosion, resilient to large flood events.	Does not encourage vegetation establishment.	N
Reach 3	Site 13	Alternative D	Install willow stakes and live fascines	Improves bank erosion resistance and aesthetics, uses on-site materials.	Does not create in-stream pools.	Y
Reach 3	Site 14	Alternative A	Improve vegetation without grading	Improves bank erosion resistance and aesthetics, uses on-site materials.	Does not create natural profile or cross-section.	Y
Reach 3	Site 15	Alternative A	Clear trees and remove woody debris	Improves conveyance and reduces flooding potential.	Can increase velocities.	Y