

Appendices

Appendix A
Site Visit Photos

Photo 1: Site 1a. Bare soil on the right bank at station 0+40.



Photo 2: Site 1a. BEHI measurement at the right bank of station 1+60.



Photo 3: Site 1b. Downstream section at the right bank of station 4+50.



Photo 4: Site 1c. BEHI measurement at the right bank of station 7+20.



Photo 5: Site 1d. Large right bank deposition facing downstream of station 8+50.



Photo 6: Site 1d. BEHI measurement at the left bank of station 9+10.



Photo 7: Site 1e. Gully formation from parking lot runoff on the left bank of station 12+20.



Photo 8: Site 1e. Drainpipe and bare soil on the left bank of station 13+50 (facing upstream).



Photo 9: Site 1f. Bare soil at the right bank of station 12+30.



Photo 10: Site 2a. Left bank of station 16+80.



Photo 11: Site 2b. BEHI measurement at the right bank of station 18+50.



Photo 12: Site 2c. Large deposition at the right bank of station 19+50 (facing downstream).



Photo 13: Site 2c. BEHI measurement and bare soil at the left bank of station 19+90 (facing downstream).



Photo 14: Site 2d. BEHI measurement at the right bank of station 21+10.



Photo 15: Site 2d. Upstream section of the left bank at station 21+10.



Photo 16: Site 2e. BEHI measurement at the left bank of station 22+50.



Photo 17: Site 2f. Concrete-filled pipe and right bank undercutting at station 22+75.



Photo 18: Site 2f. Left bank undercutting at station 23+10.



Photo 19: Site 2g. Bare soils and undercutting at the right bank of station 27+60.



Photo 20: Site 2h. BEHI measurement at the right bank of station 29+00.



Photo 21: Site 2i. Downstream section at station 29+90.



Photo 22: Site 2i. Right bank of station 30+10.



Photo 23: Site 2j. Left bank outlet at station 31+00 directly upstream of a sanitary sewer that crosses the creek.



Photo 24: Site 2k. Undercutting at the right bank of station 32+25.



Photo 25: Site 2l. BEHI measurement and undercut at the left bank of station 34+25.



Photo 26: Site 2m. Soil exposure and deposition at the right bank of station 35+60 (facing downstream).



Photo 27: Site 2m. Deposition and undercut at the left bank of station 36+60.



Photo 28: Site 2n. Undercut on the left bank of station 37+90; deposition on the right bank (facing downstream).



Photo 29: Site 2n. Undercut on the left bank of station 39+10. Deposition on the right bank (facing downstream).



Photo 30: Site 3b. Undercut on the left bank of station 42+70. Deposition on the right bank (facing downstream).



Photo 31: Site 3c. Undercut at the upstream section at station 46+50.



Photo 32: Site 3d. Upstream section of the left bank of station 47+50.



Photo 33: Site 33e. Downstream section at station 47+70.



Photo 34: Site 3f. Bare soil at the upstream section at station 50+90.



Photo 35: Site 3g. Undercut and deposition at right bank of station 50+20.



Photo 36: Site 3h. BEHI measurement at right bank of station 51+00 with undercut and deposition.



Photo 37: Site 3i. Left bank of station 52+30.



Photo 38: Site 3i. Left bank of station 53+50.



Photo 39: Site 3i. BEHI measurement at the right bank of station 53+00 (facing upstream).



Photo 40: Site 3j. Undercut at the left bank of station 55+20.



Photo 41: Site 4a. Right bank of station 57+80.



Photo 42: Site 4b. Right bank of downstream section at station 60+00.



Photo 43: Site 4c. Downstream section before oxbow at station 61+40.



Photo 44: Site 4d. Right bank of station 65+70 (facing downstream).



Photo 45: Site 4e. Undercut at station 65+50 (facing upstream).



Photo 46: Site 4f. Sanitary manhole at the left bank of station 65+90.



Photo 47: Site 4f. Left bank of station 66+70.



Photo 48: Site 4g. Downstream section of station 67+50.



Photo 49: Site 4h. Left bank at station 68+80 (facing upstream).



Photo 50: Site 4h. Downstream section at station 70+70.



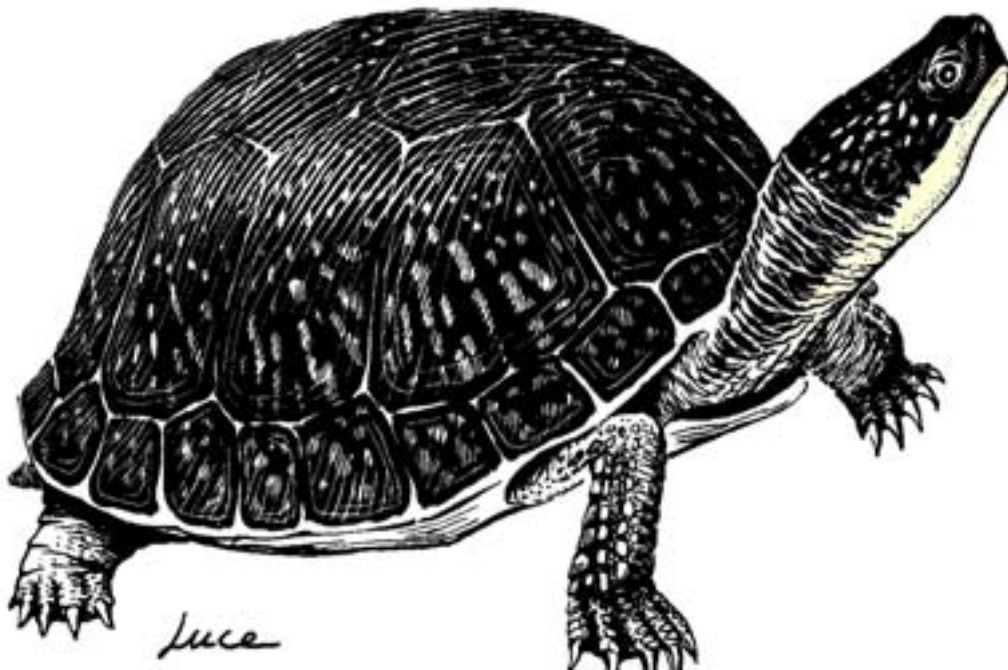
Photo 51: Site 4i. Poor riprap at the right bank of station 70+80 (facing downstream).



Appendix B

Blanding's Turtle Flyer

CAUTION



BLANDING'S TURTLES MAY BE ENCOUNTERED IN THIS AREA

The unique and rare Blanding's turtle has been found in this area. Blanding's turtles are a State Threatened species and are protected under Minnesota Statute 84.095, Protection of Threatened and Endangered Species. Please be careful of turtles on roads and in construction sites. For additional information on turtles, or to report a Blanding's turtle sighting, contact the DNR Nongame Specialist nearest you: Bemidji (218-308-2641); Grand Rapids (218-327-4518); New Ulm (507-359-6033); Rochester (507-280-5070); or St. Paul (651-259-5764).

DESCRIPTION: The Blanding's turtle is a medium to large turtle (5 to 10 inches) with a black or dark blue, dome-shaped shell with muted yellow spots and bars. The bottom of the shell is hinged across the front third, enabling the turtle to pull the front edge of the lower shell firmly against the top shell to provide additional protection when threatened. The head, legs, and tail are dark brown or blue-gray with small dots of light brown or yellow. A distinctive field mark is the bright yellow chin and neck.

Illustration by Don Luce, from *Turtles in Minnesota*, Natural History Leaflet No. 9, June 1989, James Ford Bell Museum of Natural History

SUMMARY OF RECOMMENDATIONS FOR AVOIDING AND MINIMIZING IMPACTS TO BLANDING'S TURTLE POPULATIONS

(see Environmental Review Fact Sheet Series for full recommendations)

- A flyer with an illustration of an adult Blanding's turtle should be given to all contractors working in the area. Homeowners should also be informed of the presence of Blanding's turtles in the area.
- Turtles which are in imminent danger should be moved, by hand, out of harms way. Turtles which are not in imminent danger should be left undisturbed to continue their travel among wetlands and/or nest sites.
- If a Blanding's turtle nests in your yard, do not disturb the nest, and do not allow pets near the nest.
- Blanding's turtles do not make good pets. It is illegal to keep this threatened species in captivity.
- Silt fencing should be set up to keep turtles out of construction areas. It is critical that silt fencing be removed after the area has been revegetated.
- Small, vegetated temporary wetlands should not be dredged, deepened, or filled.
- All wetlands should be protected from pollution; use of fertilizers and pesticides should be avoided, and run-off from lawns and streets should be controlled. Erosion should be prevented to keep sediment from reaching wetlands and lakes.
- Roads should be kept to minimum standards on widths and lanes.
- Roads should be ditched, not curbed or below grade. If curbs must be used, 4" high curbs at a 3:1 slope are preferred.
- Culverts under roads crossing wetland areas, between wetland areas, or between wetland and nesting areas should be at least 36 in. diameter and flat-bottomed or elliptical.
- Culverts under roads crossing streams should be oversized (at least twice as wide as the normal width of open water) and flat-bottomed or elliptical.
- Utility access and maintenance roads should be kept to a minimum.
- Because trenches can trap turtles, trenches should be checked for turtles prior to being backfilled and the sites should be returned to original grade.
- Terrain should be left with as much natural contour as possible.
- Graded areas should be revegetated with native grasses and forbs.
- Vegetation management in infrequently mowed areas -- such as in ditches, along utility access roads, and under power lines -- should be done mechanically (chemicals should not be used). Work should occur fall through spring (after October 1st and before June 1st).

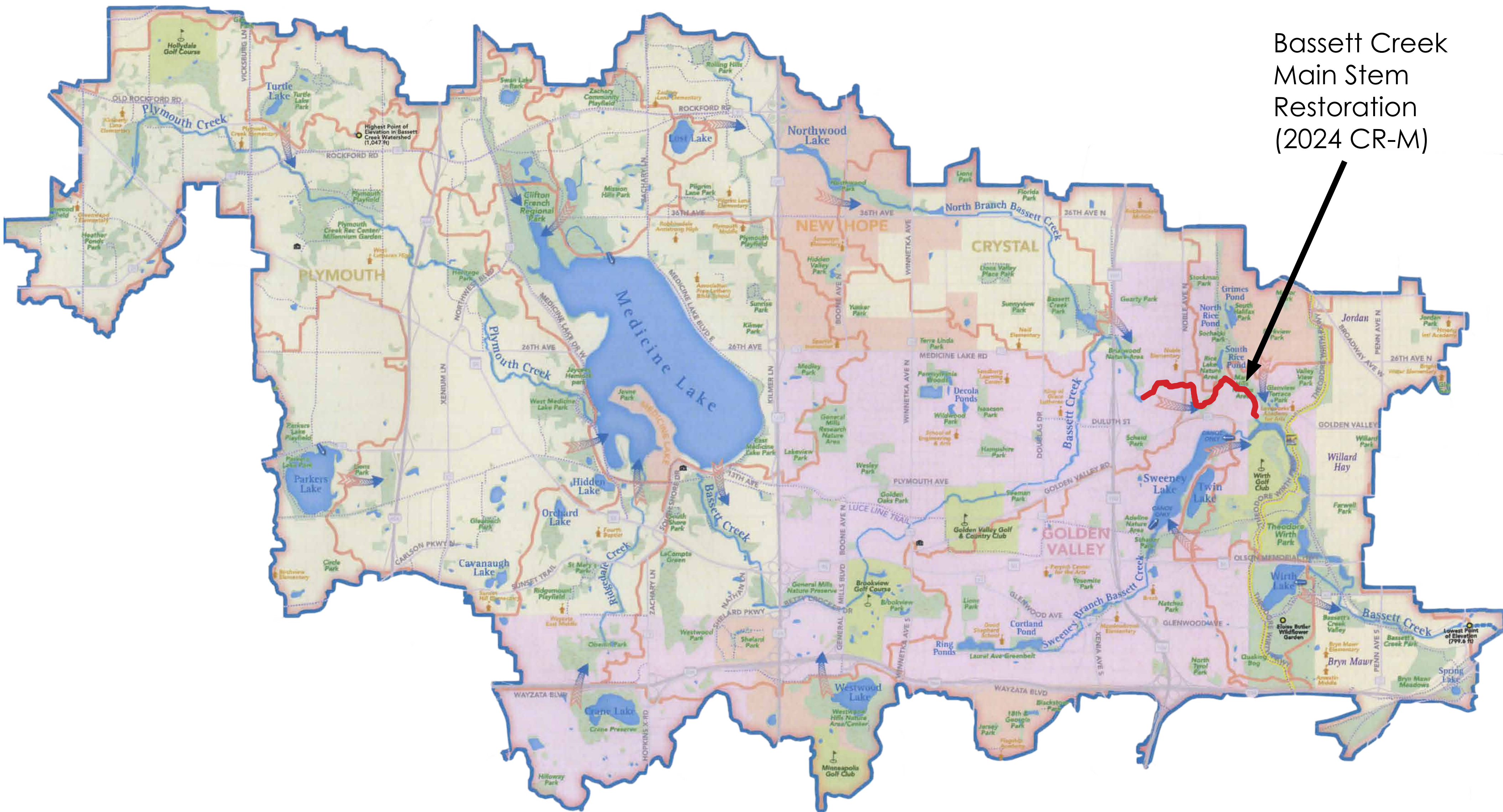
*Compiled by the Minnesota Department of Natural Resources Division of Ecological Resources, Updated March 2008
Endangered Species Environmental Review Coordinator, 500 Lafayette Rd., Box 25, St. Paul, MN 55155 / 651-259-5109*

Appendix C

Open House Materials

About the Bassett Creek Watershed Management Commission (BCWMC)

The vision: stewardship of water resources to protect and enhance our communities



About the BCWMC

- **Regional government organization** formed in 1969 to focus on flood control along Bassett Creek
- **Operates under 1982 Metropolitan Surface Water Management Act**
- **Focused on providing flood management and improving and protecting the water quality** of Bassett Creek and lakes/streams
- **Nine member cities:** Crystal, Golden Valley, Medicine Lake, Minneapolis, Minnetonka, New Hope, Plymouth, Robbinsdale, St. Louis Park,
- **Area:** approximately 40 square miles

Commission funding

- Contributions from nine member cities (approximately \$600,000 per year)
- Hennepin County tax levy for major projects (approximately \$1.5–2 million per year)
- Grant funds and application fees (varies)

Commission activities

- Implements capital improvement projects that reduce flooding and improve lakes, streams, and wetlands throughout the watershed
- Monitors water quality, performs studies, maps resources
- Provides water resource education and watershed-wide coordination
- Reviews developments for compliance with standards and requirements

EXAMPLE BCWMC CIP PROJECTS



Wirth Lake outlet



Bassett Creek restoration



Bassett Creek Main Stem Erosion Issues and Restoration Prioritization



Restoration Prioritization Factors

Several factors will impact prioritization of Bassett Creek Main Stem restoration locations, including:

- Severity of existing erosion
- Public access/ownership
- Protection of existing structures / infrastructure
- Impact to surrounding areas
- Public visibility / accessibility
- Potential for future erosion (near bank stress and bank erosion hazard index ratings)
- Opportunity for habitat creation or restoration
- Maintaining healthy, native significant trees (minimize removal)
- Vegetation establishment potential (exposure to sunlight)
- Ease of construction access
- Consider proximity/possibility for other improvements (e.g. new sediment trapping device in nearby storm drains)



Streambank undercutting



Tributary erosion



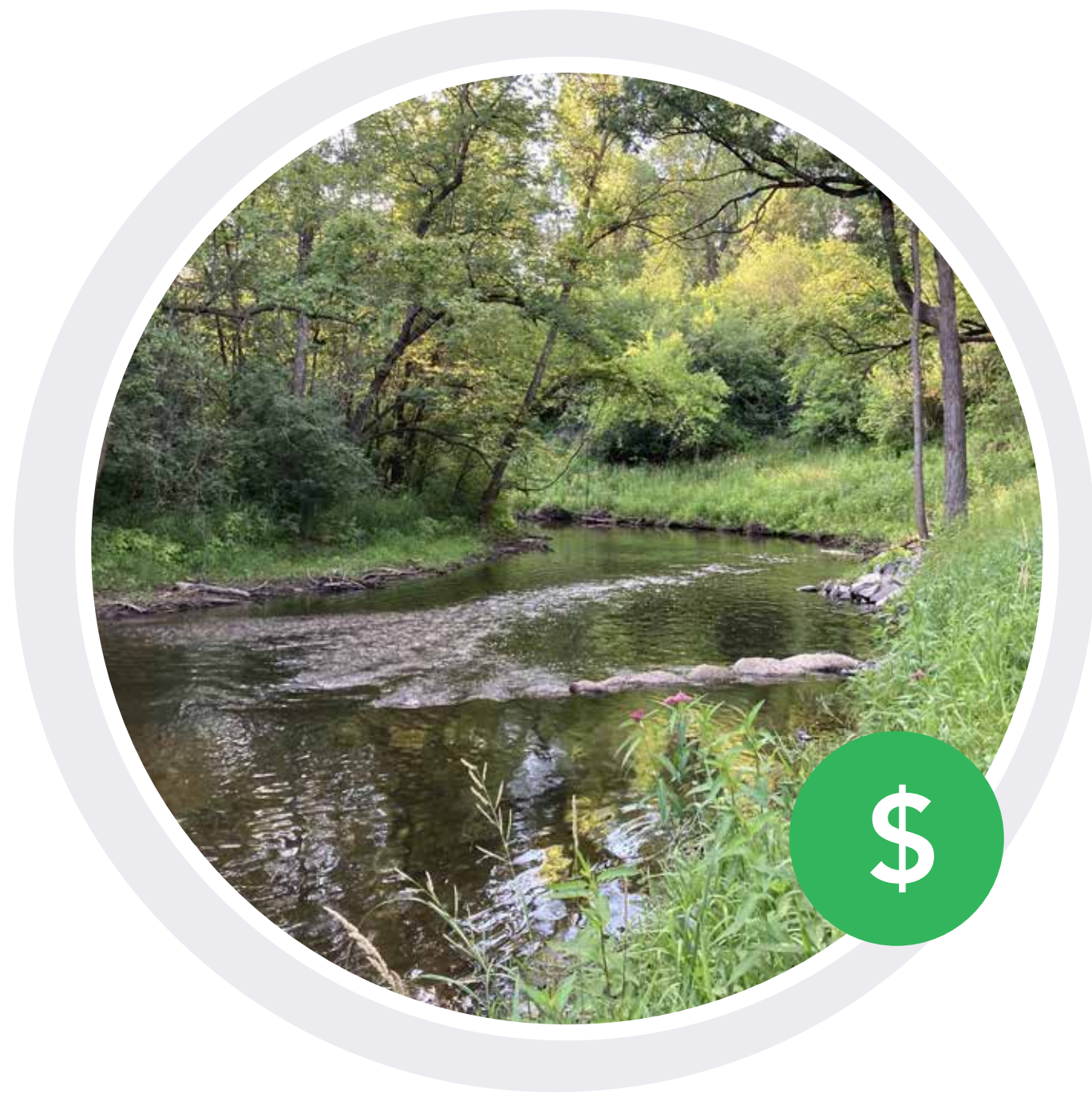
Scour near culverts

Any type of erosion comes with the associated issues:

- Introduction of sediment to stream and downstream water bodies
- Degradation of bank vegetation and reduced potential for re-growth
- Degradation of in-stream and bank habitats
- Increased risk of continued erosion
- Changing of the stream shape and size overtime

Alternate Design Concepts Summary

1



In-stream structures

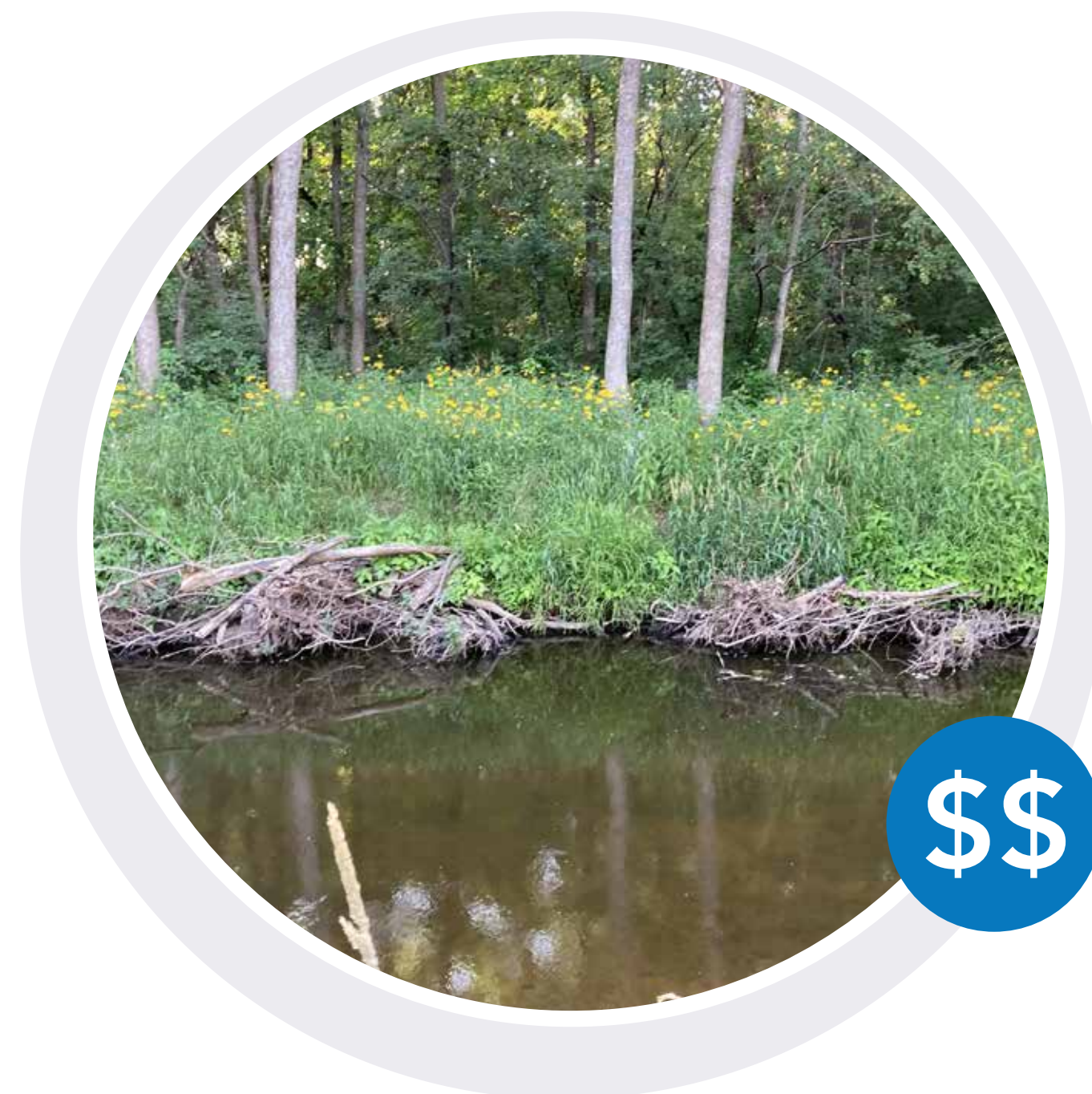
Pros

- Reduces near-bank stress
- Minimal bank disturbance
- Lowest construction cost
- Diversifies flow within stream, including energy dissipation pools
- Features provide in-stream habitat

Cons

- In stream features can be obstructed with sediment and debris
- Continued erosion on unprotected bank toe outside the zone of influence of the structures

2

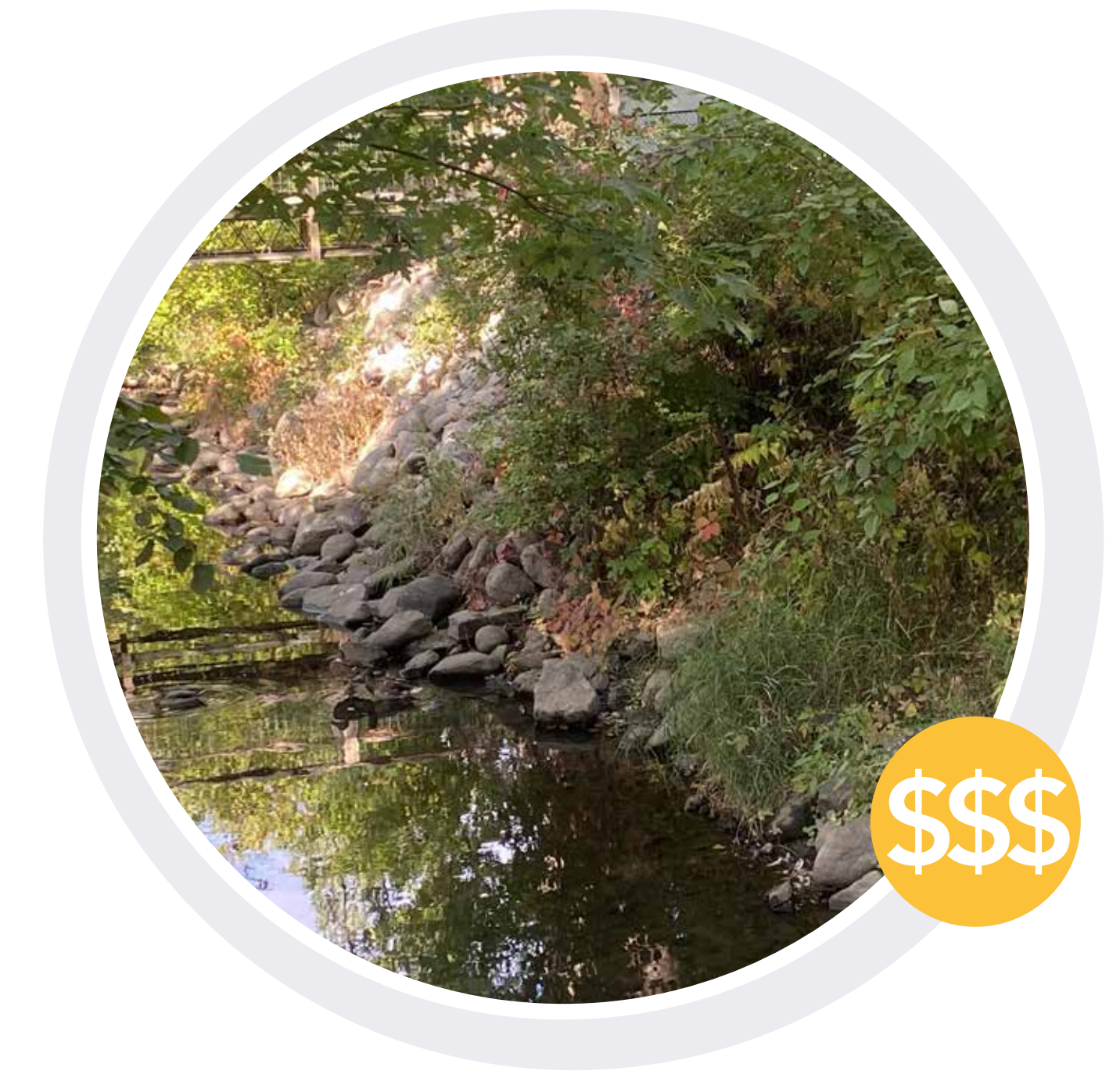


Bank stabilization with bioengineering methods

- More erosion protection along the base of the bank, also known as the bank toe
- Bioengineering and vegetation features can improve in-stream and bank habitat

- Requires establishment period for vegetation features
- Moderate grading can increase construction costs, bank disturbance, and potential tree removal

3

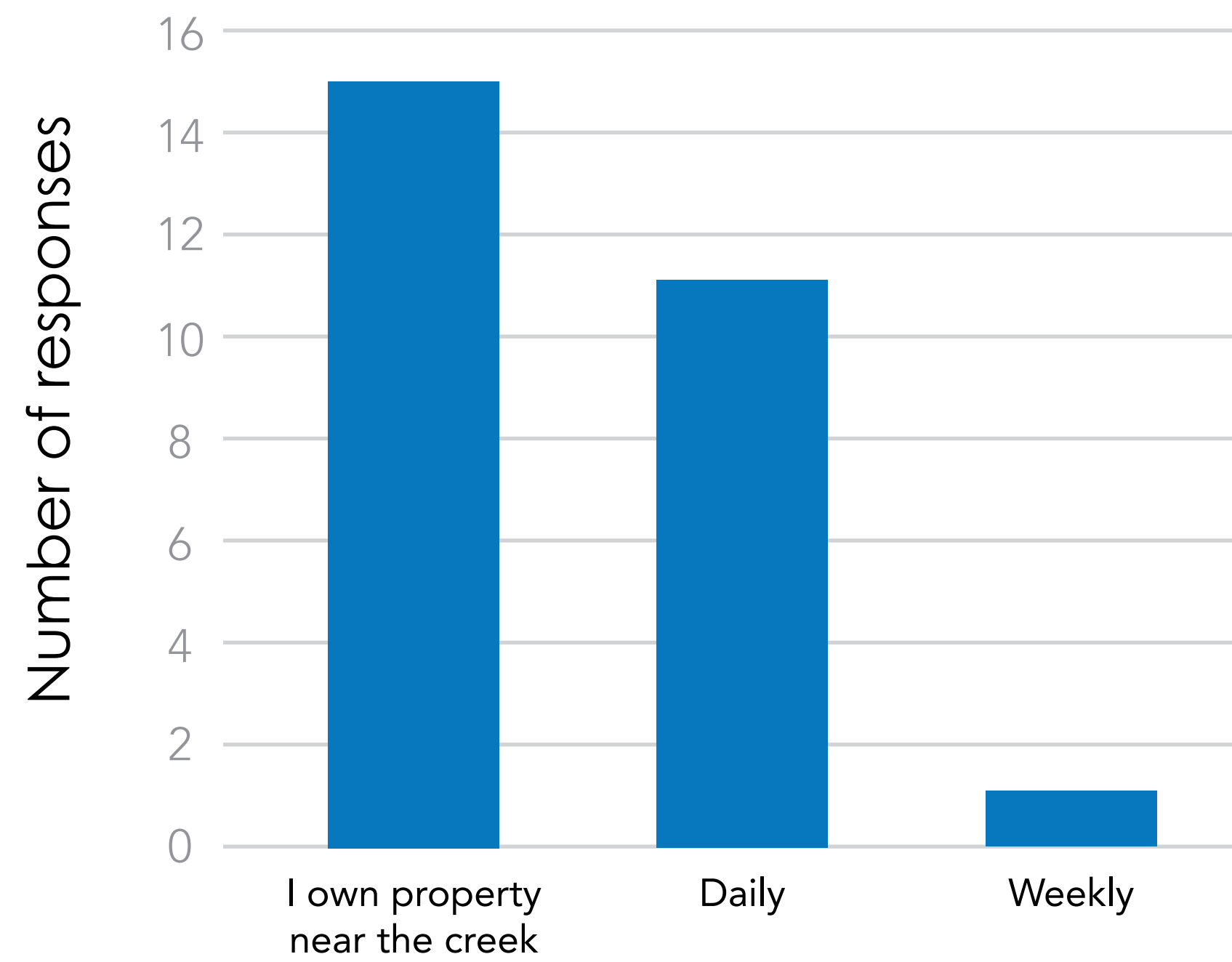


Bank grading with riprap and vegetation establishment

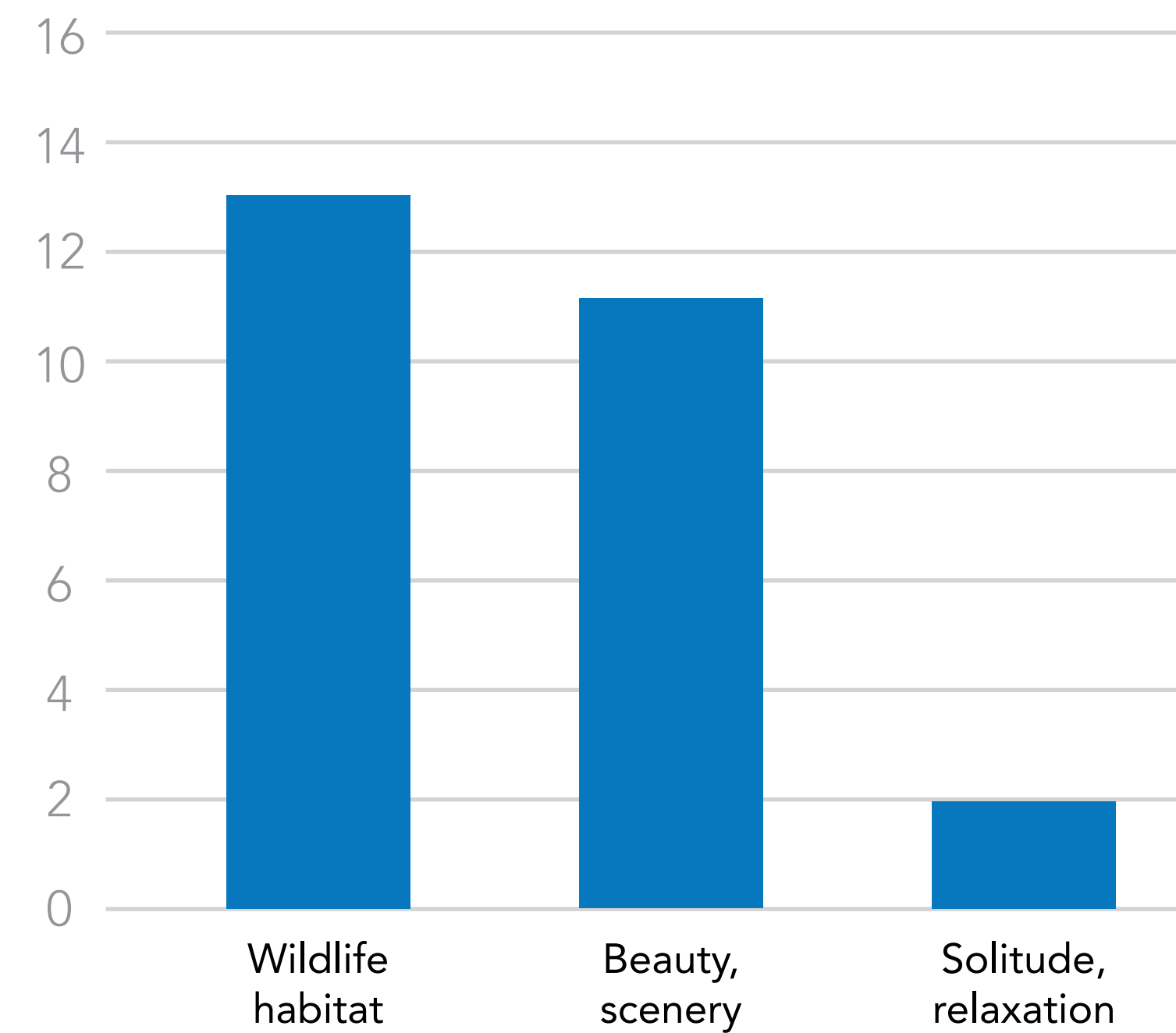
- Riprap allows for the most protection against high shear stress flows
- Immediate stabilization of eroding areas

- Riprap provides minimal in-stream or bank habitat
- Riprap and grading are more cost intensive
- Most bank disturbance during construction, and potential tree removal

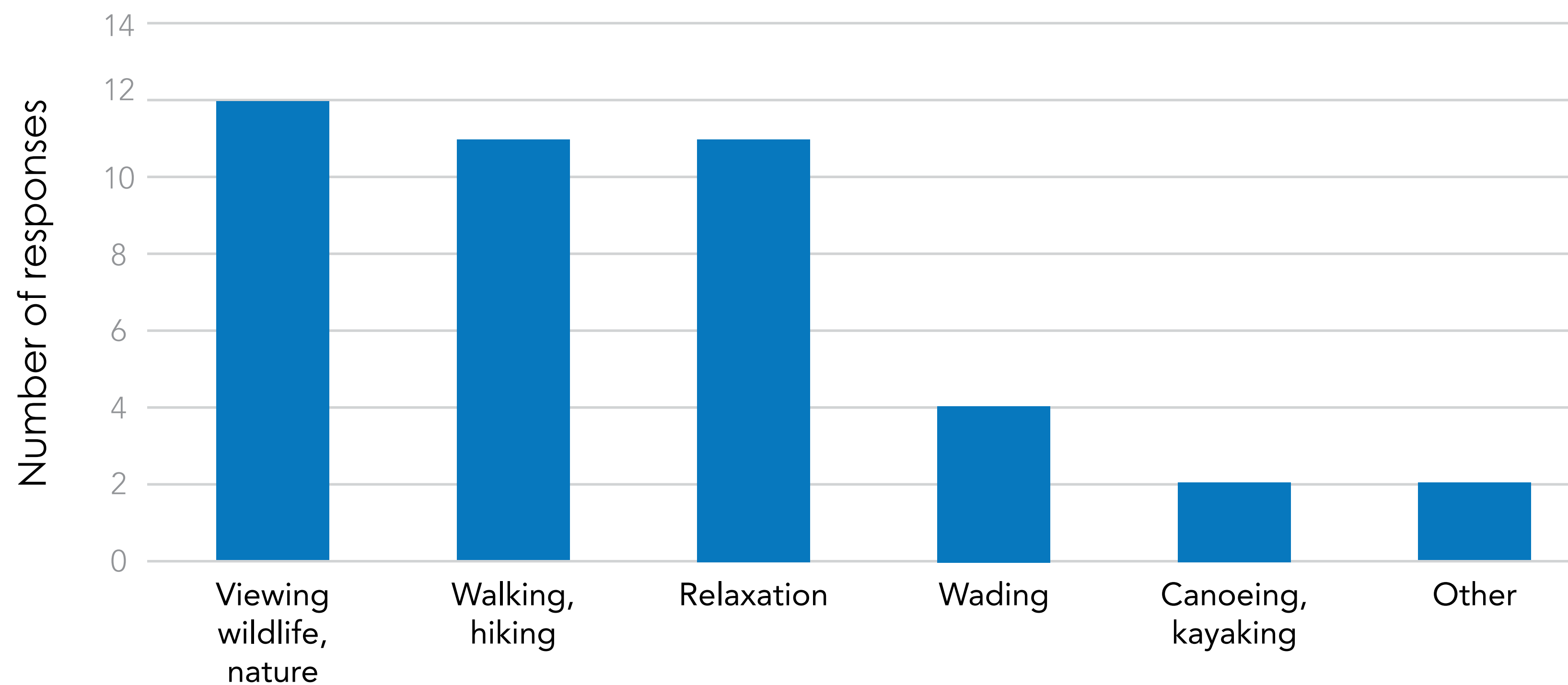
How often do you visit Bassett Creek?



What do you appreciate about Bassett Creek?



How do you interact with Bassett Creek?



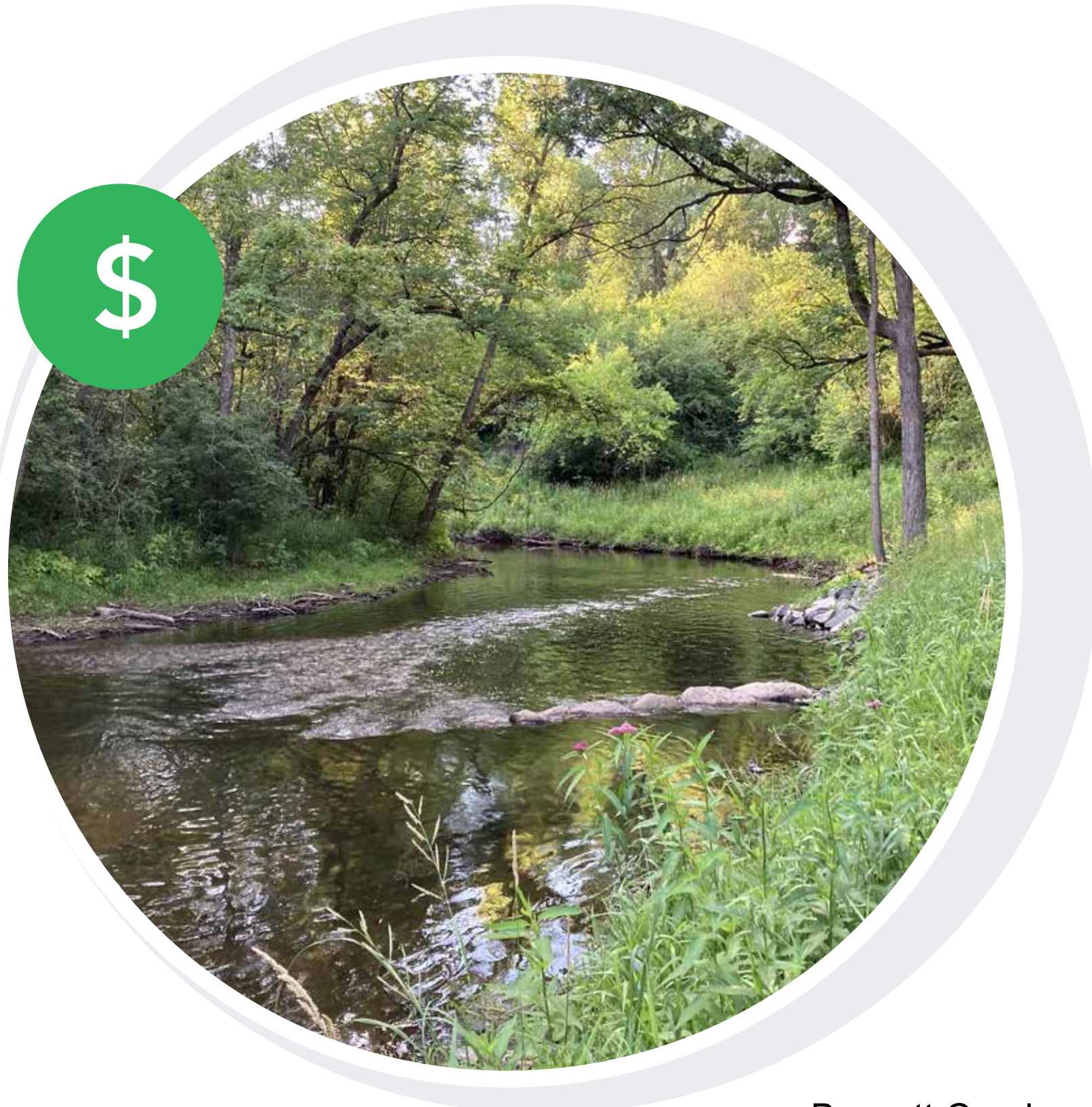
How can Bassett Creek be improved as part of this project?

- Mitigate erosion and stabilize channel banks.
- Protect and preserve as many trees as possible.
- Protect and improve wildlife habitat.
- Control invasive species.
- Mitigate flooding.
- Remove debris clogging the channel.
- Improve navigability.

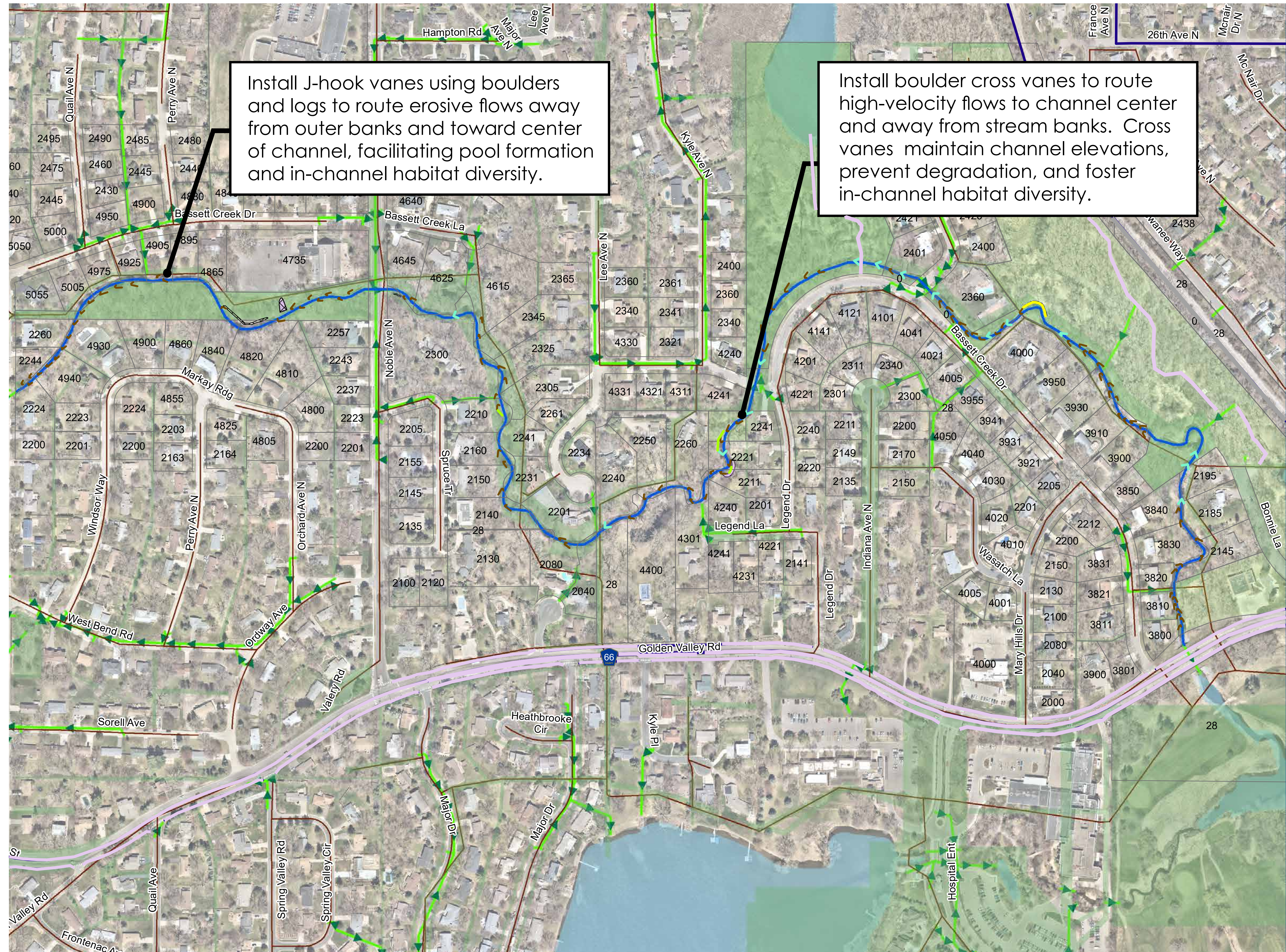
Concern	Response
Tree removal and loss of wildlife habitat	Tree removal will be limited to only those trees essential to the project construction; our goal is to protect as many healthy trees as possible. The proposed stream restoration project will increase wildlife habitat by increasing native vegetation adjacent to streambanks, as well as by introducing woody habitat to the streams.
Property access and property damage	All areas disturbed during the stream restoration project will be restored with seeding.
Cost to adjacent property owners	This project would be funded through taxes collected from all residents of the Bassett Creek Watershed area through the BCWMC Capital Improvement Program. Additional funds may be collected from partners, grants, or the city of Golden Valley. There will be no special assessments to property owners for the Bassett Creek Main Stem Restoration Project.
Effects on the floodplain and flood risk to properties	The proposed restoration will not result in net fill in the floodplain, therefore, flood risk will not increase.
Effects on utility lines	The project will be designed to avoid impacts to utility lines. A utility locate will occur during the design and construction process to ensure all utilities are avoiding during construction.
Concerns about the ability of fish to migrate upstream	Any in-stream structure that spans the width of the creek (i.e. cross vanes) will be designed to allow fish passage during low and high flow events.
Ability to inform restoration design	Public input gathered via the online Story Map and public meetings will inform design decisions.

Restoration Design Concept

1 In stream structures with minimal grading, riprap, and vegetation establishment

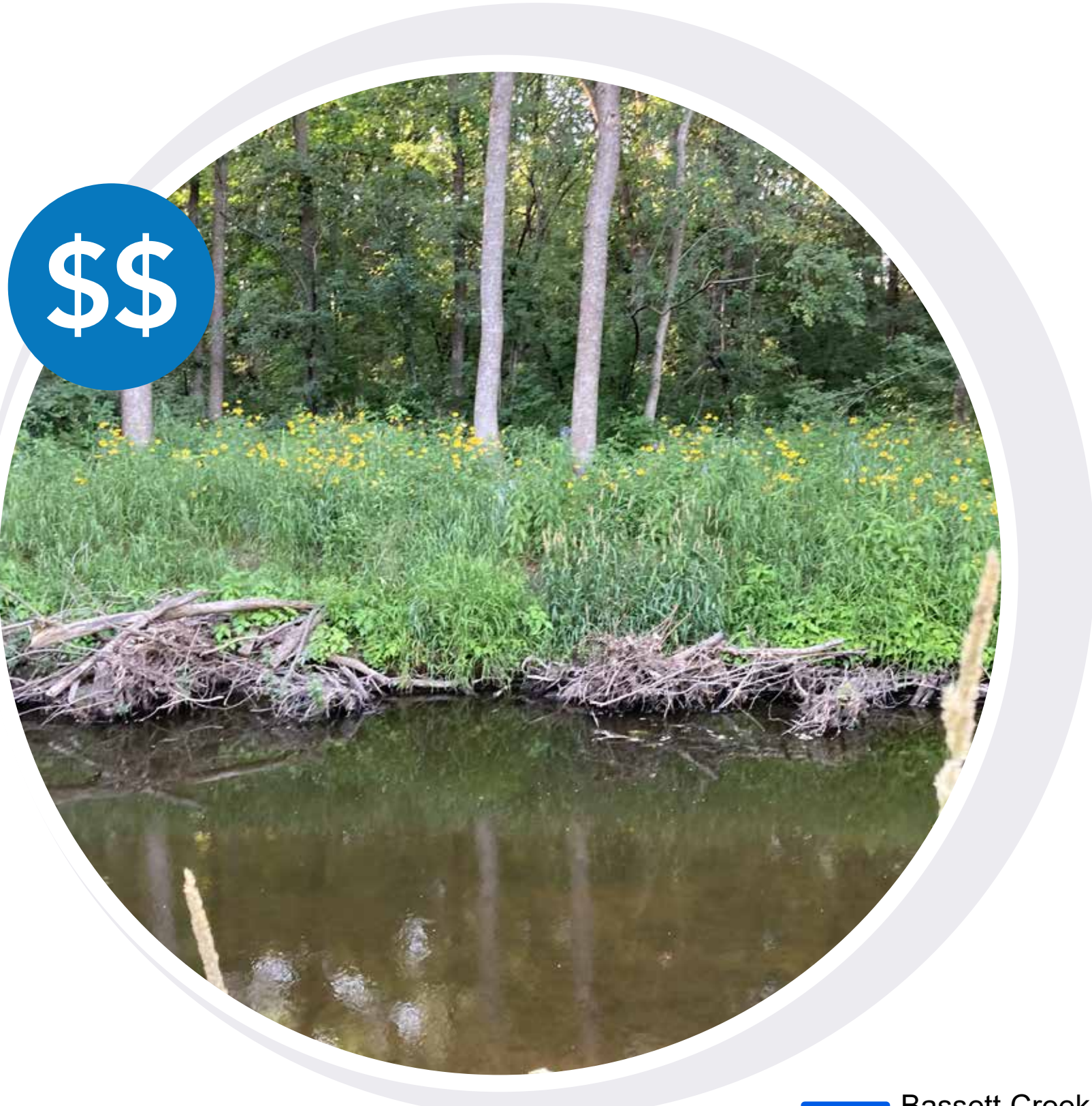


- Bassett Creek
- Bike and Pedestrian Trail System
- Easement
- Sanitary Main
- ▶ Gravity Storm Sewer
- Toe Wood
- Root Wad
- J Hooks
- Cross Vane
- Riprap
- Bank and Channel Grading with Vegetation Establishment
- Bioengineering Features (coir log and/or fascine)



Restoration Design Concept

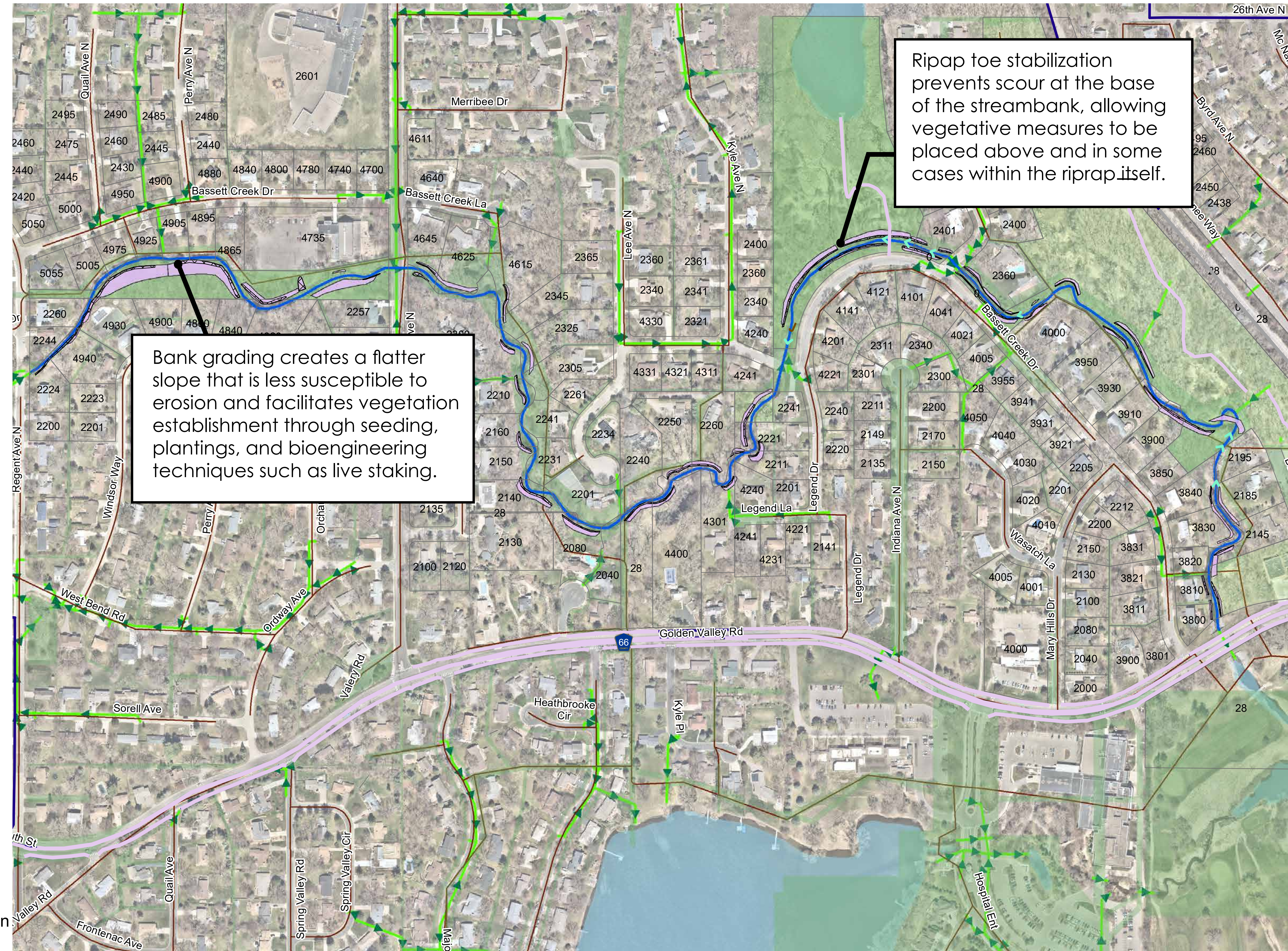
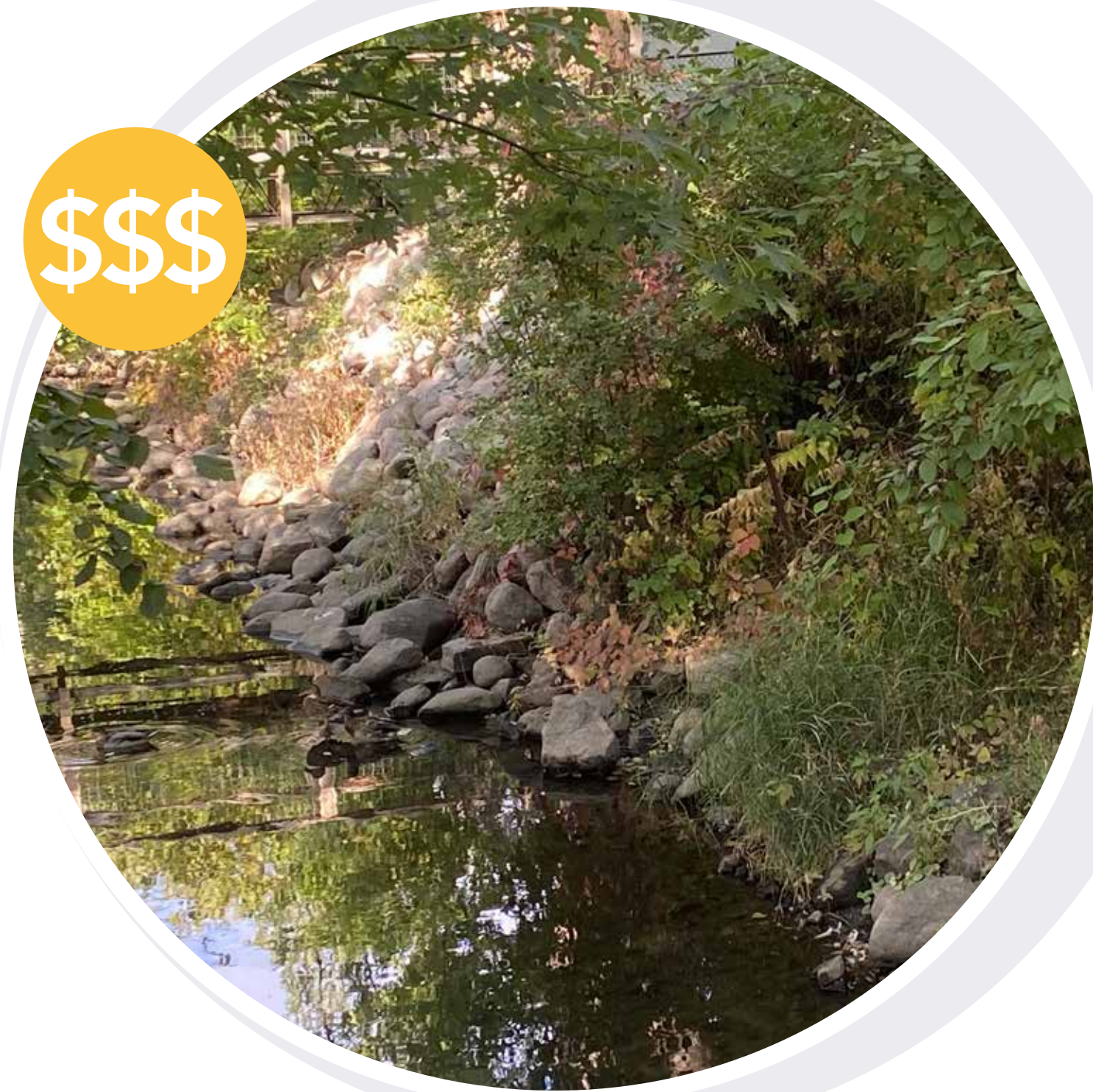
2 Toe stabilization with bioengineering methods with minimal in-stream structures and riprap, as well as moderate grading and vegetation establishment



Restoration Design Concept

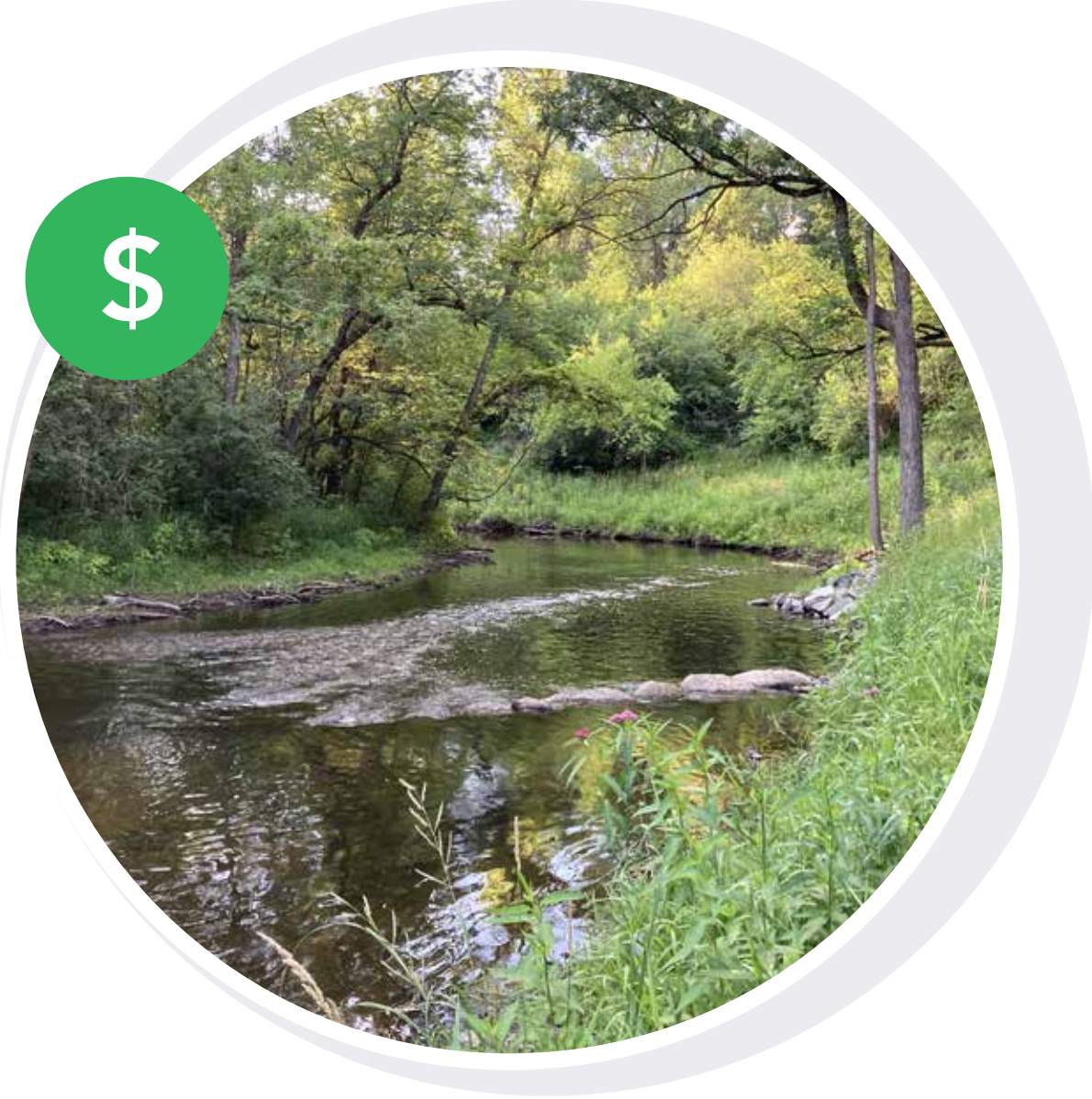
3 Bank grading with riprap and vegetation establishment with minimal in-stream structures and bioengineering

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Restoration Design Concept

1 In-stream structures with minimal grading, riprap, and vegetation establishment

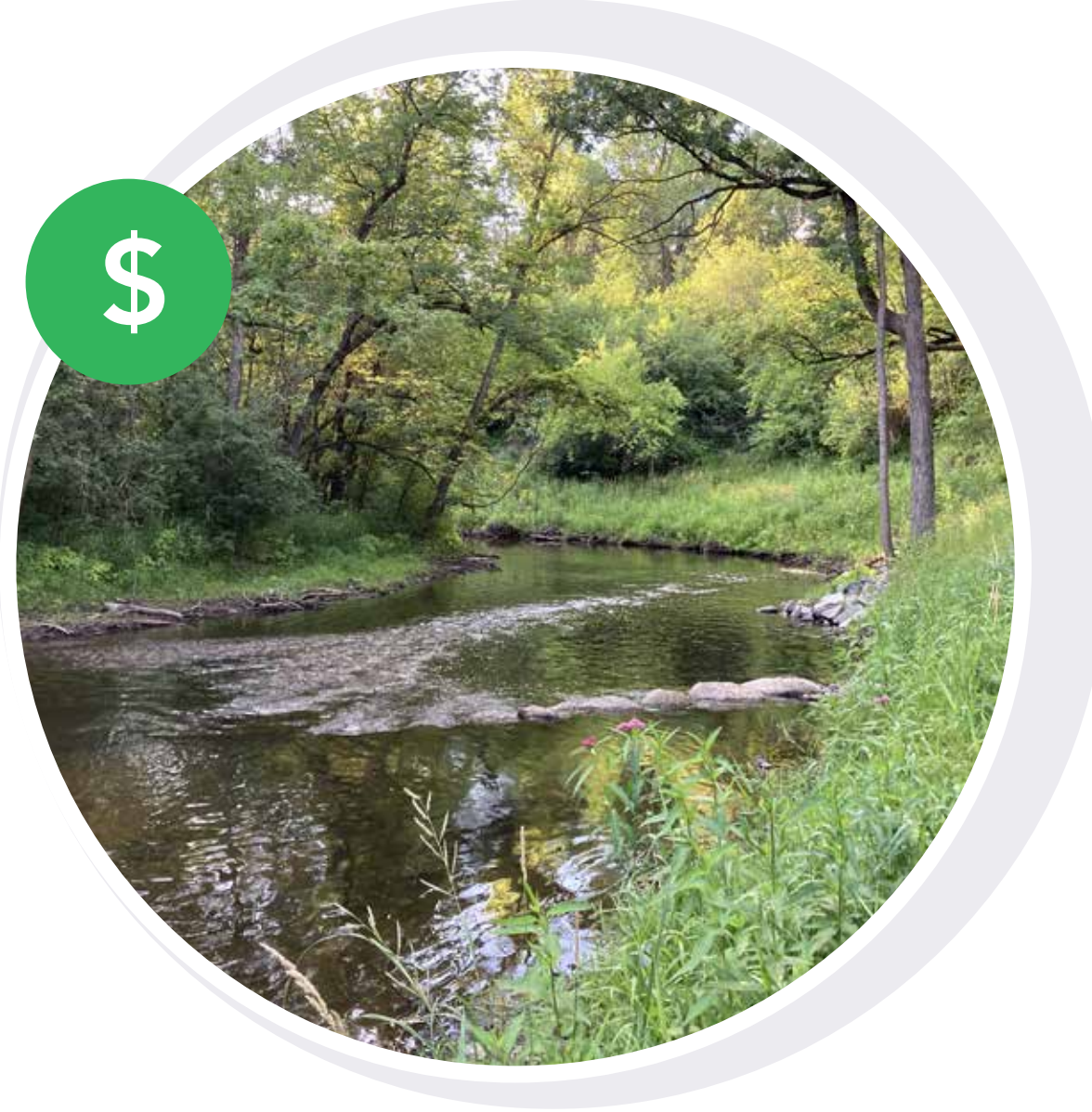


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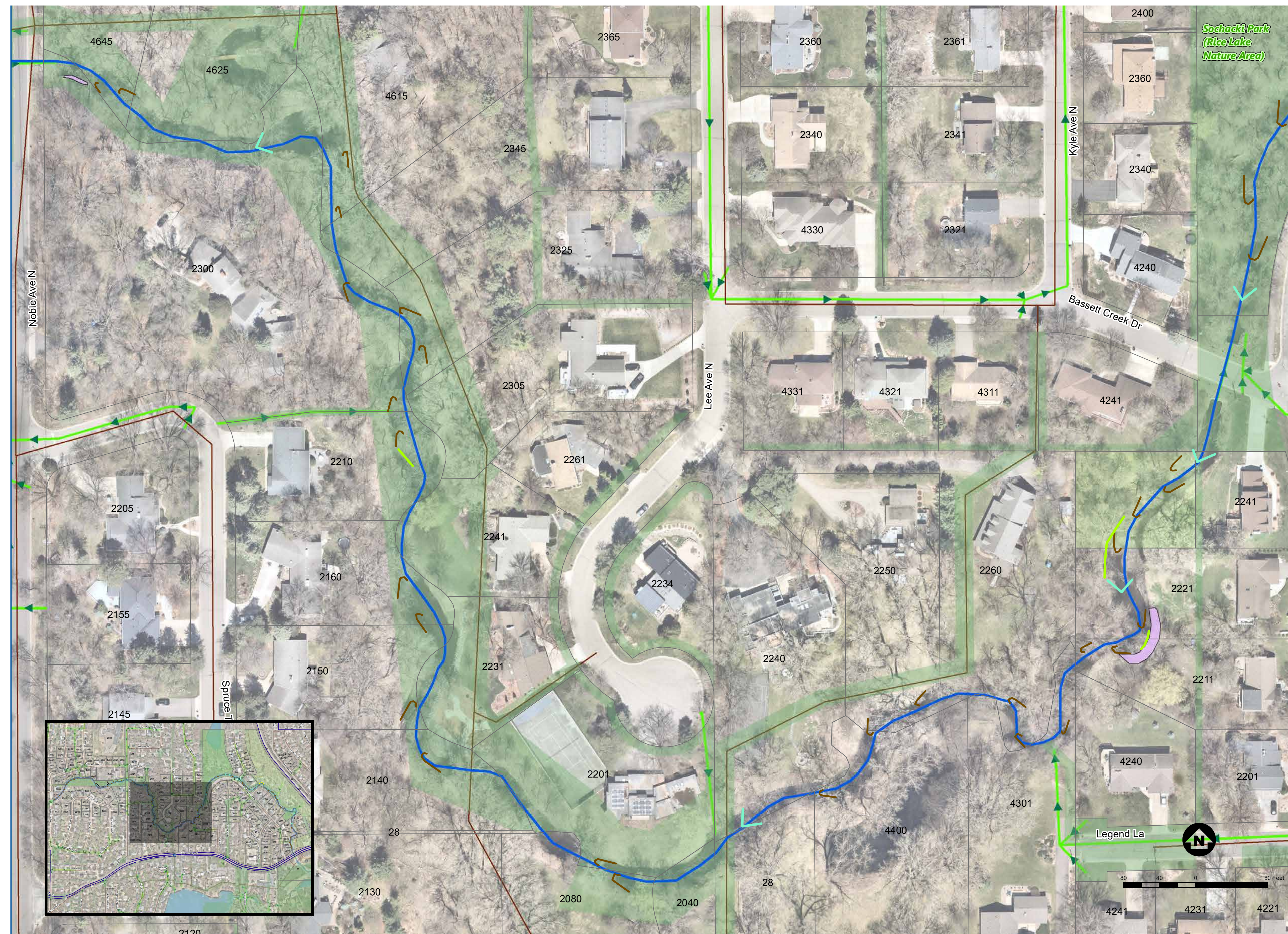


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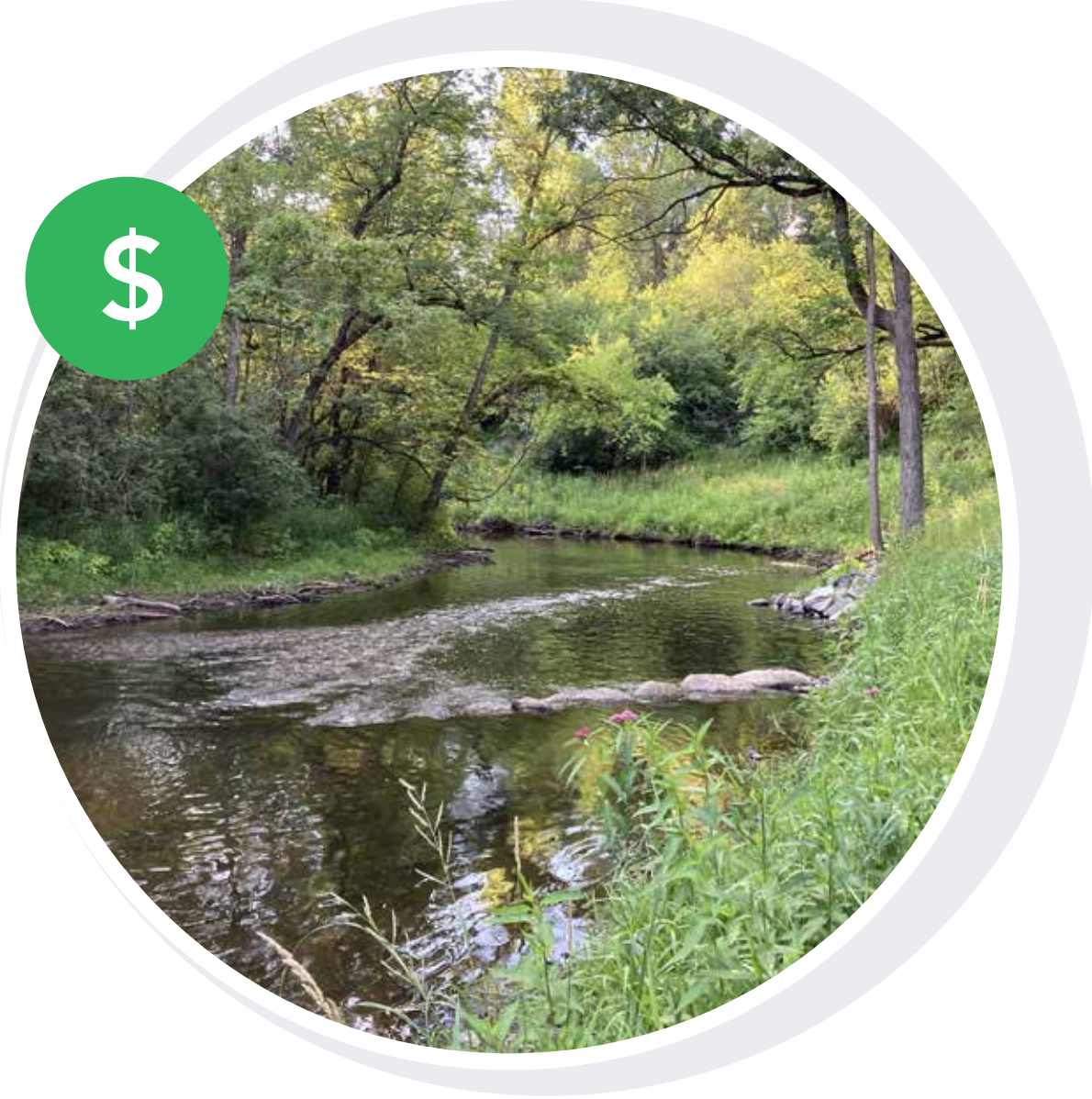


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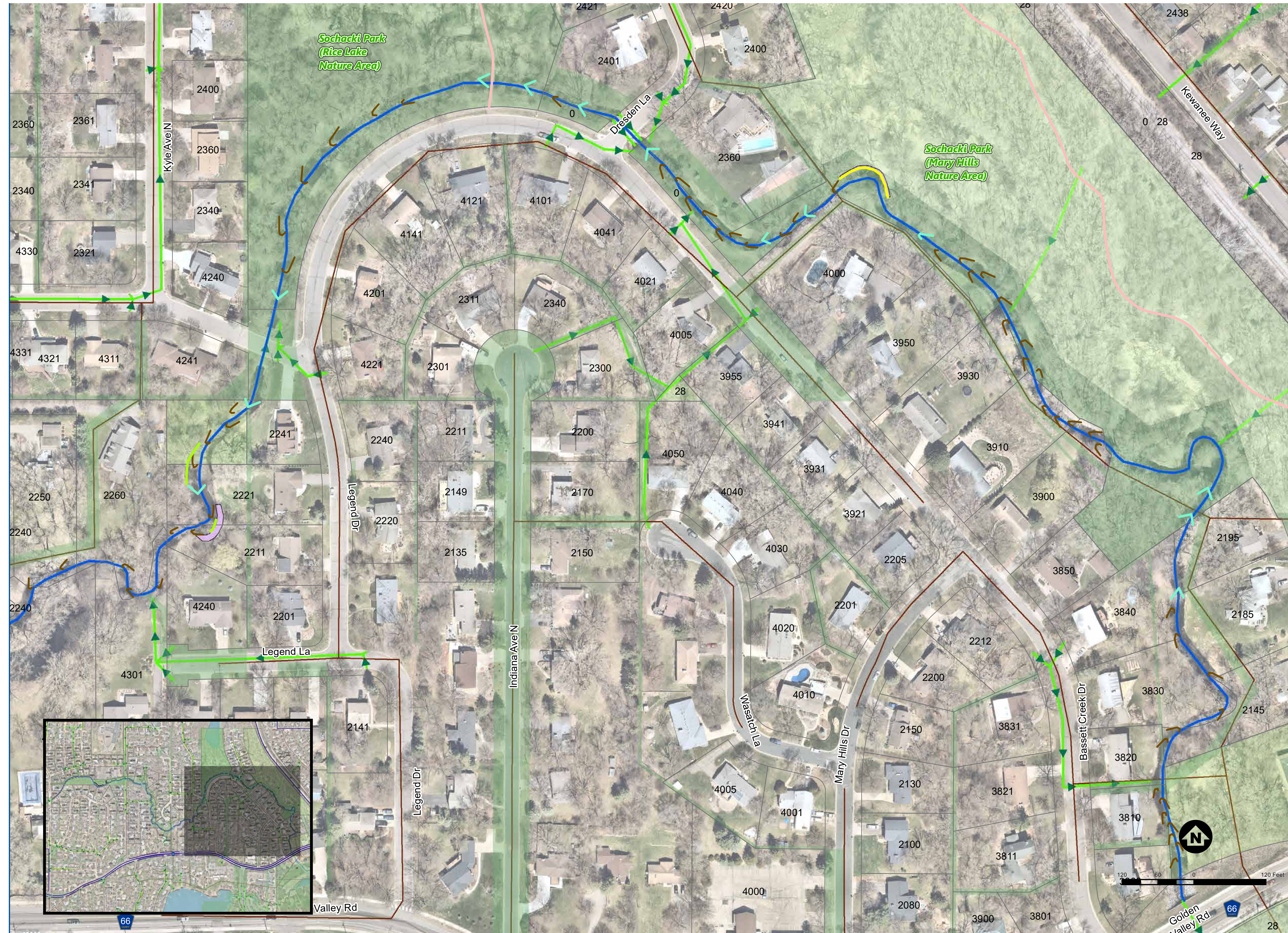


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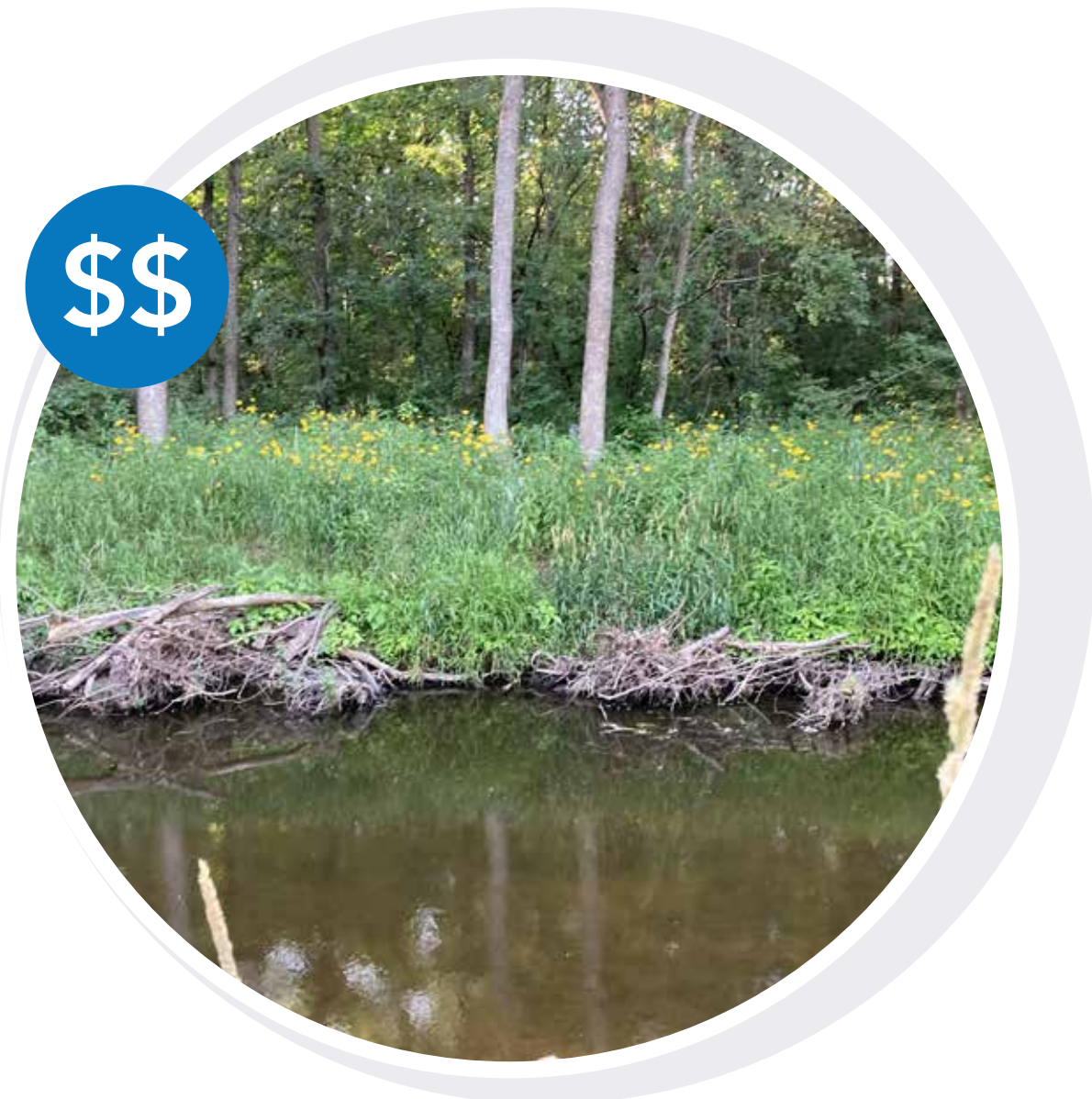



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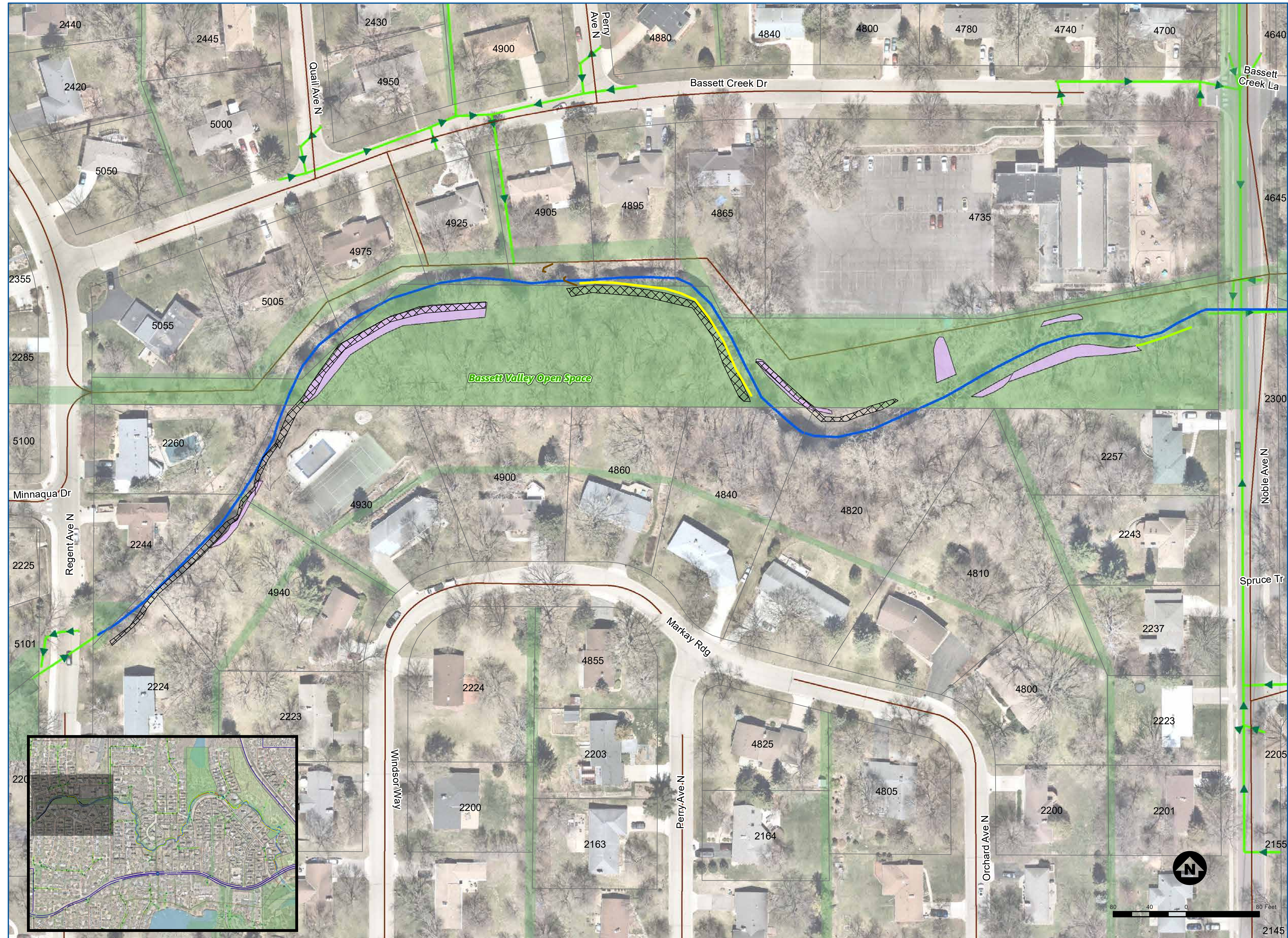


Restoration Design Concept

2 Toe stabilization with bioengineering methods with minimal in-stream structures and riprap, as well as moderate grading and vegetation establishment

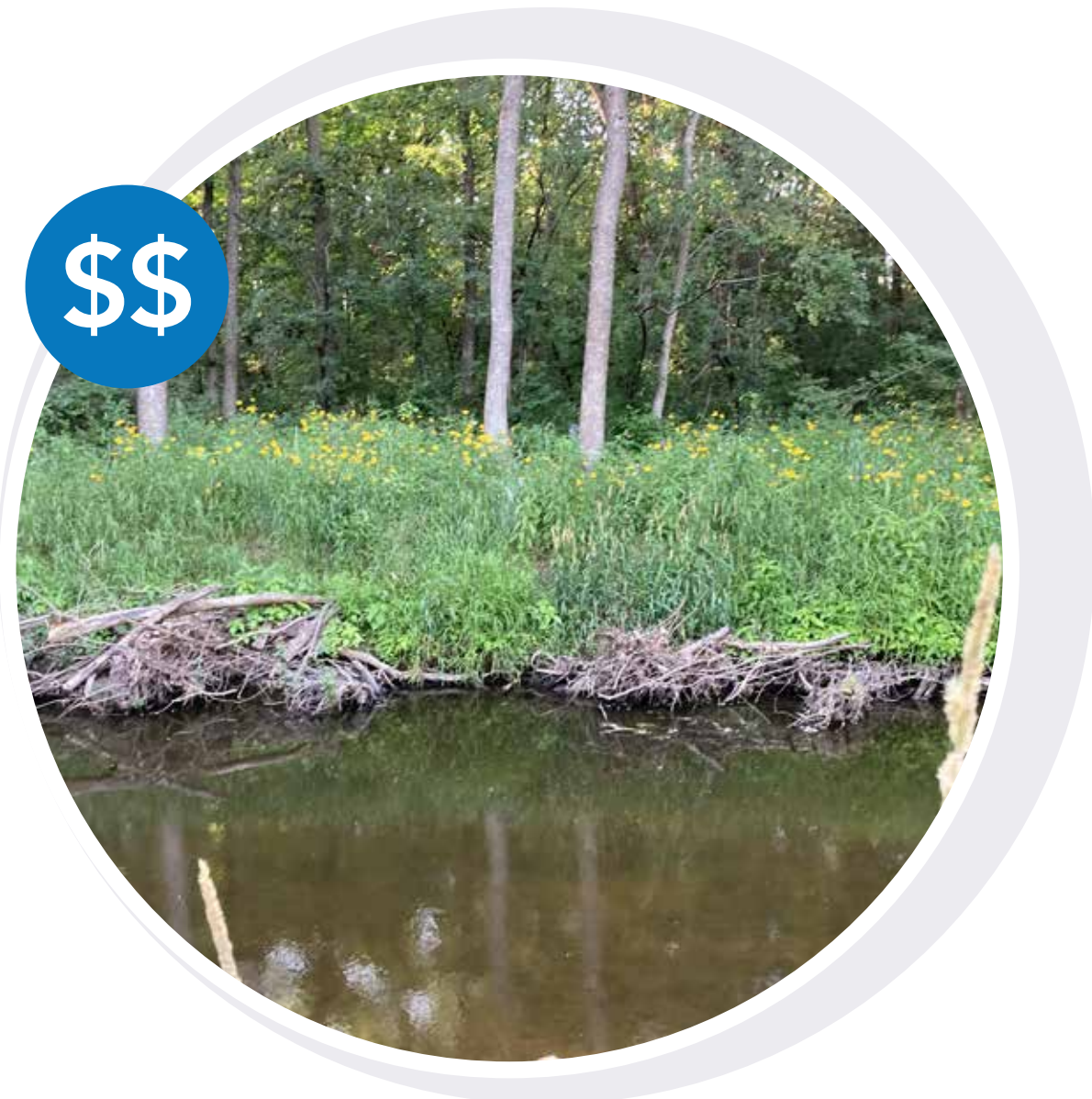


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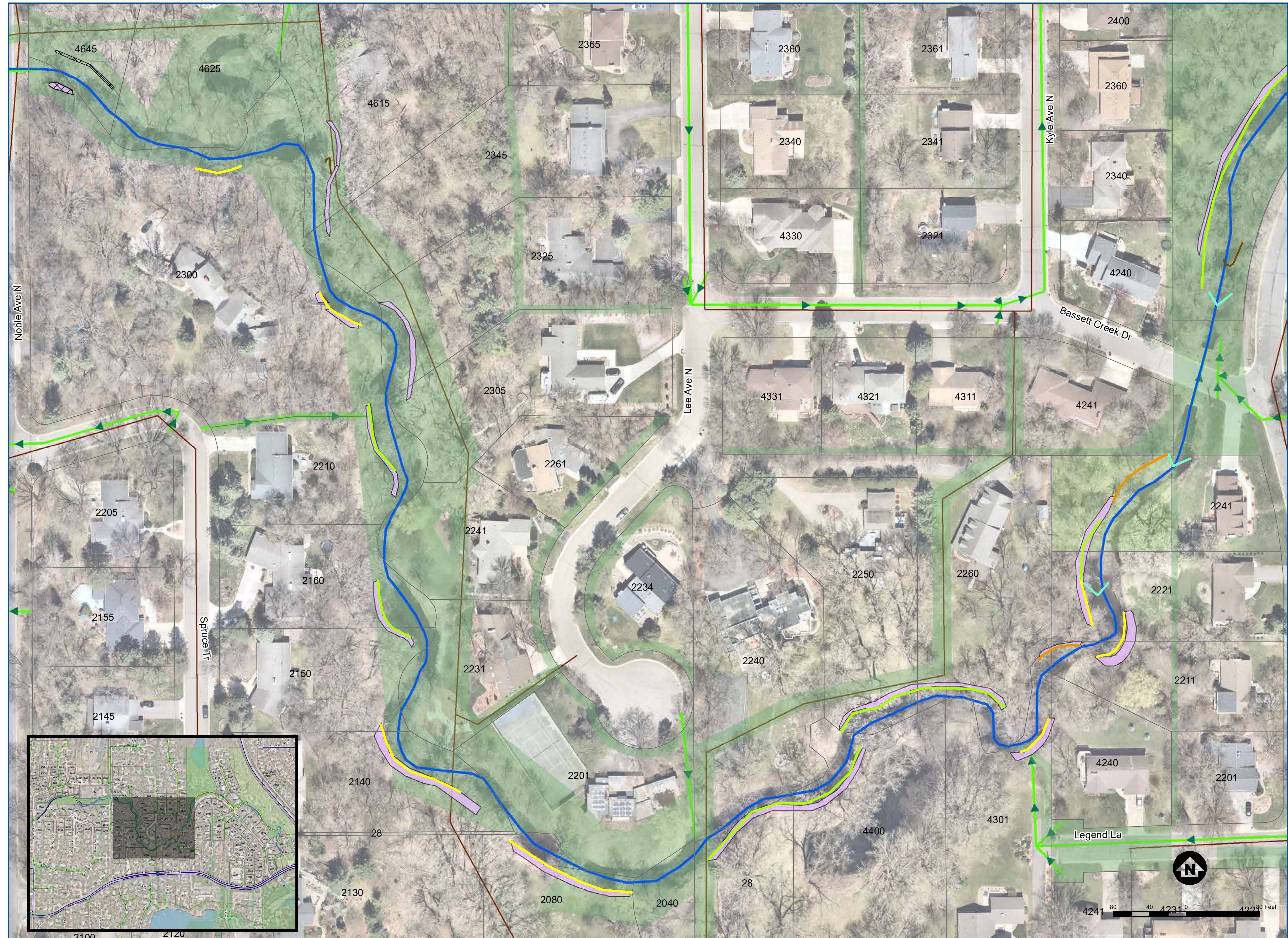


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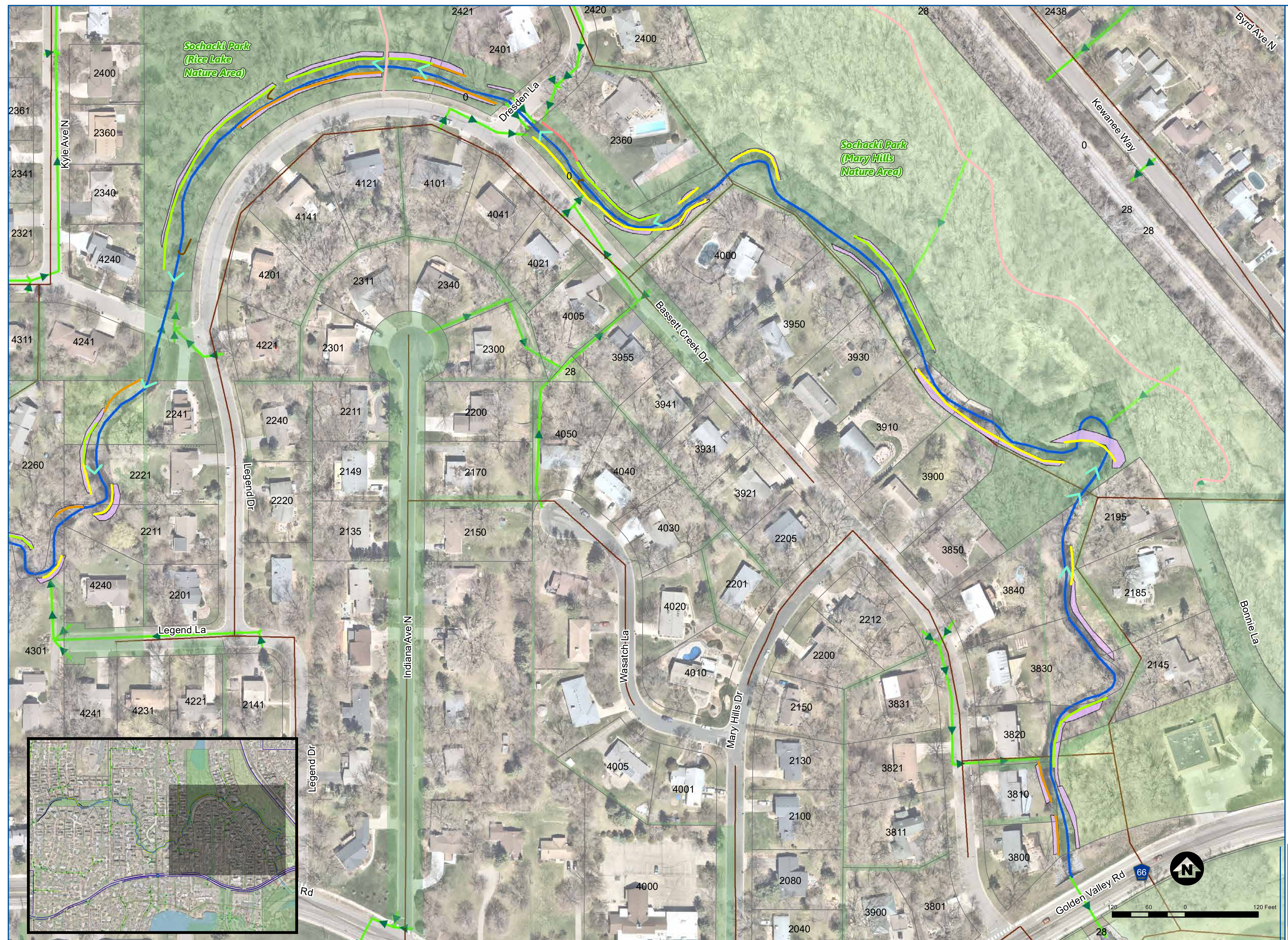
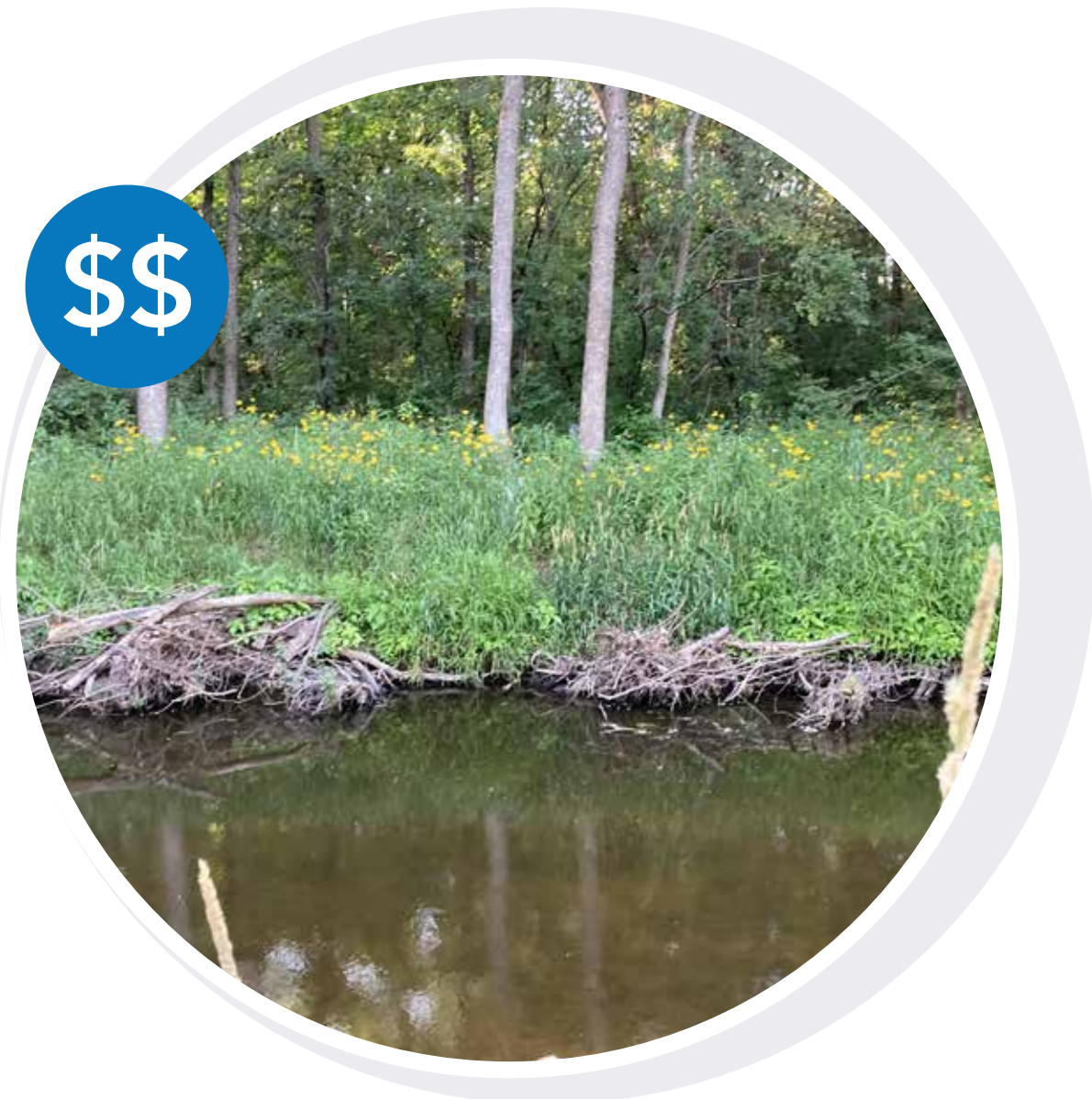


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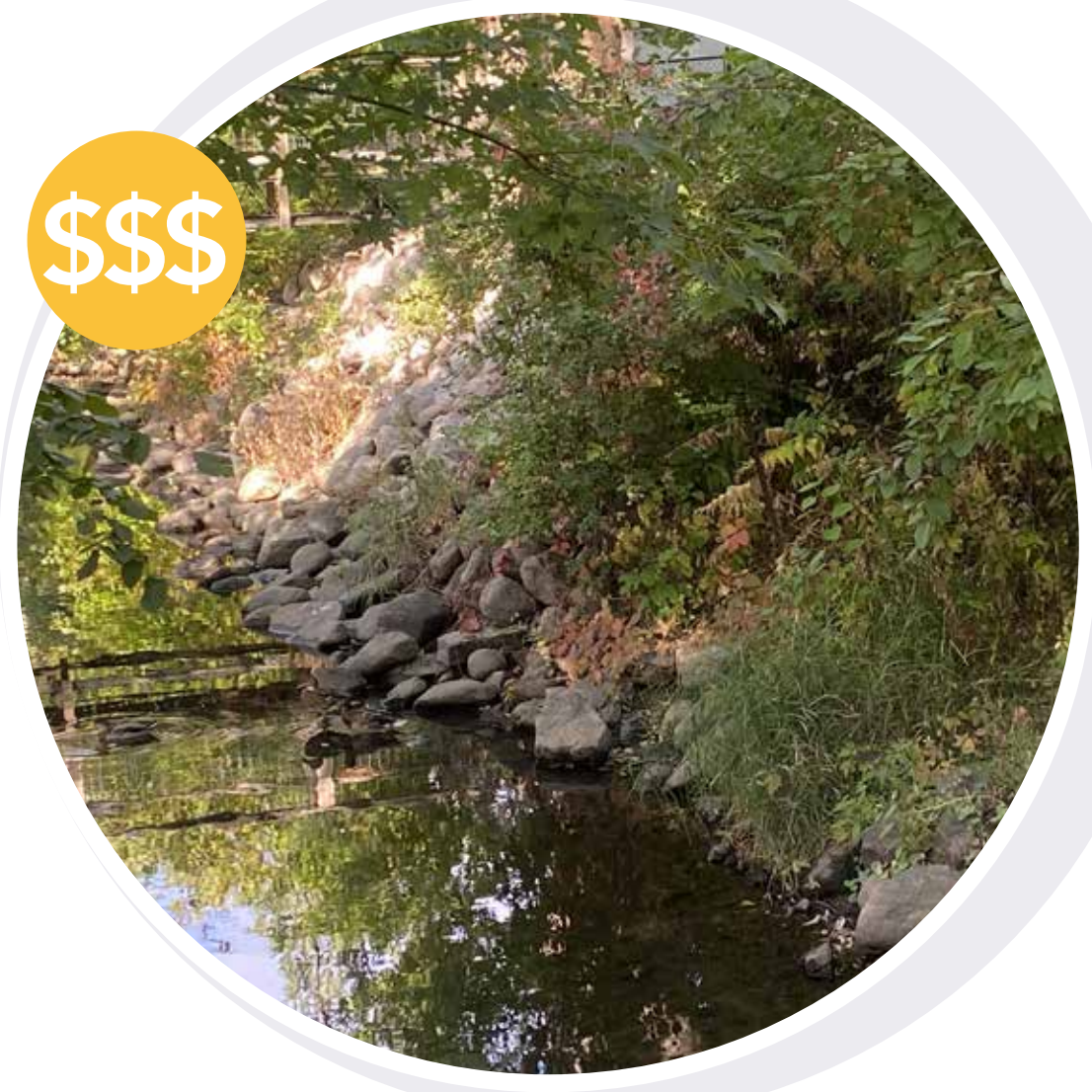











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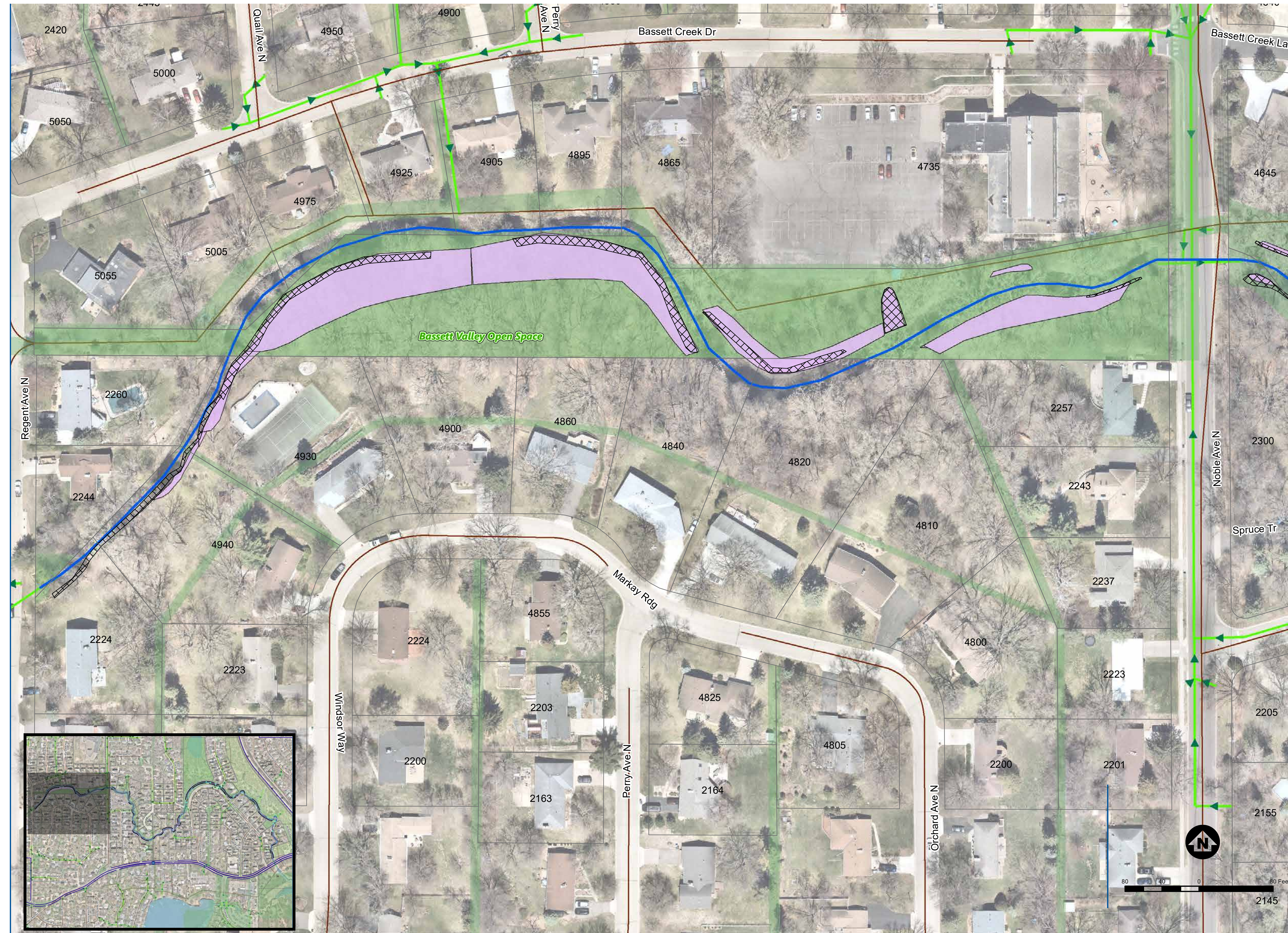
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3 Bank grading with riprap and vegetation establishment
with minimal in-stream structures and bioengineering

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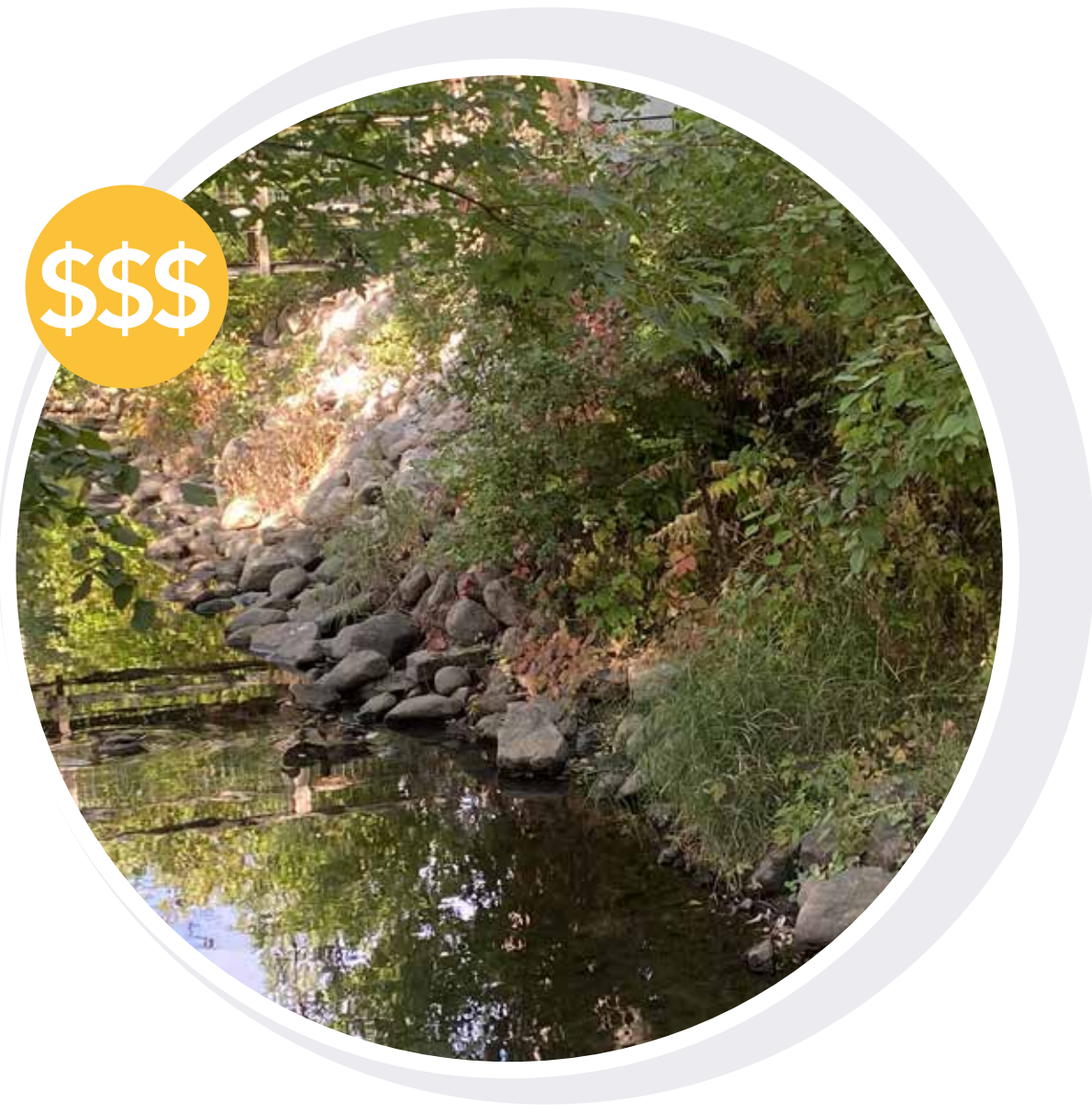


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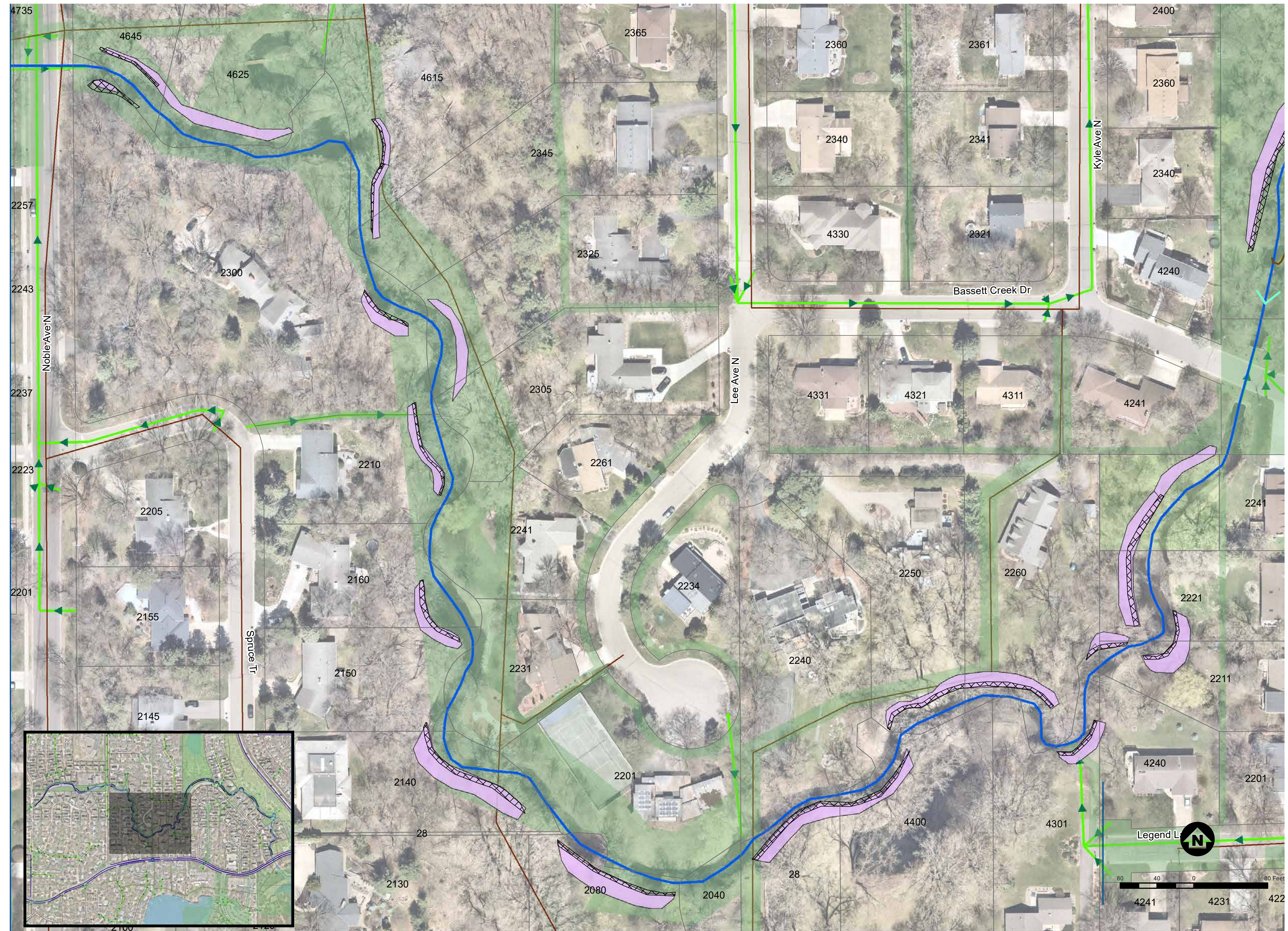


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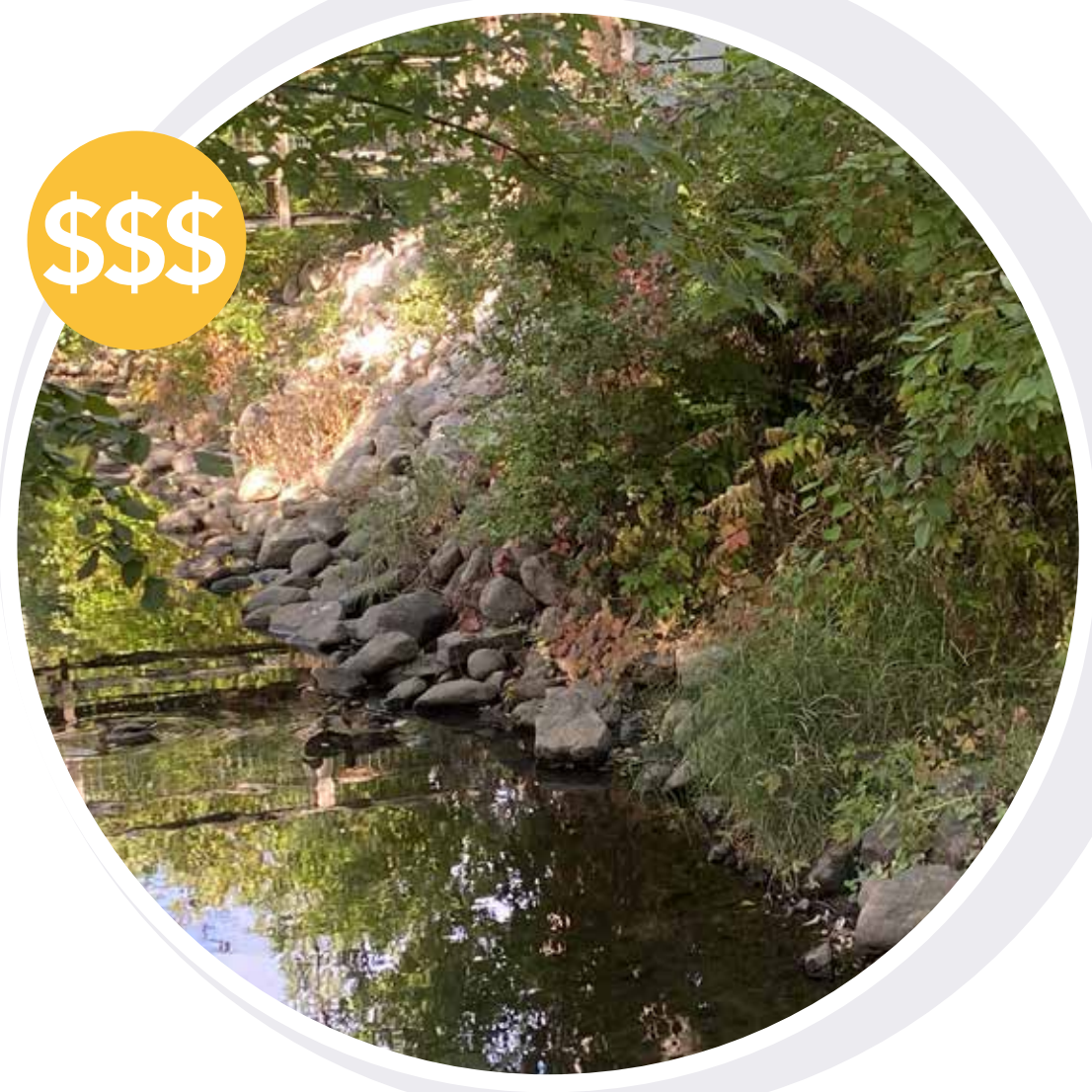
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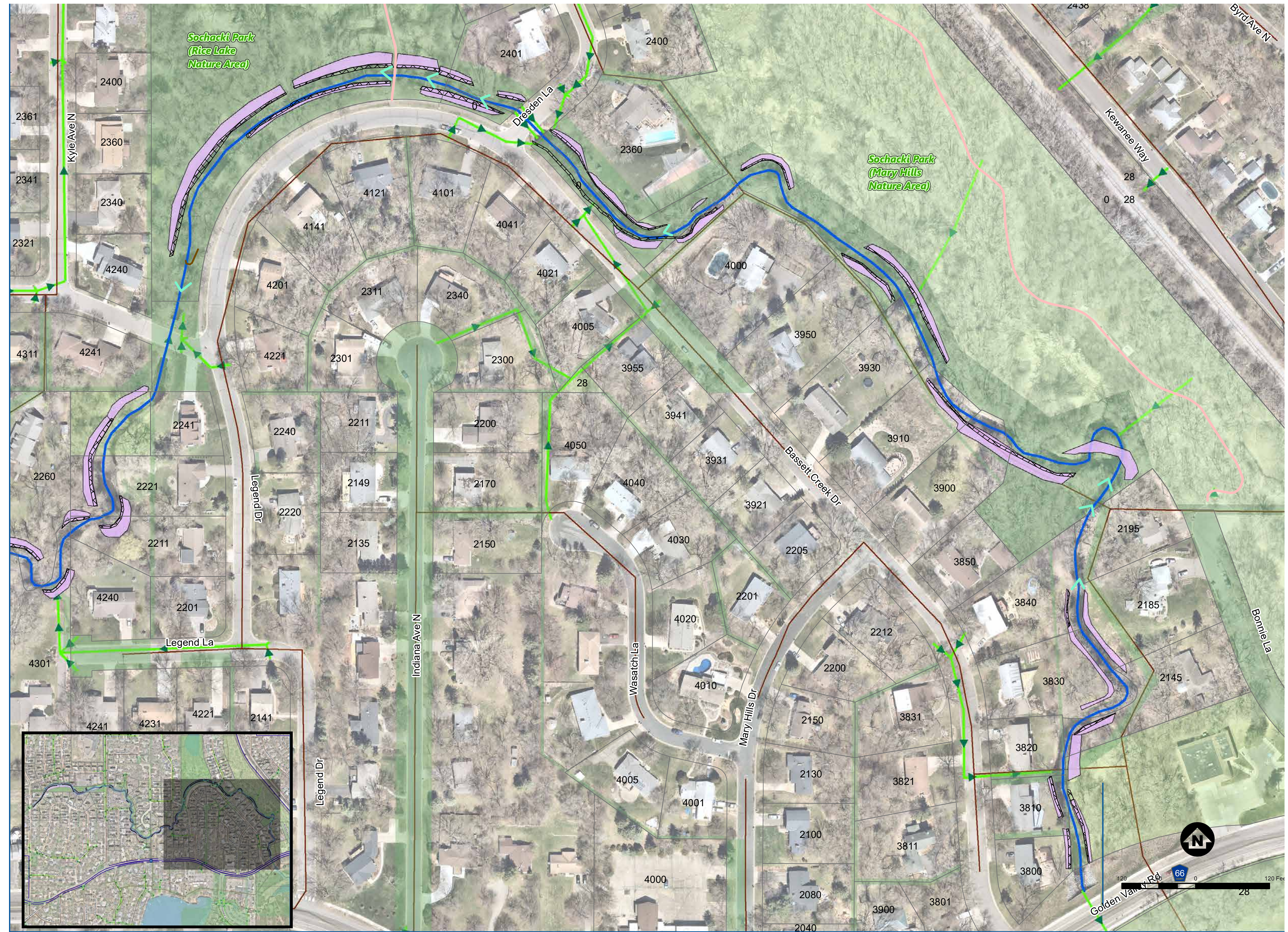
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Appendix D

Restoration Table

Restoration Table

Location	Station	Specific Proposed Restoration	Site Area Restoration	Severity of Existing Erosion ¹	Public Access/Ownership	Regular Easement	Platted easement	Protection of Existing Structures/Infrastructure ²	Impact to Surrounding Areas ³	Potential for Future Erosion (BEHI/NBS) ⁴	Opportunity for Habitat Restoration (riparian/upland)	Opportunity for Habitat Restoration (in channel)	Maintaining Healthy, Native Significant Trees	Vegetation Establishment	Ease of Construction ⁵ Access ⁵	Consider proximity/possibility of other improvements	Count	Notes
Both	0+00 to 1+50	In-stream structures (2 each bank)	1a. Right bank and left bank stabilization with j hooks (Sta. 0+00 to 2+50)	1	0	0	0	0	1	2	0	1	1	0	2	1	9	This area is monitored for BCWMC CIP
Right bank	1+50 to 2+50	Grading with toe stabilization with riprap and toe wood combo with bankfull bench	1a. Right bank and left bank stabilization with j hooks (Sta. 0+00 to 2+50)	1	0	0	0	0	0	2	0	0	1	1	2	0	7	
Right bank	2+50 to 4+00	In-stream structures and grading between 2+90 and 3+60	1b. Right bank stabilization with grading, vegetated riprap toe and j hooks (Sta. 2+40 to 5+20)	1	4	0	0	5	1	2	1	1	1	1	2	0	19	Save Hackberry (4+00)
Right bank	4+00 to 4+70	Grading with toe stabilization with vegetated riprap with bankfull bench	1b. Right bank stabilization with grading, vegetated riprap toe and j hooks (Sta. 2+40 to 5+20)	1	4	0	0	0	0	2	1	0	0	1	2	0	11	
Right bank	4+75 to 5+20	In-stream structures, j hooks (50 feet apart)	1b. Right bank stabilization with grading, vegetated riprap toe and j hooks (Sta. 2+40 to 5+20)	1	4	0	0	0	1	2	0	1	1	0	2	0	12	Save elm (near 4+80)
Right bank	5+50 to 6+40	Grading with toe wood stabilization	1c. Right bank stabilization with toe wood, j hooks and fascines (Sta. 5+20 to 9+25)	1	4	0	0	0	0	2	1	1	0	1	2	0	12	
Right bank	6+75 to 7+00	Toe wood stabilization	1c. Right bank stabilization with toe wood, j hooks and fascines (Sta. 5+20 to 9+25)	1	4	0	0	0	0	2	1	1	1	1	2	0	13	
Right bank	7+00 to 8+50	Instream structures, j-hooks and fascines	1c. Right bank stabilization with toe wood, j hooks and fascines (Sta. 5+20 to 9+25)	2	4	0	0	0	1	3	1	1	1	1	2	0	16	
Right bank	8+50 to 9+25	Floodplain bench with toe wood	1c. Right bank stabilization with toe wood, j hooks and fascines (Sta. 5+20 to 9+25)	2	4	0	0	0	1	3	1	1	0	1	2	0	15	
Left bank	9+15 to 10+20	Grading and single j-hook vane	1d. Right and left bank stabilization with toe wood and j hooks (Sta. 7+75 to 10+20)	2	4	0	0	0	1	3	1	1	0	0	2	0	14	
Right bank	9+25 to 10+00	Grading with vegetation	1d. Right and left bank stabilization with toe wood and j hooks (Sta. 7+75 to 10+20)	2	4	0	0	0	1	3	1	0	0	1	2	0	14	
Left bank	12+20 to 12+45	Grade left bank as part of gully restoration	1e. Left bank stabilization with grading, vegetation, and section of toe wood (Sta. 12+20 to 14+00)	2	0	0	0	5	0	3	1	0	0	0	2	0	13	
Left bank	12+45 to 14+00	floodplain bench with toe wood	1e. Left bank stabilization with grading, vegetation, and section of toe wood (Sta. 12+20 to 14+00)	2	0	0	0	15	0	3	1	0	1	1	2	1	26	
Right bank	12+30 to 12+40	install j-hook downstream of 45 inch cottonwood	1f. Right bank stabilization with grading, vegetation, and j hooks (Sta. 12+30 to 14+90)	2	0	0	0	0	0	3	0	1	1	0	2	0	9	
Right bank	12+40 to 14+90	Grading with vegetation, with one or two j hooks as needed	1f. Right bank stabilization with grading, vegetation, and j hooks (Sta. 12+30 to 14+90)	2	0	0	0	0	0	3	1	1	1	1	2	0	11	Monitored for BCWMC CIP

Restoration Table

Location	Station	Specific Proposed Restoration	Site Area Restoration	Severity of Existing Erosion ¹	Public Access/Ownership	Regular Easement	Platted easement	Protection of Existing Structures/Infrastructure ²	Impact to Surrounding Areas ³	Potential for Future Erosion (BEHI/NBS) ⁴	Opportunity for Habitat Restoration (riparian/upland)	Opportunity for Habitat Restoration (in channel)	Maintaining Healthy, Native Significant Trees	Vegetation Establishment	Ease of Construction ⁵ Access ⁵	Consider proximity/possibility of other improvements	Count	Notes
Left and Right bank	16-50 to 16-70	Riprap	2a. Bank stabilization with riprap and cross vane (16-50 to 16+80)	2	0	0	0	5	0	3	0	1	0	0	1	1	13	
Left and Right bank	16+80	Cross vane		2	0	0	0	0	0	3	0	1	0	0	1	1	8	Monitored for BCWMC CIP
Right bank	18+20 to 19+00	Vegetated riprap toe	2b. Right and left bank stabilization with grading and vegetated riprap toe protection (Sta. 18+20 to 19+00)	1	0	0	2	0	0	2	0	0	1	1	1	0	8	Protect silver maple at 18+50
Left bank	18+20 to 19+00	Grading, preserve the three healthy trees in this area		1	0	0	2	0	0	5	1	0	1	1	1	0	12	
Right bank	18+20 to 19+00	Vegetated riprap toe		1	0	0	2	0	0	2	0	0	1	1	1	0	8	Protect silver maple at 18+50
Left bank	18+20 to 19+00	Grading, preserve the three healthy trees in this area	2c. Left bank stabilization with riprap toe and root wads right bank grading to keep cross sectional area (Sta. 19+00 to 20+50)	1	0	0	2	0	0	5	1	0	1	1	1	0	12	
Left bank and Right bank	19+50 to 20+50	Grading with riprap and root wads on left bank, right bank grade to keep cross sectional area		2	0	0	2	15	0	6	1	1	0	1	1	0	29	Protect sanitary
Left bank	20+25	J-hook	2d. Right and left bank stabilization with j hooks (Sta. 20+50 to 21+80)	1	0	0	0	15	1	2	0	1	1	0	1	0	22	Protect sanitary
Right bank	21+20 to 21+80	J-hooks, possibly two (upper and lower end)		2	0	0	2	0	1	3	0	1	1	0	1	0	11	
Left Bank	21+80 to 22+50	Grading with vegetation	2e. Left bank stabilization with grading and vegetation (Sta. 21+80 to 22+50)	1	0	0	2	15	0	2	1	0	0	1	1	0	23	
Left bank	22+75	J-hook		2	0	0	2	0	0	3	0	1	1	0	0	0	9	
Right bank	22+80 to 23+80	3 j-hook vanes	2f. Right and left bank stabilization with j hooks and section of toe wood (Sta. 22+75 to 27+75)	2	0	0	2	0	1	3	0	1	1	0	0	0	10	
Right bank	24+80 to 25+60	2 j-hooks and some toe wood		2	0	0	2	0	1	3	1	1	1	1	0	0	12	
Right bank	26+70 to 27+75	Toe wood		3	0	0	2	0	1	4	1	1	0	1	0	0	13	
Both banks	27+70	Cross vane	2g. Bank stabilization with cross vane (Sta. 27+70)	2	0	0	2	15	1	3	0	1	1	0	0	0	25	Protect sanitary
Right bank	28+00 to 29+50	Grading with vegetative buffer and floodplain bench	2h. Right bank stabilization with grading, vegetation, and floodplain bench (Sta. 28+00 to 29+50)	2	0	0	2	0	0	3	1	0	1	1	0	0	10	
Left bank	29+70	J-hook		1	0	2	2	15	1	2	0	1	0	0	0	0	24	
Right bank	29+90	J hook, upstream healthy willow	2i. Right and left bank stabilization with j hooks (Sta. 29+70 to 30+90)	2	0	0	2	0	1	3	0	1	1	0	0	0	10	
Right bank	30+90	J-hook. Reinforced pipe in this area		2	0	0	2	5	1	3	0	1	1	0	0	0	15	Protect storm sewer outfall
Left bank and Right bank	31+00	Cross Vane, protect sanitary below the creek	2j. Bank stabilization with cross vane (Sta. 31+00)	1	0	0	2	15	1	1	0	1	0	0	0	0	21	Protect sanitary and storm sewer outfalls
Right bank	31+00 to 32+30	Grading, vegetation with toe protection (riprap)		2	0	0	2	0	1	3	0	0	1	1	0	0	10	
Right bank	32+30, 33+10	2 J-hook	2k. Right bank stabilization with grading, vegetation, riprap toe protection, and j hooks (Sta. 31+00 to 33+10)	2	0	0	2	0	1	3	0	1	0	0	1	0	10	

Restoration Table

Location	Station	Specific Proposed Restoration	Site Area Restoration	Severity of Existing Erosion ¹	Public Access/Ownership	Regular Easement	Platted easement	Protection of Existing Structures/Infrastructure ²	Impact to Surrounding Areas ³	Potential for Future Erosion (BEHI/NBS) ⁴	Opportunity for Habitat Restoration (riparian/upland)	Opportunity for Habitat Restoration (in channel)	Maintaining Healthy, Native Significant Trees	Vegetation Establishment	Ease of Construction Access ⁵	Consider proximity/possibility of other improvements	Count	Notes
Left bank	33+30	J-hook,	2l. Left bank stabilization with j hooks, grading, vegetation, and riprap (Sta. 33+30 to 35+10)	2	0	0	0	15	1	3	0	1	1	0	1	0	24	Protect sanitary
left bank	33+30 to 34+40	Riprap to protect sanitary, if possible make floodplain bench		2	0	0	0	15	1	3	0	0	0	0	1	0	22	Protect sanitary
Left bank	34+50, 35+00	J-hooks with grading between		2	0	0	0	5	1	3	0	1	0	0	1	0	13	Protect sanitary
Right bank	35+50 to 35+90	Toe wood (or riprap) with floodplain bench, with j hook vane at 35+50	2m. Right and left bank stabilization with j hooks, grading, vegetation, and section of toe wood (Sta. 35+50 to 37+50)	2	0	0	0	0	0	6	1	1	0	1	1	0	12	Protect storm sewer outfall
Left bank	36+50,37+00	2 J-hooks		1	0	0	0	0	1	2	0	1	1	0	1	0	7	Protects multiple silver maples
Right bank	37+20 to 37+50	J-hook at the start and end of stations, with grading and vegetation in-between		2	0	0	0	0	1	5	1	1	0	1	1	0	12	
Left bank	37+50 to 39+60	J-hooks with grading between	2n. Right and left bank stabilization with j hooks and cross vane (Sta 37+50 to 39+60)	2	0	0	0	0	0	3	0	1	1	0	1	0	8	
Right bank	39+10	J-hook		1	4	0	0	0	1	2	0	1	0	0	1	0	10	
Left bank and Right bank	39+80	Cross vane		2	4	0	0	5	1	3	0	1	1	0	1	0	18	Protect red maple
Left bank and Right bank	41+40	Cross vane	3a. Bank stabilization with cross vane (Sta. 41+40)	2	4	0	0	5	1	3	0	1	0	0	2	0	18	
Left bank	42+20 to 44+50	Grading and vegetation, establish bankfull bench. Add a few root wads (near 44+00)	3b. Left bank stabilization with grading, vegetation, and section of root wads (Sta. 42+20 to 44+50)	1	4	0	2	0	0	2	1	1	0	1	2	0	14	
Left bank and Right bank	45+20 to 46+50	J-hook alternating on banks, 2 each side	3c. Right and left bank stabilization with j hooks and cross vanes (Sta. 45+20 to 47+00)	2	4	0	2	5	1	3	0	1	1	0	2	0	21	Protect silver maples
Left bank and Right bank	47+00	Cross vane		2	4	0	2	5	1	3	0	1	0	0	2	0	20	
Left bank	47+20 to 48+20	Grading	3d. Left bank stabilization with grading and vegetation (Sta. 47+20 to 48+20)	1	0	0	2	5	0	2	1	0	0	1	2	0	14	
Left bank and Right bank	47+70, 48+70	Cross Vane	3e. Bank stabilization with cross vanes (Sta. 47+70 to 48+70)	2	0	0	2	5	1	3	0	1	0	0	2	0	16	
Right bank	48+30 to 49+20	J-hook	3f. Right bank stabilization with grading, vegetation, rock toe, and bankfull bench (Sta. 48+50 to 52+00)	1	0	0	2	5	1	2	0	1	0	0	2	0	14	
Right bank	48+50 to 51+30	Bankfull bench with rock toe		2	0	0	0	5	0	3	0	1	1	0	2	0	14	Protect multiple silver maples, stop at outlet drain
Right bank	51+40 to 52+00	Grading with rock toe		2	4	0	0	5	0	3	1	1	0	1	2	0	19	
Left bank	48+50 to 50+70	Grading with vegetation	3g. Left bank stabilization with grading, vegetation, j hooks, and section of toe wood (Sta. 48+50 to 51+00)	1	0	0	2	5	1	2	1	1	1	0	2	0	16	
Left bank	50+70 to 51+00	J-hook at 50+70 and then grading with toe wood		2	4	0	2	0	0	3	1	1	1	1	2	0	17	Protect Ash tree

Restoration Table

Location	Station	Specific Proposed Restoration	Site Area Restoration	Severity of Existing Erosion ¹	Public Access/ Ownership	Regular Easement	Platted easement	Protection of Existing Structures/ Infrastructure ²	Impact to Surrounding Areas ³	Potential for Future Erosion (BEHI/NBS) ⁴	Opportunity for Habitat Restoration (riparian/upland)	Opportunity for Habitat Restoration (in channel)	Maintaining Healthy, Native Significant Trees	Vegetation Establishment	Ease of Construction Access ⁵	Consider proximity/ possibility of other improvements	Count	Notes
Left bank	51+00 to 52+50	Grading with tree preservation	3h. Left bank stabilization with grading, vegetation, and tree preservation (Sta. 51+00 to 52+50)	1	0	0	2	0	0	2	1	0	1	1	2	0	10	
Right bank	52+10 to 53+00	J-hooks at start and 40 feet later, then root wads	3i. Right and left bank stabilization with j hooks, cross vanes, and section of root wads (Sta 52+10 to 54+15)	2	4	0	2	0	0	3	1	1	1	0	2	0	16	Pipe at 52+50, preserve upland trees
Both	53+25, 54+15	Cross Vane		2	4	0	2	15	1	3	0	1	0	0	2	0	30	Protect sanitary
Left bank	54+20 to 55+20	Toe wood (or riprap) with floodplain bench	3j. Left bank stabilization with toewood and floodplain bench (Sta. 54+20 to 55+20)	2	4	0	2	0	0	3	1	1	1	1	2	0	17	
Left bank	56+10	J-hook	4a. Right and left bank stabilization with j hooks (Sta. 56+00 to 59+50)	2	4	0	2	0	1	3	0	1	1	0	2	0	16	Protect green ash
Left and right bank	56+80 to 59+50	Alternating j-hooks		2	4	0	2	15	1	3	0	1	1	0	2	0	31	
Right bank	59+60 to 61+00	Toe wood with bankfull bench,	4b. Right and left bank stabilization with grading, vegetation, and section of toe wood (Sta. 59+60 to 61+00)	2	0	0	0	15	0	3	1	1	1	0	2	0	25	
Left	59+60 to 61+00	Grading		2	4	0	2	0	0	3	1	0	1	1	2	0	16	
Both	61+00	Cross Vane	4c. Right and left bank stabilization with j hooks and cross vanes (Sta. 61+00 to 64+40)	2	4	0	2	15	1	3	0	1	1	0	2	0	31	Protect utility pole and two cottonwood
Right bank	61+40, 61+80	J-hooks		2	4	0	2	15	1	3	0	1	0	0	2	0	30	Protect sanitary line
Left bank	62+20 and 62+50	J-hook, one large to divert flow		1	4	0	2	0	1	5	0	1	0	0	2	0	16	
Both	64+60	Cross vane		1	0	0	2	15	1	2	0	1	1	0	2	0	25	Protect sanitary line and cottonwood
Right bank	65+40 to 67+00	Grading and vegetation with j-hooks (use her J-hooks)	4d. Right bank stabilization with grading, vegetation, and j hooks (Sta. 65+40 to 67+00)	1	0	0	0	15	0	2	1	1	1	1	2	0	24	Protect ash and cottonwood
Left bank and Right bank	65+50	Cross vane	4e. Bank stabilization with cross vane (Sta. 65+50)	1	0	0	0	15	1	2	0	1	0	0	2	0	22	
Left bank	65+60 to 66+00	Riprap	4f. Left bank stabilization with grading, vegetation, and toe wood stabilization (Sta. 65+50 to 68+30)	1	0	0	0	15	0	2	0	1	1	0	2	0	22	
Left bank	66+00 to 67+70	Grading and vegetation		1	0	0	0	15	0	2	1	0	1	1	2	0	23	Protect sanitary and maple trees
Left bank	67+70 to 68+30	Toe wood stabilization		2	0	0	0	15	0	3	1	1	1	1	2	0	26	Protect maples and sanitary
Right bank	66+80 to 67+50	Grading and vegetative buffer	4g. Right bank stabilization with grading and vegetation. Increase cross sectional area if toe wood on left bank installed (Sta. 66+80 to 68+30)	1	0	0	0	0	0	2	1	0	1	1	2	0	8	Protect maple trees
Right bank	67+70 to 68+30	Grade and vegetation, keep same cross sectional area		1	0	0	0	0	0	2	1	0	0	1	2	0	7	Protect maple and sanitary (on left bank, but need to keep cross sectional area)

Restoration Table

Location	Station	Specific Proposed Restoration	Site Area Restoration	Severity of Existing Erosion ¹	Public Access/Ownership	Regular Easement	Platted easement	Protection of Existing Structures/Infrastructure ²	Impact to Surrounding Areas ³	Potential for Future Erosion (BEHI/NBS) ⁴	Opportunity for Habitat Restoration (riparian/upland)	Opportunity for Habitat Restoration (in channel)	Maintaining Healthy, Native Significant Trees	Vegetation Establishment	Ease of Construction Access ⁵	Consider proximity/possibility of other improvements	Count	Notes
Left bank	68+30 to 69+90, 70+10 to 71+00	Grading and vegetation with fascines	4h. Left bank stabilization with grading, vegetation, and fascines (Sta. 68+30 to 69+90, 70+10 to 71+00)	2	0	0	0	0	0	3	1	1	1	1	2	0	11	Preserve black willow 70+50
Right bank	69+00 to 69+90, 70+10 to 71+50	Riprap enhancement and grading with vegetation behind	4i. Right bank stabilization with riprap enhancement, grading, and vegetation (Sta. 69+00 to 69+90, 70+10 to 71+50)	2	0	0	0	15	0	3	1	0	0	1	2	0	24	Protect sanitary
Left and Right bank	69+90 to 70+10	Cross vane and riprap to protect sanitary	4j. Right and left bank stabilization with riprap and cross vane (Sta. 69+90 to 70+10)	2	0	0	0	15	0	3	0	1	0	1	2	0	24	Protect sanitary

1. Based on BEHI score. Moderate=1, High=2, Very high= 3

2. Given score of 15 if protects a sanitary sewer

3. Given score of 1 if little earth work

4. Based on adding BEHI and NBS. Moderate BEHI=1, High BEHI=2, Very high BEHI= 3, Very low NBS=1, Low NBS=2, Moderate NBS=3, High NBS= 4, Very high NBS=5

5. 2 points if use public property for access, 1 point if use easements for access

Appendix E

Erosion Rates

Erosion Rates Left Bank

Reach	Reach	Site Description	Restoration Alternative Description	Site Length	Length of Eroding Bank (ft)	Length of Repaired Bank (ft)	Est. Avg. Bank Height (ft)	BEHI rating	NBS rating	Est. Erosion Rate* (ft/yr)	Est. Erosion Rate (CF/yr)
Station 0+00 To 7+00	1			700	200	120	2.5	Moderate	Very Low	0.008	4.0
Station 9+25 To 10+25	1			i	100	95	5	High	Very Low	0.08	40.0
Station 10+25 To 12+50	1			225	225	0	5	Moderate	Very Low	0.008	9.0
Station 12+50 To 15+50	1			300	300	180	4.5	High	Very Low	0.08	108.0
Station 16+50 To 17+00	2			50	50	50	3	Moderate	Very Low	0.008	1.2
Station 17+00 To 18+50	2			150	150	30	2	High	Very Low	0.08	24.0
Station 18+50 To 19+50	2			100	100	100	2	Moderate	Extreme	0.7	140.0
Station 19+50 To 20+50	2			100	100	100	4	High	Extreme	0.4	160.0
Station 20+50 To 21+75	2			125	125	60	1.5	Moderate	Very Low	0.008	1.5
Station 21+75 To 22+75	2			100	100	75	3	Moderate	Very Low	0.5	150.0
Station 22+75 To 23+25	2			50	50	50	3.5	High	Very Low	0.08	14.0
Station 33+00 To 35+00	2			200	200	170	5	High	Very Low	0.08	80.0
Station 35+00 To 37+25	2			275	250	120	4.5	Moderate	Very Low	0.008	9.0
Station 37+50 To 42+25	2			475	350	330	3.5	High	Very Low	0.08	98.0
Station 42+25 To 43+75	2 and 3			150	150	150	3.5	Moderate	Very Low	0.008	4.2
Station 43+75 To 47+50	3			400	400	285	4	High	Very Low	0.08	128.0
Station 47+50 To 49+25	3			175	175	175	4	Moderate	Very Low	0.008	5.6
Station 50+00 To 51+00	3			100	100	100	4	High	Very Low	0.08	32.0
Station 51+00 To 53+50	3			250	250	150	4.5	Moderate	Very Low	0.008	9.0
Station 53+50 To 60+00	3			450	450	450	5	High	Very Low	0.08	180.0
Station 60+00 To 64+25	3 and 4			425	300	300	3.5	Moderate	High	0.1	105.0
Station 67+25 To 69+00	4			175	175	105	3.5	Moderate	Low	0.02	12.3
Station 69+00 To 71+50	4			250	250	200	3	High	Very Low	0.08	60.0
				Totals	4550	3395					

Erosion Rates Left Bank

Reach	Reach	Est. Sed. Load (ton/yr)	Est "Stable" Erosion Rate (ft/yr)	Est "Stable" Sed. Load Rate (ft/yr)	"Stable" Sed. Load (ton/yr)	Est. Sed. Load Reduction (ton/yr)	TSS Reduction (lb/yr)	TP Reduction (lb/yr)
Station 0+00 To 7+00	1	0.2	0.004	1.2	0.1	0.1	120	0.06
Station 9+25 To 10+25	1	1.9	0.004	1.9	0.2	1.7	3,480	1.74
Station 10+25 To 12+50	1	0.4	0.004	0.0	0.4	0.0	0	0.00
Station 12+50 To 15+50	1	5.2	0.004	3.2	2.2	3.0	5,930	2.96
Station 16+50 To 17+00	2	0.1	0.004	0.6	0.0	0.0	60	0.03
Station 17+00 To 18+50	2	1.2	0.004	0.2	0.9	0.2	440	0.22
Station 18+50 To 19+50	2	6.7	0.350	70.0	3.4	3.4	6,740	3.37
Station 19+50 To 20+50	2	7.7	0.350	140.0	6.7	1.0	1,930	0.96
Station 20+50 To 21+75	2	0.1	0.004	0.4	0.1	0.0	30	0.02
Station 21+75 To 22+75	2	7.2	0.004	0.9	1.8	5.4	10,750	5.37
Station 22+75 To 23+25	2	0.7	0.004	0.7	0.0	0.6	1,280	0.64
Station 33+00 To 35+00	2	3.9	0.004	3.4	0.7	3.1	6,220	3.11
Station 35+00 To 37+25	2	0.4	0.004	2.2	0.3	0.1	210	0.10
Station 37+50 To 42+25	2	4.7	0.004	4.6	0.5	4.2	8,450	4.23
Station 42+25 To 43+75	2 and 3	0.2	0.004	2.1	0.1	0.1	200	0.10
Station 43+75 To 47+50	3	6.2	0.004	4.6	2.0	4.2	8,340	4.17
Station 47+50 To 49+25	3	0.3	0.004	2.8	0.1	0.1	270	0.13
Station 50+00 To 51+00	3	1.5	0.004	1.6	0.1	1.5	2,930	1.46
Station 51+00 To 53+50	3	0.4	0.004	2.7	0.3	0.1	260	0.13
Station 53+50 To 60+00	3	8.7	0.004	9.0	0.4	8.2	16,470	8.23
Station 60+00 To 64+25	3 and 4	5.1	0.060	63.0	3.0	2.0	4,040	2.02
Station 67+25 To 69+00	4	0.6	0.010	3.7	0.4	0.2	350	0.18
Station 69+00 To 71+50	4	2.9	0.004	2.4	0.7	2.2	4,390	2.20
		66.2			24.7	41.4	82890.0	41.4

Appendix F
Tree Loss Summary

Tree Loss Summary

Tree Species	Healthy Trees Removed for High, Medium, and Low Priority Sites	Healthy Trees Removed for High and Medium Priority Sites	Healthy Trees Removed for High Priority Sites
Basswood/American	2	2	1
Birch/River	1	0	0
Box Elder	33	28	16
Cottonwood	8	7	5
Elm/American	4	4	2
Hackberry	3	2	1
Maple/Amur	1	1	1
Maple/Red	1	0	0
Maple/Silver	30	24	18
Oak/Bur	1	1	1
Spruce Sp.	1	1	0
Walnut/Black	2	2	1
Willow/Black	1	1	1
	88	73	47

Appendix G

Cost Estimates

Cost Estimates

High, Medium, and Low Priority Site Cost Estimate

Item Description	Unit	Estimated Quantity	Unit Price	Extension
Mobilization	LS	1	\$109,700.00	\$109,700.00
Control of Water	LS	1	\$40,000.00	\$40,000.00
Erosion Control	LS	1	\$49,390.00	\$49,400.00
Clearing and Grubbing	ACRE	2.5	\$20,800	\$52,000.00
Clear and Grub Woody Invasive Plant Removal (<=6" DBH tree)	ACRE	2.2	\$6,000	\$13,200.00
Clear and Grub Woody Invasive Plant Removal (>=6" DBH tree)	EACH	31	\$666	\$20,700.00
Herbaceous vegetation herbicide treatment	ACRE	5	\$1,000	\$5,000.00
Select Tree Removal (>6")	Each	88	\$325	\$28,600.00
Grading	SY	12000	\$15	\$180,000.00
Fieldstone Riprap	SY	1470	\$90.00	\$132,300.00
Clear and Salvage Trees and Install as Root Wad	EACH	13	\$600	\$7,800.00
Cross Vane	EACH	13	\$4,000	\$52,000.00
J-hook Vane	EACH	65	\$1,200	\$78,000.00
Fascines	LF	570	\$25	\$14,300.00
Toe wood	LF	1470	\$65	\$95,600.00
Rootwad and riprap	SY	300	\$121	\$36,300.00
Plant Trees	EACH	55	\$290	\$16,000.00
Plant Shrubs	EACH	3680	\$40	\$147,200.00
Plant Plugs	EACH	3680	\$4.5	\$16,600.00
Seeding	ACRE	2.5	\$1,400	\$3,500.00
Live Stakes	EACH	8280	\$6	\$47,700.00
Erosion Control Blanket	SY	11,700	\$4	\$41,000.00
One-Year Establishment Maintenance Period	LS	1	\$19,756	\$19,800.00
Construction Total				\$ 1,206,700
Construction Total w/ Contingency (30%)				\$ 1,568,700
Planning, Engineering & Design (25%)				\$ 392,200
Construction Management (10%)				\$ 156,900
Project Total				\$ 2,118,000
Total w/ Construction Lower Bound (-15%), Legal, and Engineering				\$ 1,801,000
Total w/ Construction Upper Bound (+30%), Legal, and Engineering				\$ 2,754,000
Annual Maintenance Cost (2%)				\$ 42,400

Cost Estimates

High, Medium, and Low Priority Sites: 30-yr and Annualized Cost analysis		Project Total
Category:		Bioengineering
Estimated life span (years)		20
Number of major maint. Events		1
Annual maintenance % of original project cost		15%
End of life span % of original project cost		25%
Expected annual maintenance		\$ 7,700
End of life span maintenance		\$ 529,500
Future Capital Cost		\$ 5,140,900
Future annual maintenance		\$ 366,330
Future end of life span cost		\$ 956,340
Total Future Worth		\$ 6,464,000
Annualized Cost		\$ 136,000
Annual Maintenance Cost		\$ 42,400

Cost Estimates

High and Medium Priority Sites Cost Estimate

Item Description	Unit	Estimated Quantity	Unit Price	Extension
Mobilization	LS	1	\$89,430.00	\$89,500.00
Control of Water	LS	1	\$30,000.00	\$30,000.00
Erosion Control	LS	1	\$40,385.00	\$40,400.00
Clearing and Grubbing	ACRE	1.9	\$20,800	\$39,600.00
Clear and Grub Woody Invasive Plant Removal (<=6" DBH tree)	ACRE	2.2	\$6,000	\$13,200.00
Clear and Grub Woody Invasive Plant Removal (>=6" DBH tree)	EACH	31	\$666	\$20,700.00
Herbaceous vegetation herbicide treatment	ACRE	5	\$1,000	\$5,000.00
Select Tree Removal (>6")	Each	73	\$325	\$23,800.00
Grading	SY	9171	\$15	\$137,600.00
Fieldstone Riprap	SY	1500	\$90.00	\$135,000.00
Clear and Salvage Trees and Install as Root Wad	EACH	13	\$600	\$7,800.00
Cross Vane	EACH	10	\$4,000	\$40,000.00
J-hook Vane	EACH	43	\$1,200	\$51,600.00
Fascines	LF	570	\$25	\$14,300.00
Toe wood	LF	1170	\$65	\$76,100.00
Rootwad and riprap	SY	270	\$121	\$32,700.00
Plant Trees	EACH	44	\$290	\$12,800.00
Plant Shrubs	EACH	2830	\$40	\$113,200.00
Plant Plugs	EACH	2830	\$4.5	\$12,800.00
Seeding	ACRE	1.9	\$1,400	\$2,700.00
Live Stakes	EACH	6360	\$6	\$36,600.00
Erosion Control Blanket	SY	9,200	\$4	\$32,200.00
One-Year Establishment Maintenance Period	LS	1	\$16,154	\$16,200.00
Construction Total				\$ 983,800
Construction Total w/ Contingency (30%)				\$ 1,278,900
Planning, Engineering & Design (25%)				\$ 319,700
Construction Management (10%)				\$ 127,900
Project Total				\$ 1,727,000
Total w/ Construction Lower Bound (-15%), Legal, and Engineering				\$ 1,468,000
Total w/ Construction Upper Bound (+30%), Legal, and Engineering				\$ 2,246,000
Annual Maintenance Cost (2%)				\$ 34,600

Cost Estimates

High and Medium Priority: Sites 30-yr and Annualized Cost analysis		Project Total
Category:		Bioengineering
Estimated life span (years)		20
Number of major maint. Events		1
Annual maintenance % of original project cost		15%
End of life span % of original project cost		25%
Expected annual maintenance		\$ 5,900
End of life span maintenance		\$ 431,750
Future Capital Cost		\$ 4,191,900
Future annual maintenance		\$ 280,690
Future end of life span cost		\$ 779,790
Total Future Worth		\$ 5,252,000
Annualized Cost		\$ 110,000
Annual Maintenance Cost		\$ 34,500

Cost Estimates

High Priority Sites Cost Estimate

Item Description	Unit	Estimated Quantity	Unit Price	Extension
Mobilization	LS	1	\$58,210.00	\$58,300.00
Control of Water	LS	1	\$20,000.00	\$20,000.00
Erosion Control	LS	1	\$26,260.00	\$26,300.00
Clearing and Grubbing	ACRE	1.3	\$20,800	\$27,100.00
Clear and Grub Woody Invasive Plant Removal (<=6" DBH tree)	ACRE	2.2	\$6,000	\$13,200.00
Clear and Grub Woody Invasive Plant Removal (>=6" DBH tree)	EACH	31	\$666	\$20,700.00
Herbaceous vegetation herbicide treatment	ACRE	5	\$1,000	\$5,000.00
Select Tree Removal (>6")	Each	47	\$325	\$15,300.00
Grading	SY	6000	\$15	\$90,000.00
Fieldstone Riprap	SY	435	\$90.00	\$39,200.00
Clear and Salvage Trees and Install as Root Wad	EACH	13	\$600	\$7,800.00
Cross Vane	EACH	7	\$4,000	\$28,000.00
J-hook Vane	EACH	29	\$1,200	\$34,800.00
Fascines	LF	420	\$25	\$10,500.00
Toe wood	LF	950	\$65	\$61,800.00
Rootwad and riprap	SY	270	\$121	\$32,700.00
Plant Trees	EACH	28	\$290	\$8,200.00
Plant Shrubs	EACH	1860	\$40	\$74,400.00
Plant Plugs	EACH	1860	\$4.5	\$8,400.00
Seeding	ACRE	1.3	\$1,400	\$1,900.00
Live Stakes	EACH	4180	\$6	\$24,100.00
Erosion Control Blanket	SY	6,300	\$4	\$22,100.00
One-Year Establishment Maintenance Period	LS	1	\$10,504	\$10,600.00
Construction Total				\$ 640,400
Construction Total w/ Contingency (30%)				\$ 832,500
Planning, Engineering & Design (25%)				\$ 208,100
Construction Management (10%)				\$ 83,300
Project Total				\$ 1,124,000
Total w/ Construction Lower Bound (-15%), Legal, and Engineering				\$ 956,000
Total w/ Construction Upper Bound (+30%), Legal, and Engineering				\$ 1,462,000
Annual Maintenance Cost (2%)				\$ 22,500

Cost Estimates

High Priority Sites: 30-yr and Annualized Cost analysis		Project Total
Category:		Bioengineering
Estimated life span (years)		20
Number of major maint. Events		1
Annual maintenance % of original project cost		15%
End of life span % of original project cost		25%
Expected annual maintenance		\$ 3,900
End of life span maintenance		\$ 281,000
Future Capital Cost		\$ 2,728,200
Future annual maintenance		\$ 185,540
Future end of life span cost		\$ 507,520
Total Future Worth		\$ 3,421,000
Annualized Cost		\$ 72,000
Annual Maintenance Cost		\$ 22,500