Lower Riley Creek Corridor (Reach E and D3)

Enhancement Plan

March, 2019

Prepared for
Riley Purgatory Bluff Creek Watershed District and the City of Eden Prairie

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

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Ecological Enhancement Plan

Lower Riley Creek Stabilization Project

March 2019

Contents

List of Tables

List of Figures

List of Appendices

1.0 Context and Goals for this Ecological Enhancement Plan

This document was written to guide enhancement and stewardship efforts of ecological resources within Reach E and Site D3 of Lower Riley Creek (i.e. the Lower Riley Creek Stabilization Project, or Project) as shown in Figure 1-1. The project partners include the Riley Purgatory Bluff Creek Watershed District (RPBCWD), Lower Minnesota River Watershed District (LMRWD), and City of Eden Prairie (City). This partnership was created when the City granted RPBCWD rights to the property for stream restoration and resulting ecological enhancement. LMRWD and the City are funding partners for the Project. This Ecological Enhancement Plan documents the goals of the partnership for the Lower Riley Creek Stabilization Project and establishes roles and responsibilities of Project partners for the 20 year life of the agreement.

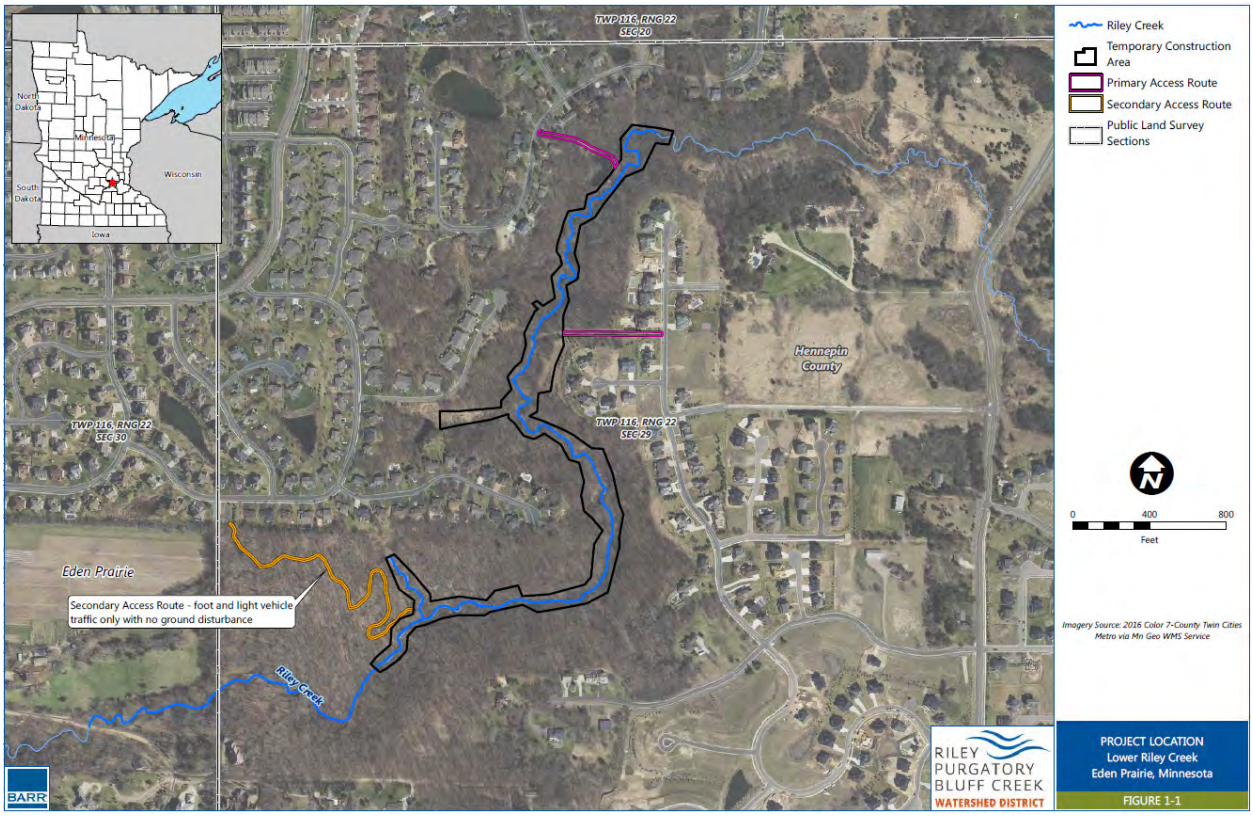


Figure 1-1 Location of Lower Riley Creek Stabilization Project

The partners will work collaboratively to review this ecological enhancement plan and financial prospectus that collectively establish leadership by each organization in site

management tasks. The financing plan in Section 9.0 includes information on which tasks are lead by which partner and how they are paid for.

2.0 Vision, Goals, and Project Approach

The vision for this Project is to provide an ecologically diverse stream reach that significantly reduces streambank erosion, provides diverse habitat layers, and enhances the public's access and their understanding of why stable stream systems are important. Presently, Reach E has a primarily sandy channel bed with limited riffle/pool variability. The Project will provide greater stream depth variability, more channel bed substructure types, and varied channel velocities. The proposed Project will reduce erosion and improve water quality while also improving natural stream habitat for aquatic organisms. Providing better floodplain connectivity for Lower Riley Creek also enhances surrounding riparian habitat. By establishing a stable stream corridor, the Project will also address the Minnesota Pollution Control Agency's (MPCA's) identified turbidity impairment within this reach of Riley Creek. The Project's location in the Riley Creek Conservation Area provides opportunities for interpretive signage and future programming to educate the public on the importance of diverse stream corridors.

As part of the Project partners planning processes, each have established goals intended to protect, restore, and enhance water resources. Table 2-1provides a summary of how the Project aligns with these goals.

Table 2-1 Summary of Partner Goals and Project

Partner	Goals	How Project Aligns with Goal
RPBCWD	Design, maintain, and implement Education and Outreach programs to educate the community and engage them in the work of protecting, managing, and restoring water resources. (EO 1)	The project will educate the community that is near and recreational users on the project itself but also stewardship ideas that they can implement.
	Include sustainability and the impacts of climate change in District projects, programs, and planning.	The District is going to utilize sustainable materials as part of the project.
	Protect, manage, and restore water quality of District lakes and creeks to maintain designated uses. (WQual 1)	The project is restoring the reach E and D3 of Riley Creek.
	Preserve and enhance habitat important to fish, waterfowl, and other wildlife.(WQual 3)	The project will enhance the creek corridor which includes both terrestrial and aquatic habitats. The project will enhance the aquatic habitats by stabilizing eroding streambanks. Furthermore, the project will reduce habitat fragmentation by reconnecting the creek with the terrestrial uplands.
	Protect and enhance the ecological function of District floodplains to minimize adverse impacts. (WQuan 1)	The project will reconnect the creek to the floodplain which will also help increase of pollutant removal, promote infiltration and enhancing the ecological habitat.
	Limit the impact of stormwater runoff on receiving waterbodies. (WQuan 2)	The project will dissipate the energy of stormwater runoff entering the creek at stormwater sewer discharge at location.
LMRWD	Erosion and Sediment Control – To manage erosion and control sediment discharge	The project will stabilize the streambanks and reconnect the stream to the floodplain which will dissipate the energy of the runoff, enhance pollutant removal, minimize streambank erosion, and reduce sediment discharge downstream.

Partner	Goals	How Project Aligns with Goal
City of Eden Prairie	Work to achieve water quality standards in Lakes, Streams and Wetlands consistent with intended use and classification and State of Minnesota water quality standards.	The City will work in partnership with the Watershed District, DNR, adjacent property owners and other interested parties to restore creeks, creek banks, and gullies for health, safety and ecological integrity, using bioengineering for stabilization projects where feasible. We will also be setting an example for citizens and property owners by managing City-owned property.
	Protect downstream water resources, reduce the potential for flooding and minimize related public capital and maintenance expenditure necessary to control excessive volume and rates of runoff and to mitigate erosion.	The project will provide education information and opportunities for residents to restore similar projects to restore shorelines.
	Increase public involvement in knowledge in management and protection of water resources	The project will facilitate a better understanding of water resource issues in the creek corridor while involving the public in the process.
	Support water recreation activities and fish and wildlife habitat by implementation of programs to maintain or improve water quality.	The project will enhance recreational opportunities and access to the creek corridor while maintaining the accessibility and habitat in the creek corridor.

This plan intends to adopt an adaptive management approach to restoring Riley Creek at Reach E and D3. An adaptive management approach evaluates the project performance following implementation and then determine if further actions are necessary to maintain the restoration.

This project looks to mitigate and prevent additional erosion of streambanks and foster the use of natural materials and bioengineering principals for the restoration and maintenance of stream reaches whenever feasible. Technical stakeholders, including the USACE and MNDNR, have expressed a preference for bioengineering over hard armoring for stream stabilization where possible. Bioengineering techniques maintain more of a stream's natural function and provide better habitat and a more natural appearance than hard armoring.

3.0 Location

Reach E (Figure 3-1) is approximately 4,600 feet long and located in the lower portion of Riley Creek as it flows to the Minnesota River. Site D3 is a 375-foot long ravine that conveys urban runoff to Reach E. Both Reach E and Site D3 are located within the boundaries of the Riley Creek Conservation Area, owned by the City of Eden Prairie, and have a watershed area of approximately 9.2 acres.

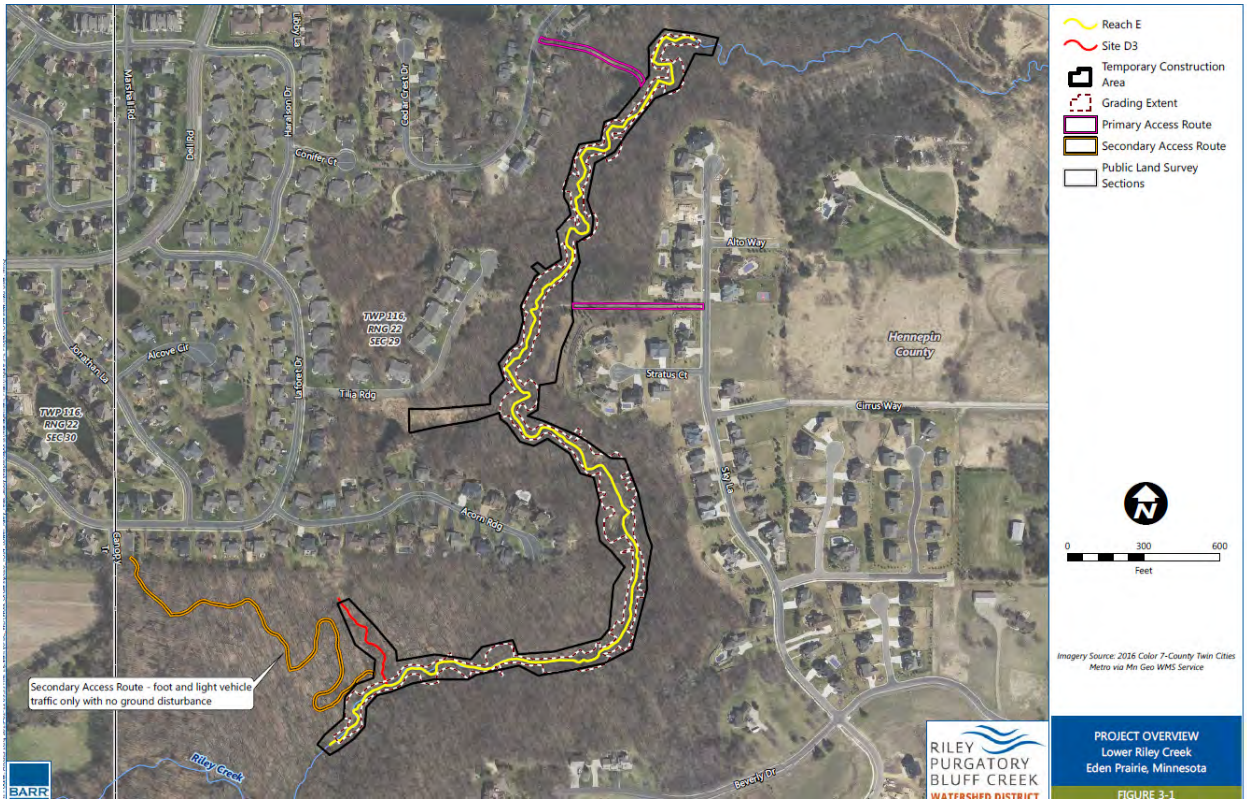


Figure 3-1 Location of Lower Riley Creek Stabilization Project

4.0 Land Use History

Prior to European settlement, the entire Riley Creek watershed was located in an ecoregion known as the Big Woods, where oak woodland and maple-basswood forests were the dominant vegetation types. As settlement occurred, much of the landscape was initially converted to farmland. As urban development spread outwards from the Minneapolis core, areas of farmland then became converted to urban and suburban landscapes. This conversion is ongoing in some of the undeveloped areas of Riley Creek watershed.

As development occurred, the City of Eden Prairie recognized the importance of protecting remnants of the Big Woods landscape and creek corridors some of which are found within the boundaries of the Riley Creek Conservation Area. The Project is located in the Riley Creek Conservation Area, which is owned by the City of Eden Prairie. Three different zoning classifications are found in the vicinity, including public, residential, and rural. Adjacent land use is primarily residential.

5.0 Existing Conditions

5.1 Vegetation

A vegetation assessment was completed in July 2016 to determine vegetation composition of the riparian portions of the Project area. The plant community surrounding Riley Creek in Reach E and Site D3 is dense hardwood forest with a nearly continuous canopy cover (90-100%). The riparian area is dominated by sugar maple, northern red oak, and basswood tree species. Other canopy and sub-canopy species commonly found throughout the Project area, though more prevalent in upstream portions, include ironwood, black cherry, bitternut hickory, and hackberry. The understory is comprised of marginal coverage to total coverage (30-100% cover) with large bare patches on heavily eroded slopes found closer to Riley Creek's banks. Wood nettle is the dominant understory species, covering 80-100% of the ground layer along large stretches of the Project area. Other native plant species found frequently through the Project area include wild ginger, Pennsylvania sedge, bloodroot, riverbank rye, and golden glow.

Forest in the upstream portions of the Project exhibits characteristics of a native hardwood forest community, with a nearly closed canopy and open understory (Figure 5-1). However, glossy buckthorn is prevalent in the downstream portion of the Project area, with trees ranging from approximately three to eight feet in height, and saplings comprising a significant portion of the understory (Figure 5-2). Canada thistle is also found in the Project area, primarily in locations where small openings in the forest canopy allow for more sunlight in the understory layer.

Figure 5-1 Native Hardwood Forest Community, upstream portion of Project

Figure 5-2 Buckthorn Dominated Forest, downstream portion of Project

5.2 Soils and Hydrology

Five different soil types are found in the Project area, as described in Table 5-1. Although soils in the Project area generally have low to moderate susceptibility to erosion, most of these soils are generally found on steep slopes.

Table 5-1 Summary of Soils Conditions within the Project Area

Soil Type	Typical Soil Slopes	Erosion Susceptibility	Hydric Status
Hawick loamy sand	20-40 percent slopes	Low to Moderate	Not hydric
Hawick gravelly sandy loam	12-20 percent slopes	Low to Moderate	Not hydric
Lister-Ridgeton complex	25-45 percent slopes	Moderate	Predominantly non-hydric
Suckercreek fine sandy loam	0-2 percent slopes	Moderate	Predominantly hydric
Metea loamy fine sand	6-12 percent slopes	Low to Moderate	Not hydric
Lester-Metea complex	18-25 percent slopes	Low to Moderate	Predominantly non-hydric

Riley Creek is the primary hydrologic resource in the Project area. It travels through a steep valley, known as the Riley Creek Lower Valley, before flowing to the Minnesota River. This reach of Riley Creek has a deeply incised channel with a very limited floodplain. The narrow Riley Creek Lower Valley limits the ability of high flows to spread into a floodplain, thereby keeping high flows concentrated in and near the main channel, exacerbating existing bank erosion. Table 5-2 summarizes the flow rates in Reach E for design storm event of various sizes and the observed flows at Flying Cloud Drive.

Table 5-2 Summary of Design Flows within the Project Area

Design Event	Hydrologic Model, Station 140+00 (cfs)	Met. Council Gage, Flying Cloud Drive (cfs)
1 year	86	23
2 year	134	96
10 year	323	297
100 year	804	--
Maximum observed	--	472

5.3 Water Quality Impairments

The MPCA maintains a list of impaired waters for the state of Minnesota. A body of water is considered impaired if it fails to meet one or more of the state's water quality standards presented in Table 5-3. Waters that are not able to meet their designated uses due to exceeding water quality standards are considered impaired. Lower Riley Creek, from Lake Riley to Grass Lake is included on the MPCA's 2018 Inventory of Impaired Waters (MPCA, 2016) for several impairments as summarized Table 5-4.

States must develop a list of impaired waters that require total maximum daily load (TMDL) studies and routinely coordinate with the U.S. Environmental Protection Agency (EPA) for study approval. A TMDL study identifies the maximum amount of a certain pollutant that a body of water can receive without violating water quality standards and allocates that amount to the pollutant's sources. The MPCA began a TMDL study for this impaired reach of Riley Creek in 2014 and is targeted to complete the study in 2019.

Table 5-3 MPCA Water Quality Standards

Water Quality Parameter	MPCA Water Quality Standard
Total Phosphorus (summer average, µg/L)	100
Chlorophyll *a* (summer average, µg/L)	18
Secchi Disc Transparency (summer average, m)	NA
Total Suspended Solids (mg/L)	30
Daily Dissolved Oxygen Flux (mg/L)	3.5
Biological Oxygen Demand (5 day) (mg/L)	2
Escherichia coli (# per 100 mL)	126 [3]
Chloride (mg/L)	230

Table 5-4 Riley Creek and Minnesota River Impairments

Waterbody	Impaired Use	Pollutant or Stressor	Year Listed	TMDL Study Target Start	TMDL Study Target Completion	TMDL Study Approved
Riley Creek	Aquatic Life	Turbidity	2002	2014	2019	--
	Aquatic Life[1]	Aquatic Macroinvertebrate Bioassessments	2018		2019	
	Aquatic Life[1]	Fishes Bioassessments	2018		2019	
	Aquatic Recreation[1]	Escherichia coli	2018		2019	
	Aquatic Consumption	Mercury in Fish Tissue[3]	1998	1998	2025	--
Minnesota River	Aquatic Life	Nutrients/Eutrophication	2016	2014	2019	--
	Aquatic Life	Turbidity	1996	2014	2019	--
	Aquatic Consumption	PCB in Fish Tissue	1998	1998	2025	--
	Aquatic Consumption	Mercury in Water Column	1998	--	--	2008[2]
	Aquatic Consumption	Mercury in Fish Tissue	1998	--	--	2008[2]

[1] Included on the MPCA's Draft 2018 impaired waters list.
[2] Covered under the statewide mercury TMDL, approved in 2007.
[3] Mercury impairments for Lake Riley and Staring Lake are not covered by the statewide mercury TMDL due to mercury in fish tissue exceeding a threshold value of 0.57 mg/kg.

5.4 Wetlands

One wetland has been delineated within the Project area, located in the downstream end of Reach E. This wetland is an excavated stormwater pond approximately 0.38 acres in size and classified as a shallow open water basin.

5.5 Stream Geomorphic Assessment

The Riley Creek channel through this reach is deeply incised and entrenched with large, steep, eroding valley walls. One erosion location measured approximately 50 feet wide and 40 feet tall. RPBCWD staff also noted that the headcuts documented in RPBCWD's2007 *Lake Riley Outlet Improvements and Riley Creek Lower Valley Stabilization Feasibility Study*. have migrated upstream such that the upstream reach is also now incised and entrenched.

Stream survey data was collected in 2016 and compared to similar data collected in 2007 to verify the stream geomorphic changes during this time period. The 2007 survey

was conducted during the winter months and included limited data in the upstream portions of the reach below the ice. However, the points available below the ice clearly show that the channel bed has lowered in the upper portions of the reach (approximately 2,500 feet of the reach) while remaining fairly unchanged in the lower section. This survey data correlates with field observations of active erosion and head cutting in the upper section of the study reach. A comparison of cross sections (Figure 5-3) also shows that the channel has lowered since the 2007 survey as it is currently both deeper and wider.

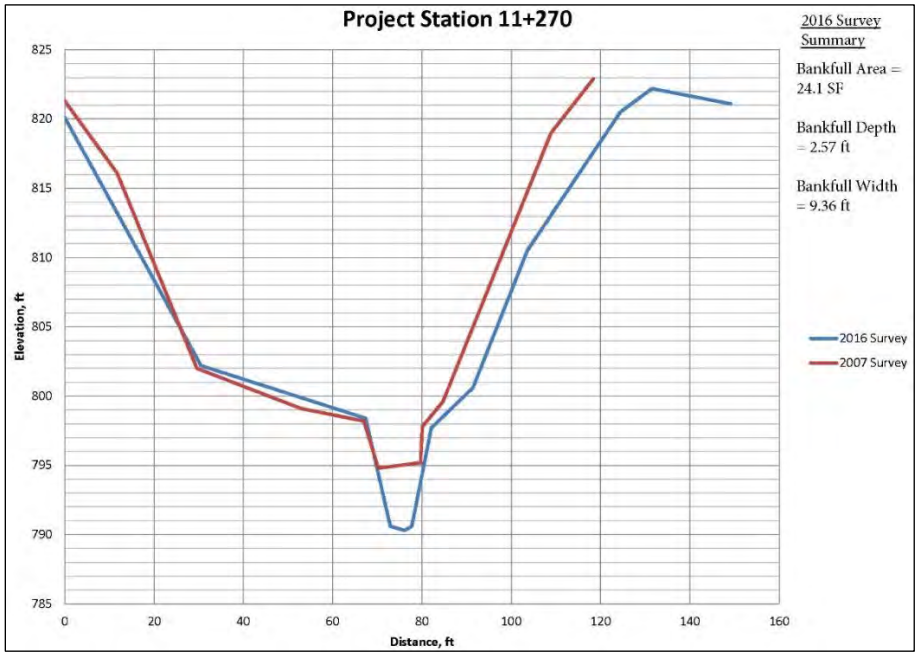


Figure 5-3 Reach E Cross Section Comparison Example

Channel dimensions and ratios were not summarized for Site D3 because flow in this ravine is very sporadic. The cause of erosion at Site D3 is flashy stormwater runoff from adjacent residential and park property to a ravine.

5.6 Streambank Erosion

The initial instability within Reach E was likely caused by the gradual increase in runoff volume and increased peak runoff rates generated by a developing watershed. The bank soils within the Lower Valley are clayey and cohesive, making them somewhat naturally resistant to erosion, particularly if sufficient vegetation is present to provide reinforcement with root masses. Streambanks within this reach are 6 to 10 feet tall, with vertical side slopes that are largely bare of vegetation. A narrow valley concentrates

flood flows closer to the channel than in a wide floodplain, thereby generating more erosive pressure on the stream bed and banks, especially during larger storm flows. Due to the channel depth, the creek has limited access to a floodplain. Based on MDNR regional curves and USGS regression equations. Riley Creek should have a mean bankfull depth of 1.5 to 2.5 feet instead of the current 6 to 10 feet. Based on Barr's 2015 PCSWMM model, design flood events up to the 100-yr design storm are largely conveyed within the channel.

At Site D3, the original cause of erosion appears to be concentrated runoff into the ravine from agricultural fields, as shown in Figure 5-4. It appears that the top of the ravine was partially filled and some erosion protection was installed when the current development was built. The adjacent parkland and the back half of seven residential lots along Laforet Drive and Acorn Ridge drain toward the ravine, and the runoff is captured by two berms located near the top of the ravine. A small storm sewer system captures stormwater collected behind the berms and discharges the runoff into the ravine. It is assumed that the current development reduced the drainage area to the ravine and the runoff rates and volume to the ravine have likely been further reduced by the berms installed to intercept runoff at the top of the ravine. However, erosion has continued, as evidenced by undermining of the riprap installed at the storm sewer outlet. The storm sewer outlet is still located high enough within the ravine that the discharge causes erosion of the ravine bed. High velocities from the culvert (12 to 13 feet per second) combined with the steep channel slope of the ravine (11 percent slope) to cause continual erosion downstream of the culvert outfall. The invert of the ravine is actively eroding, creating scarps and adding sediment load to Riley Creek.

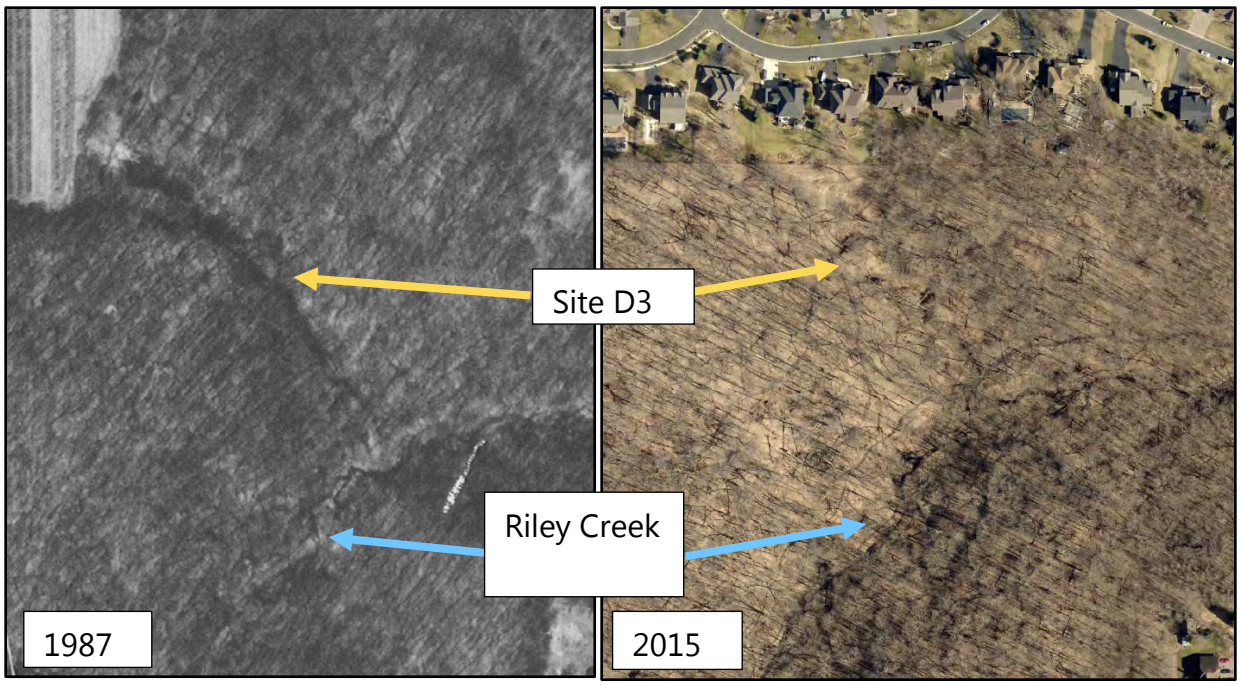


Figure 5-4 Aerial images of Site D3 from 1987 and 2015

5.7 Wildlife

Riley Creek Corridor which includes an upland deciduous forest provide potential habitat for a diversity of organisms, such as fish, including green sunfish, fathead minnow, and bluntnose minnow; amphibians, such as frogs, toads, and salamanders; birds such as bald eagles, hawks, heron, wood ducks, and perching birds; and mammals, such as fox, deer, squirrels, beaver, and muskrats. Wildlife found in the Project area are primarily expected to be habitat generalists due to the present lack of high-quality habitat through a majority of this Riley Creek reach.

The proposed Project area is located within the Minnesota Biological Survey (MBS) Riley Creek Site of Biodiversity Significance, which is ranked high with regard to biodiversity significance (SBS; MNDNR 2017). The proposed Project area is also located within a Central Region Regionally Ecological Significant Area (RESA; MNDNR 2003). In general, RSEAs include places where intact native plant communities and/or native animal habitat are still found in the region and continue to provide important ecological functions. The Project's location within these designated areas enhances the importance of improving local habitat quality and diversity.

6.0 Desired Future Outcomes

The proposed stabilization measures will result in reduced stream bank erosion and, therefore, reduced sediment and phosphorus loading to Riley Creek and all downstream water bodies, including Grass Lake, the Minnesota River, the Mississippi River, and Lake Pepin. The existing stream bank erosion rate (in units of feet per year) for each stabilization site was estimated based on a field assessment method known as the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model. The BANCS model uses two erosion-estimation tools to develop risk ratings for the Bank Erosion Hazard Index (BEHI) and the Near-Bank Stress (NBS).

The portions of Reach E and Site D3 analyzed are generally rated "moderate" or "high" for BEHI due to the high, steep eroding banks. For NBS, the sub-reaches are designated "low" or "high". The total reduction in pollutant loading as a result of stabilizing the Reach E and Site D3 project reaches is estimated as **2,173,930** pounds per year **TSS** and **1,250** pounds per year **TP**. These values are representative of an erosion rate of approximately 0.1 to 0.2 feet per year for the stream banks.

The proposed Project has been designed to provide streambank stability while improving degraded habitat conditions of Reach E and Site D3. Presently, Reach E has a primarily sandy channel bed with limited riffle/pool variability. The proposed Project would provide greater stream depth variability, more channel bed substructure types, and varied channel velocities. Each of these variabilities enhances in-stream habitat features, potentially allowing more opportunities for macroinvertebrates and fish to use this reach of Lower Riley Creek. Providing better floodplain connectivity for Lower Riley Creek also enhances surrounding riparian habitat.

In addition to the expected water quality improvement expect from restoring the stream, the Project will provide other benefits as summarized in Table 6-1.

Table 6-1 Project Benefit Summary

Benefits	Qualitative Discussion	Metric
Habitat (acres)	Create in-channel habitat for fish and macroinvertebrates providing pools, riffle and refuge area for aquatic life. Improve riparian habitat conditions through invasive species removal and better connection of riparian corridor to stream channel.	2.9 acres of in-channel habitat improvements; 2.4 acres of riparian habitat improvements
Pollutants (e.g., TP, TSS, etc; lbs)	Restore stable streambanks and improve riparian buffer to reduce movement of eroded soil and nutrients to Riley Creek	Reduce TSS by 2,173,930 lbs/yr; Reduce TP by 1,250 lbs/yr
Abstraction (cubic ft)	Re-connecting Riley Creek channel to floodplain allows for greater infiltration due to sandy soils found in the floodplain. Vegetation found within the floodplain also improves infiltration.	Metric cannot be measured in the context of this Project.
Streambank Restored (feet)	Restore stable streambanks and improve riparian buffer is significant driver of the other benefits presented in this table.	4,600 feet of Reach E; 375 feet of Site D3
Groundwater Conserved (gal)	Benefit is not applicable.	
Community Reach	Location in a recreation area allows for public accessibility; public hearing held prior to RPBCWD Board ordering project; will hold neighborhood meetings prior to construction; informational pamphlets explaining project will be placed at recreation trailhead during construction; plans for future interpretive signage	
Flow Reduction (fps, cfs, psf, etc.)	Re-connect Riley Creek channel to floodplain, allowing high flows to extend into floodplain, reducing velocity of flows through the area.	
Flood Storage (acft)	Improve connectivity of creek to floodplain, providing for project resiliency and reducing flow velocities	
Wetland Management Class	Benefit is not applicable.	

[1] These values are representative of an erosion rate of approximately 0.1 to 0.2 feet per year for the stream banks.

7.0 Strategies for Ecological Enhancement and Management

The RPBCWD is proposing to enhance 4,600 feet of Lower Riley Creek (Reach E), as well as approximately 375 feet of a ravine tributary to the creek (Site D3) as summarized on Figure 2. All restoration projects require ongoing management to ensure their long-term success. This section describes the initial restoration techniques and outlines a management program.

7.1 Restoration Activities

Improvements to Reach E will be provided through several methods (Figure 7-1a & b). The elevation of the Riley Creek channel in Reach E will be raised through constructing a series of approximately 30 rock riffles. The constructed riffles will raise the elevation of the channel by providing areas of grade control, allowing higher flows to better widen outside of the creek channel. The newly connected floodplain would be sized proportional to its setting in a narrow valley and would be approximately 30 to 60 feet wide. Allowing higher flower to more easily move outside the creek channel reduces the potential of further downcutting and associated erosion. As such, raising the channel elevation will increase the stability of Reach E. A series of approximately 8 log/rock step pools will be constructed to provide variable flow conditions. These step pools are planned to be constructed using trees salvaged on-site. In addition, a variety of bioengineering methods, including rock cross vanes, rock vanes, log vanes, root wads, and toe wood bank stabilization, will be incorporated across the proposed Project reach as needed to dissipate stream flows. Overbank areas would be graded to a stable, 2:1 or flatter slope. The proposed Project is planned to be cut/fill neutral, meaning there will be no net gain or loss of soil materials from the Project site.

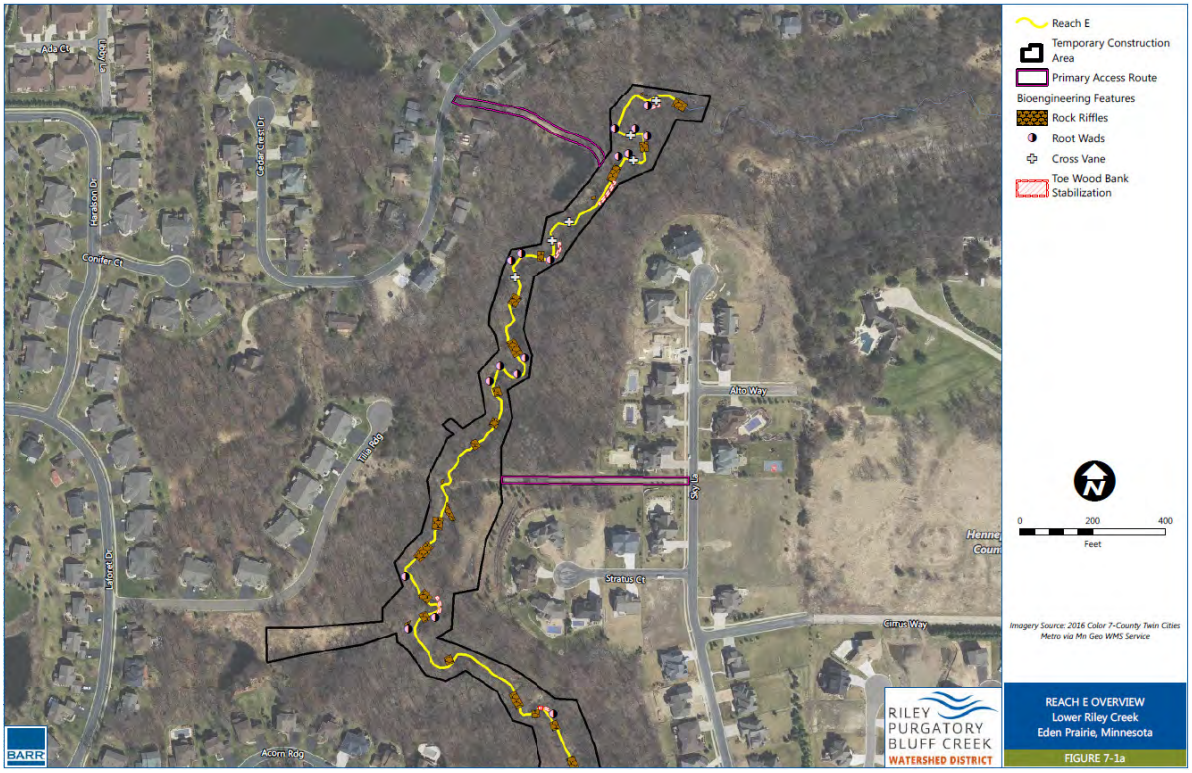


Figure 7-1a Northern Portion of Reach E Restoration Methods

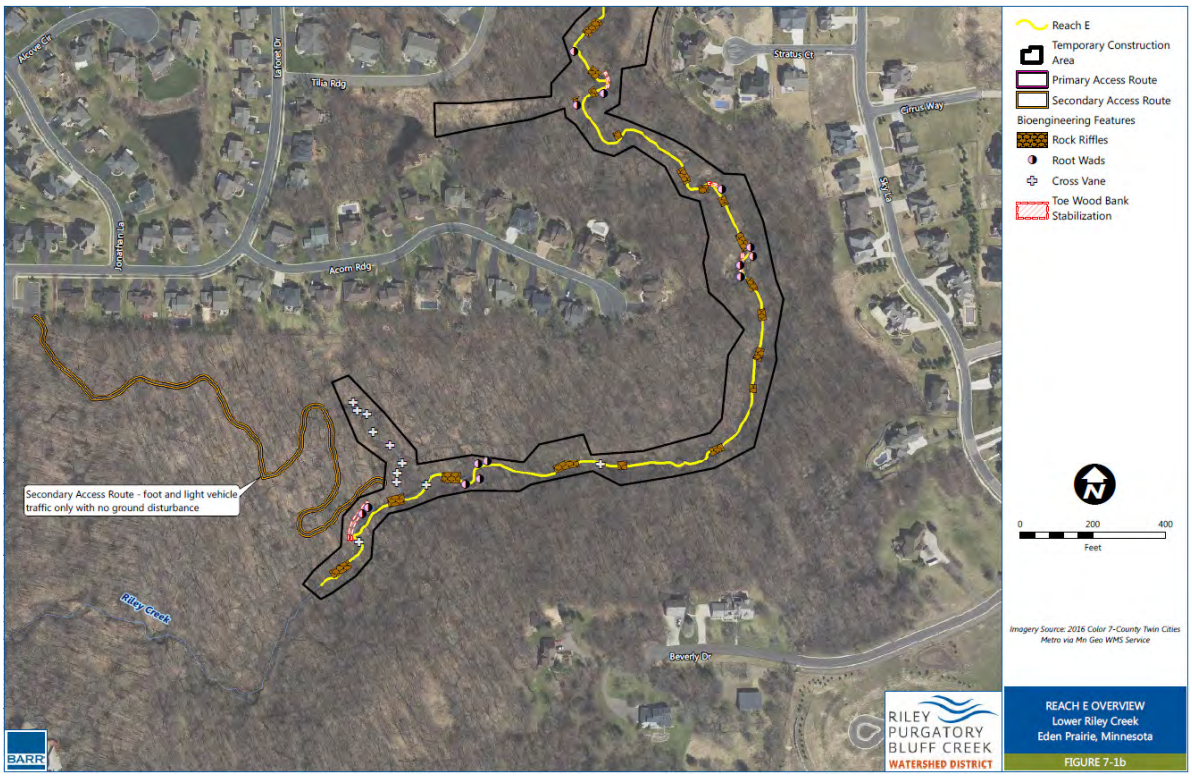


Figure 7-2b Northern Portion of Reach E Restoration Methods

Site D3 would be stabilized through the use of riprap, cross checks, scarp toe stabilization, and scarp stabilization (Figure 7-3). The existing riprap outfall in Site D3 would be reconstructed using new, appropriately-sized riprap. Eight boulder cross vanes would be installed in the lower two-thirds of Site D3 to provide ravine bottom stability and manage flow velocities through the ravine. There are several scarps adjacent to Site D3; these scarps and associated scarp toes would also be stabilized.

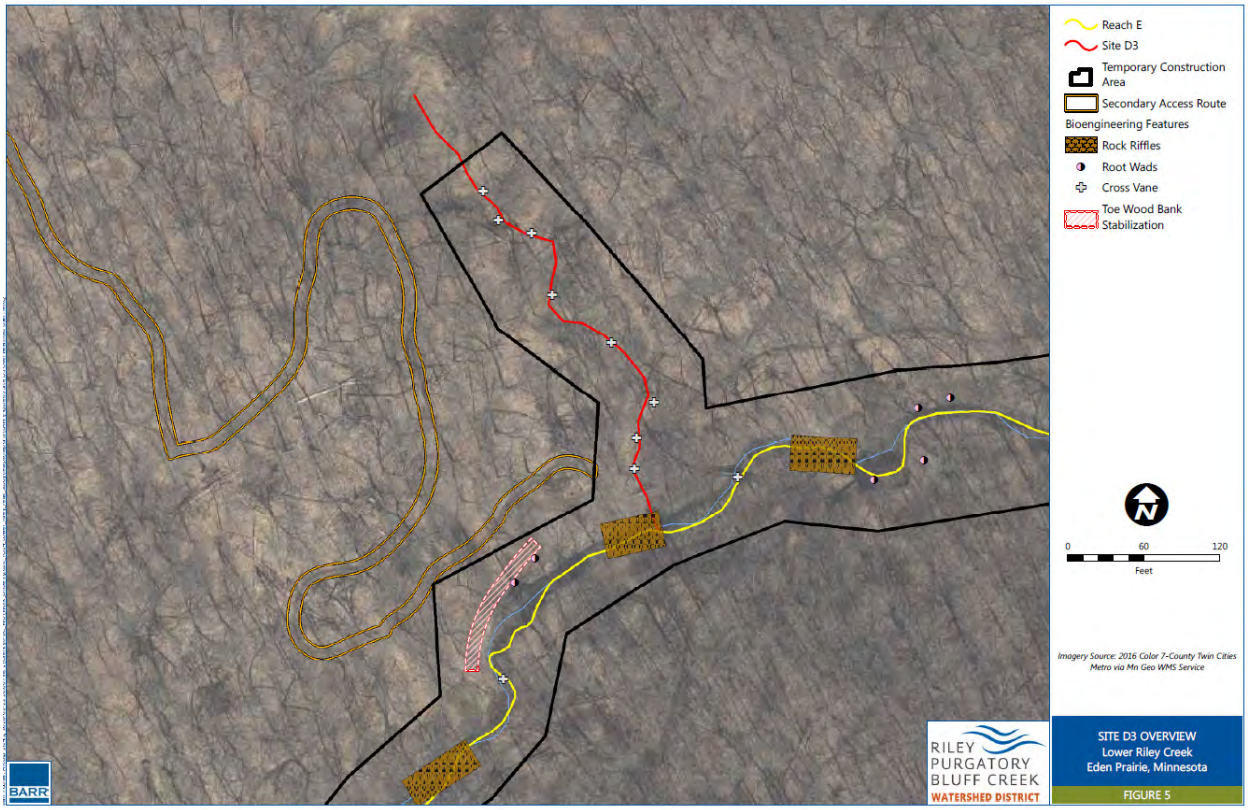
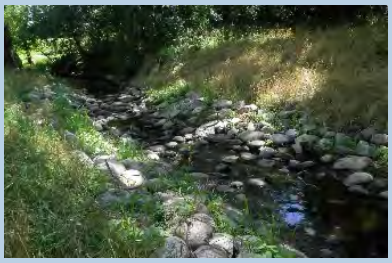


Figure 7-3 Reach D3 Restoration Methods

The proposed Project will require modification or replacement of five storm sewer outfalls within the extents of Reach E. Existing pedestrian bridges are anticipated to remain in place; however, one new pedestrian bridge would be constructed to connect with an existing, paved access trail to the nature trails within the Riley Creek Conservation Area.

Table 7-1 Project Design Elements

Design Element	Purpose	Ecological Benefit
Rock Riffles 	Gravel or cobble-sized material installed in the stream bed to create natural flow patterns and to control stream bed elevations.	The variety in flow and channel substrate size provides habitat diversity for aquatic species.
Cross Vanes 	Boulders buried in the stream bed and extending partially ("vanes") or entirely across the stream ("cross vanes") to achieve one or more of the following goals: re-direct flows away from banks, encourage sediment deposition in selected areas, and control stream bed elevations.	Scour pools develop over time near the vane, which provide habitat diversity for species that prefer pools to faster flowing in-channel habitat.
Scarp and Scarp Toe Stabilization	Vertical cedar pilings placed one foot on center along the toe of the actively eroding scarp and extending approximately 2 feet above the channel bed. Salvaged trees are installed longitudinally on the landward side of the cedar pilings. The combined structure reduces further erosion of the scarp toe and provide a bench for scarp material to deposit, eventually reducing the slope of the scarp and allowing for the scarp revegetation.	

Design Element	Purpose	Ecological Benefit
Root Wads 	Tree trunks with the root ball attached, installed either singly (root wads) or in conjunction with additional large woody debris and toe wood to Increase bank roughness and resistance to erosion, re-direct flows away from banks, and provide a bench for establishment of riparian vegetation	Creates undercut/overhanging bank habitat features.
VRSS/Toe Wood Bank Stabilization 	Soil lifts created with a combination of root wads and long-lasting, biodegradable fabric and vegetated to stabilize steep slopes and encourage establishment of root systems for further stabilization.	Creates undercut/overhanging bank habitat features.
Floodplain Connectivity 	Active floodplain/vegetated bench—modifications made to the stream cross section to increase floodplain connectivity and decrease erosive stress during flood flows; for this project, constructed by raising the channel bed.	Provides a smooth transition between in-channel, riparian, and upland habitat.
Vegetation/Buffer 	Established along a stream bank or overbank area to stabilize bare soils and increase resistance to fluvial erosion.	Using trees, shrubs, and a seed mix of grass and forbs provides a diverse array of vegetation strata and habitat types. Allows for more naturalized aesthetics, with emphasis on native species.

7.2 Management Activities

7.2.1 Inspections

The RPBCWD and/or city of Eden Prairie will conduct an inspection of the Project during the growing season each year. All inspections will include the tasks listed below, along with any other visual observation necessary. In addition, stream bank erosion issues often develop following high flow events; therefore the inspection tasks listed below should also be performed following storm events exceeding a 10-year return period for storm events with durations of 12 hours or greater, as defined by Atlas 14 and as recorded at the National Weather Service station in Chanhassen.

- Inspect the condition of each of the stream bank protection locations throughout the Project Area. Criteria to note include but are not limited to the following:
    - For areas with riprap protection, should note:
        - The general condition of the riprap.
        - Observed displacement of riprap material.
    - For areas with rock vanes and cross vanes for bank protection, should note:
        - Displacement of boulders used to construct the vanes.
        - Potential undermining of the vanes due to scour immediately downstream of the vanes.
        - Flow patterns that appear to be eroding around the vane.
        - Any bank erosion within approximately 10 feet of the vane.
    - For areas with root wads for bank protection, should note:
        - The general condition of the root wads (moved, rotted, etc.).
        - Any bank erosion within approximately 10 feet of the root wad.
    - For areas with re-established vegetation, should note:
        - The general condition of seeded areas and vegetative plantings.
        - The survival rates of vegetative plantings.
        - The percent cover by grasses and forbs in seeded areas.
- Document significant bank erosion locations, as defined as areas with raw, unvegetated banks greater than approximately two feet tall and with bank angles steeper than approximately 45 degrees.
- Note any observed changes in the stream flow pattern or direction throughout the Project, and note other locations where bank protection may be required;
- Examine storm sewer outlets for undermining, blockage and scour at the outlet and erosion;
- Record location of accumulated debris, downed trees and branches that may adversely redirect the stream flow into the stream banks;

- Take photographs to document the inspection findings in the preceding inspection tasks.

The inspection results will be summarized in a brief inspection report as described in the ANNUAL REPORT section. Appendix A contains the inspection form to be used during field inspections. Over the life of the project, the inspection form may be periodically revised to improve inspection effectiveness, including but not limited to the implementation of a mobile data collection app. The assessment will be amended to this report (the Lower Riley Creek Corridor Enhancement Plan) and can be used to inform potential actions.

7.2.2 Maintenance

Routine maintenance activities may include removal of fallen trees that may impede the flow of water, revegetating exposed soils, replacement of boulders for cross vanes, repair of displaced riprap and maintenance of buffer areas as identified through the inspection report. Maintenance will consist of activities to ensure that the flow of water is not impeded. All maintenance activities will comply with RPBCWD's standard buffer maintenance requirements as summarized below:

- Buffer vegetation must not be cultivated, cropped, pastured, mowed, fertilized, subject to the placement of mulch or yard waste, or otherwise disturbed, except for periodic cutting or burning that promotes the health of the buffer, actions to address disease or invasive species, mowing for purposes of public safety, temporary disturbance for placement or repair of buried utilities, or other actions to maintain or improve buffer quality and performance, each as approved by RPBCWD in advance in writing or when implemented pursuant to a written maintenance plan approved by RPBCWD.
- Diseased, noxious, invasive or otherwise hazardous trees or vegetation may be selectively removed from buffer areas and trees may be selectively pruned to maintain health.
- Pesticides and herbicides may be used in accordance with Minnesota Department of Agriculture rules and guidelines.
- No fill, debris or other material will be placed within a buffer.
- No structure or impervious cover (hard surface) may be created within a buffer area.

Routine Maintenance of the Project is defined as activities that will not require equipment that would adversely impact the Project area, as follows:

- Removing fallen trees that are causing bank erosion;
- Vegetation maintenance, such as vegetation replacement that does not require the use of heavy equipment within the Project area;
- Replacement of cross vane boulders and repair of displaced riprap.

Routine Maintenance does not include reconstruction of failed toe and bank stabilization design elements requiring heavy equipment. The City may solicit the RPBCWD for funding to address these non-Routine Maintenance repairs collaboratively.

7.2.3 Annual report

A brief Project inspection and maintenance report will be developed on or before January 31 of each year. The report will contain the following information:

- A summary of the inspection, including the presence or absence of any and all items specifically mentioned in the Inspections section above.
- Describe any maintenance activities completed for the previous 12-month period ending December 31, including dates and actions.
- A record of the location and quantity of any debris or fallen trees removed from Riley Creek.
- List the type and quantities of materials used to repair bank protection at any repair locations stabilized.
- A tabulation of costs for all labor, materials, and equipment involved in any maintenance activities for the previous 12-month period ending December 31.

8.0 Agreements

Table 8-1 summarizes anticipated agreements required prior to construction of the Lower Riley Creek Restoration Project.

Table 8-1 Summary of Anticipated Agreements

Description	Notes	Period	Lead Organization
Cooperative agreement between RPBCWD, LMRWD and city of Eden Prairie	Cooperative agreement between RPBCWD, LMRWD and city of Eden Prairie for activities related to construction and maintenance of the restoration project. The agreement would establish procedures for performing specific tasks, and define responsibilities of each organization.	2018	RPBCWD, LMRWD, and city of Eden Prairie

9.0 Financing, Work Plan and Responsibilities

Table 9-1 identifies work plan, finances and responsibilities for the project. There are four main parts to the project: design, implementation, post-construction monitoring and long-term monitoring.

Table 9-1 Financing, Work Plan Summary

	Activity	Estimated Dollars	Year	Organization Lead
Design	Riley Creek Stabilization	$147,900	2017-2019	RPBCWD
	Bridge	TBD	2017-2019	City of Eden Prairie
Bidding and Award	Riley Creek Stabilization with Bridge as option	$4,600	2019	RPBCWD*
Implementation	Bridge	TBD	2019-2020	City of Eden Prairie*
	Creek, ravine, trail restorations	$1,500,000 (includes $150,000 from each City of Eden Prairie and Lower Minnesota River Watershed District)	2019-2020	RPBCWD
	Storm sewers outfalls	RPBCWD and City to Split cost 50/50	2019-2020	RPBCWD
Post-Construction monitoring and inspections	3-year Warranty	Staff will monitor	2020-2023	RPBCWD and City of Eden Prairie
Long-term	Inspections	In-Kind	2023-2040	RPBCWD (most years) and City of Eden Prairie (every 5th year)(
	Routine maintenance	TBD	2023-2040	City of Eden Prairie
	Non-Routine maintenance	Determined as needed based on inspections	2023-2040	City of Eden Prairie and RPBCWD

* The project bidding and award will be through RPBCWD. Supervision of implementation of the bridge will fall to the City.

The primary points of contact are presented in the table below.

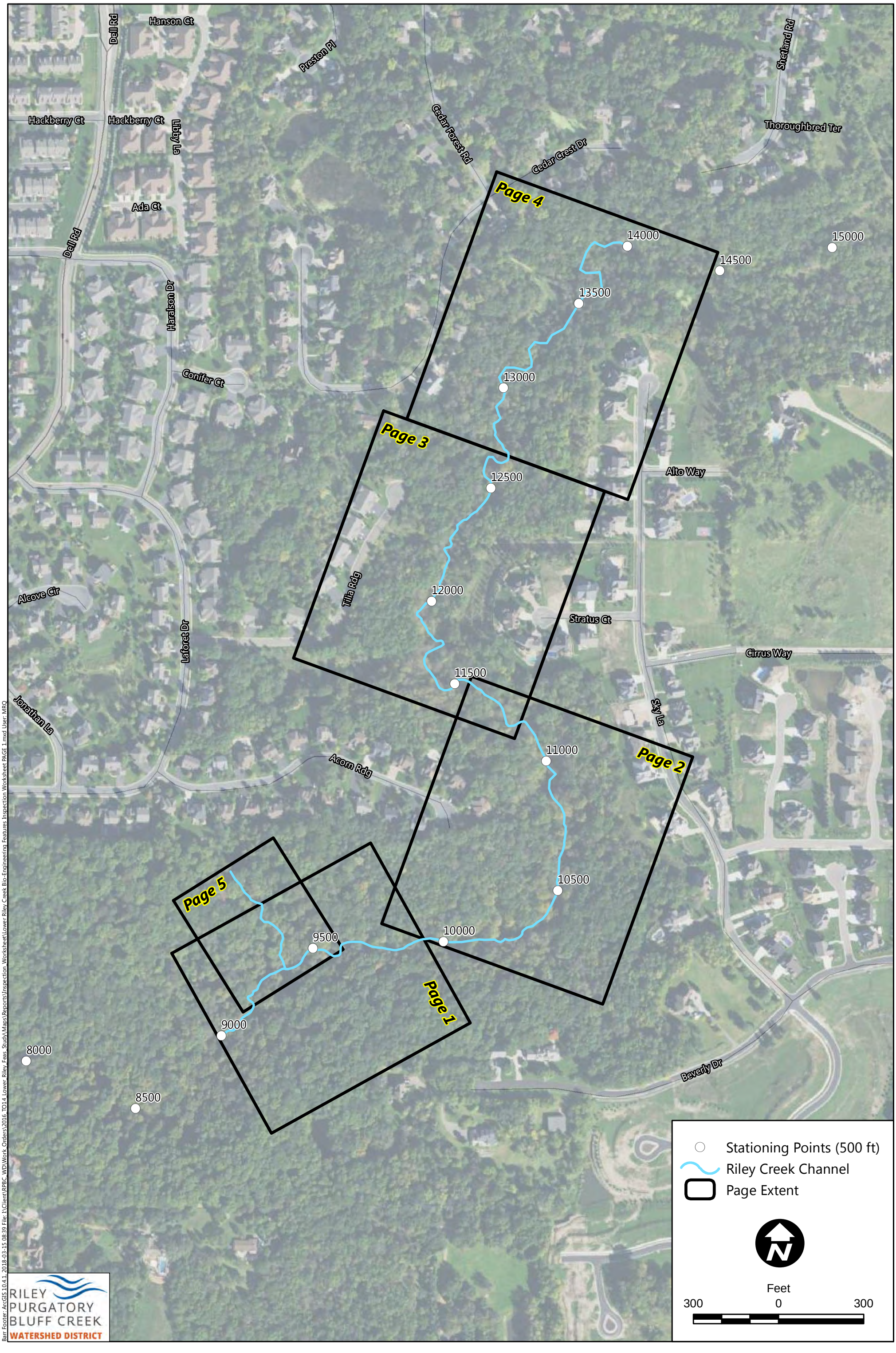
Organization	Name	Phone
RPBCWD	Claire Bleser	952-687-1348
Eden Prairie Engineering	Patrick Sejkora	952-949-8360
Eden Prairie Park	Matt Bourne	952-949-8535
LMRWD	Linda Loomis	763-545-4659

Financial Participation Summary

Organization	Amount
RPBCWD	$1,265,000
Eden Prairie	150,000+Bridge+ outfalls+ routine maintenance
LMRWD	$150,000

Appendix A Inspection Form: Lower Riley Creek Corridor Enhancement Plan

Inspection Form: Lower Riley Creek Corridor Enhancement Plan



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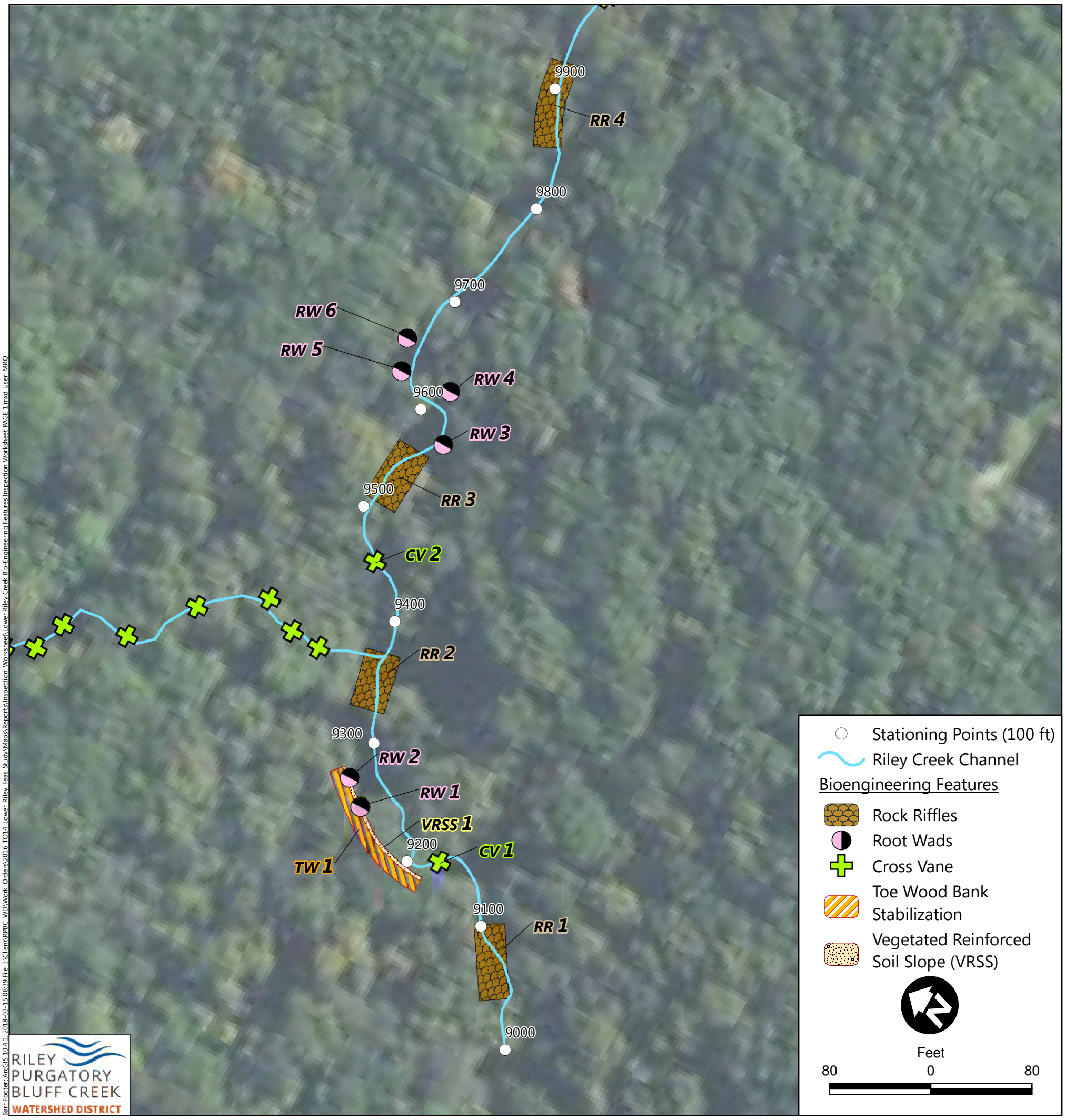
Inspection Form: Lower Riley Creek Corridor Enhancement Plan



Rock Riffle (RR)	Erosion	Sedimentation	Migration
RR 1	Yes No	Yes No	Yes No
RR 2	Yes No	Yes No	Yes No
RR 3	Yes No	Yes No	Yes No
RR 4	Yes No	Yes No	Yes No

Toe Wood Bank Stabilization (TW)	Moved	Rotten/Damaged	Feature above/below water line	Vegetation established above
TW 1	Yes No	Yes No	Above Below	Stressed Established

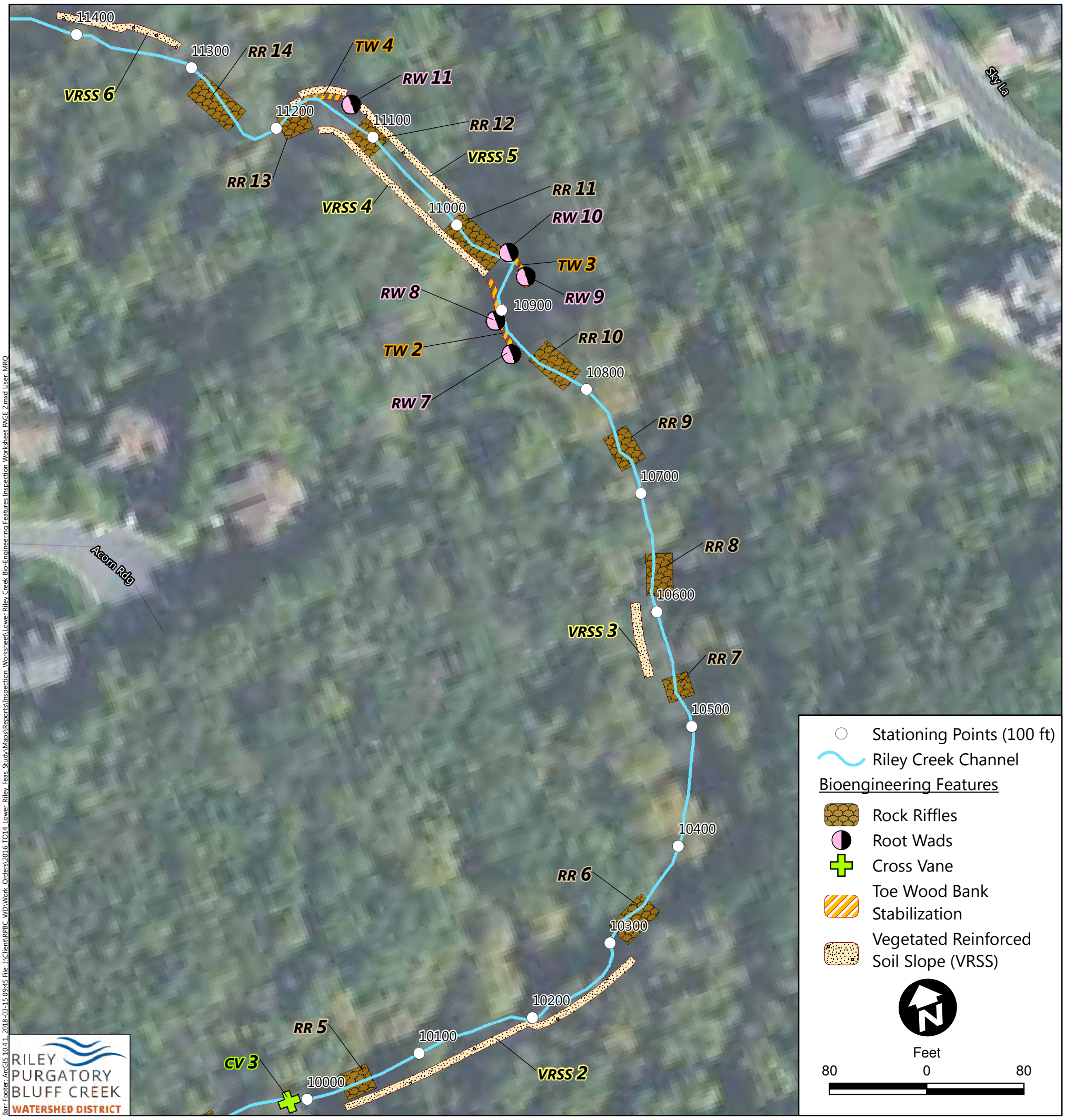
Vegetation Reinforced Soil Slope (VRSS)	Moved	Rotten/Damaged	Feature above/below water line	Vegetation established above
VRSS 1	Yes No	Yes No	Above Below	Stressed Established

Other features to note:
Significant bank erosion: raw unvegetated, >2 ft. tall, >45 degree angle
Observed changes in streamflow
Storm sewer outlets - blockage, scour at outlet, erosion
Accumulated debris, downed trees and branches, trash

Rock/Cross Vane (CV)	Boulder displacement	Downstream Scour	In-channel erosion	Bank erosion within 10ft	Debris buildup
CV 1	Yes No	Yes No	Yes No	Yes No	Yes No
CV 2	Yes No	Yes No	Yes No	Yes No	Yes No

Root Wads (RW)	Root wad present	Root wad general condition	Feature above/below water line	Bank erosion within 10ft	Downstream Scour	Vegetation established above
RW 1	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 2	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 3	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 4	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 5	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 6	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No

Inspection Form: Lower Riley Creek Corridor Enhancement Plan



Toe Wood Bank Stabilization (TW)	Moved	Rotten/Damaged	Feature above/below water line	Vegetation established above
TW 2	Yes No	Yes No	Above Below	Stressed Established
TW 3	Yes No	Yes No	Above Below	Stressed Established
TW 4	Yes No	Yes No	Above Below	Stressed Established

Rock/Cross Vane (CV)	Boulder displacement	Downstream Scour	In-channel erosion	Bank erosion within 10ft	Debris buildup
CV 3	Yes No	Yes No	Yes No	Yes No	Yes No

Vegetation Reinforced Soil Slope (VRSS)	Moved	Rotten/Damaged	Feature above/below water line	Vegetation established above
VRSS 2	Yes No	Yes No	Above Below	Stressed Established
VRSS 3	Yes No	Yes No	Above Below	Stressed Established
VRSS 4	Yes No	Yes No	Above Below	Stressed Established
VRSS 5	Yes No	Yes No	Above Below	Stressed Established
VRSS 6	Yes No	Yes No	Above Below	Stressed Established

Rock Riffle (RR)	Erosion	Sedimentation	Migration
RR 5	Yes No	Yes No	Yes No
RR 6	Yes No	Yes No	Yes No
RR 7	Yes No	Yes No	Yes No
RR 8	Yes No	Yes No	Yes No
RR 9	Yes No	Yes No	Yes No
RR 10	Yes No	Yes No	Yes No
RR 11	Yes No	Yes No	Yes No
RR 12	Yes No	Yes No	Yes No
RR 13	Yes No	Yes No	Yes No
RR 14	Yes No	Yes No	Yes No

Root Wads (RW)	Root wad present	Root wad general condition	Feature above/below water line	Bank erosion within 10ft	Downstream Scour	Vegetation established above
RW 7	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 8	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 9	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 10	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 11	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No

Other features to note:

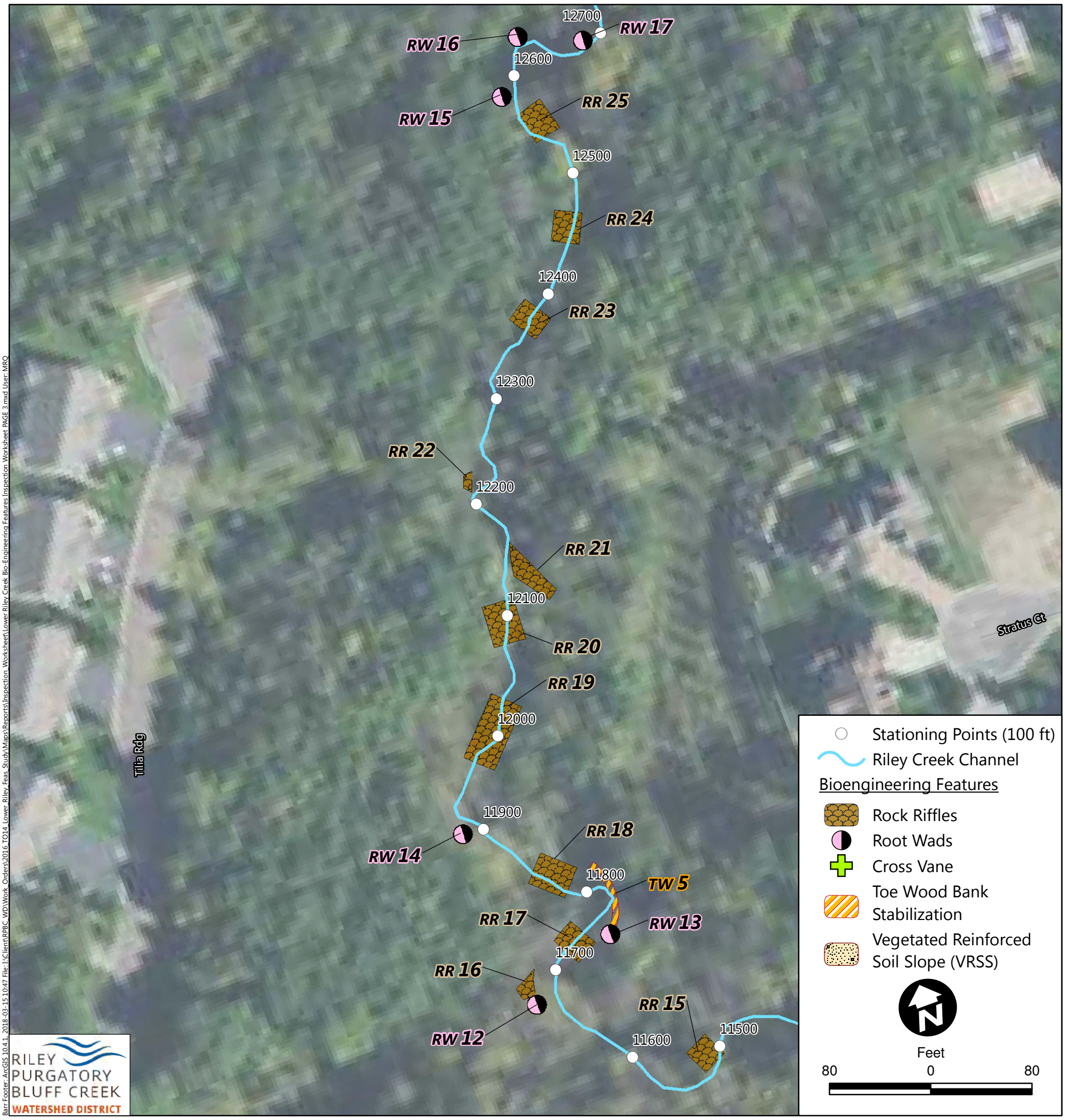
Significant bank erosion: raw unvegetated, >2 ft. tall, >45 degree angle

Observed changes in streamflow

Storm sewer outlets - blockage, scour at outlet, erosion

Accumulated debris, downed trees and branches, trash

Inspection Form: Lower Riley Creek Corridor Enhancement Plan

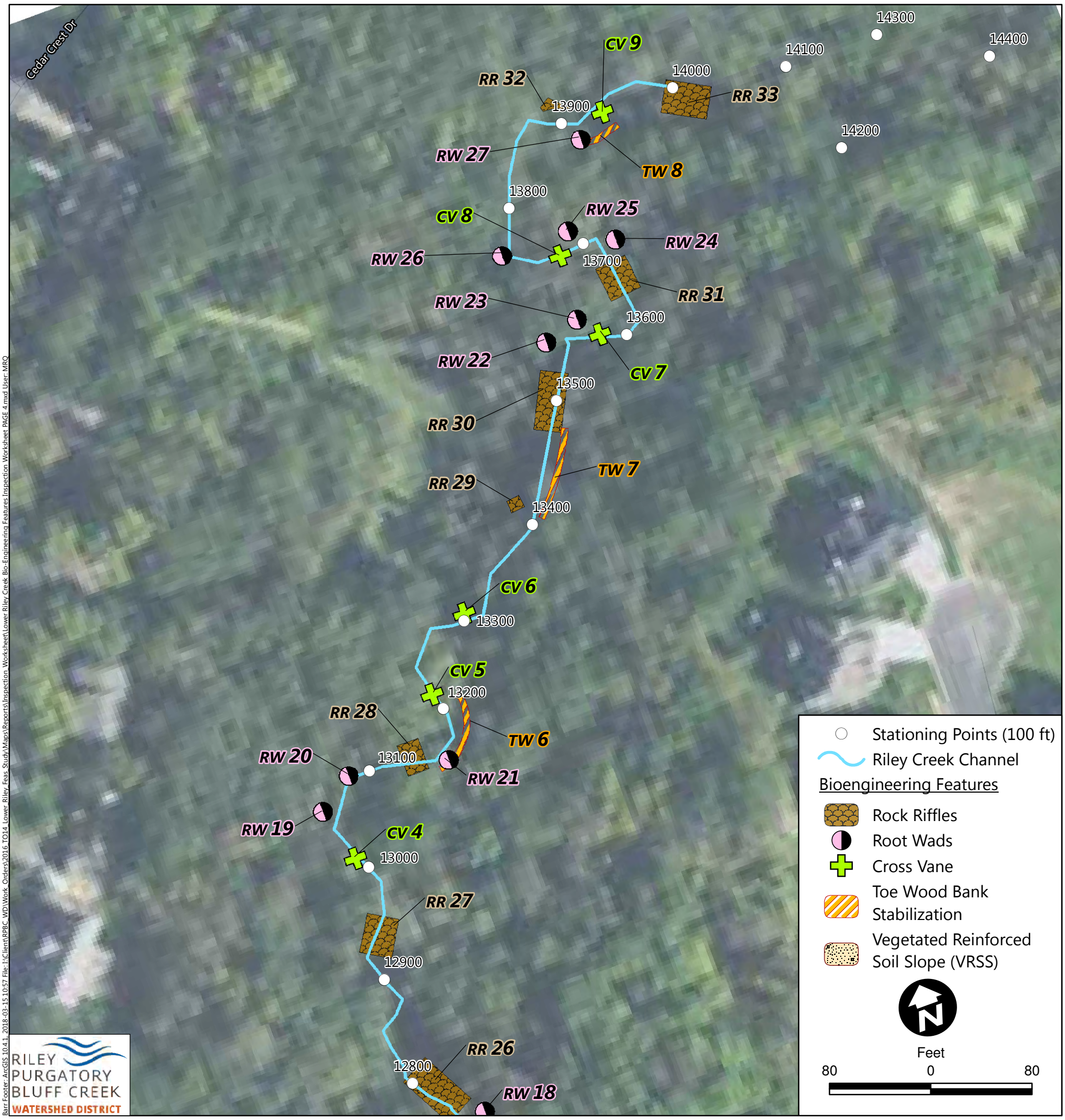


Toe Wood Bank Stabilization (TW)	Moved	Rotten/Damaged	Feature above/below water line	Vegetation established above
TW 5	Yes No	Yes No	Above Below	Stressed Established

Root Wads (RW)	Root wad present	Root wad general condition	Feature above/below water line	Bank erosion within 10ft	Downstream Scour	Vegetation established above
RW 12	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 13	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 14	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 15	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 16	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 17	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No

Rock Riffle (RR)	Erosion	Sedimentation	Migration
RR 15	Yes No	Yes No	Yes No
RR 16	Yes No	Yes No	Yes No
RR 17	Yes No	Yes No	Yes No
RR 18	Yes No	Yes No	Yes No
RR 19	Yes No	Yes No	Yes No
RR 20	Yes No	Yes No	Yes No
RR 21	Yes No	Yes No	Yes No
RR 22	Yes No	Yes No	Yes No
RR 23	Yes No	Yes No	Yes No
RR 24	Yes No	Yes No	Yes No
RR 25	Yes No	Yes No	Yes No

Other features to note:
Significant bank erosion: raw unvegetated, >2 ft. tall, >45 degree angle
Observed changes in streamflow
Storm sewer outlets - blockage, scour at outlet, erosion
Accumulated debris, downed trees and branches, trash



Toe Wood Bank Stabilization (TW)	Moved	Rotten/Damaged	Feature above/below water line	Vegetation established above
TW 6	Yes No	Yes No	Above Below	Stressed Established
TW 7	Yes No	Yes No	Above Below	Stressed Established
TW 8	Yes No	Yes No	Above Below	Stressed Established

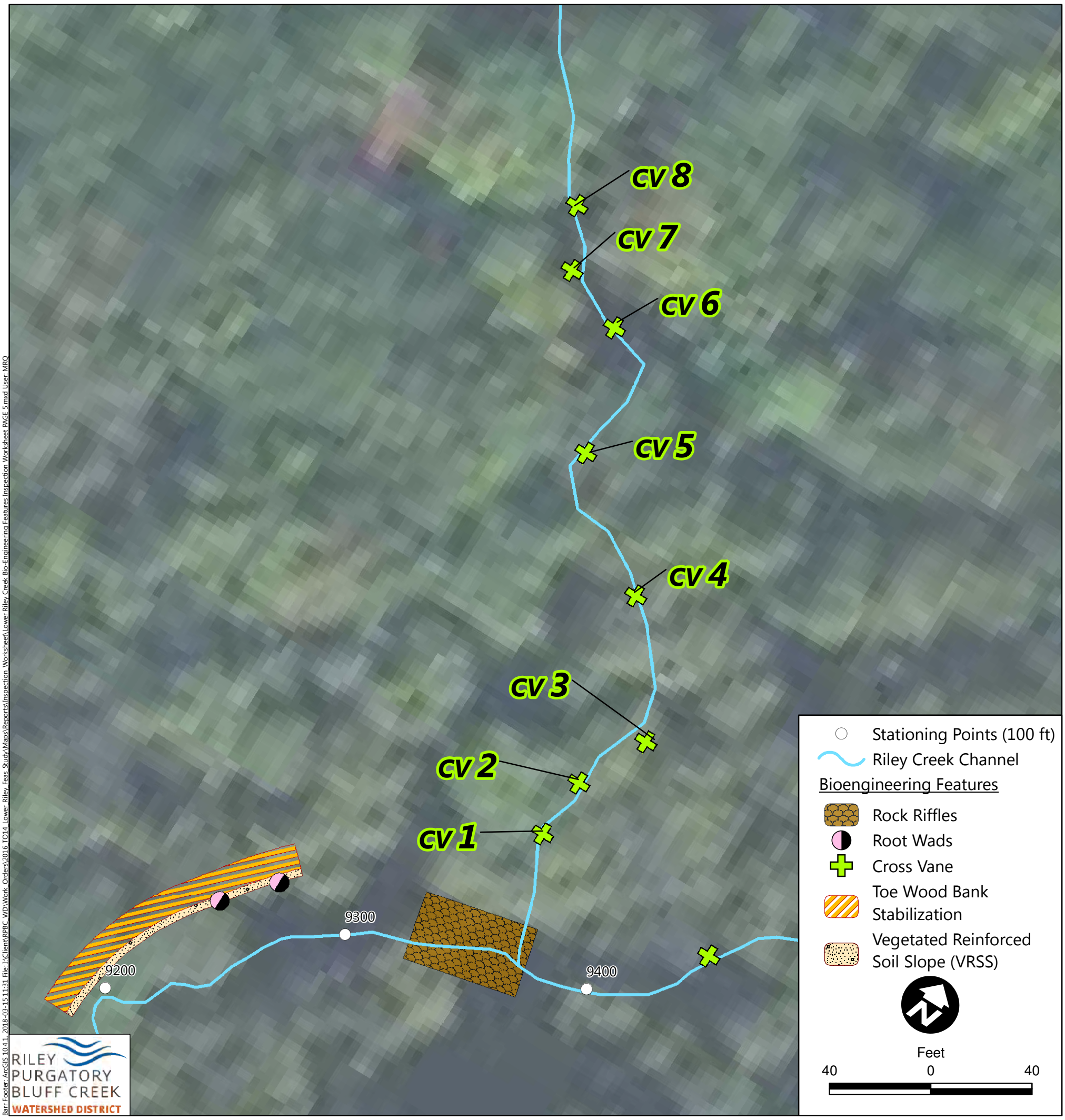
Rock/Cross Vane (CV)	Boulder displacement	Downstream Scour	In-channel erosion	Bank erosion within 10ft	Debris buildup
CV 4	Yes No	Yes No	Yes No	Yes No	Yes No
CV 5	Yes No	Yes No	Yes No	Yes No	Yes No
CV 6	Yes No	Yes No	Yes No	Yes No	Yes No
CV 7	Yes No	Yes No	Yes No	Yes No	Yes No
CV 8	Yes No	Yes No	Yes No	Yes No	Yes No
CV 9	Yes No	Yes No	Yes No	Yes No	Yes No

Root Wads (RW)	Root wad present	Root wad general condition	Feature above/below water line	Bank erosion within 10ft	Downstream Scour	Vegetation established above
RW 19	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 20	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 21	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 22	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 23	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 24	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 25	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 26	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No
RW 27	Yes No	moved rotted	Above Below	Yes No	Yes No	Yes No

Rock Riffle (RR)	Erosion	Sedimentation	Migration
RR 26	Yes No	Yes No	Yes No
RR 27	Yes No	Yes No	Yes No
RR 28	Yes No	Yes No	Yes No
RR 29	Yes No	Yes No	Yes No
RR 30	Yes No	Yes No	Yes No
RR 31	Yes No	Yes No	Yes No
RR 32	Yes No	Yes No	Yes No
RR 33	Yes No	Yes No	Yes No

Other features to note:
Significant bank erosion: raw unvegetated, >2 ft. tall, >45 degree angle
Observed changes in streamflow
Storm sewer outlets - blockage, scour at outlet, erosion
Accumulated debris, downed trees and branches, trash

Inspection Form: Lower Riley Creek Corridor Enhancement Plan



Rock/Cross Vane (CV)	Boulder displacement	Downstream Scour	In-channel erosion	Bank erosion within 10ft	Debris buildup
CV 1	Yes No	Yes No	Yes No	Yes No	Yes No
CV 2	Yes No	Yes No	Yes No	Yes No	Yes No
CV 3	Yes No	Yes No	Yes No	Yes No	Yes No
CV 4	Yes No	Yes No	Yes No	Yes No	Yes No
CV 5	Yes No	Yes No	Yes No	Yes No	Yes No
CV 6	Yes No	Yes No	Yes No	Yes No	Yes No
CV 7	Yes No	Yes No	Yes No	Yes No	Yes No
CV 8	Yes No	Yes No	Yes No	Yes No	Yes No

Other features to note:
Significant bank erosion: raw unvegetated, >2 ft. tall, >45 degree angle
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