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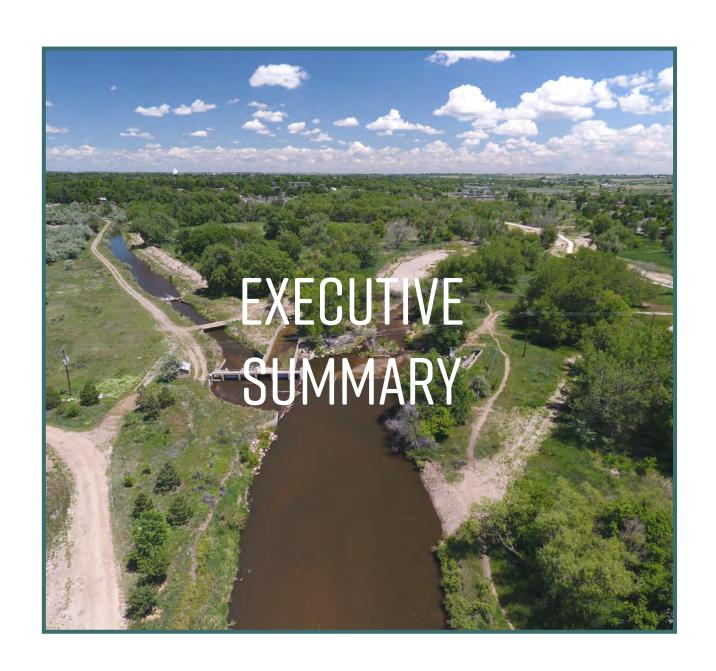
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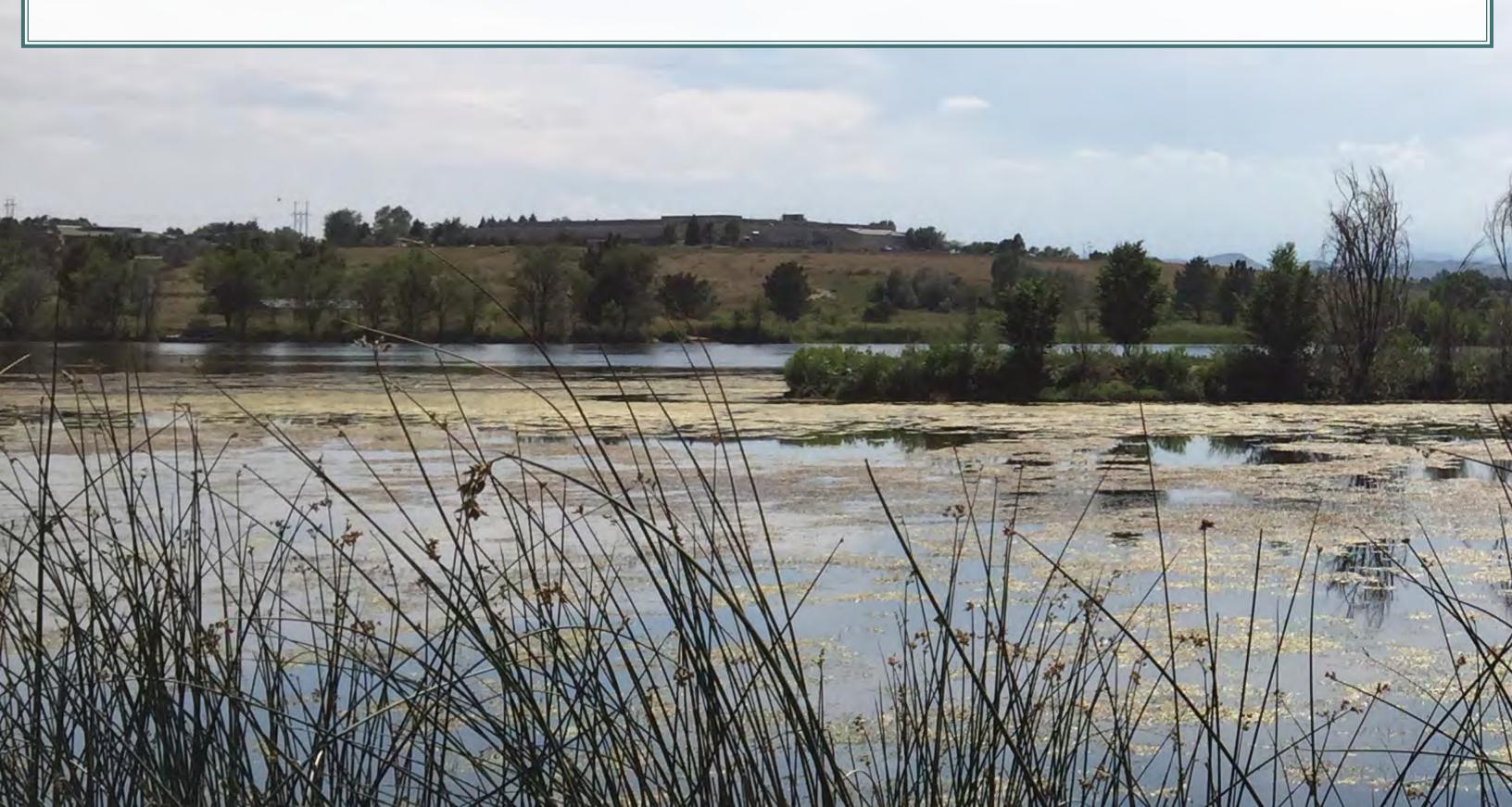
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EXECUTIVE SUMMARY

This document is a Master Plan for the Big Thompson River Corridor from the Morey Wildlife Reserve on the west to the gravel pit ponds east of County Road 9E, where Boyd Lake Avenue will be extended to cross the river in the future. Figure ES-1 illustrates the extents of the Master Plan.

The vision for this Master Plan has been shaped by significant public input received throughout the project along with the shared vision of previous planning efforts to preserve natural areas along the Big Thompson River Corridor for floodplain, ecological, and other community benefits. Representatives from multiple City departments including Public Works, Parks & Recreation, and Water & Power have provided input through a Technical Advisory Committee, as have the Big Thompson Watershed Coalition (BTWC) and the Big Thompson Water Quality Forum.

The overall vision for Big Thompson River Corridor through the City of Loveland is based on preserving and enhancing natural functions of the corridor while providing more opportunities for the community to interact with the river along the corridor. This vision of the corridor includes:

- 1. Creating a resilient river corridor that is a treasured asset of the City of Loveland.
- 2. Flood conveyance improvements to provide north-south passage under major flood conditions.
- 3. Preserving and maintaining remaining natural areas along the river.
- 4. A river that supports an urban fishery.
- 5. Continued acquisition of land along the river corridor including floodway and floodplain areas.
- 6. New opportunities for river access in existing City parks and natural areas, with improved access for active water-based recreational uses along reaches with publicly owned river frontage.
- east (and eventually to I-25).
- 8. Open land for wildlife where elk, deer, small mammals and many species of birds find habitat.
- 9. Access to City-owned natural areas and trails for newly developing areas.
- 10. A comprehensive maintenance and management plan and program.
- 11. Increased community involvement with the river corridor through additional programs and events.

The study area was evaluated on a reach-by-reach basis, following the same reach boundaries and numbering conventions as the 2015 Big Thompson River Restoration Maser Plan that Ayres Associates prepared for the BTWC. Tables ES-1 summarizes reach names and upstream and downstream limits.

This Master Plan was funded by both the City of Loveland and a Community Development Block Grant - Disaster Recovery (CDBG-DR) planning grant as administered by the State of Colorado Department of Local Affairs (DOLA).

Given the nine-mile extent of the corridor evaluated and the complexity of issues along each reach, this Master Plan provides conceptual-level guidance for future improvements. Implementation of conceptual plans will require detailed design involving coordinated efforts between multiple City departments and collaboration between the City and Larimer County in some areas. Implementation of improvements along the corridor is already occurring on the western end of the project area with the BTWC's Rossum to Wilson River Improvement Project and Larimer County's Namaqua Road Bridge Replacement Project.

Flood hazard reduction projects are designed and funded to raise approaches for Wilson Avenue to provide northsouth passage in greater than a 100-year event, and plans have also been developed to upgrade the Railroad Avenue crossing to pass a 50-year event without road overtopping. In addition to these two imminent flood hazard reduction projects, the Master Plan places a high priority on the improvements to upgrade the Lincoln Avenue - U.S. Hwy 287 crossing to pass the 100-year peak discharge without road overtopping.

Reach Number	Name	Upstream Boundary	Downstream Boundary
29	Morey Wildlife Reserve	MM 87.7	Rossum Drive
30	Rossum-Namaqua	Rossum Drive	Namaqua Avenue
31	Namaqua-Wilson	Namaqua Avenue	Wilson Avenue
32	Wilson-Taft	Wilson Avenue	Taft Avenue
33	Taft-Railroad	Taft Avenue	Railroad Avenue
34	Fairgrounds Park	Railroad Avenue	Lincoln Avenue - U.S. Hwy 287
35	Lincoln-St. Louis	Lincoln Avenue - U.S. Hwy 287	St. Louis Avenue
36	St. Louis-Boise	St. Louis Avenue	Boise Avenue
37	Boise-CR 9E	Boise Avenue	CR 9E
38	CR9E-d/s Study Limit	CR 9E	Ponds d/s of CR 9E

Table ES-1. Reach Designations

There are several overarching concepts to provide better geomorphic stability and a more resilient river corridor that should be implemented throughout the study area where feasible. These include development of stabilized overflow spillways between the river and gravel pits and high flow channels to convey flood flows while minimizing erosion and avulsions, increasing the capacity of bridges and/or the use of relief culverts, use of multi-stage channels with a low flow channel or inner berm where practical, re-connection of the floodplain through use of floodplain benches, and improving overall conveyance capacity and connectivity of the river corridor. Some of these tactics can be easily 7. A continuous regional bike/pedestrian trail from Rossum Drive on the west to County Road 9E on the applied to the study corridor, while others are more difficult due to property ownership, existing land uses, and associated space constraints.

> Parks and natural areas are central components of the Master Plan. Namagua, Centennial, Fairgrounds, and Barnes Parks provide many amenities including picnic areas, ball fields, racquet courts, and playgrounds. In addition to these more traditional park areas, the City Parks & Recreation Department's Open Lands/ Natural Areas Program has acquired significant land along the river corridor. The parks and natural areas have not only kept development out of hazardous locations but also have created a greenway through a significant part of the City that provides trails, recreational opportunities, and natural areas for wildlife.

The Master Plan for infrastructure and land use decisions in the corridor is based on long-term resilience. This strategy includes maximizing flood hazard reduction benefits while minimizing long-term costs, improving life safety and emergency access, and reducing impacts and economic hardships to local businesses during a flood to the extent feasible. The approach that the City envisions includes restoring natural river and floodplain functions where they are currently lacking, returning to a more natural and beautiful riparian corridor, improving recreation opportunities for citizens to enjoy the corridor, improving water quality, and creating a sustainable and

Flood History

The flood history of the Big Thompson River is infamous in Colorado with two major flood events occurring within less than a 40-year period, from the 1976 flood that ravaged the canyon and was the deadliest flood in Colorado history to the 2013 flood that was remarkable in magnitude and duration. The September 2013 event was a 100-year event for Loveland and clearly demonstrated the vulnerabilities of road crossings to overtopping and gravel pit embankments to massive erosion and avulsion. This Master Plan includes recommendations to improve resilience and public safety in future flood events including improvements for 100-year capacity at Lincoln Avenue - US Hwy 287 and the 2018 Wilson Avenue Bridge project to raise approaches to provide in excess of 100-year capacity before road overtopping.

economically stable environment for future community and business development.

By developing a comprehensive river corridor plan for the nine-mile stretch of the Big Thompson River from the Morey Wildlife Reserve to the future extension of Boyd Lake Avenue downstream of County Road 9E, the City of Loveland seeks to transform the Big Thompson River Corridor into a community greenway, connecting people with nature and the river and providing a balance of passive and active uses that complement surrounding land uses, accommodate wildlife, and preserve the natural beauty of the riparian corridor.

It will take years and significant funding to implement the full plan. Realizing the vision of this Master Plan will require long-term investment in the corridor and diligent management by the City to coordinate efforts to improve and maintain the river corridor between multiple City departments, the County, private property owners, and other stakeholders. This investment and diligence will transform what is currently an underutilized resource into a resilient community greenway that will be enjoyed by residents of Loveland for years into the future.

Community Input

Community input was fundamental in shaping the vision of this Master Plan. Citizen and stakeholder input was solicited throughout the project. Community outreach activities included:

- Participation in major City summer events including the 4th of July Celebration, The Cherry Pie Festival, and the Corn Roast Festival, as well as select Farmers' Markets and Foote Lagoon concerts.
- Organizing and conducting a two-day Strategic Planning Workshop to obtain public input as plans were being formulated.
- Creation and operation of a project website (www.ABetterBigT.com) with information on public outreach events, project updates, and a news blog.
- Creation and distribution of an online public survey through Open City Hall, social media, and the website.

Together, these elements gave members of the public the platform to voice their opinions and ideas about decisions along the corridor and provided the project team with valuable local knowledge upon which design decisions could be based.

Community input emphasized that the citizens of Loveland value to Big Thompson River Corridor as a recreational and natural resource. People surveyed felt satisfied with the extent of formal parks such as Centennial and Fairgrounds/Barnes Park and preferred that the remainder of the river corridor retain a natural character. This desire is well aligned with the City's strategy of acquiring natural areas within the corridor and the flood resilience strategy of preserving land within the floodplain and floodway as open space.

People also expressed a desire for more river access and opportunities for water-based recreational activities including fishing, wading, swimming and tubing. These activities are already occurring along the corridor; however, there are few designated river access areas. Providing designated river access areas will improve public safety for those who currently access the river and will help direct river users away from reaches of the river that run through private property.

The top five priorities identified in this Master Plan are as follows:

Priority #1 - Maintenance of River Corridor

Because there is no formal management and maintenance program for the Big Thompson River, portions of the river have been neglected, which creates potential hazards and reduces the conveyance capacity of the Big Thompson River through the City. The highest priority identified in this Master Plan is to conduct maintenance along the river corridor in areas with publicly owned river frontage. Maintaining the existing infrastructure along the river corridor will increase the capacity at some road crossings without the large expense of capital improvement projects. The estimated annual cost to perform routine maintenance for City-accessible portions of the river is on the order of \$120,000 per year. Initial costs may be higher due to the lack of maintenance for many years; however, establishing a maintenance program would have a significant positive impact on the Big Thompson River Corridor and its conveyance of flows through the City.

While the City currently does not have a budget line item for river maintenance activities, this is a modest cost in the context of departmental budgets. It is also an extremely important item in terms of municipal liability. There are legal precedents for municipalities being sued for failing to maintain the flood carrying capacity of a waterway in an urban area. While natural rivers require little to no maintenance, and trees and large woody debris in natural streams provide habitat and other benefits, in urban areas where a river has been channelized and constricted by bridges and other encroachments, maintenance cannot be ignored. Large woody debris in the channel has the potential to become lodged in bridge openings, causing elevated floodwaters upstream. It also can form debris dams in the river during a flood that can cause localized increases in peak flow rates when they breach.

To efficiently plan and execute maintenance activities, developing a maintenance and management plan for the river is recommended. This plan would begin by itemizing reach-by-reach maintenance needs and cost projections and would include a map showing specific areas for maintenance activities (e.g. snags to remove, minor bank repair areas, bridge maintenance, etc.). A maintenance and debris removal plan could be developed for \$10,000 to \$20,000 that would outline areas for removal, estimated quantities, and cost estimates.

Priority #2 - River Corridor Coordinator

Because neither the City of Loveland nor Larimer County has a formal management and maintenance program for the Big Thompson River, responsibilities for the river corridor are shared between multiple City departments such as Parks and Recreation, Open Lands, and Public Works. However, none of these departments have funding dedicated to the maintenance of the actual river itself. Therefore, the Master Plan recommends that the City establish a new full-time position for a River Corridor Coordinator. This position would have many responsibilities but ultimately would coordinate between departments and programs in the City that have overlapping responsibilities for the river corridor to maximize the effectiveness of their combined efforts. This person also would seek funding through grants and other sources to implement projects along the river corridor.

A River Corridor Coordinator would be an investment by the City that will pay dividends in terms of obtaining state and federal money to invest in the river corridor and in terms of reduced municipal liability due to improved management and maintenance of the river corridor. The estimated annual cost of a full time employee to fulfill this position is on the order of \$100,000 or less. The City should also continue its River Team, which was created in response to the 2013 Flood. The River Team, currently led by Stormwater Engineering but including representatives from other affected departments, can continue to coordinate projects related to the river corridor and implementation of this Master Plan. The proposed River Corridor Coordinator would ultimately lead this team.

BTWC could potentially perform many of the duties of a River Corridor Coordinator in the near-term and already has well-established relationships with public and private entities along the river corridor. Until the City is able to establish a staff position for the River Corridor Coordinator, the City could consider contracting with BTWC to perform some or all of the position's functions.

Priority #3 - Lincoln Avenue - US Hwy 287 Improvements

Improving north-south travel capabilities during a major flood event is a high priority for public safety. Because Lincoln Avenue is a federal highway and major north-south route in Larimer County, implementing improvements to allow for safe crossing in a 100-year event is critical. Ayres has already developed plans for these improvements

that include: (1) replacement of the existing bridge with a new 240-foot span bridge and raising the roadway south of the bridge by as much as four feet; (2) creating lowered and widened floodplain benches through Fairgrounds Park, with some minor top-of-bank berming; (3) reducing the size of the pond south of the channel and west of Hwy 287 so that a low floodplain bench can be constructed on the south side of the channel; and (4) construction of a lowered and widened floodplain bench downstream of Hwy 287. The cost of this project is estimated at approximately \$17M, which makes it one of the most expensive projects included in the Master Plan. The importance of Hwy 287 as a north-south major arterial route, the potential to reduce land included in the floodplain and floodway, and the overall improvements in resilience of the area helps justify these costs.

The City should continue to pursue potential funding sources including FHWA, CDOT, and/or FEMA. This is an expensive project, but it is a very important project for public safety and flood hazard reduction. This project is also a critical component to implementation of the Hwy 287 Strategic Plan and its vision of both a River District and southern gateway into Loveland.

Priority #4 - Wilson Avenue - Elevation of Roadway Approaches to Bridge

Raising the approaches to the Wilson Avenue Bridge to prevent overtopping in the 100-year event is a high priority because it is the most economical way to establish a north-south arterial with better than 100-year crossing capacity. During the 2013 flood, Wilson Avenue was the last street to overtop and the first to reopen. This project is currently under design and anticipated to be constructed in 2018. This project will increase the resilience of the reach from Namaqua Avenue to Wilson Avenue, the lowest ranked reach in the baseline resilience assessment. This project is already funded, so costs are not included in the Master Plan.

Priority #5 - Mariano Exchange Ditch Water Quality Evaluation

Based on water quality data, observations, and comments from the public, the single greatest water quality issue for the Big Thompson River through Loveland is the poor quality of water from Mariano Exchange Ditch. Where the Mariano Exchange Ditch enters the Big Thompson River upstream of Wilson Avenue, there is a visual spike in turbidity that can be seen at the confluence with the ditch and in the river downstream. Given public desires for greater river access and a healthy urban fishery, addressing the water quality of the Mariano Exchange Ditch return flows is a high priority. Finding a solution will require cooperation between the City, the Ditch and Reservoir Company and the State. Improving the water quality of the Big Thompson River through the City of Loveland would be a major step toward gaining public support for future Master Plan improvements. It will also benefit recreation and public safety for water users. The estimated cost of further study and conceptual design of improvements for reducing sediment discharges from Boedecker Reservoir is approximately \$300,000.

BIG THOMPSON RIVER CORRIDOR MASTER PLAN

Study Limits Map

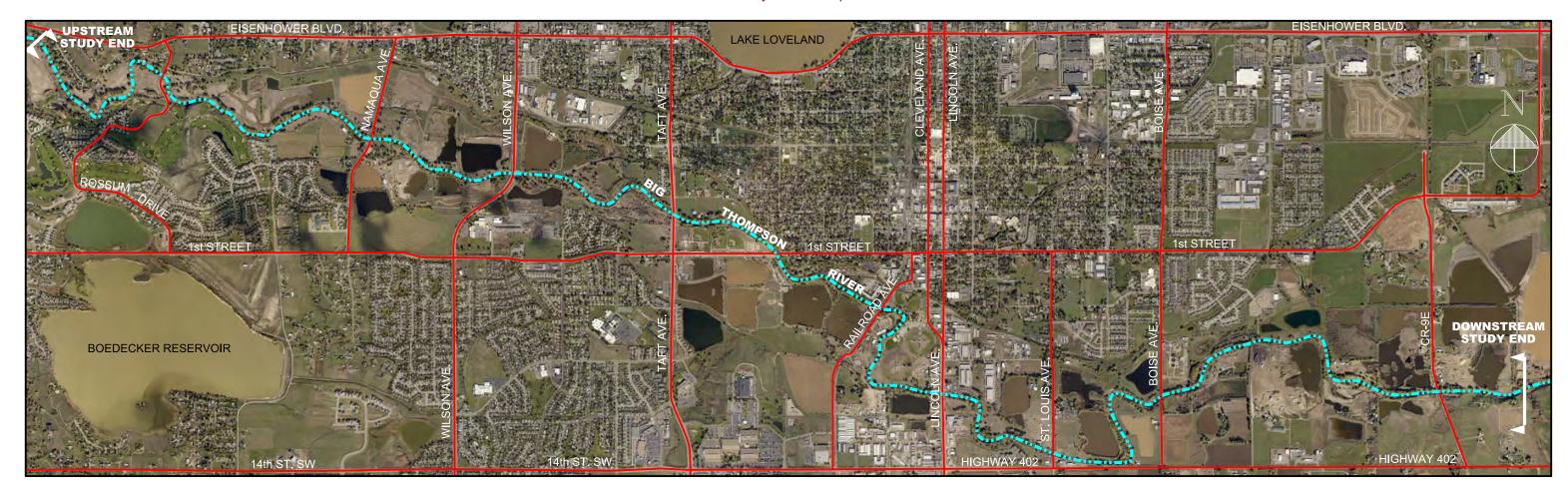


Figure ES-1. Big Thompson River Corridor Master Plan Study Limits Map

	Category & Cost											
Reach	Flood Hazard Reduction	Gravel Pits ²	Aquatic Habitat	Geomorphology ²	Natural Area/ Open Space	Parks & Recreation	Trails	Land Use	Utilities	Water Quality	Maintenance ⁴	Total
29	\$1,660,000		retrofit - not included i	f Big Barnes diversion dam n overall cost estimate since vate dam	\$100,000	\$745,000	\$1,083,000				\$23,000	\$3,590,000
30	\$350,000¹	3	3	3	\$100,000	\$489,000	\$368,000	\$174,000			\$26,000	\$1,483,000
31	1	3	3	3		\$43,000	\$368,000	\$14,000		\$300,000	\$16,000	\$725,000
32				\$1,430,000	\$161,000	\$162,000	\$84,000		\$111,000		\$19,000	\$2,473,000
33	1	\$2,450,000				\$133,000	\$123,000		\$37,000		\$24,000	\$2,743,000
34	\$16,900,000			\$945,000		\$4,792,000	\$267,000		\$74,000		\$17,000	\$22,970,000
35	\$3,230,000	\$675,000		\$945,000	\$24,000	\$933,000	\$811,000				\$14,000	\$6,620,000
36		\$1,575,000		\$790,000	\$100,000	\$578,000	\$734,000				\$20,000	\$3,800,000
37		\$2,625,000		\$2,363,000	\$136,000	\$35,000	\$1,493,000			\$368,000	\$34,000	\$6,660,000
38	1	\$1,050,000		\$473,000			\$210,000				\$10,000	\$2,790,000
Totals	\$21,790,000	\$8,375,000	3	\$6,946,000	\$621,000	\$7,910,000	\$5,541,000	\$190,000	\$220,000	\$670,000	\$203,000	\$52,824,000

Table ES-1. Conceptual Costs by Reach and Category

¹ Costs for road crossing improvements for Namaqua, Wilson and Railroad are not included because these projects are already funded; costs for future Boyd Lake Avenue bridge and conveyance improvements not included since funding for this will be from Transportation.

² Gravel pit and geomorphology improvements for reaches 35 - 38 involve public and private lands. More detailed planning should identify stakeholders and potential cost sharing opportunities.

³ BTWC working on improvements for Rossum to Wilson reach.

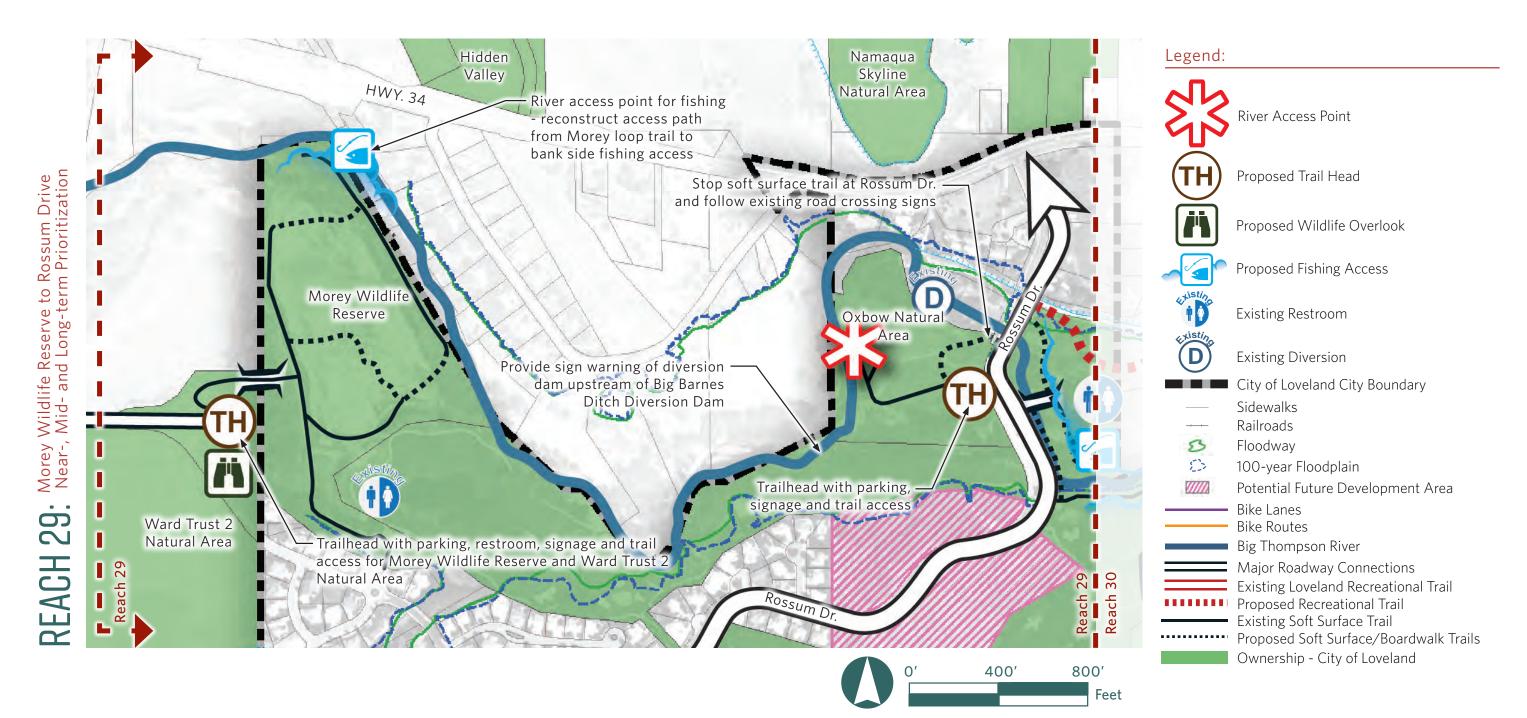
⁴ Maintenance cost estimates are for entire length of river through each reach, including public and private land. Maintenance costs are not included in total since they are estimated average annual costs.





Major Roadway Connections Big Thompson River Tributary of the Big Thompson River High Flow Path Existing Diversion Dam City of Loveland City Boundary Sidewalks Railroads Floodway 100-year Floodplain Ownership - City of Loveland Armored Overflow Protection See UDFCD Urban Storm Drainage Criteria Manual or USACE guidance for riprap sizing, use soil riprap in higher visibility area to soften appearance and provide vegetation Constructed Wetland Overflow Channel Sanitary Pressurized Main Water Pressurized Main Water Pressurized Main Stormwater Outfall 0' 400' 800' Feet			
Existing Diversion Dam City of Loveland City Boundary Sidewalks Railroads Floodway 100-year Floodplain Ownership - City of Loveland Armored Overflow Protection See UDFCD Urban Storm Drainage Criteria Manual or USACE guidance for riprap sizing, use soil riprap in higher visibility area to soften appearance and provide vegetation Constructed Wetland Overflow Channel Sanitary Gravity Main Sanitary Pressurized Main Water Pressurized Main Stormwater Outfall 0' 400' 800'			Big Thompson River
City of Loveland City Boundary Sidewalks Railroads Floodway 100-year Floodplain Ownership - City of Loveland Armored Overflow Protection See UDFCD Urban Storm Drainage Criteria Manual or USACE guidance for riprap sizing, use soil riprap in higher visibility area to soften appearance and provide vegetation Constructed Wetland Overflow Channel Sanitary Gravity Main Sanitary Pressurized Main Water Pressurized Main Stormwater Outfall 0' 400' 800'		\longrightarrow	High Flow Path
City Boundary Sidewalks Railroads Floodway 100-year Floodplain Ownership - City of Loveland Armored Overflow Protection See UDFCD Urban Storm Drainage Criteria Manual or USACE guidance for riprap sizing, use soil riprap in higher visibility area to soften appearance and provide vegetation Constructed Wetland Overflow Channel Sanitary Gravity Main Sanitary Pressurized Main Water Pressurized Main Stormwater Outfall 0' 400' 800'	ı	D	Existing Diversion Dam
Railroads Floodway 100-year Floodplain Ownership - City of Loveland Armored Overflow Protection See UDFCD Urban Storm Drainage Criteria Manual or USACE guidance for riprap sizing, use soil riprap in higher visibility area to soften appearance and provide vegetation Constructed Wetland Overflow Channel Sanitary Gravity Main Water Pressurized Main Stormwater Outfall 0' 400' 800'	J		City of Loveland City Boundary
Ownership - City of Loveland Armored Overflow Protection See UDFCD Urban Storm Drainage Criteria Manual or USACE guidance for riprap sizing, use soil riprap in higher visibility area to soften appearance and provide vegetation Constructed Wetland Overflow Channel Sanitary Gravity Main Sanitary Pressurized Main Water Pressurized Main Stormwater Outfall 0' 400' 800'	i		
Ownership - City of Loveland Armored Overflow Protection See UDFCD Urban Storm Drainage Criteria Manual or USACE guidance for riprap sizing, use soil riprap in higher visibility area to soften appearance and provide vegetation Constructed Wetland Overflow Channel Sanitary Gravity Main Sanitary Pressurized Main Water Pressurized Main Stormwater Outfall 0' 400' 800'		3	Floodway
Armored Overflow Protection See UDFCD Urban Storm Drainage Criteria Manual or USACE guidance for riprap sizing, use soil riprap in higher visibility area to soften appearance and provide vegetation Constructed Wetland Overflow Channel Sanitary Gravity Main Sanitary Pressurized Main Water Pressurized Main Stormwater Outfall O' 400' 800'		8	100-year Floodplain
Water Pressurized Main Stormwater Outfall 0' 400' 800'		A A A	Armored Overflow Protection See UDFCD Urban Storm Drainage Criteria Manual or USACE guidance for riprap sizing, use soil riprap in higher visibility area to soften appearance and provide vegetation Constructed Wetland Overflow Channel
Stormwater Outfall 0' 400' 800'			Sanitary Pressurized Main

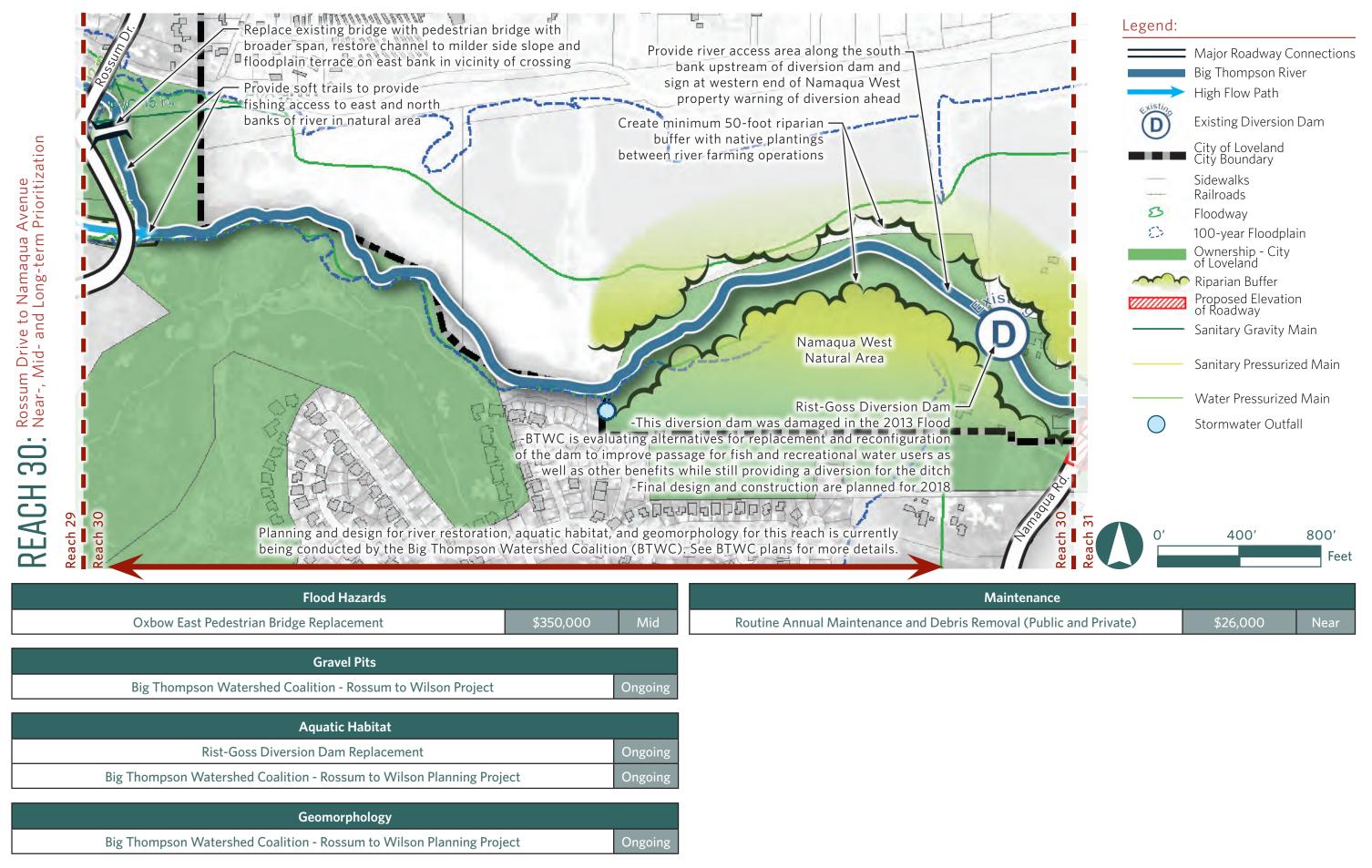
Flood Hazards		
Morey Wildlife Reserve Constructed Wetland Overflow Channel	\$1,350,00	Mid
Overflow Weir upstream of Oxbow Natural Area	\$310,000	Mid
Aquatic Habitat		
Big Barnes Ditch Diversion Dam Fish and Boat Passage	\$1,810,000	Mid
Maintenance		
Routine Annual Maintenance and Debris Removal (Public and Private)	\$23,000	Near

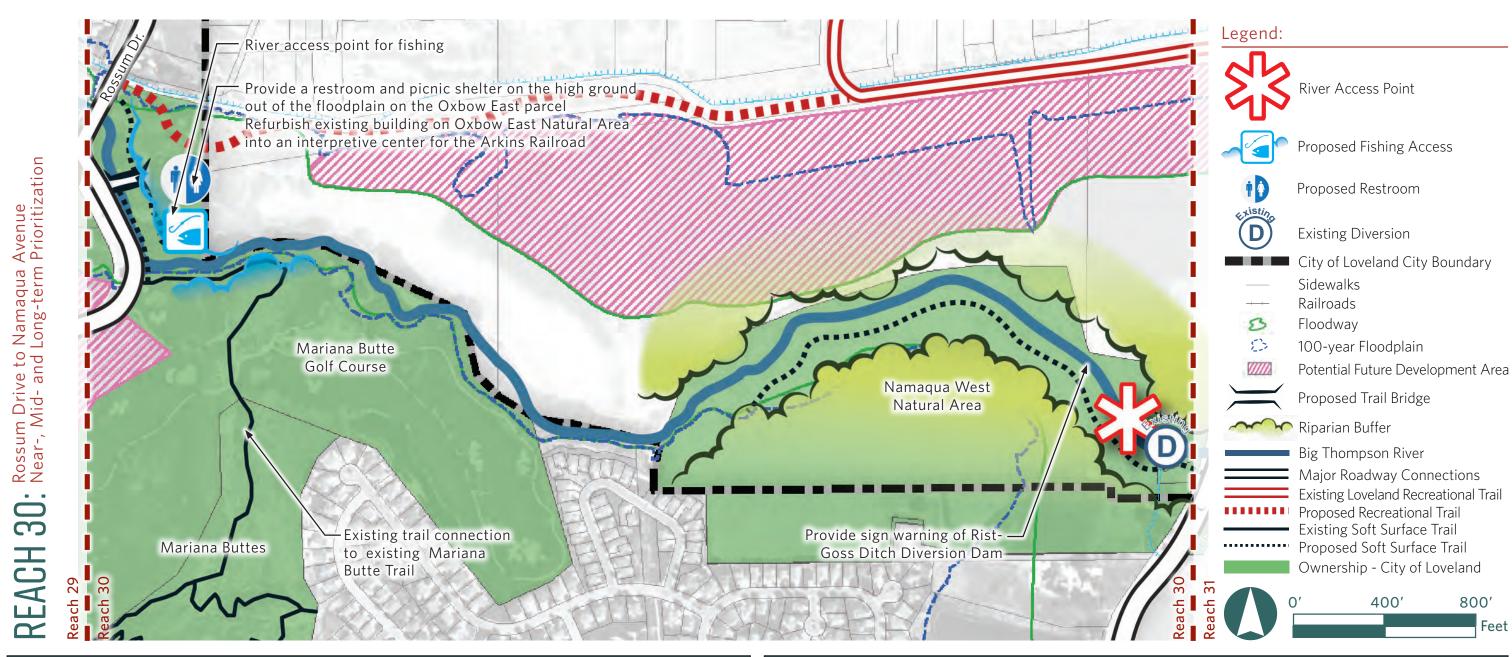


Natural Area/Open Space		
Morey Wildlife Reserve Revegetation and Weed Control	\$70,000	Near
Oxbow Natural Area Revegetation and Weed Control	\$30,000	Near

Parks & Recreation			
Oxbow Natural Area River Access	\$39,000	Mid	
Morey Wildlife Reserve Fishing Access	\$6,000	Near	
Morey Wildlife Reserve Trailhead	\$525,000	Mid	
Oxbow Natural Area Trailhead	\$175,000	Mid	

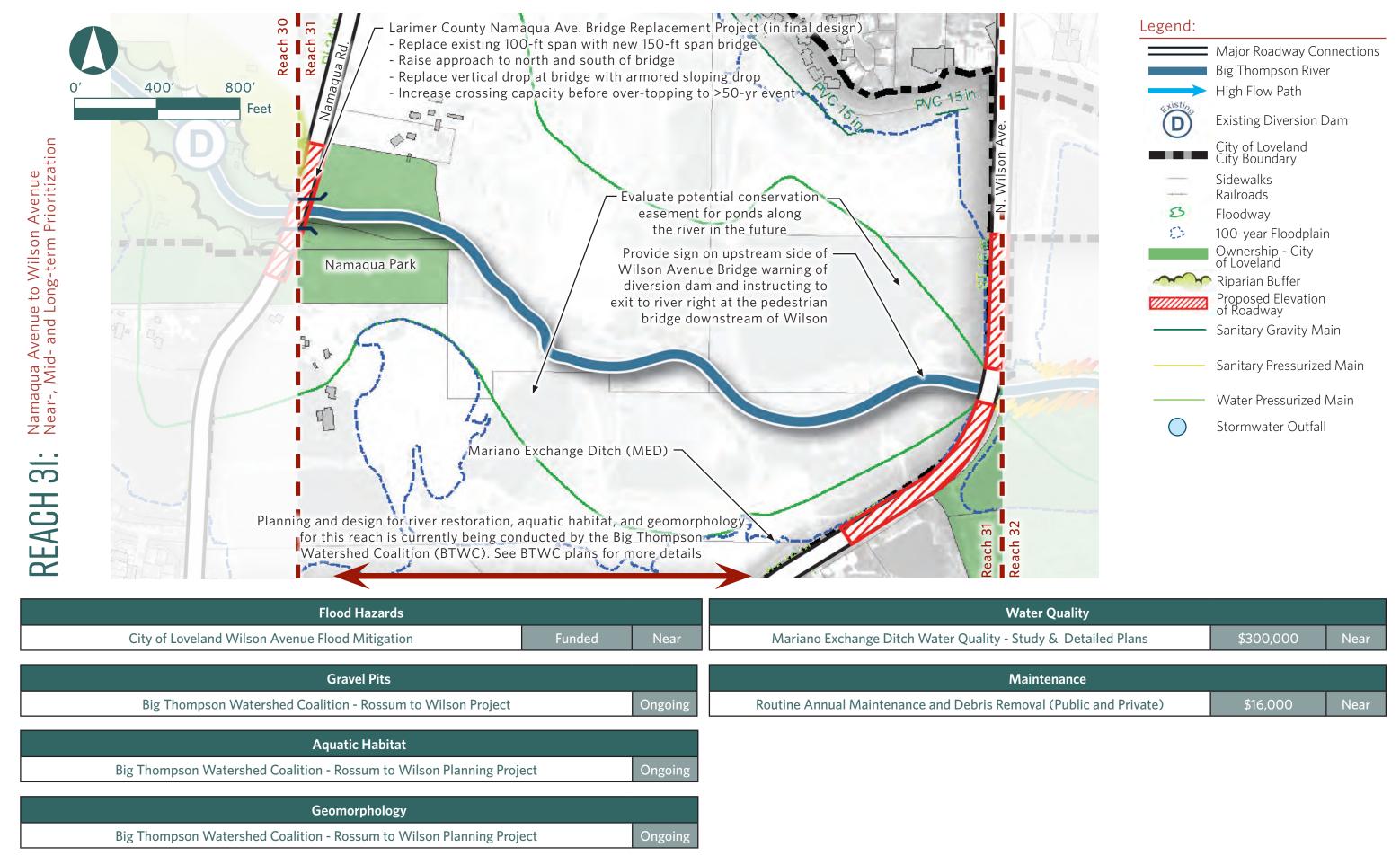
Trails		
Morey Wildlife Reserve Soft Surface Trails	\$320,00	Long
Trail Access to Morey Wildlife Reserve from New Trailhead	\$430,000	Long
Morey Wildlife Reserve Boardwalk Trails	\$360,000	Long

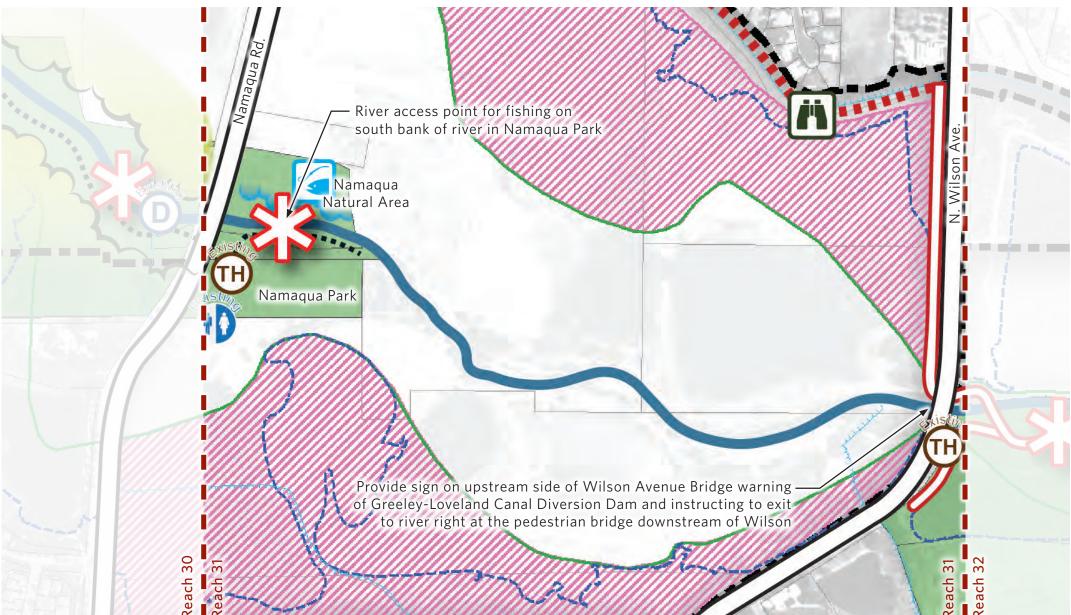




Natural Area/Open Space		
Oxbow East Natural Area Weed Control & Vegetation	\$20,000	Mid
Namaqua West Natural Area Weed Control & Vegetation	\$80,000	Mid
Parks & Recreation		
Oxbow East Parcel Picnic Shelter and Refurbished Building	\$440,000	Mid
Oxbow Natural Area Fishing Access	\$9,000	Mid
Rist-Goss Diversion Dam Warning	\$40,000	Near

Trails			
Rossum - Namaqua Recreational Trail Extension	\$368,000	Mid	
Land Use			
Riparian Buffer	\$113,000	Mid	
Buffer Area Livestock Exclusion	\$48,000	Mid	
Loveland Ready Mix Coordination	\$13,000	Ongoing	





Landuse

Coordinate with Property Owners

Floodway **Parks & Recreation** Namaqua Park River Access \$40,000 Near Greeley-Loveland Canal Diversion Dam Warning \$3,000 Near **Trails** Namaqua - Wilson Recreational Trail Connection \$368,000

\$14,000

Legend:



River Access Point



Existing Trail Head



Proposed Wildlife Overlook



Proposed Fishing Access



Existing Restrooms

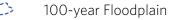


City of Loveland City Boundary









Potential Future Development Area



Major Roadway Connections Existing Loveland Recreational Trail

Proposed Recreational Trail Existing Soft Surface Trail

Proposed Soft Surface Trail

Ownership - City of Loveland



Ongoing

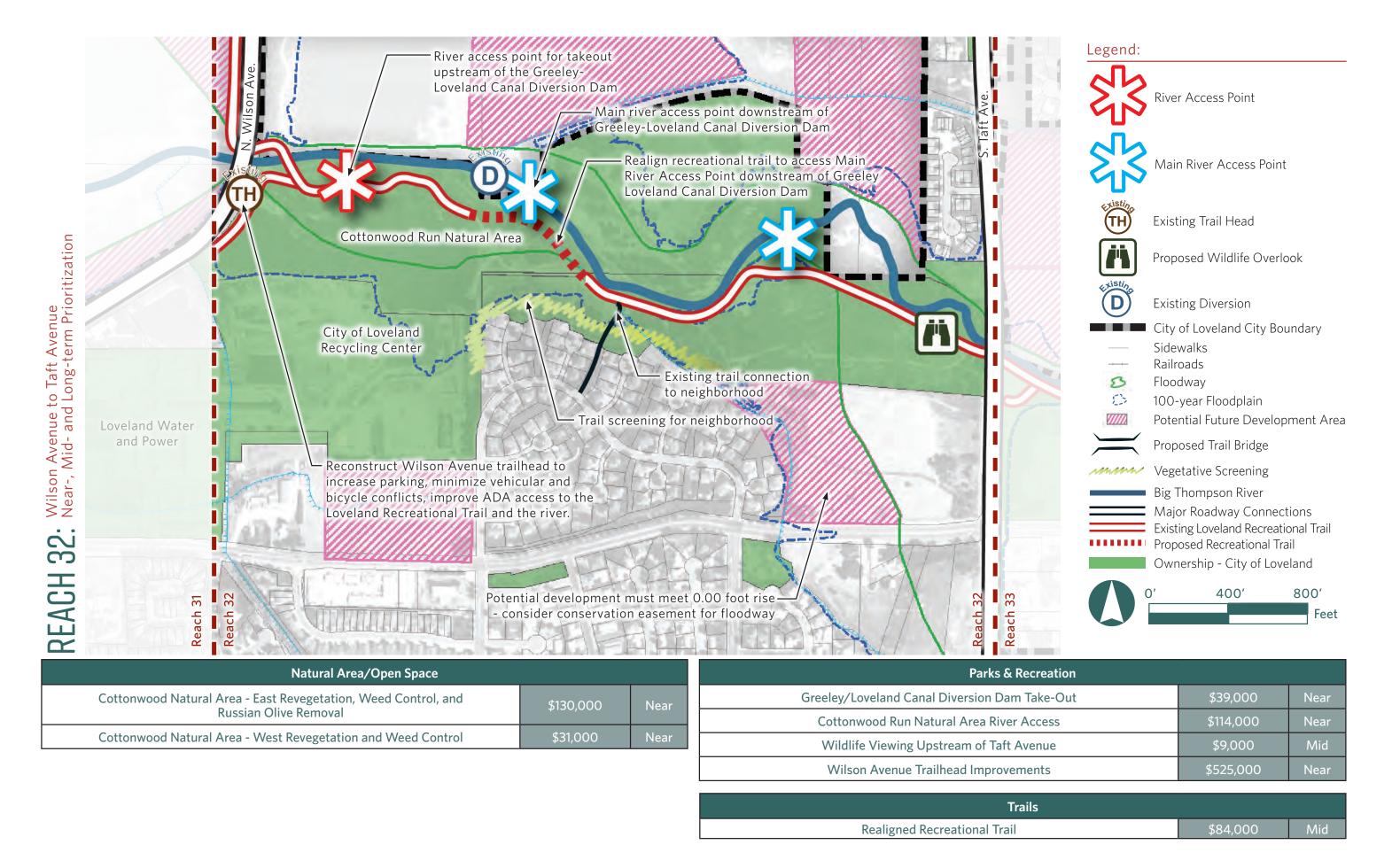
Legend: ■ Major Roadway Connections Big Thompson River High Flow Path Existing Diversion Dam City of Loveland City Boundary Sidewalks Railroads 53 Floodway 100-year Floodplain Ownership - City of Loveland Proposed Elevation of Roadway Bank Stabilization Sanitary Gravity Main Sanitary Pressurized Main Water Pressurized Main Stormwater Outfall

400'

800'

Feet





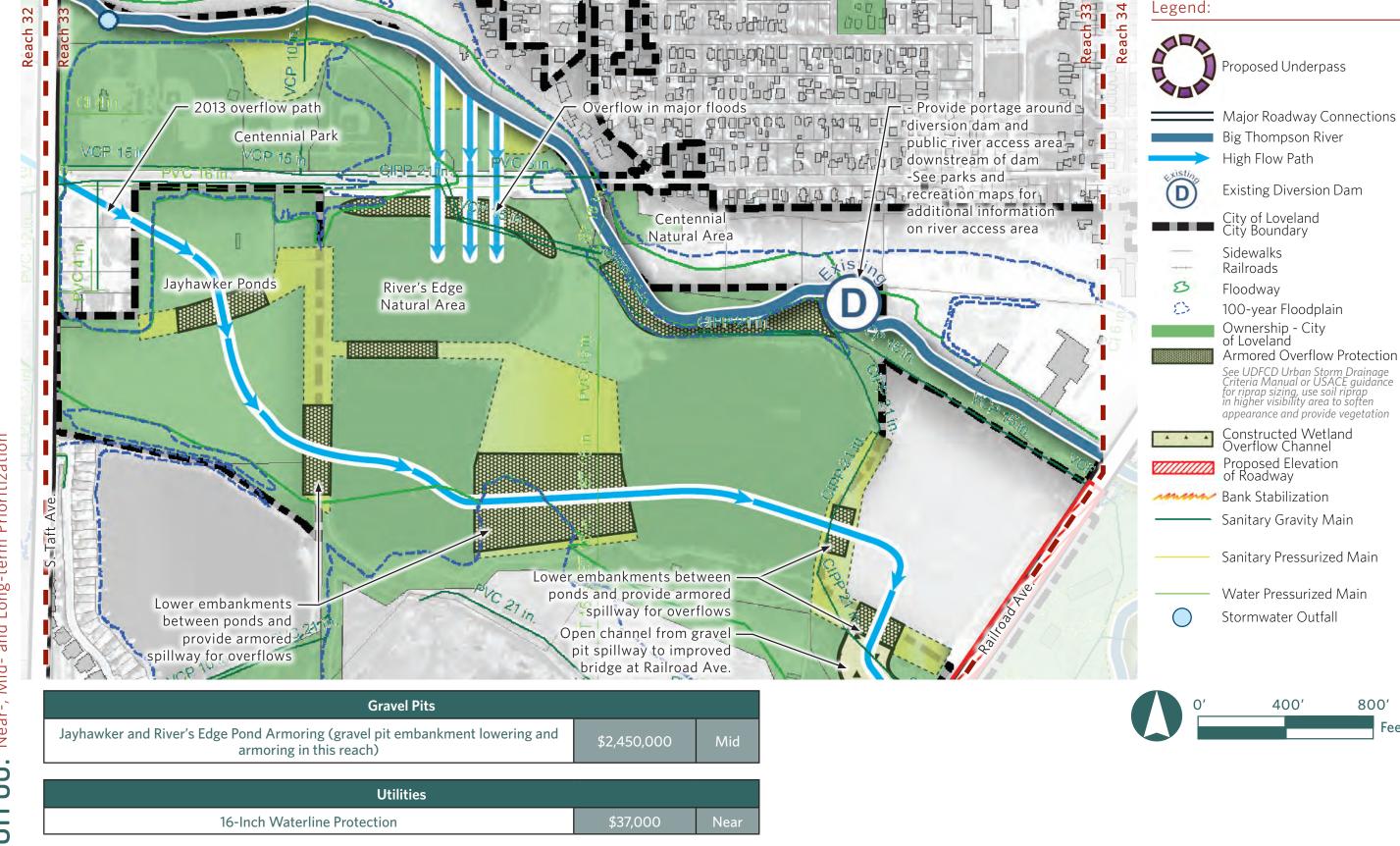


Figure ES-9-Reach 33 H & H Map

Near

\$24,000

Maintenance

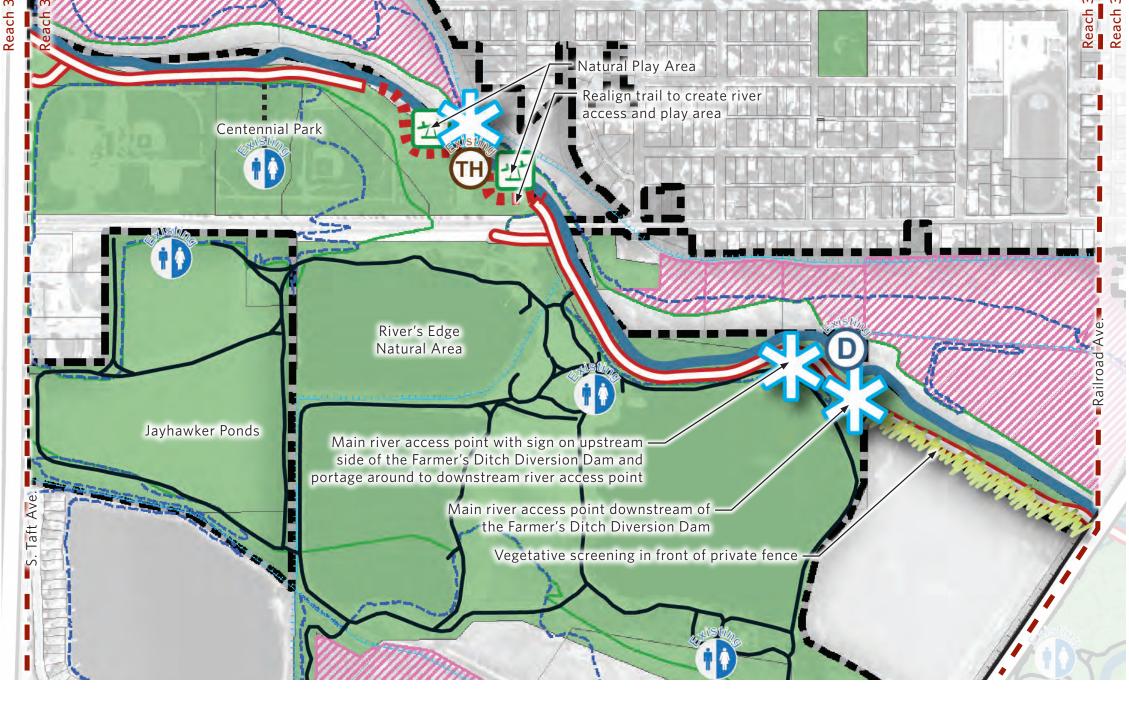
Routine Annual Maintenance and Debris Removal (Public and Private)

800'

Feet

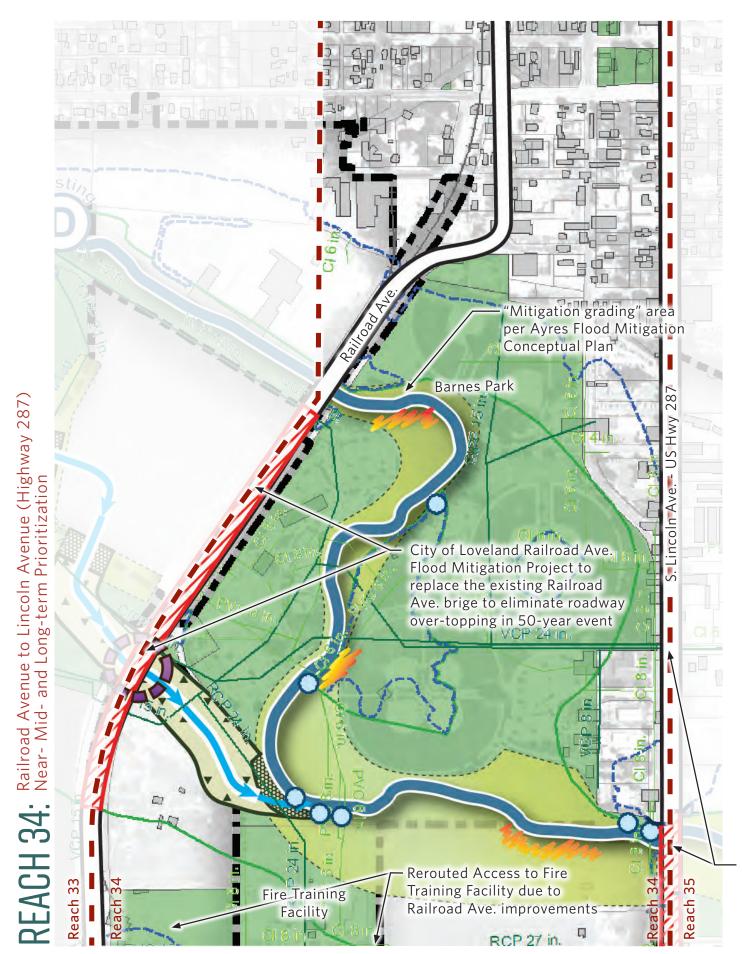
400'

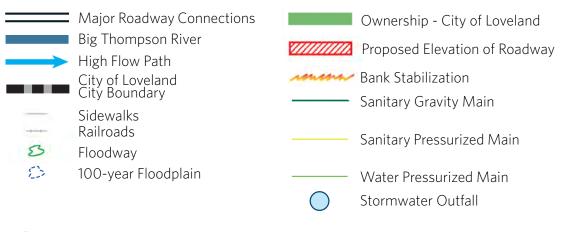




34	Legend:	
Reach 34		Main River Access Point
	(TH)	Existing Trail Head
	existing 1	Existing Restroom
	Existing.	Existing Diversion
	廿	Natural Play Area
		City of Loveland City Boundary
		Sidewalks
, Ve		Railroads
₹ D	3	Floodway
oac	23	100-year Floodplain
Railroad Ave.	/////	Potential Future Development Area
¥	mm	Vegetative Screening
		Big Thompson River
		Major Roadway Connections
		Existing Loveland Recreational Trail
		Proposed Recreational Trail
		Existing Soft Surface Trail
		Proposed Soft Surface Trail
		Ownership - City of Loveland
		0' 400' 800'
		00 000

Parks & Recreation			
Centennial Park River Access	\$53,000	Mid	
Farmers Ditch Diversion Take-Out and Put-In	\$80,000	Near	
Trails			
Vegetative Screening	\$18,000	Near	
Realigned Recreational Trail	\$105,000	Near	



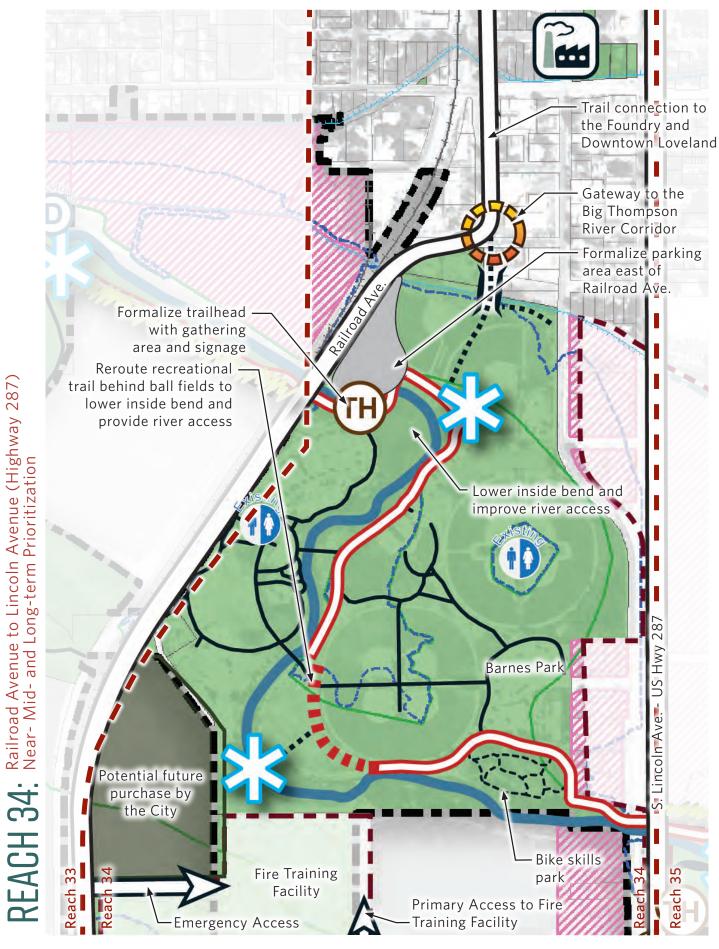


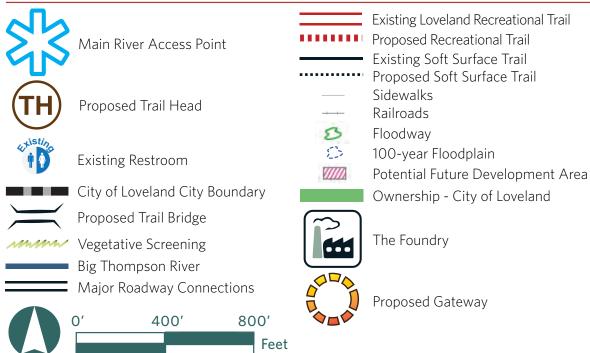


Flood Hazards			
City of Loveland Lincoln Avenue - US Highway 287 Flood Mitigation	\$16,900,000	Near	
Geomorphology			
Bank Stabilization (~ 1200 feet)	\$945,000	Mid	
Utilities			
24-Inch Sanitary Sewer Protection	\$37,000	Near	
6-Inch Waterline Protection	\$37,000	Near	
Maintenance			
Routine Annual Maintenance and Debris Removal (Public and Private)	\$17,000	Near	

City of Loveland Lincoln Ave. - US Hwy 287 Flood Mitigation Project

- Replace existing bridge with 240-ft span bridge
- Elevate roadway to eliminate 100-yr over-topping
- "Mitigation grading" upstream and downstream of crossing for additional floodplain
- See Ayres US Hwy 287 Bridge & Flood Mitigation Conceptual Plan





Parks & Recreation		
Fairgrounds Park River Access	\$110,000	Mid
Fairgrounds Park Bike Skills Park	\$132,000	Mid
Gateway to the Big Thompson River Corridor Railroad Avenue Improvements	\$3,500,000	Long
Redevelopment of Old Loveland Wastewater Treatment Plant Site	\$875,000	Mid
Fairgrounds Park Trailhead	\$175,000	Mid

Trails		
Bike Trail Connection from North End of Fairgrounds Park to 1st Street	\$158,000	Mid
Realignment of Trail Near Fairgrounds Park River Access	\$109,000	Mid

Armor overflow point - "Mitigation grading" area per Ayres Flood Mitigation Conceptual Plan - Armor return flow point to river When the St. Louis -Crossing Avenue Bridge is Natural Area replaced in the future, evaluate costs and benefits of increased conveyance capacity 弘 Lincoln Avenue (Highway 287) to St. Louis Avenue Near-, Mid- and Long-term Prioritization Hwy 402 Raise Hwy 402 through floodplain Provide culvert beneath Hwy 402 when roadway is elevated and provide flap gate if needed Potential area for future regional detention or water quality pond when area south of Hwy 402 develops -If flap gate is provided on culvert beneath Hwy 402, size based on retention standard - Sizing to be determined based on future proposed development in watershed - Future development in watershed to minimize directly connected impervious area to reduce runoff - Floodplain fill south of Hwy 402 35. and future detention/water quality pond not included in Master Plan costs (private development)

Legend: Water Quality Pond ■ Major Roadway Connections Big Thompson River Potential Floodplain Fill Area High Flow Path Constructed Wetland Overflow Channel City of Loveland City Boundary Proposed Elevation of Roadway Sidewalks Bank Stabilization Railroads Sanitary Gravity Main 53 Floodway 100-year Floodplain Sanitary Pressurized Main Ownership - City of Loveland Ownership - Conservation Easement Water Pressurized Main Ownership - Larimer County Stormwater Outfall 400' 800' Feet

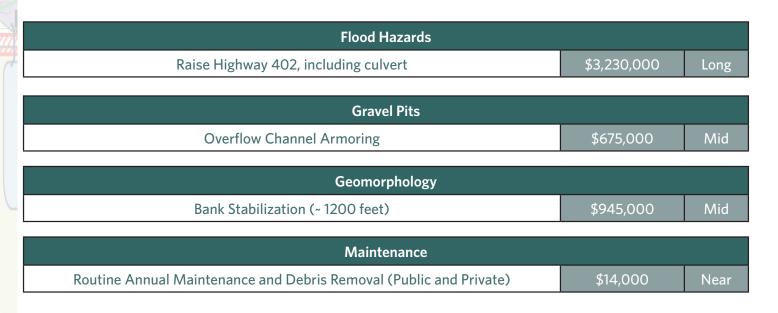


Figure ES-13-Reach 35 H & H Map



Feet

Natural Area/Open Space		
King's Crossing Natural Area Weed Control and Revegetation	\$24,000	Ne
Parks & Recreation		
Gateway to Downtown Architectural Element Along Lincoln Avenue	\$132,000	М
King's Crossing Natural Area Trailhead	\$525,000	М
King's Crossing Natural Area River Access	\$276,000	М
Trails		
Vegetative Screening	\$5,000	Ne
Lincoln Ave St. Louis Ave. Recreational Trail and Pedestrian Bridge	\$635,000	М
Lincoln Ave St. Louis Ave. Soft Trail	\$171,000	М

Figure ES-14-Reach 35 Rec Map

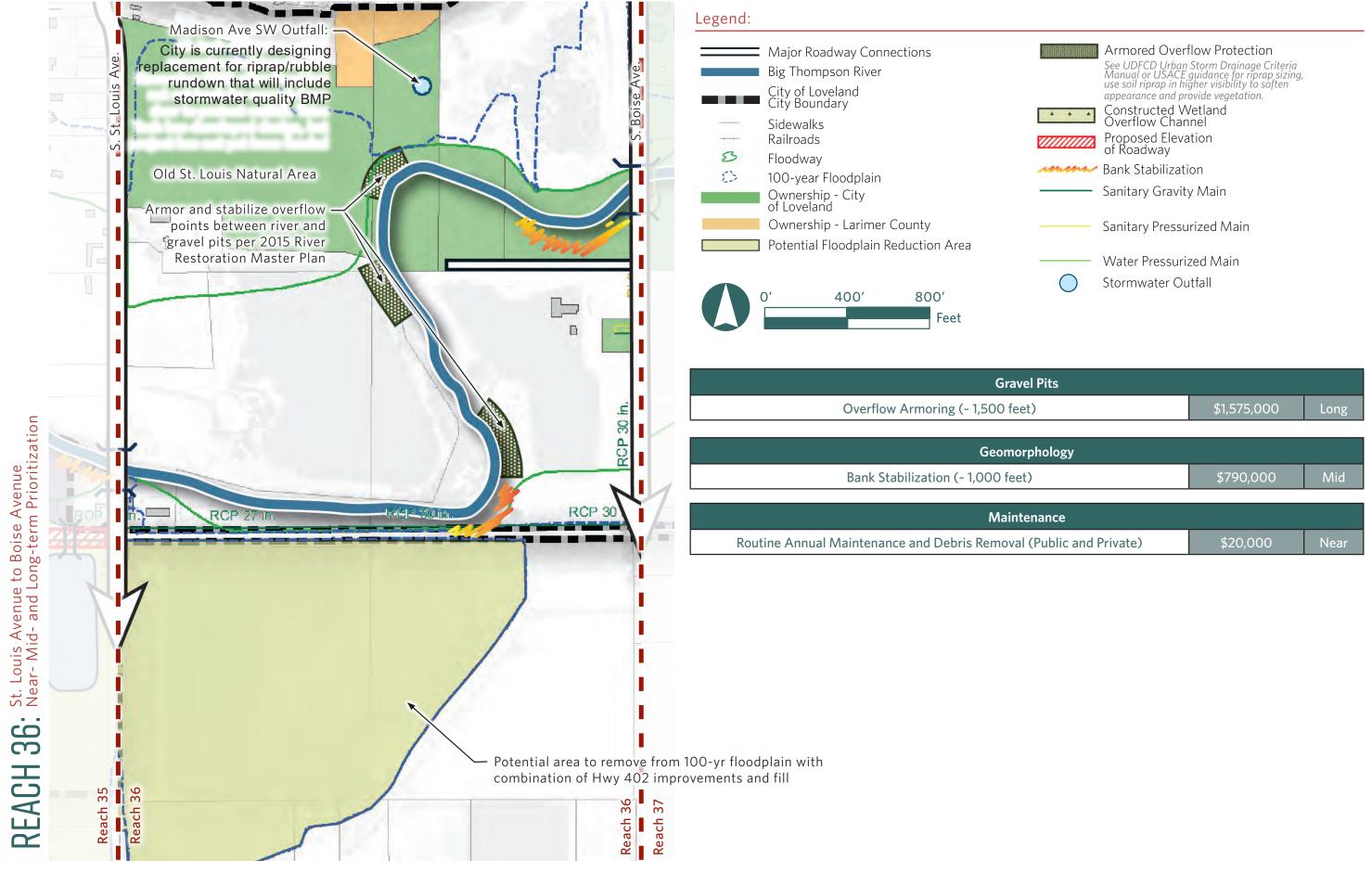
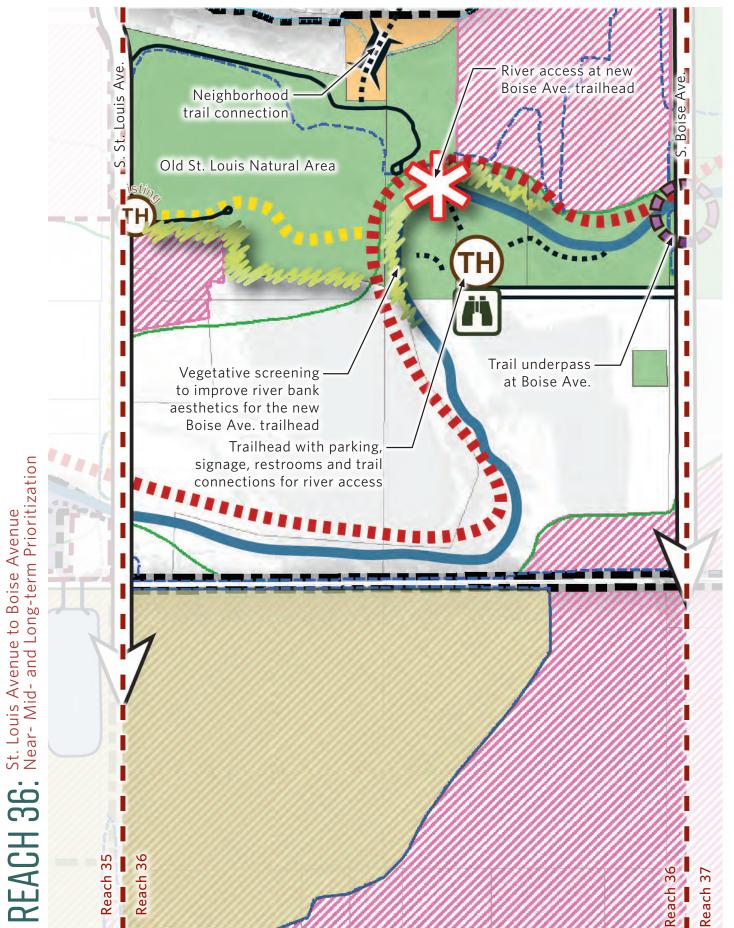
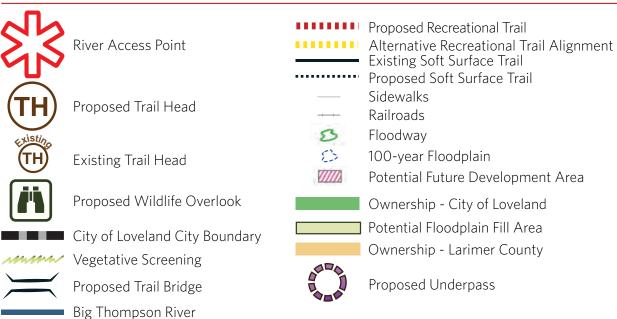


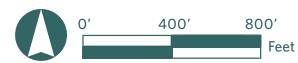
Figure ES-15-Reach 36 H & H Map



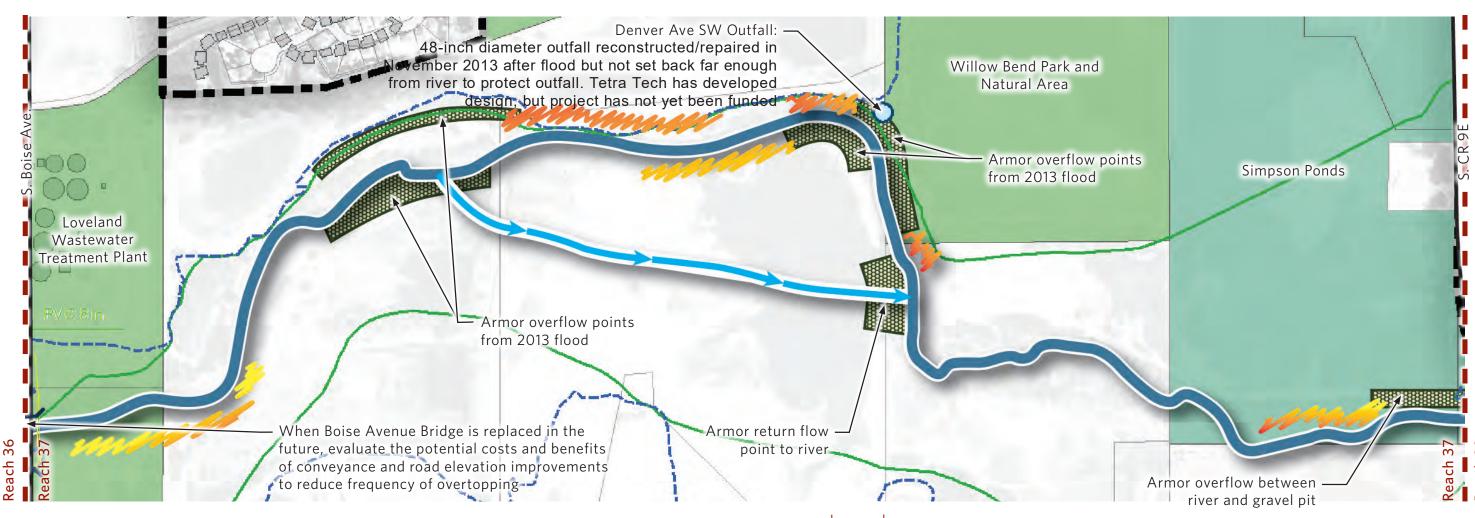


Natural Area/Open Space		
Old St. Louis Natural Area Weed Control, Revegetation and Wetland Creation	\$100,000	Mid
Parks & Recreation		
Old St. Louis Natural Area Shelter	\$53,000	Near
Boise Ave. Site Trailhead	\$525,000	Mid
Parks & Recreation		
Vegetative Screening	\$12,000	Near
St. Louis Ave - Boise Ave Recreational Trail	\$530,000	Mid
Madison Avenue Neighborhood Trail Connection	\$130,000	Mid
Old. St. Louis Natural Area Soft Trail	\$62,000	Mid

Note: Proposed underpass costs not included in Master Plan because underpass will be constructed as part of road project.



Major Roadway Connections

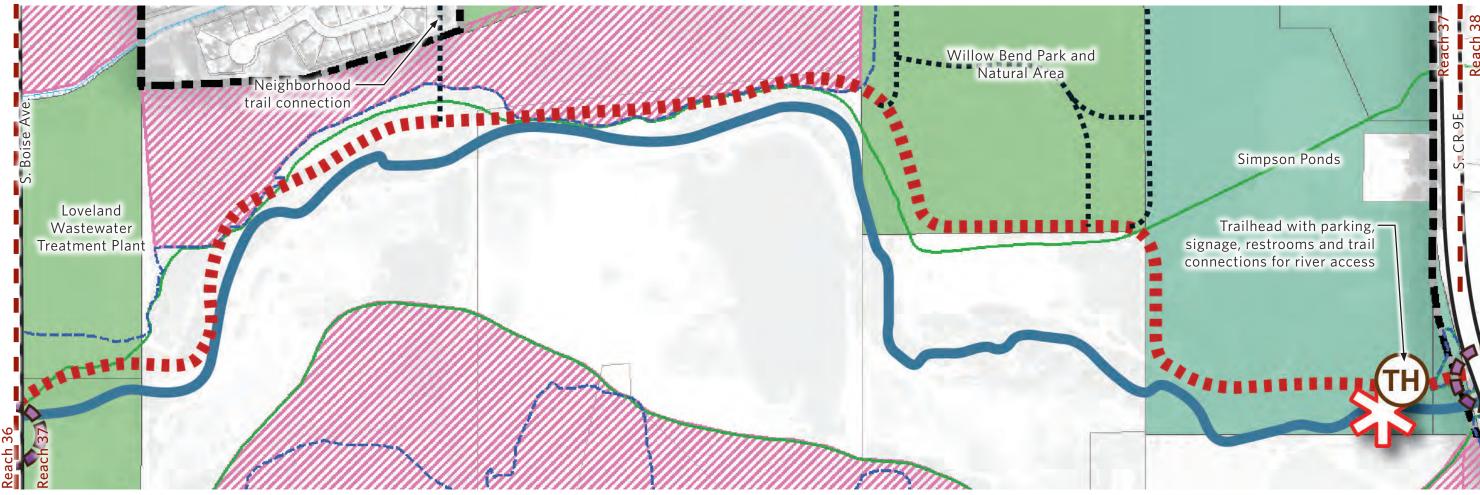




800'

Feet

Boise Avenue to CR 9E Near-, Mid and Long-term Prioritization

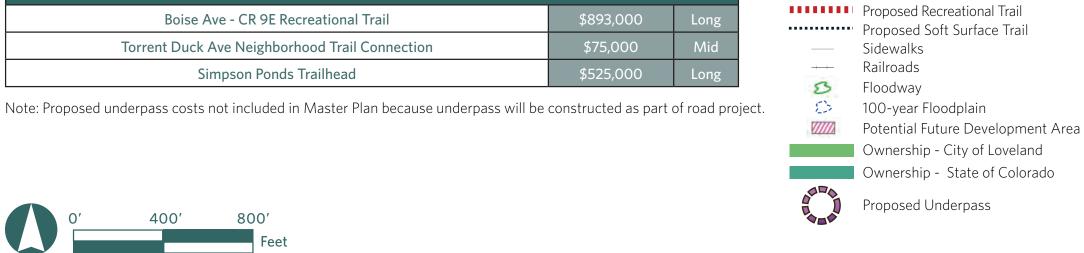


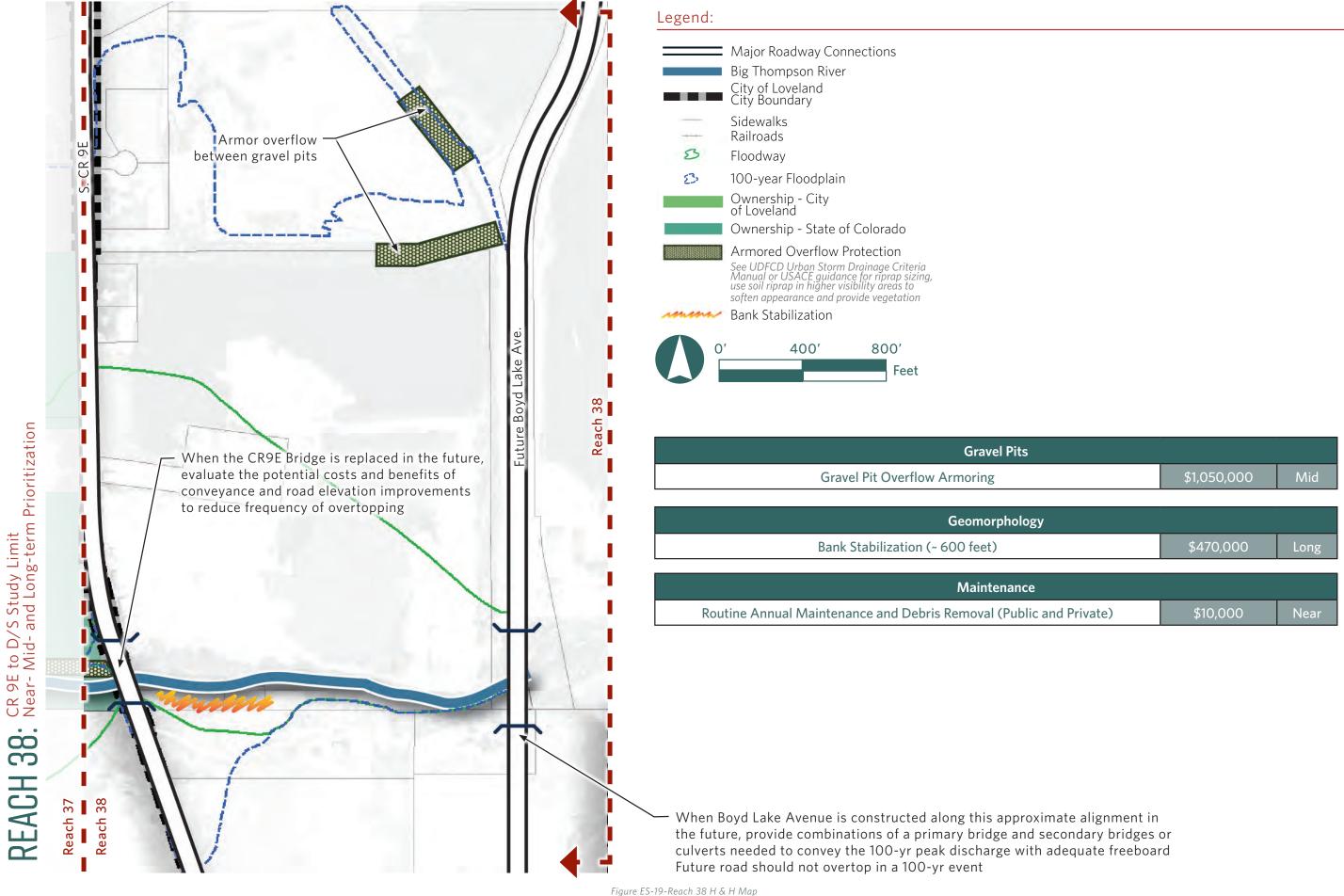
River Access Point

City of Loveland City Boundary Big Thompson River

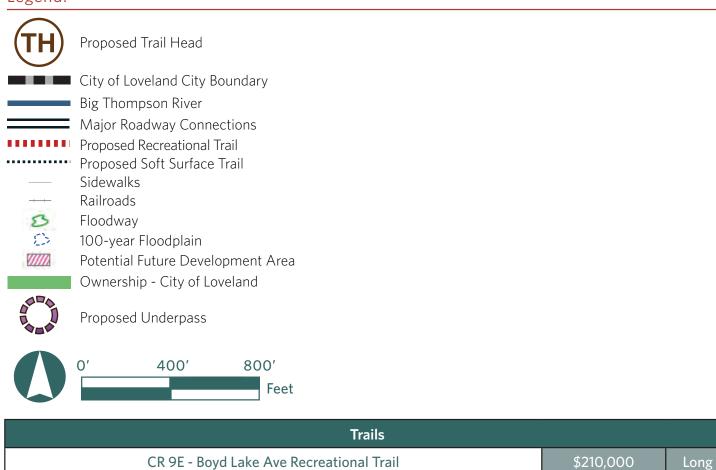
Major Roadway Connections

Natural Area/Open Space							
Willow Bend Park and Natural Area Weed Control and Revegetation	\$136,000	Near					
Parks & Recreation							
Simpson Ponds River Access	\$35,000	Mid					
Trails							
Boise Ave - CR 9E Recreational Trail	\$893,000	Long					
Torrent Duck Ave Neighborhood Trail Connection	\$75,000	Mid					
Simpson Ponds Trailhead	\$525,000	Long					

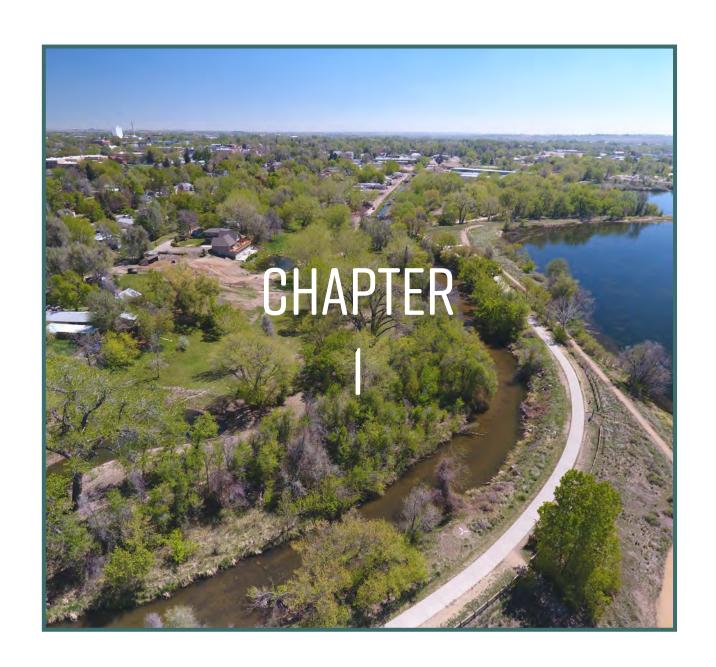




S. CR 9E Future trail connection along Boyd Lake Ave will be part of the Boyd Lake Avenue road project Trail underpass at CR9E CR 9E to D/S Study Limit Near- Mid- and Long-term Prioritization REACH 38:

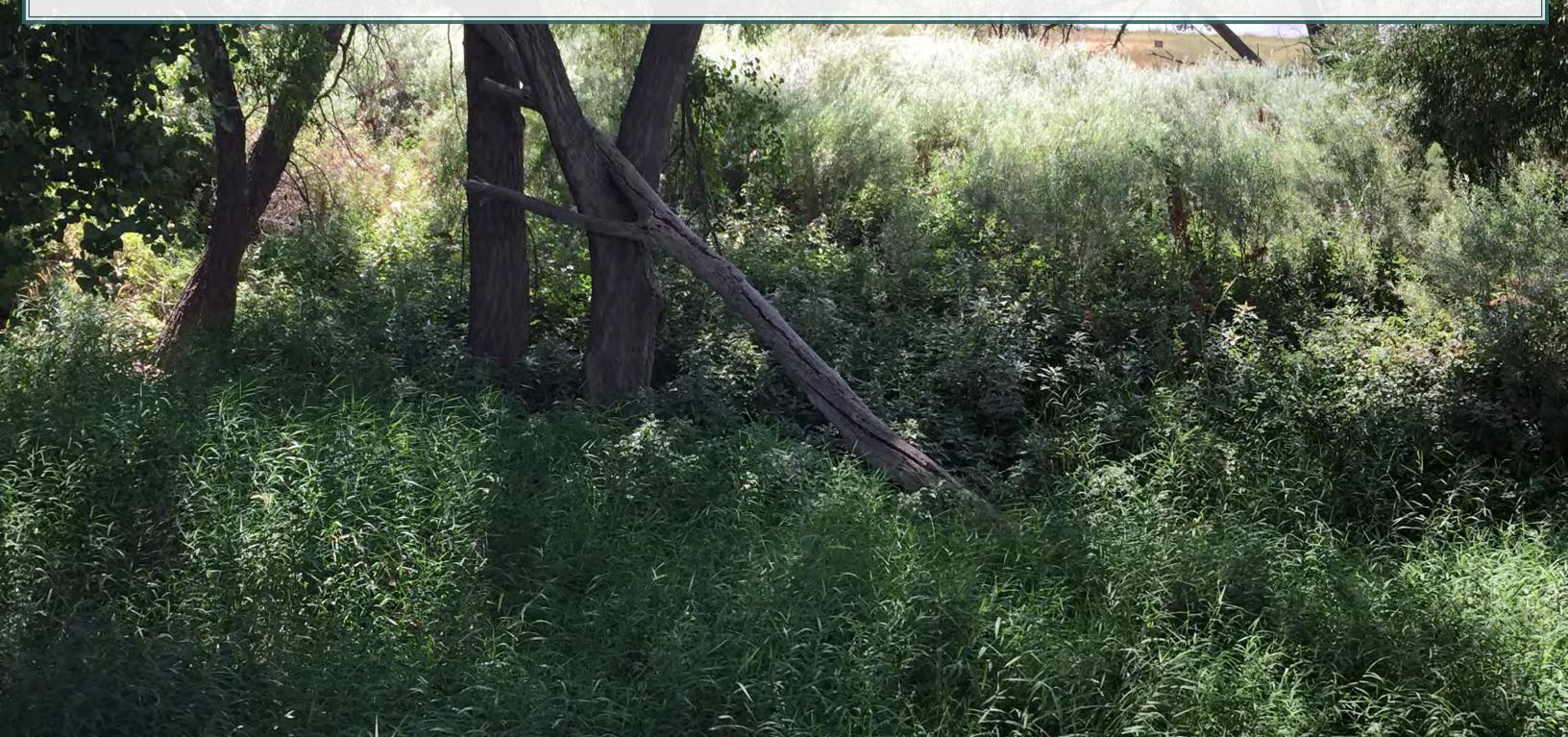


Note: Proposed underpass costs not included in Master Plan because underpass will be constructed as part of road project.

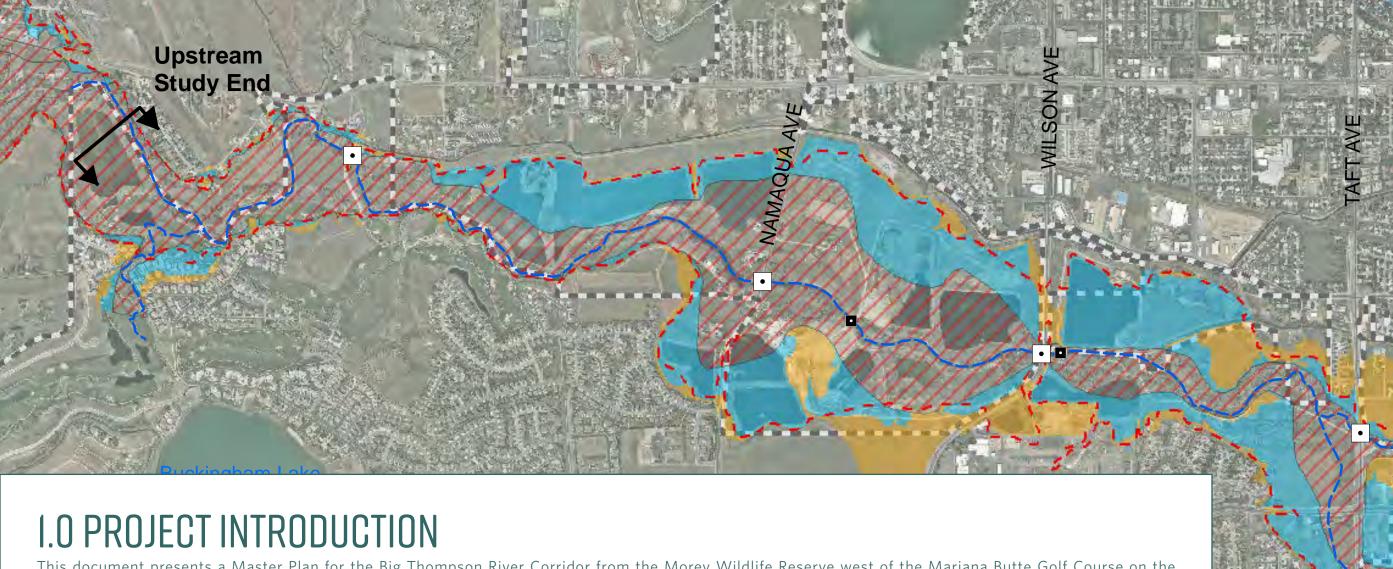


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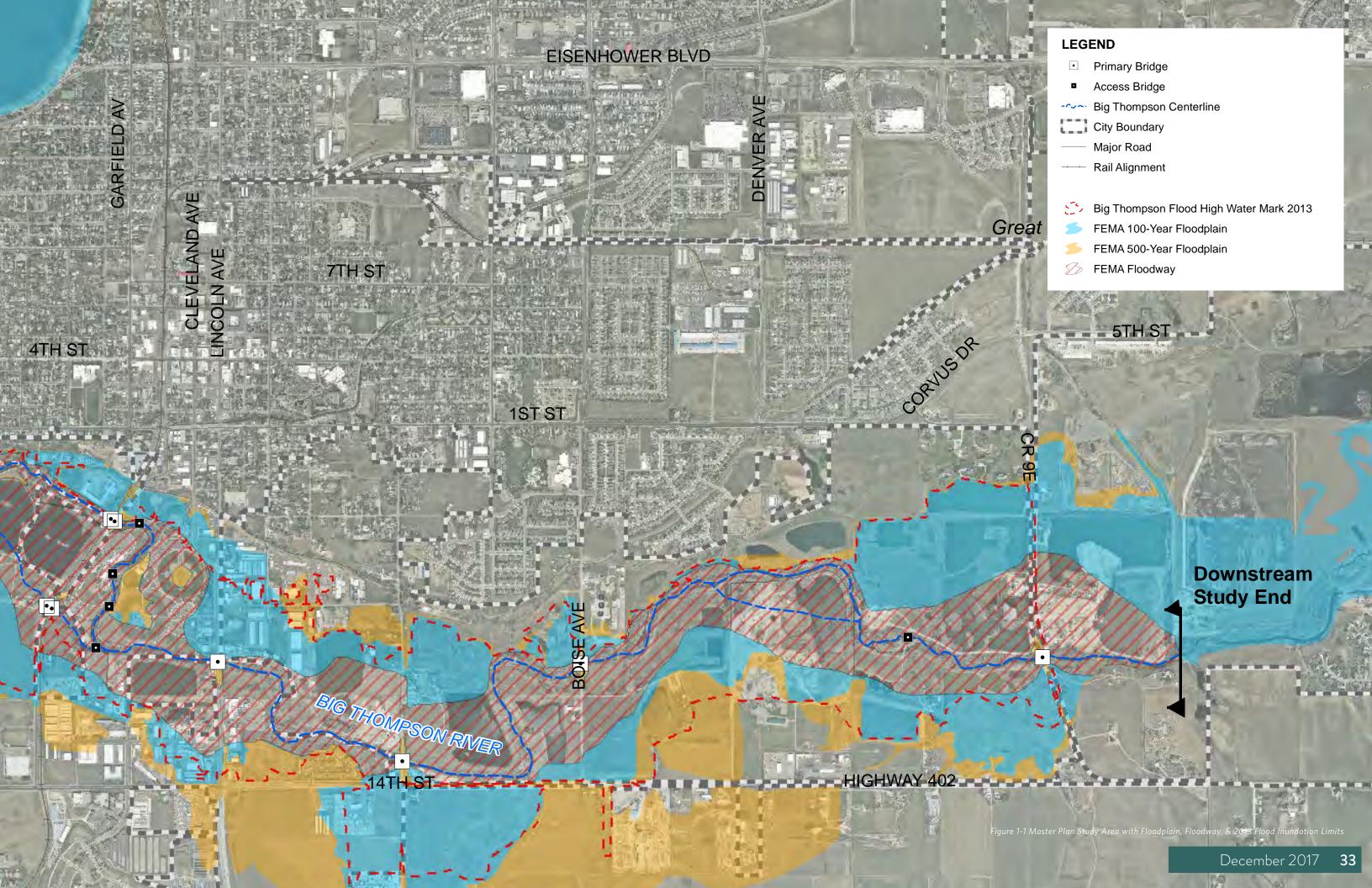
This document presents a Master Plan for the Big Thompson River Corridor from the Morey Wildlife Reserve west of the Mariana Butte Golf Course on the west downstream to the Kauffman's property at CR-9E and the eventual extension of Boyd Lake Avenue over the river. Figure 1-1 illustrates the study extents and shows the 100-year floodplain, floodway, and September 2013 flood extents along with major roads. This study includes land in Larimer County and in the City of Loveland. The City and County have acquired land along the corridor that provides for parks and natural areas that the public can access, but there is also a significant amount of private property along the corridor, much of which is used for gravel mining.

This Master Plan was funded by both the City of Loveland and a Community Development Block Grant – Disaster Recovery (CDBG-DR) planning grant as administered by the State of Colorado Department of Local Affairs (DOLA). Given the nine-mile extent of the corridor evaluated and the complexity of issues along each reach, this Master Plan provides conceptual-level guidance for future improvements. Implementation of conceptual plans will require detailed design involving coordinated efforts between multiple City departments and collaboration between the City and the County in some areas. Implementation of improvements along the corridor is already occurring on the western end of the project area with the Big Thompson Watershed Coalition's (BTWC's) Rossum to Wilson River Improvement Project and Larimer County's Namaqua Road Bridge Replacement Project.

The BTWC is a collaborative group of government, private landowners, and non-profit organizations working to implement restoration of the Big Thompson River after the September 2013 flood. The BTWC has led numerous river improvement projects over the last three years. Many of the BTWC projects are located higher in the Big Thompson River watershed, but they have also involved City of Loveland-owned properties. The BTWC is also looking into funding and opportunities to do ongoing adaptive management and maintenance of several sections of the Big Thompson River. Additional information on the BTWC can be found at www.bigthompson.co.

32 Chapter 1

ISLE DR



I.I NEED FOR PROJECT

The flood history of the Big Thompson River is infamous in Colorado with two major flood events occurring in less than a 40-year period, from the 1976 flood that ravaged the canyon and was the deadliest flood in Colorado history to the 2013 flood that was remarkable in magnitude and duration. While the 1976 flood was the deadliest, the 2013 flood brought the highest peak flows and greatest damages to the immediate Loveland area. Since this was not a flash flood, much of the damage occurred by erosion and the effects of a long duration, 19,000 cubic foot per second (cfs) peak flow rate. Multiple channel avulsions occurred during the flood with floodwater leaving the river and flowing through gravel pits, eroding embankments, and overtopping roads. The September 2013 event was a 100-year event for Loveland and clearly demonstrated the vulnerabilities of road crossings to overtopping and gravel pit embankments to massive erosion and avulsion.

Soon after the 2013 flood, the newly formed BTWC, working with Ayres Associates (Ayres), prepared a River Restoration Master Plan for the Big Thompson River from Lake Estes downstream to the river's confluence with the South Platte River (2015 River Restoration Master Plan). The City of Loveland contributed to this effort. With over 75 miles of river corridor in greatly varying geographical regions (mountains, plains, and urban areas), the 2015 River Restoration Master Plan was a successful big picture/high-level planning effort pertinent to immediate flood recovery efforts. Figure 1-2 provides an example of conceptual plans developed by BTWC as a part of the 2015 River Restoration Master Plan. The example in Figure 1-2 is for the reach from Rossum Drive to Wilson Avenue. This Master Plan builds on the 2015 River Restoration Master Plan with a more detailed evaluation specific to the City of Loveland's goals and objectives.

Through the project reaches, the 2015 River Restoration Master Plan has helped guide long-term recovery of the river corridor Recovery from the 2013 flood and will take many years by the time all projects are complete. The City expects remaining City flood recovery projects to be completed in 2017 to early 2018.

One of the primary goals of floodplain management is to reduce flood risk over time through sufficient floodplain regulations, smart land use planning, designing resilient infrastructure, and mitigating high-risk problems that were often created many decades before floodplain regulations. In the Loveland area, important roadways are overtopped in a 10-year flood event. All are overtopped in a 100-year event, effectively cutting the City in half. Lincoln Avenue - U.S. Highway 287 (Hwy 287), a vital north-south transportation corridor and the southern gateway into Loveland overtops in a 10-year flood. Capacity restrictions work to create enormously wide floodplain segments and split flows away from the channel. Providing increased capacity at these road crossings to allow for north-south passage during a 100-year flood is a primary objective of this Master Plan and is needed for public safety.



Nater overtopping 1st Street and Taft Avenue in 2013 flood. Overtopping flows entered the Jayhawker Ponds and River's Edge Natural Area causing significant damages



Lincoln Avenue -Hwy 287 was underwater and impassible during the 2013 flood, effectively cutting the City in half. Improving conveyance to allow for north-south passage on major arterials is a major objective of the Master Plan.



Water cascading over the railroad and Railroad Avenue and into Fairgrounds Park during 2013 flood. The railroad acts like a dam, ponding water upstream due to conveyance limitations and eventually overtopping and flooding property downstream.

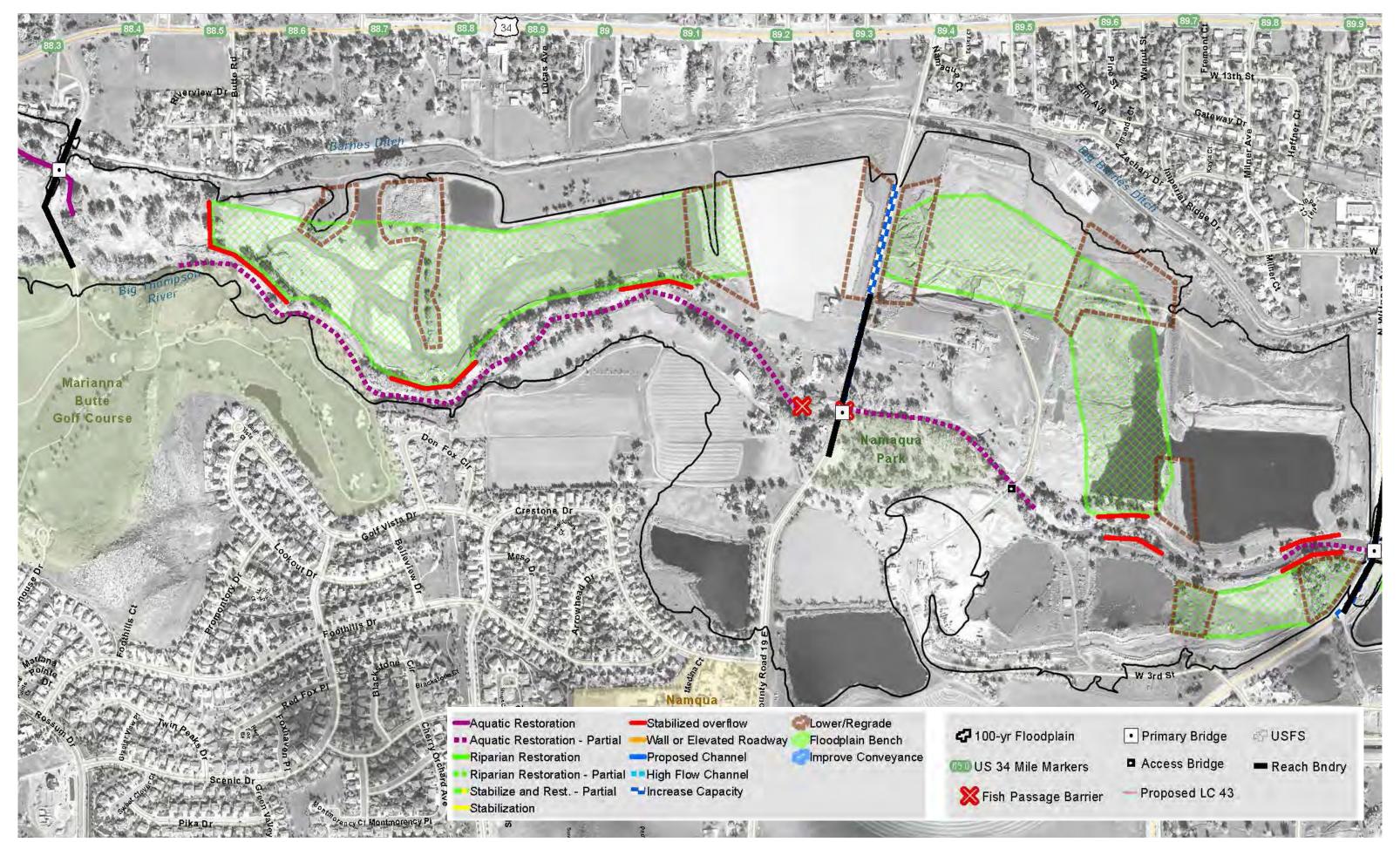


Figure 1-2 Conceptual Recommendations from the Big Thompson River Restoration Master Plan from 2015 River Restoration Master Plan (Ayres 2015)

The City desires to change the direction of infrastructure and land use decisions in the corridor to one based on long-term resilience. Such a strategy includes maximizing flood hazard reduction benefits while minimizing long-term costs, significantly improving life safety and emergency access, and reducing impacts and economic hardships to local businesses during a flood. The new approach that the City envisions includes restoring natural river and floodplain functions where they are currently lacking, returning to a more natural and beautiful riparian corridor, improving recreation opportunities for citizens to enjoy the corridor, improving water quality, and creating a sustainable and economically stable environment for future community and business development.

To accomplish this, the City has developed this Master Plan, which addresses six key overlapping areas:



VISION



FLOOD HAZARD REDUCTION AND MITIGATION



RESILIENCE - THE RIVER AND INFRASTRUCTURE



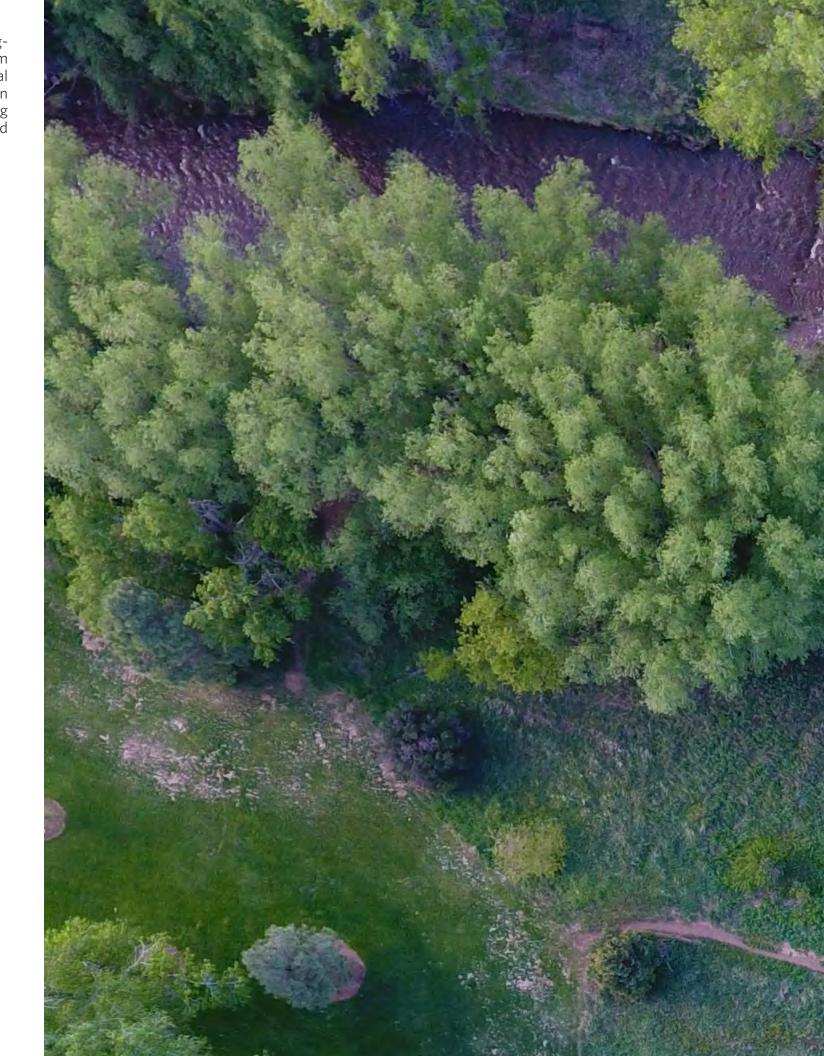
ECOLOGICAL RESTORATION

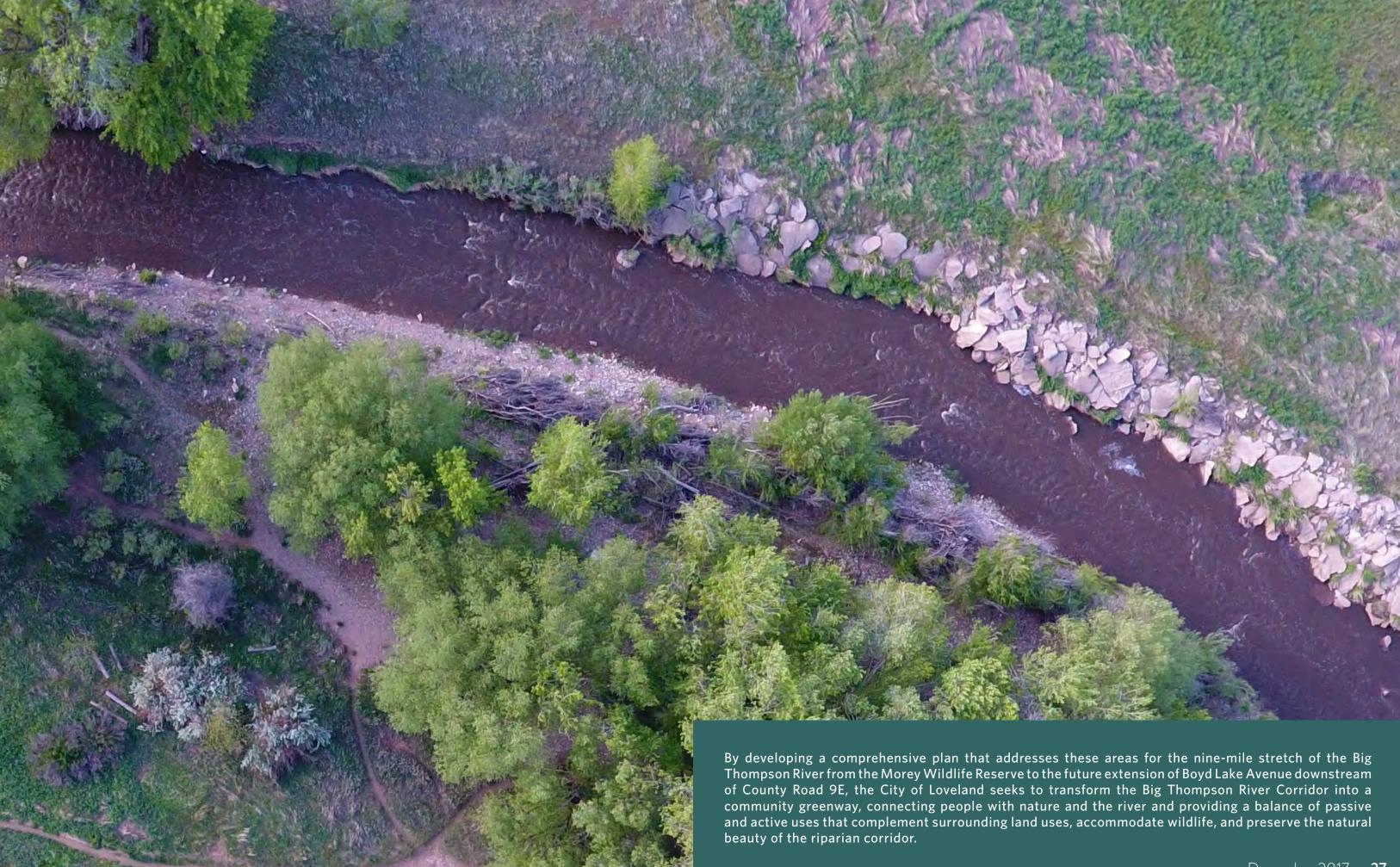


RECREATION AND PUBLIC-NATURE INTERACTION



CORRIDOR MANAGEMENT





While some sections of the river corridor have been significantly modified by sand and gravel mining operations, other portions, like this reach upstream from Rossum Drive support a healthy riparian corridor that provides important habitat for aquatic and terrestrial wildlife.



Some portions of the river corridor have a natural character and require little maintenance; however, in other areas, a better maintenance program is needed. As an example, cleaning sediment and vegetation from the northern cell of the Taft Avenue Bridge would increase conveyance capacity significantly.

1.2 MASTER PLAN OBJECTIVES

Resilience can be defined as the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events or conditions. Much of the current river corridor is not resilient due to past infrastructure decisions, encroachments, and manmade modifications to the river channel and floodplain. The 2013 flood and previous smaller floods have proven that the river corridor cannot sufficiently handle even moderate-sized flood events without damages and significant negative impacts. Lives are put at risk. Recovery has been extremely difficult, expensive, and time consuming. Besides public infrastructure, many small businesses and jobs are placed in jeopardy. Because the river corridor is not resilient, it also has very low sustainability from an economic, social, and environmental standpoint. A major goal of this project is to lay the groundwork for greatly increasing resilience within the Big Thompson River Corridor through the Loveland area.

Major objectives of this Master Plan include:

- 1. Capturing a long-term vision for the river corridor, making it a landmark for the City, and recommending a process for how the City should see that vision through to fruition. This vision will be key to vetting proposed projects along the corridor.
- 2. Identifying and evaluating potential projects to recommend which projects, particularly from flood mitigation and ecological restoration perspectives, provide cost-effective benefits meeting multiple objectives.
- 3. Conducting an analysis of resilience metrics and benefits for proposed projects related to protecting existing infrastructure and environment, public and private properties, and local businesses.
- 4. Restoring natural ecological functions of the river and riparian corridor. Recommending on a reach-by-reach basis how the City can best restore the river corridor to a more naturally functioning, healthy river system that is a better public amenity and more resilient to future floods.
- 5. Recommending how the City can better capitalize on opportunities that take advantage of the scenic river corridor that runs through it. This includes consideration of recreational opportunities, small projects, restoration efforts, open space connections, trails, strategic alliances, tourism/economic opportunities, property acquisitions, private redevelopment, and other aspects.
- 6. Improving opportunities for the public to interact with nature and the river, and enhancing the fishery provided by the Big Thompson River.
- 7. Developing recommendations for management and maintenance of the river corridor. Currently, the City does not have an existing department responsible for the corridor, advocating for it, or a unified approach to managing it. It has generally remained neglected for being outside of the Stormwater Utility's responsibility for floodplain regulations and waterway cleanup days, Open Lands Division's responsibility for natural area acquisitions and management, and Parks and Recreation Department's responsibility for the public parks and facilities.

Parks & Natural Areas

Parks and Natural Areas are central components of the Big Thompson River Corridor Master Plan. Namagua, Centennial, Fairgrounds, and Barnes Parks provide many amenities including picnic areas, ball fields, racket courts, and playgrounds. In addition to these more traditional park areas, the City Parks & Recreation Department's Open Lands/ Natural Areas Program has acquired significant land along the river corridor. The parks and natural areas have not only kept development out of hazardous locations but also have created a greenway through a significant part of the City that provides trails, recreational opportunities, and natural areas for wildlife.

Figure 1-3 illustrates City-owned parks and natural areas.

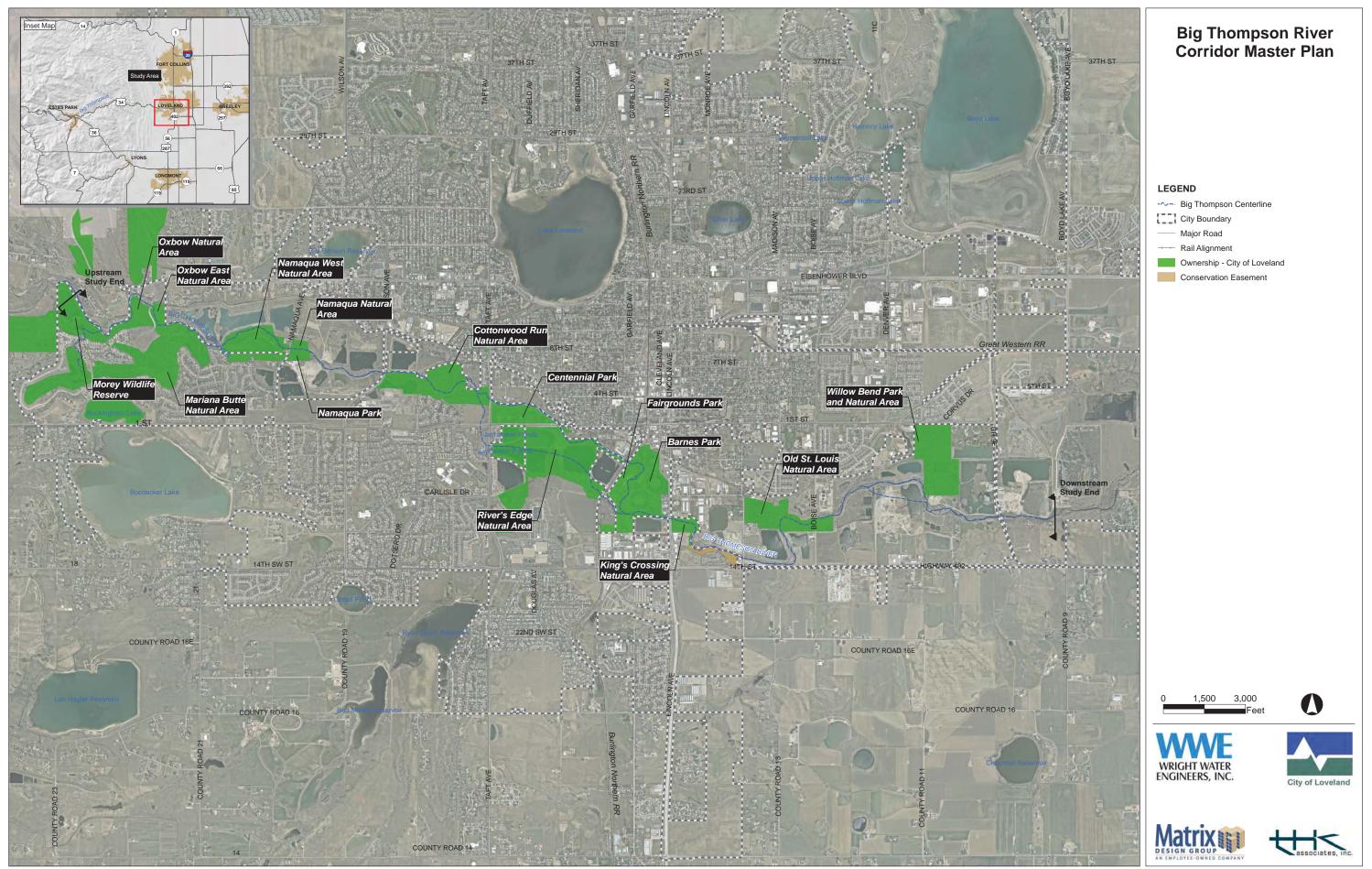


Figure 1-3 City Parks and Natural Areas along the River Corridor

Specific goals identified by the City include:

- 1. Reducing the number of structures, properties, and critical infrastructure in the floodplain and/or reducing the overall risk to those that remain in the floodplain, including critical water and wastewater utility lines that cross the river or run through the floodplain.
- 2. Decreasing the frequency at which roadways and bridges overtop. In the 2013 flood, all of the road crossings of the Big Thompson River were impassible. Having at least one, and preferably several, road crossings of the river passable in a 100-year event would be a significant improvement in public safety.
- 3. Reducing the potential for debris hazards and debris impacts on infrastructure during future floods.
- 4. Reconnecting the channel and floodplain in areas where the floodplain is incised.
- 5. Reducing the potential for bank erosion and future avulsions in locations where avulsions occurred in 2013.
- 6. Restoring natural ecological functions of the river and riparian corridor. This includes providing better connectivity between the channel and the floodplain by creating floodplain terraces, providing stable and safe overflow spillways for gravel pits susceptible to avulsion, and implementing in-channel improvements to provide better aquatic habitat.
- 7. The riparian corridor and connected uplands are very valuable to the area's wildlife. Mule deer and elk are commonly seen along the corridor, especially in the fall and winter, and black bear are seen annually. Waterfowl frequent the river and adjacent gravel pit ponds along with bald eagles hunting in the winter. In spite of the human impacts and proximity, there is a surprising amount of wildlife. The



There are many fishing opportunities along the Big Thompson River Corridor, including the ponds at the River's Edge Natural Area. While the river is limited by flow during times of the year, there are a number of locations that support fish including brown trout on the western end where the water is cooler. Residents attending public meetings and workshops reported catching fish along most reaches of the river through the study area.

Master Plan seeks to balance wildlife and human uses of the corridor.

- 8. The river through Loveland is a transitional zone between cold and warm water fisheries. However, current conditions and habitat limit the potential of the river as a fishery. Residents report catching fish along all reaches within the study area, with brown trout more common west of Wilson Avenue. The gravel pit ponds along the corridor also provide aquatic habitat and fishing opportunities. The goal of the Master Plan is to improve the habitat and natural functions of the river and create a successful fishery as much as feasible given conditions and constraints.
- 9. Improving opportunities for property and business redevelopment by removing them from the floodplain or floodway where feasible and/or otherwise decreasing flood risk.
- 10. Creating a natural open space corridor connecting the existing public natural areas and parks and provide opportunities that would occur through future open space property acquisition. Providing more and better opportunities for public interaction with the river through natural areas, access to the river, sitting/viewing, recreation, trails, bicycling, and fishing.
- 11. Creating more resilient infrastructure that can better withstand, recover, and adapt to future floods with less impact and cost to both the public and area businesses.
- 12. Improving water quality, particularly from existing storm sewer outfalls or other potential pollutant sources that directly affect the river.
- 13. Providing a plan that prioritized projects and identifies potential funding sources.
- 14. Connecting the proposed river corridor Master Plan to the City's existing planning efforts and documents such as the 2015 River Restoration Master Plan by the BTWC, the 2014 Parks and Recreation Master Plan, the Highway 287 Strategic Plan, the Highway 287 Flood Mitigation Feasibility Study, the City's Comprehensive Plan Update, the Stormwater Master Plan, the 2035 Transportation Master Plan, and others.
- 15. Determining the types of projects and level of improvements along with possible infrastructure, land use, and management changes needed to cost-effectively fulfill the vision for the river corridor.

In summary, this is a detailed, multi-objective river corridor Master Plan that uses other recent planning efforts as its starting point to develop a holistic plan for the river corridor to enhance the natural functions and benefits and to provide increased opportunities for the public to interact with the river and nature. In addition to capital improvements proposed along various reaches, this Master Plan provides recommendations for sustainable management and maintenance of this valuable community resource.

1.3 VISION

The vision for this Master Plan has been shaped by significant public input received throughout the project along with the shared vision of previous planning efforts to preserve natural areas along the Big Thompson River Corridor for floodplain, ecological, and other community benefits. Representatives from multiple City departments including Public Works, Parks & Recreation, and Water & Power have provided input, as have the Big Thompson Watershed Coalition and the Big Thompson Water Quality Forum.

The overall vision for Big Thompson River Corridor through the City of Loveland is based on preserving and enhancing natural functions of the corridor while providing more opportunities for the community to interact with the river along the corridor. This vision of the corridor includes:

- 1. Creating a resilient river corridor that is a treasured asset to the City of Loveland through sound floodplain management policies, preservation of natural areas, flood conveyance improvements, and community involvement/engagement;
- 2. Flood conveyance improvements to provide north-south passage under major flood conditions on major routes including Wilson Avenue, Taft Avenue, Railroad Avenue (50-year plus, and Hwy 287;
- 3. Preserving and maintaining remaining natural areas along the river that provide ecological functions and flood conveyance and attenuation benefits;
- 4. A river that supports an urban fishery with reduced barriers to fish passage, improved access for fishing, and improved low flow conditions;
- 5. Continued acquisition of land along the river corridor including floodway and floodplain areas the City has a very successful track record of purchasing properties or obtaining conservation easements when development has been proposed along the corridor;

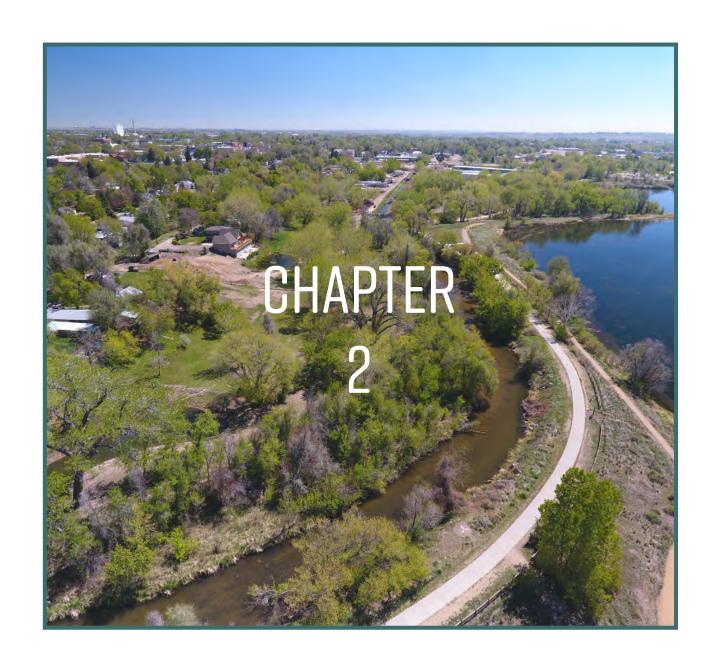
The Wilson Avenue Bridge has capacity to convey the 100-year peak discharge of the Big Thompson River; however, in the 2013 flood, the approaches to the bridge overtopped, cutting off north-south access. The City is currently in design stages of a project to raise the approaches to the bridge to prevent overtopping in flows up to and exceeding the 100 year event.

- 6. New opportunities for river access in existing City parks and natural areas, with improved access for active water-based recreational uses (tubing, swimming, fishing, etc.) focused in more-developed areas of the corridor where the City or County owns river frontage;
- 7. A continuous regional bike/pedestrian trail from Rossum Drive on the west to County Road 9E on the east (and eventually to I-25), including additional trails connecting to urban centers to the north and south, and signage to direct users to local areas of interest;
- 8. Open land for wildlife where elk, deer, small mammals and many species of birds find habitat;
- 9. Access to City-owned natural areas and trails for newly developing areas to the east of Lincoln Avenue;
- 10. A comprehensive maintenance and management plan and program involving the City and the County for publicly-owned portions of the river corridor, a public outreach effort to inform private property owners of maintenance responsibilities, and a policy to allow the City or County to maintain a privately owned portion of the river if needed for public safety;
- 11. Community involvement with the river corridor including volunteer programs for trash clean up, educational activities, nature walks, an annual community event related to the river, and/or other activities or events.

This Master Plan provides a conceptual plan for nine miles of the river and adjoining floodplain. It will take years and significant funding to implement the full plan. Realizing the vision of this Master Plan will require long-term investment in the corridor and diligent management by the City to coordinate efforts to improve and maintain the river corridor between multiple City departments, the County, private property owners, and other stakeholders. This investment and diligence will transform what is currently an underutilized resource into a resilient community greenway that will be enjoyed by residents of Loveland for years into the future.

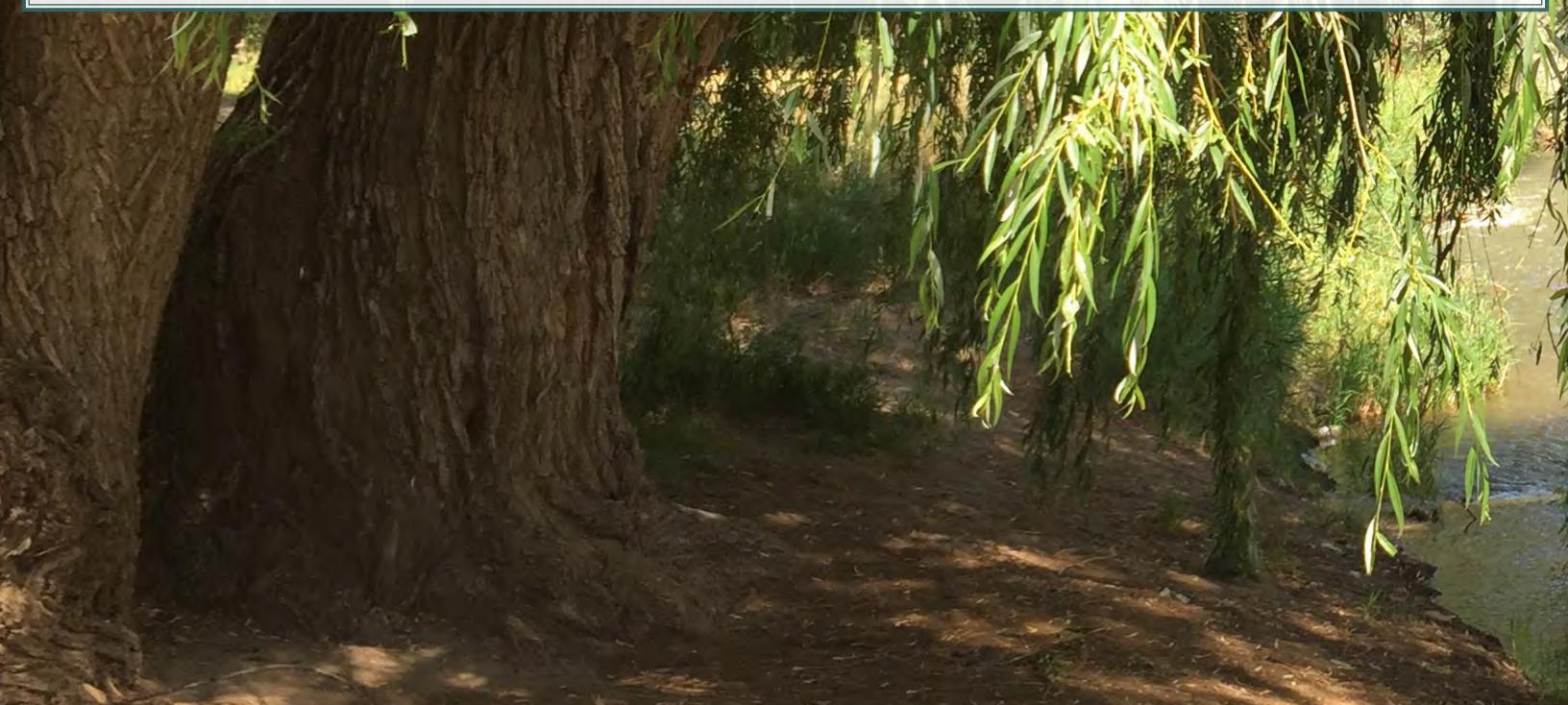


The terraces and concrete steps leading down into the river in Fairgrounds Park are a popular destination for families on warm summer days. A goal of the Master Plan is to provide more areas where the public can access the river for swimming/wading, fishing or tubing along portions of the corridor where there is publicly owned river frontage.



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2.0 BACKGROUND INFORMATION

Extensive work has previously been conducted along the Big Thompson River Corridor related to flood recovery, identification of problem areas, and potential improvements. The majority of this work was related to recovery from the 2013 flood and does not capture other important goals identified by the City of Loveland to help improve the overall resilience of the Big Thompson River Corridor. This Master Plan integrates information from previous planning, design, and construction projects and evaluates how the resilience of the stream corridor can be increased by increasing the benefits that the river corridor provides to the community, transforming the Big Thompson River Corridor from an under-utilized resource to a valued asset that provides multifunctional benefits to the City of Loveland and Larimer County.

2.1 PROJECT APPROACH

The Big Thompson River Corridor through the City of Loveland and adjacent portions of Larimer County has many excellent existing resources and opportunities to enhance and add to the benefits that the corridor provides to the public and the ecosystem. Much of the floodplain in the western and eastern reaches of the corridor is undeveloped, and the City has many existing parks and natural areas along the corridor. The City owns more than a half dozen natural areas along the corridor, and primary parks include Namaqua, Centennial, Fairgrounds, and Barnes Parks.

There are also many privately-owned natural areas along the corridor, often on inactive portions of property used for gravel mining. The preservation of the floodplain along many reaches in this corridor is due to sound planning and the lessons learned from the 1976 Big Thompson River Flood. Despite this sound planning and preservation of floodplain and natural areas along the river, the Big Thompson River Corridor is largely an underutilized resource. While parks including Centennial, Fairgrounds and Barnes Park are heavily used along with the River's Edge Natural Area, portions of the corridor to the west and east of the central portion from Wilson Avenue to Hwy 287 are less frequently visited and offer fewer amenities. Colder water and better habitat lead anglers upstream to the canyon to fish, and some of the parks and open space areas lack interconnecting trails. The 2013 flood caused damages along the corridor from undersized crossings, out of bank flows, and erosion, among other factors.

While some portions of the river support healthy riparian vegetation and have habitat that would be suitable for aquatic organisms including game-fish, other portions are more degraded due to disconnection of the river and the floodplain, bank erosion, and limitations on available water due to upstream diversions that can dry up the river through Loveland. The ultimate vision for the Big Thompson River Corridor through Loveland is a fully "connected corridor," which includes a network of interconnected greenways, parks, open space, and natural areas that provides the public with opportunities for recreation and interaction with the river and nature, while at the same time providing a healthy river and riparian ecosystem for aquatic and terrestrial wildlife and reducing flood hazards. This will be supported by compatible adjacent land uses and communities to create a system where human development and natural preservation benefit one another.

7

MAJOR TASKS

were identified to develop this comprehensive Master Plan

Task 1: Assemble Comprehensive Mapping for the Stream Corridor into GIS

A critical component in the success of the Big Thompson River Corridor Master Plan was the development of a comprehensive GIS database that served as a central data repository for the project. This database, housed by the City following completion of the Master Plan, is intended to be a resource that continues to be used for planning and design along the corridor. It contains extensive information on the geography, topography, land use, floodplains, and many other aspects of the river corridor and will be a tool for engineers and planners working on the corridor to use and add to for years to come. A selection of maps that were prepared for this task are provided in Appendix B.

Task 2: Baseline Resilience Assessment

An assessment of the existing conditions of the reaches along the corridor was conducted by using a resilience "scorecard" approach. These scorecards were used to identify additional benefits that could be achieved related to flood hazard reduction, recreation, ecological health, and other measures of resilience. Completed Baseline Resilience Scorecards are in Appendix C. These Baseline Resilience Scorecards can be updated as projects are implemented to determine an initial assessment of the benefit provided by the project. Resilience Assessments should not be the only tool used to assess the benefits from projects as there are many factors that may not be incorporated into the Resilience Assessments.

Task 3: Gap Analysis

A lot of existing planning has occurred along the Big Thompson River Corridor; therefore, the gap analysis was conducted to determine where there were gaps in previous planning and additional recommendations and projects could be identified in this Master Plan.

Task 4: Planning and Engineering

In areas where additional planning and engineering were needed to reduce flood hazards, improve connectivity, provide access and opportunities for public-nature interaction, and/or improve ecological health, conceptual plans for additional improvements were developed.

Task 5: Public Involvement

The development of this Master Plan included extensive public outreach to allow for interaction with the community to gather input, address issues and concerns, and vet design ideas. Public involvement included attendance to many community events held in the City of Loveland, as well as a two-day Strategic Planning Session which consisted of presentations, an open house, site tours, and an evening public meeting.

Task 6: Project Cost Projections and Prioritization

Top five action items and/or projects have been identified as the higheset priorities in order to provide a catalyst for future proposed projects that can be implemented when funding becomes available. To aid in prioritization of other projects, each project proposed has been assigned a Near-, Mid-, or Long-term timescale for implementation.

Task 7: Final Master Plan

This Master Plan is a comprehensive document that describes the master planning process, identifies improvements along the river corridor, and presents a practical and achievable near-term plan that will begin with improved management and maintenance of the river and improved flood resilience at major road crossings. Additional projects are included that can be implemented in the next 5 to 30 years.

2.2 MASTER PLAN OBJECTIVES

A project kick-off meeting was conducted on April 18, 2017 at the City of Loveland Public Works Building. As shown in Table 2-1, the following City representatives and project team members were in attendance:

Person	Representing		
Andrew Earles, Ph.D., P.E.	Wright Water Engineers, Inc. (WWE)		
Shannon Tillack, P.E.	WWE		
Kevin Shanks, RLA, ASLA	THK		
Kim Elorriaga, RLA	THK		
Scott Schreiber, P.E.	Matrix Design Group (Matrix)		
Chris Carlson, P.E., CFM	City Public Works - Stormwater		
Marilyn Hilgenberg	City Parks & Recreation - Open Lands		
Larry Howard	Loveland Water and Power		
Brian Hayes	City Parks & Recreation - Open Lands		
Tracy Wendt, FP-A	Big Thompson Watershed Coalition		
Shayna Jones	Big Thompson Watershed Coalition		
Joe Chaplin, CSM	City Public Works - Stormwater		
Greg Dewey, P.E.	Loveland Water and Power		
Janet Meisel-Burns	City Parks & Recreation		
Mike Jacobson	City Public Works - Engineering		
Scott Sinn, RLA, ASLA	City Parks & Recreation - Open Lands		
Jodi Lessman	City Public Works		
Tom Hacker	City Public Information Officer		
Karl Barton, AICP	City Community & Strategic Planning		
Eric Lessard, P.E.	City Public Works - Stormwater		
Kevin Gingery, P.E.	City Public Works - Stormwater		
Roger Berg, P.E.	Loveland Water and Power		

Table 2-1. Attendees of Project Kick-Off Meeting

It was determined during the kick-off meeting that the meeting attendees would serve as the Technical Advisory Committee (TAC) for the project since each attendee is an integral part in the development of the Master Plan. In addition, Traci Shambo, P.E. of Larimer County was included in the TAC.

The TAC included members from multiple departments and divisions within the City of Loveland. Each department and division within the City has its own goals and objectives, so the formation of the TAC provided a multi-departmental committee to facilitate collaboration between the various City departments. It was also hoped that including representatives from multiple City departments on the TAC would facilitate the development on an inter-departmental management and maintenance strategy for the Big Thompson River Corridor through the City of Loveland. Currently, there is little programmatic maintenance for the river. Most maintenance activities by the City and County are in response to problems, and maintenance access is limited for some reaches where property is privately owned. A major goal of this Master Plan is to develop recommendations for improved maintenance and management of the corridor.

Over the course of the project, three meetings were held with the TAC. As discussed above, the initial meeting was conducted in June to introduce the project and to facilitate information exchange. A second meeting was held on July 14, prior to the Stakeholder Meeting, which included a progress update. The third TAC meeting was held on November 17, 2017 to obtain feedback on the draft Master Plan.

Final adoption of the Master Plan will require presentation of the plan to different boards within the City and ultimately the City Council. Larimer County also plans to carry this Master Plan through their county process of endorsement and/or adoption. This work will occur in 2018 to formally adopt the Master Plan.

Stakeholders for the project were determined by agencies, special stakeholder groups, and community members who added their names to our stakeholder list during a community outreach event that would have an interest in the Master Plan and/or may be affected by the Master Plan. A stakeholder meeting was held on July 14, 2017 at the City of Loveland Public Works Building to provide an update by the project team on the progress that had been made to-date on the project. In addition, there was an open discussion with the stakeholder group allowing for the stakeholders to provide their input. Multiple meeting invites were sent to the stakeholder list shown in Table 2-2, and the names with an asterisk indicate their participation in the July 14, 2017 stakeholder meeting: Meeting minutes from the kick-off meeting, TAC, and stakeholder meetings are provided in Appendix E.

Person	Representing	
Tracy Wendt, Shayna Jones*, David Jessup*	Big Thompson Watershed Coalition	
Andy Fayram	Big Thompson Watershed Form	
Andy Pineda, Jeff Drager, Eric Wilkinson	Colorado Water Conservation Board	
Team 5	Northern Colorado Water Conservancy District	
Larry Rogstad, Ben Swingle	U.S. Army Corps of Engineers	
Jim Eussen, Brian Varrella	Colorado Department of Transportation	
Tim Katers	Department of Local Affairs	
Ron Brinkman	Greeley/Loveland Irrigation Co.	
Minerva Lee	Home Supply Ditch	
Dick Coulson	Big Thompson Ditch & Manufacturing Co.	
Greg Dewey*	Rist-Goss Ditch	
Jim Croissant	Reorganized Farmers Ditch Co.	
Jan Lanting, Brett Dowgin*	Thompson School District	
Coy Wylie	Trout Unlimited	
Bill Zawacki*	City of Loveland Open Lands Advisory Commission	
Sean Cronin*, Gary Hausman*, Larry Roos*	City Public Works - Engineering	
Chuck Riblett*, Steve Miller, Russell Fruits, Ann Bradbury, Don Jarrett, Jim Moening, Leslie Moening, Larry Luke, Amy Rupp, Xiaping Zhang, Jamie Roskie, Judy Sandage, Dale Piers, Ralph Armitage, Robin Shivery, Carolyn Bignall, and Daryl Gingery, P.E.	Community	

Table 2-2. Project Stakeholder List

2.3 PREVIOUS STUDIES AND SOURCES OF INFORMATION

There have been many planning efforts along the Big Thompson River Corridor within the area of interest identified by this Master Plan. The 2015 River Restoration Master Plan helped establish priority areas for BTWC's regional long-term flood recovery and restoration work. The 2015 River Restoration Master Plan divides 78 miles of the river into "reaches," from the Olympus Dam to the river's confluence with the South Platte River, and includes several large tributaries. The plan prioritizes each reach based on geomorphic risk, flood risk, and opportunity for riparian and aquatic habitat improvement. The BTWC has planned and implemented projects based on this prioritization and on the guiding principles of the 2015 River Restoration Master Plan. Many elements of the BTWC 2015 River Restoration Master Plan are integrated with this Master Plan, along with additional recommendations for natural areas, recreation, trails and other features identified through public outreach and analysis. The following summarizes additional studies and projects that have been or are currently being conducted in chronological order from when the project began.

The City of Loveland retained Ayres to design permanent repairs from the 2013 flood along the Big Thompson River Corridor between Wilson Avenue and Taft Avenue to replace the temporary repairs made by the City following the flood. The permanent repairs provide more resilient infrastructure and improve the ecosystem throughout the reach.

The Wilson to Taft Avenue Flood Recovery Project design was completed in March 2015, which consisted of the installation of a new pedestrian bridge with a span of approximately 130 feet downstream of Wilson Avenue and replacement of the trail segments that were destroyed by the flood with connection to the new pedestrian bridge. The southern bank of the river was lowered to create a wider riparian bench adjacent to the channel, proving more capacity while simultaneously creating an ecologically beneficial riparian and wetland area. The construction of this project was completed by early summer 2017.

By the end of 2016, RockSol and Ayres had developed construction plans for the Railroad Avenue Flood Recovery Project which consists of the design of permanent repairs to Railroad Avenue and replacement of the 96-inch culvert at the Railroad Avenue secondary channel crossing with a new 100-foot span bridge. As of the fall of 2017, construction of this project has not commenced. This project is ready to go out to bid, but the City is waiting on a final approval from the Burlington Northern and Santa Fe (BNSF) Railroad before this can happen.

The BTWC contracted with Stantec to develop conceptual level (30%) designs and supporting documentation for several areas along the Big Thompson River that were impacted by the 2013 flood including the area from Morey Open Space to Rossum Drive. The 30% design, completed in January 2017, maintains the existing channel alignment through this reach with adjustments to the channel geometry and slope along most of the reach including select locations of floodplain bench grading.

Another flood-response planning study that has been conducted for the City of Loveland is the March 2017 Highway 287 Flood Mitigation Feasibility Study prepared by Ayres. The 2013 flood brought to light the problems caused by an inadequate floodplain corridor, undersized bridges, and developed floodplain in the vicinity of the Highway 287 bridge. The low resilience nature of this area diminishes the potential for economic, social, and environmental improvement. The Highway 287 Flood Mitigation Study consists of three primary features including creating a wider riparian corridor, replacement of the Highway 287 Bridge, and raising Highway 287 south of the bridge. These improvements would greatly reduce flood risk in the area and contribute to a much healthier and more functional river. This Master Plan has not reanalyzed this area, but incorporates the feasibility study's recommendations and conceptual cost estimates

At the time of the development of this Master Plan, there were some concurrent studies and projects being conducted. For example, the BTWC is currently working with Otak on an 80% design from Rossum Drive to Wilson Avenue which focuses on channel restoration and conceptual plans for avulsion areas. At the time of the development of this Master Plan, development of plans was in progress. In addition, Larimer County, working with Interwest Consulting Group and Anderson Consulting Engineers, Inc. is designing the replacement of the Namaqua Avenue bridge due to its poor structural condition, narrow roadway width, and damage from the 2013 flood. It was determined that replacing and widening the Namaqua Avenue Bridge and removal of the grade control structure immediately downstream of the bridge would minimize potential future damages to the Namaqua Avenue bridge crossing and provide relief to surrounding property. Lastly, the BTWC is currently working on the evaluation of improvements at the Rist-Goss ditch diversion structure just upstream of the Namaqua Avenue bridge and is looking at alternatives to allow for fish passage.

As summarized above, the 2013 flood triggered multiple planning studies and design work along the corridor. Significant progress has been made on repair and restoration following the flood, and projects to improve aquatic habitat are in planning stages for western portions of the river corridor. These projects are in varying stages of planning, design, and implementation, some of which may have a hydraulic effect on other downstream projects. The Big Thompson River Corridor is dynamic with multi-agency involvement with the design and construction of improvements along the river corridor. Collaboration between all of the agencies and stakeholders involved will be crucial to develop a cohesive improvement plan for the river corridor. This Master Plan documents the proposed plans for these various projects as of the end of 2017. The actual implementation of these proposed projects may deviate from what is presented in this Master Plan.

Many other sources of information were used in the development of this Master Plan. Information was provided by the City of Loveland, Larimer County, BTWC, Big Thompson Watershed Forum (BTWF), field research, community outreach events, etc. The following provides a list of additional resources not mentioned above that were relied upon for the development of this Master Plan. This list is not comprehensive of all of the information and references that were used to develop this Master Plan; see Chapter 9, Bibliography, for additional supporting information and references.

- City of Loveland Parks and Recreation Master Plan, MIG, July 15, 2014.
- 2013 Big Thompson River Flood Inundation Area Map, October 2013.
- Denver Avenue Outfall Flood Recovery Project Draft Technical Memorandum and associated construction plans, Tetra Tech, June 5, 2014.
- Federal Emergency Management Agency (FEMA)
 Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM), December 19, 2006.
- Fire Training Grounds Flood Recovery Project Floodplain and Design Report and associated construction plans, Ayres Associates, June 2014.
- Force Main Sanitary Sewer at Boise Avenue Crossing Big Thompson River Hydraulics Report, Ayres Associates, June 2014.

- Draft Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery, Ayres Associates, October 2013.
- Loveland Area Irrigation Features, October 2012.
- Big Thompson River Water Quality Biosurvey 2012, 2014, 2015, and 2016 Annual Reports, Colorado State University Environmental Health Services.
- In the Nature of Things: City of Loveland Natural Areas Sites, Cedar Creek Associates, Inc., July 2008.
- Mariano Exchange Ditch System Assessment Project, Hydrosphere Resource Consultants, September 7, 2005.
- GIS files obtained from City including: trails, open lands, natural areas, parks, land use, ownership, floodplain information, etc.

Floodplain Information for Master Plan

The Colorado Water Conservation Board (CWCB), through the Colorado Hazard Mapping Program, is currently in the process of revising the Big Thompson River floodplain mapping through the Loveland area. The revised floodplain mapping project is using both HEC-RAS and SRH-2D for the hydraulic analysis along with updated watershed hydrology. New LiDAR aerial mapping was also flown in November 2016 to support the floodplain mapping. The updated floodplain models with the LiDAR data were not available during the course of this Master Plan. Therefore, the City of Loveland directed the project team to use the effective floodplain information for the basis of this Master Plan. For comparison purposes, the 100-year effective discharge per the 2006 FEMA FIS is 19,000 cfs through the Master Plan study limits. However, the 2015 post-flood Big Thompson Watershed Hydrologic Evaluation completed by CDOT and CWCB calculated a new 100-year peak discharge of 18,900 cfs at the Buckhorn Creek confluence upstream of the study limit, 20,000 cfs at Railroad Avenue, and 20,700 cfs downstream of Larimer County Road 9E.

2.4 REACH FACT SHEETS

The 2015 River Restoration Maser Plan divided the Big Thompson River into 59 reaches (including major tributaries to the Big Thompson River) based on a variety of factors including approximate neighborhood areas, natural geographic features, road/bridge crossings, and diversion dams. Reach numbers begin with #1 below the Olympus Dam in Estes Park and continue east along the Big Thompson River to its confluence with the South Platte River. In order to keep continuity between master planning efforts, this Master Plan adopts the same reach designation as identified in the 2015 River Restoration Master Plan. Therefore, Table 2-3 and Figure 2-1 provide an overview of the Big Thompson River reaches within the study limits.

Reach Number	Name	Upstream Boundary	Downstream Boundary
29	Morey Wildlife Reserve	MM 87.7	Rossum Drive
30	Rossum-Namaqua	Rossum Drive	Namaqua Avenue
31	Namaqua-Wilson	Namaqua Avenue	Wilson Avenue
32	Wilson-Taft	Wilson Avenue	Taft Avenue
33	Taft-Railroad	Taft Avenue	Railroad Avenue
34	Fairgrounds Park	Railroad Avenue	Lincoln-Avenue-U.S. Hwy 287
35	Lincoln-St. Louis	Lincoln-Avenue-U.S. Hwy 287	St. Louis Avenue
36	St. Louis-Boise	St. Louis Avenue	Boise Avenue
37	Boise-CR 9E	Boise Avenue	CR 9E
38	CR9E-d/s Study Limit	CR 9E	Ponds d/s of CR 9E

Table 2-3. Reach Designations

Due to the extensive amount of information provided by the City of Loveland described above, and included in Chapter 9, Bibliography, one of the first tasks of the project team was to summarize all of the existing information known about the Big Thompson River within the study limits. To accomplish this, reach "Fact Sheets" were developed for each reach within the study limits to provide a color-coded, comprehensive document that was used by the project team as a quick reference for information on each reach during the development of this Master Plan and are publicly available for use by others. The Fact Sheets are laid out in such a way that important information can easily be conveyed to project stakeholders and the general public. A glossary of terms and a list of acronyms has also been provided for definitions of the technical terms (see Appendix G for the glossary which includes definitions of acronyms).

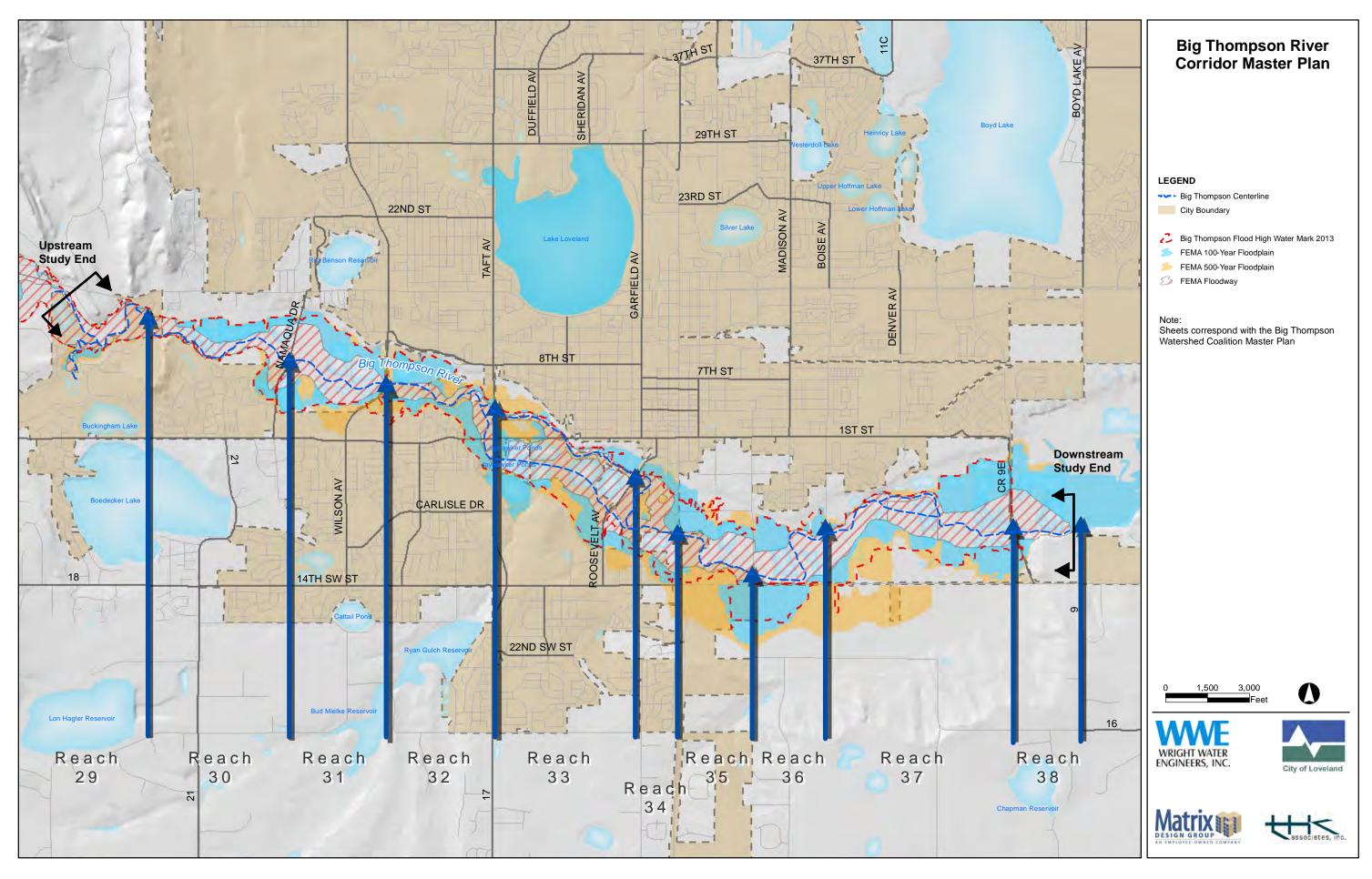


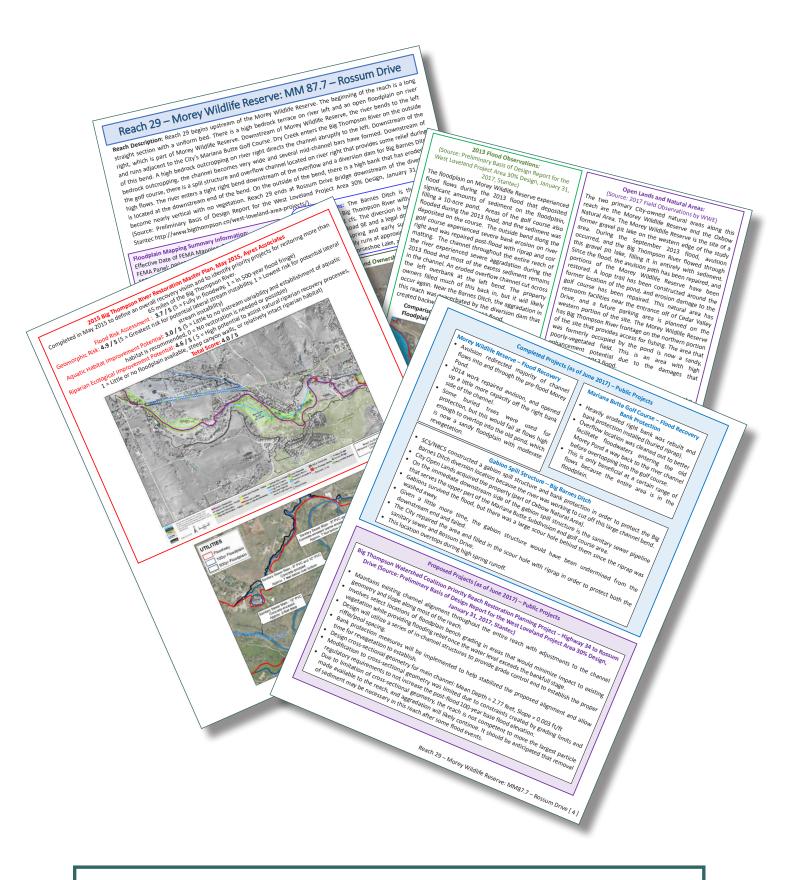
Figure 2-1 Reach Designations

The following categories of information are presented in each Fact Sheet based on the following sources of information:

- Reach Description Some of the reach descriptions were taken from previous studies while others were developed based on various sources of available information.
- Floodplain Mapping Summary Information Floodplain information was obtained from the effective FEMA FIS and FIRM dated December 19, 2006.
- Irrigation Ditches Information on water rights and irrigation ditches was gathered from correspondence with Greg Dewey - City of Loveland, an interview with Jean Lever - Water Commissioner of Water District 4 at the Colorado Division of Water Resources, and research of available data provided by Colorado's Decision Support System.
- Land Use Land use information is from City of Loveland general zoning mapping.
- Water Quality Water quality information was obtained from the Colorado Department of Public Health and Environment Water Quality Control Commission Regulation #93 – Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List, effective November 30, 2016.
- Fish & Macroinvertebrate Data Fish and macroinvertebrate data were obtained from the Big Thompson River Water Quality Biosurvey 2012, 2014, 2015, and 2016 Annual Reports prepared by the Colorado State University Environmental Health Services as well as habitat inventory information that was conducted as part of the Wilson to Taft Avenue Flood Recovery Project by Miller Ecological Consultants.
- Land Ownership Land ownership GIS files were obtained from the City at the onset of the project. However, during subsequent meetings with the City, updated land ownership information was verbally conveyed to the project team, and modifications to the GIS files were made.
- Open Lands and Natural Areas City-owned
 Open Lands and Natural Areas are identified and
 mapped with associated descriptions based on field
 observations by the project team.

- 2013 Flood Observations Descriptions of the 2013 flood observations were obtained from the Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery prepared by Ayres and 2013 flood extent mapping was provided by the City.
- 2015 Big Thompson River Restoration Master Plan –
 A summary of the flood risk assessment, geomorphic risk, aquatic habitat improvement potential, and riparian ecological improvement potential scores are presented with a snapshot of the proposed improvements presented in the 2015 River Restoration Master Plan.
- Utilities Utility crossing information was provided by Loveland Water and Power, as well as information about utility line protection.
- Recreational Trails Existing Recreational Trail
 information was based on the City of Loveland Trail
 and Bikeways Map, and additional information on
 areas of new trail construction was provided by the
 City.
- Completed Projects (as of June 2017): Public Projects

 Information on public projects that have been completed.
- Proposed Projects (as of June 2017): Public Projects Information on proposed public projects was obtained from project-specific documentation provided by the City.



FACT SHEETS

for each reach are provided on the following pages

Reach 29 - Morey Wildlife Reserve: MM 87.7 - Rossum Drive

Reach Description: Reach 29 begins upstream of the Morey Wildlife Reserve. The beginning of the reach is a long straight section with a uniform bed. There is a high bedrock terrace on river left and an open floodplain on river right, which is part of Morey Wildlife Reserve. Downstream of Morey Wildlife Reserve, the river bends to the left and runs adjacent to the City's Mariana Butte Golf Course. Dry Creek enters the Big Thompson River on the outside of this bend. A high bedrock outcropping on river right directs the channel abruptly to the left. Downstream of the bedrock outcropping, the channel becomes very wide and several mid-channel bars have formed. Downstream of the golf course, there is a spill structure and overflow channel located on river right that provides some relief during high flows. The river enters a tight right bend downstream of the overflow and a diversion dam for Big Barnes Ditch is located at the downstream end of the bend. On the outside of the bend, there is a high bank that has eroded to become nearly vertical with no vegetation. Reach 29 ends at Rossum Drive Bridge downstream of the diversion. (Source: Preliminary Basis of Design Report for the West Loveland Project Area 30% Design, January 31, 2017, Stantec http://www.bigthompson.co/west-loveland-area-projects/).

Floodplain Mapping Summary Information:

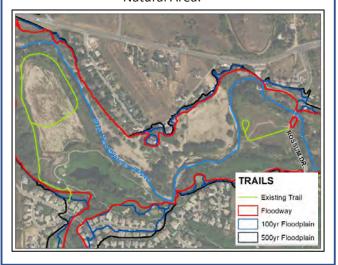
Effective Date of FEMA Mapping: December 19, 2006 FEMA Panel: 08069C1169F

100-Year Peak Discharge from FIS: 19,000 cfs CDOT July 2015 100-Year Peak Discharge: 18,900 cfs FEMA Flood Zones: Zone AE (Primary), AO, X BFE's from upstream to downstream: 5,052 ft - 5,034 ft

Land Use:

City of Loveland General Zoning -Low Density Residential, Business, Developing Resource, Planned Unit Development

Recreation Trails There are two recently built soft recreation trails within this reach. One is a loop trail at the Morey Wildlife Reserve constructed after the 2013 flood, and the other is a trail at the Oxbow Natural Area.



Irrigation Ditches: The Barnes Ditch is the largest diversion on the Big Thompson River with a decreed diversion of 3,021 cfs. The diversion is between MM 87.7 and County Road 9E and a legal dry-up point on the river. In the spring and early summer, the Big Barnes Ditch typically runs at approximately 550 cfs to fill Lake Loveland, Horseshoe Lake, and Boyd Lake.

Land Ownership Legend Land Ownership City of Lovelan Larimer Count State of Colo

Water Quality:

CDPHE river segment: COSPBT03 - Home Supply Canal diversion to Big Barnes Ditch diversion

303(d) Impairment: Cu, As Priority: Medium/High

Fish & Macroinvertebrate Data: Detailed fish and macroinvertebrate data have not been collected in this reach. This reach has cold water that is suitable for trout, and residents who have provided input have reported catching fish along this reach.

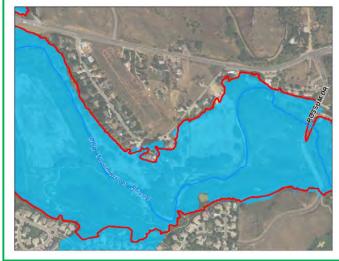
Reach 29 – Morey Wildlife Reserve: MM87.7 – Rossum Drive [1]

2013 Flood Observations:

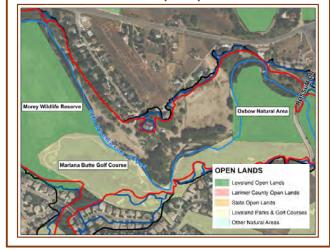
(Source: Preliminary Basis of Design Report for the West Loveland Project Area 30% Design, January 31, 2017, Stantec)

The floodplain on Morey Wildlife Reserve experienced flood flows during the 2013 flood that deposited significant amounts of sediment on the floodplain, filling a 10-acre pond. Areas of the golf course also flooded during the 2013 flood, and fine sediment was deposited on the course. The outside bend along the golf course experienced severe bank erosion on river right and was repaired post-flood with riprap and coir matting. The channel throughout the entire reach of the river experienced severe aggradation during the 2013 flood and most of the excess sediment remains in the channel. An eroded overflow channel cut across the left overbank at the left bend. The property owners filled much of this back in, but it will likely occur again. Near the Barnes Ditch, the aggradation in this reach was exacerbated by the diversion dam that created backwater during the 2013 flood.

Comparison between FEMA Effective 100-Year Floodplain (blue) and 2013 Flood Extents (red)



Parks & Open Space



Open Lands and Natural Areas:

(Source: 2017 Field Observations by WWE)

The two primary City-owned natural areas along this reach are the Morey Wildlife Reserve and the Oxbow Natural Area. The Morey Wildlife Reserve is the site of a former gravel pit lake on the western edge of the study area. During the September 2013 flood, avulsion occurred, and the Big Thompson River flowed through this gravel pit lake, filling it in entirely with sediment. Since the flood, the avulsion path has been repaired, and portions of the Morey Wildlife Reserve have been restored. A loop trail has been constructed around the former location of the pond, and erosion damage to the golf course has been repaired. This natural area has restroom facilities near the entrance off of Cedar Valley Drive, and a future parking area is planned on the western portion of the site. The Morey Wildlife Reserve has Big Thompson River frontage on the northern portion of the site that provides access for fishing. The area that was formerly occupied by the pond is now a sandy, poorly-vegetated field. This is an area with high enhancement potential due to the damages that occurred in the 2013 flood.

The other City-owned natural area in this reach is the Oxbow Natural Area. The Oxbow Natural Area is bound by the Big Thompson River on the west and north sides, by a flood overflow channel on the south side, and by Rossum Drive on the east side. This natural area has mature trees along the northern and southern boundaries that provide habitat for birds and other types of wildlife. The site provides habitat for raptors and songbirds as well as for small mammals. The majority of the site is an undeveloped field with a soft trail. The Oxbow Natural Area has high enhancement potential to provide improved amenities for recreation. Potential ideas that could be incorporated include an improved fishing area on the west side of the Oxbow Natural Area, a shelter with shade and picnic tables, parking off of Rossum Drive, a restroom, and a portage trail around the Big Barns Ditch Diversion Dam.

The City also owns the golf course property on the south side of the river that connects the Morey Wildlife Reserve and the Oxbow Natural Area. There is a trail/cart path that runs along most of this reach, which provides good access for recreation and maintenance, when needed.

The Open Lands figure on the left shows the Morey Wildlife Reserve and Oxbow Natural Area along with the floodway (red), 100-year floodplain (blue), and 500-year floodplain (black).

Reach 29 – Morey Wildlife Reserve: MM87.7 – Rossum Drive [2]

2015 Big Thompson River Restoration Master Plan, May 2015, Ayres Associates

Completed in May 2015 to define an overall recovery vision and to identify priority projects for restoring more than 65 miles of the Big Thompson River.

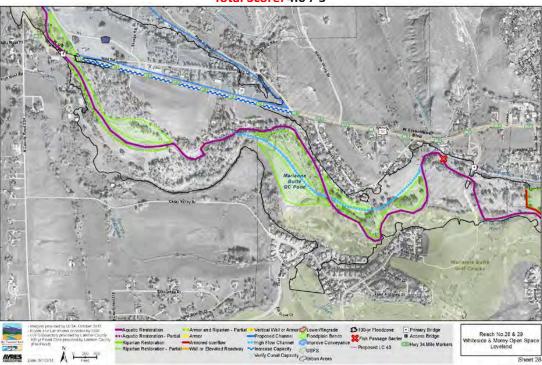
Flood Risk Assessment: 3.7 / 5 (5 = Fully in floodway, 1 = In 500-year flood fringe)

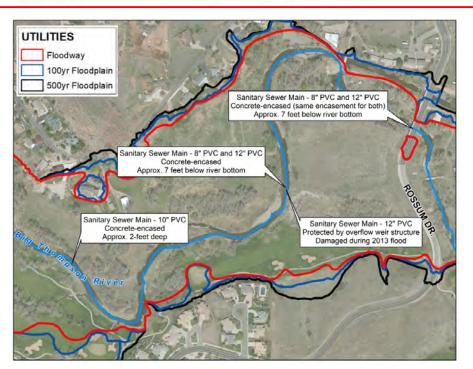
Geomorphic Risk: **4.9 / 5** (5 = Greatest risk for potential lateral stream instability, **1** = Lowest risk for potential lateral stream instability)

Aquatic Habitat Improvement Potential: **3.0 / 5** (5 = Little to no instream variability and establishment of aquatic habitat is recommended, 0 = No restoration is needed or possible)

Riparian Ecological Improvement Potential: 4.6 / 5 (5 = High potential to assist natural riparian recovery processes, 1 = Little or no floodplain available, steep canyon walls, or relatively intact riparian habitat)

Total Score: 4.0 / 5





Reach 29 – Morey Wildlife Reserve: MM87.7 – Rossum Drive [3]

Completed Projects (as of June 2017) – Public Projects

Morey Wildlife Reserve – Flood Recovery

- Avulsion redirected majority of channel flows into and through the pre-flood Morey Pond.
- 2014 work repaired avulsion, and opened up a little more capacity off the right bank side of the channel.
- Some buried trees were used for protection, but this would fail at flows high enough to overtop into the old pond, which is now a sandy floodplain with moderate revegetation.

Mariana Butte Golf Course – Flood Recovery Bank Protection

- Heavily eroded right bank was rebuilt and bank protection installed (buried riprap).
- Overflow location was cleaned out to better facilitate floodwaters entering the old Morey Pond a way back to the river channel before overtopping into the golf course.
- This is only beneficial at a certain range of flows because the entire area is in the floodplain.

Gabion Spill Structure - Big Barnes Ditch

- SCS/NRCS constructed a gabion spill structure and bank protection in order to protect the Big Barnes Ditch diversion location because the river was working to cut off this large channel bend.
- City Open Lands acquired the property (part of Oxbow Natural Area).
- On the immediate downstream side of the gabion spill structure is the sanitary sewer pipeline that serves the upper part of the Mariana Butte Subdivision and golf course area.
- Gabions survived the flood, but there was a large scour hole behind them since the riprap was washed away.
- Given a little more time, the gabion structure would have been undermined from the downstream end and failed.
- The City repaired the area and filled in the scour hole with riprap in order to protect both the sanitary sewer and Rossum Drive.
- This location overtops during high spring runoff.

Proposed Projects (as of June 2017) - Public Projects

Big Thompson Watershed Coalition Priority Reach Restoration Planning Project – Highway 34 to Rossum
Drive (Source: Preliminary Basis of Design Report for the West Loveland Project Area 30% Design,
January 31, 2017, Stantec)

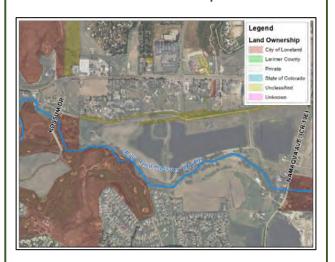
- Maintains existing channel alignment throughout the entire reach with adjustments to the channel geometry and slope along most of the reach.
- Involves select locations of floodplain bench grading in areas that would minimize impact to existing vegetation while providing flooding relief once the water level exceeds the bankfull stage.
- Design will utilize a series of in-channel structures to provide grade control and to establish the proper riffle/pool spacing.
- Bank protection measures will be implemented to help stabilized the proposed alignment and allow time for revegetation to establish.
- Design cross-sectional geometry for main channel: Mean Depth = 2.77 feet, Slope = 0.003 ft/ft
- Modification to cross-sectional geometry was limited due to constraints created by grading limits and regulatory requirements to not increase the post-flood 100-year base flood elevation.
- Due to limitation of cross-sectional geometry, the reach is not competent to move the largest particle made available to the reach, and aggradation will likely continue. It should be anticipated that removal of sediment may be necessary in this reach after some flood events.

Reach 29 – Morey Wildlife Reserve: MM87.7 – Rossum Drive [4]

Reach 30 – Rossum-Namaqua: Rossum Drive – Namaqua Avenue

Reach Description: Reach 30 begins at Rossum Drive. Near Rossum Drive, the south side of the river is bound by the Oxbow Natural Area and Mariana Butte Golf Course and the north side is bound by gravel pit ponds. About 1,000 feet downstream from the Rossum Drive Bridge, the floodplain becomes significantly constricted between a bedrock hogback to the south and high ground to the north. The floodplain is less than 600 feet wide at this location in comparison to the reaches upstream and downstream where the floodplain is at least 2 or 3 times that width. A large diversion, the Rist-Goss Ditch, with a 3-4 foot drop in water surface elevation, is present about 200 feet upstream of Namaqua Avenue. During the 2013 flood, the Namaqua Avenue Bridge was not overtopped, but the roadway to the north appeared to have conveyed a significant portion of the flood flow as well as some overtopping to the south. The Namaqua Avenue Bridge has a concrete weir with a 2-3 foot drop in the water surface elevation on the downstream side of the bridge. Reach 30 ends at Namaqua Avenue. (Source: Geomorphic Assessment of the Big Thompson River Through the City of Loveland, October 2013, Ayres Associates, http://www.bigthompson.co/master-planning/)

Land Ownership



Irrigation Ditches: Beginning at the easternmost edge of the Mariana Butte Golf Course in Loveland, a series of ponds are filled with ditch shares of mutual stock companies and water is returned back to the river to offset return flows from shares changed to municipal use out of the Barnes Ditch. The Rist-Goss Ditch diverts water upstream of Namaqua Avenue for use in gravel pit operations.

Floodplain Mapping Summary Information:
Effective Date of FEMA Mapping: December 19, 2006
FEMA Panel: 08069C1169F/08069C1188F
100-Year Peak Discharge FIS: 19,000 cfs
CDOT July 2015 100-Year Peak Discharge: 18,900 cfs
FEMA Flood Zone: AE (Primary), AO, X
BFE's from upstream to downstream: 5,034 ft – 5,007 ft

Land Use:

City of Loveland General Zoning – Low Density Residential, Developing Resource, Planned Unit Development, Gravel Pits, Cattle Grazing/Agriculture

Fish & Macroinvertebrate Data: Detailed fish and macroinvertebrate data have not been collected in this reach. Residents who have provided input on the project have reported catching fish upstream from Namaqua Avenue, and project team members have observed fish near the Namaqua Bridge.

Water Quality:

CDPHE river segment: COSPBT04a — Big Barnes Ditch diversion of the Greeley-Loveland Canal diversion 303(d) Impairment: Se Priority: Medium

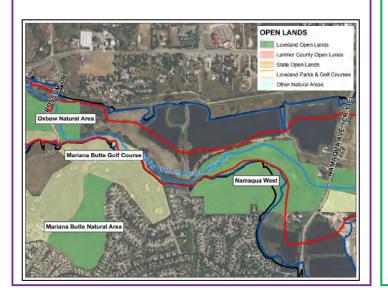
Open Lands and Natural Areas:

(Source: 2017 Field Observations by WWE)

The westernmost City-owned natural area along this reach is the newly-acquired parcel just to the east of Rossum Drive known as Oxbow East Natural Area. This is an area with river frontage and relatively healthy and diverse vegetation. This area is bordered on the east by gravel pit lakes. This natural area has high potential for wildlife viewing and passive recreation. Potential improvements for this natural area could include a soft trail, benches, etc. This natural area could share a parking area and facilities with the Oxbow Natural Area on the west side of Rossum Drive.

The other natural area along this reach is the recently-acquired Namaqua West Natural Area, which is on the south bank of the river just upstream from Namaqua Avenue. This area is currently an active farm and provides valuable open land to the west of Namaqua Avenue. According to nearby residents, elk are frequently seen in this area in winter months. This is an area that has relatively little overbank vegetation due to the current land use. Conditions on the site could be improved with planting of additional woody vegetation and native shrubs as well as restoration of grassed areas with native species. The quality of the stream corridor also could be enhanced if livestock can be kept out of the stream.

Other open lands in this reach include gravel pit ponds on the north side of the river. These parcels currently act as natural areas; however, in the future these areas may potentially be developed. If that is the case, areas within the floodway on these parcels should be retained as natural areas that will provide a buffer between development and the river.



2013 Flood Observations:

(Source: Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery, October 2013, Ayres Associates.)

The property immediately downstream of Rossum Drive was heavily damaged by flood flows and sedimentation. About 1,000 feet downstream of the Rossum Drive Bridge, the floodplain is constricted where the flow created headcutting gullies in the left overbank. Downstream of the constriction, the river avulsed into the sand and gravel pit on the left bank. The avulsion into the pit captured all of the in-bank river flow and abandoned the old channel for a significant distance downstream. The flow in the pit also avulsed into and out of the next pit and back into the channel and overtopped this pit into the eastern pit just upstream of Namagua Avenue.

The pre-flood channel has been abandoned for almost 3,500 feet from the upstream avulsion site to its return point downstream. The pre-flood channel's bed is approximately 4-5 feet above the current bed level at the upstream avulsion site. Reestablishment of flow into the pre-flood channel may require excavation of a pilot segment into the pre-flood channel at the avulsion site.

A large diversion dam with a 3-4 foot drop in water surface elevation is present about 200 feet upstream of Namaqua Avenue.

The Namaqua Avenue Bridge was not overtopped, but the roadway to the north appeared to have conveyed a significant portion of the flood flows as well as some overtopping to the south. The bridge has a concrete weir on the downstream side of the bridge that appeared intact.

Comparison between FEMA Effective 100-Year Floodplain (blue) and 2013 Flood Extents (red)



Reach 30 - Rossum-Namaqua: Rossum Drive - Namaqua Avenue [1]

2015 Big Thompson River Restoration Master Plan, May 2015, Ayres Associates

Completed in May 2015 to define an overall recovery vision and to identify priority projects for restoring more than 40 miles of the Big Thompson River.

Flood Risk Assessment: 4.0 / 5 (5 = Fully in floodway, 1 = In 500-year flood fringe)

Geomorphic Risk: **4.0 / 5** (5 = Greatest risk for potential lateral stream instability, 1 = Lowest risk for potential lateral stream instability)

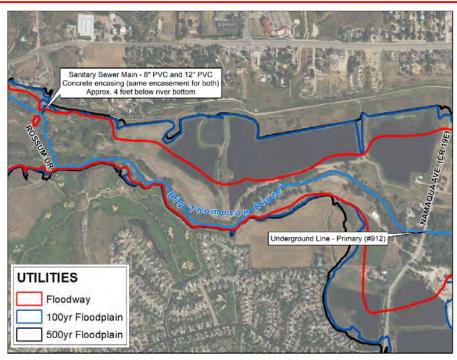
Aquatic Habitat Improvement Potential: 2.4 / 5 (5 = Little to no instream variability and establishment of aquatic habitat is recommended, 0 = No restoration is needed or possible)

Riparian Ecological Improvement Potential: 4.5 / 5 (5 = High potential to assist natural riparian recovery processes, 1 = Little or no floodplain available, steep canyon walls, or relatively intact riparian habitat)

Total Score: 3.7 / 5

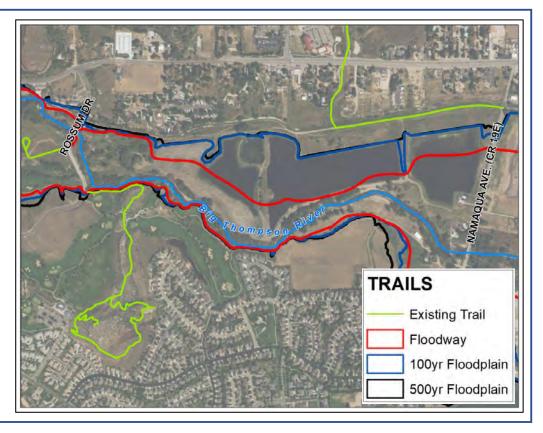






Reach 30 – Rossum-Namaqua: Rossum Drive – Namaqua Avenue [3]

Recreation Trails: There are existing recreation trails within this reach including a trail within the Mariana Butte Natural Area. (Source: City of Loveland Recreation Trail & Bikeways Map)



Proposed Projects (as of June 2017) – Public Projects

Big Thompson Watershed Coalition - Rossum to Wilson River Improvement Project

- The BTWC is analyzing options for the diversion structure that would improve fish passage while maintaining adequate water conveyance.
- Incorporating the need for the gravel pits to overflow in strategic locations in the event of future floods.
- Investigating options for improving water quality inputs from the Mariano Exchange Ditch.
- Stabilizing banks, reconnecting the floodplain, improving native vegetation growth, soils, aquatic habitat, root structure and overall river resilience.

Rist-Goss Diversion at Namaqua

- The Big Thompson Watershed Coalition is leading an effort to investigate options for improving fish passage while maintaining adequate water conveyance at this location.
- No official designs or estimates have been completed at this time.

Namaqua Avenue Bridge Replacement

- Larimer County will be replacing the Namaqua Avenue bridge in 2018 which is currently under design.
- Interwest is designing the bridge and Anderson Consulting Engineers is doing the hydraulics and floodplain work.
- As part of the project, Larimer County is removing the a small vertical drop structure on the downstream face of the bridge section.

Reach 30 – Rossum-Namagua: Rossum Drive – Namagua Avenue [4]

Reach 31 – Namaqua-Wilson: Namaqua Avenue - Wilson Avenue

Reach Description: Reach 31 begins at the Namaqua Avenue Bridge. Just downstream of Namaqua Avenue, the river is bordered by Namaqua Park to the south and Namaqua Natural Area to the north. Further downstream, the river is bound by gravel pit ponds on both sides of the river. During the 2013 flood, flows overtopped the Wilson Avenue roadway north of the bridge, but it did not appear that flows overtopped Wilson Avenue south of the bridge. Reach 31 ends at Wilson Avenue.

Legend Land Ownership City of Loveland Larimer County Private State of Colorado Unclassified Unknown

Water Quality:

CDPHE river segment: COSPBT04a – Big Barnes Ditch diversion of the Greeley-Loveland Canal diversion 303(d) Impairment: Se

Priority: Medium

Mariano Exchange Ditch enters the river just upstream from Wilson Avenue. The sediment in the water from the ditch causes a notable change in turbidity. This ditch return flow affects the water quality of the river for miles downstream.

Floodplain Mapping Summary Information:

Effective Date of FEMA Mapping: December 19, 2006

FEMA Panel: 08069C1188F

100-Year Peak Discharge FIS: 19,000 cfs

CDOT July 2015 100-Year Peak Discharge: 18,900 cfs

FEMA Flood Zone: AE (Primary), X

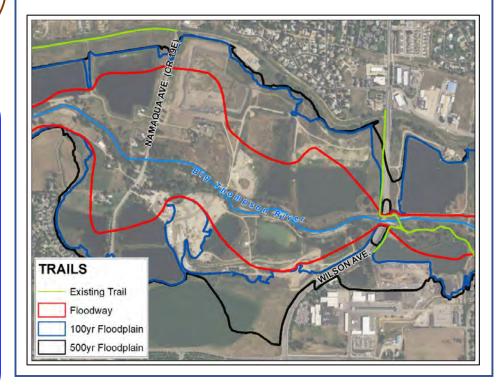
BFE's from upstream to downstream: 5,007 ft – 4,993 ft

Land Use:

City of Loveland General Zoning – Industrial, Developing Resource, Low Density Residential, Gravel Pits with Active Mining, Recreation

Irrigation Ditches: One of two ditches returning water to the river in the Loveland area, the Mariano Exchange, discharges up to 60 cfs of water back to the Big Thompson River. Although this increases the physical water supply in the Big Thompson, it does not improve the quality of the Water leaving Boedecker Reservoir via the Mariano Exchange is typically guite turbid and reduces the quality of water for miles downstream.

Recreation Trails – There are existing recreation trails within this reach. (Source: City of Loveland Recreation Trail & Bikeways Map)



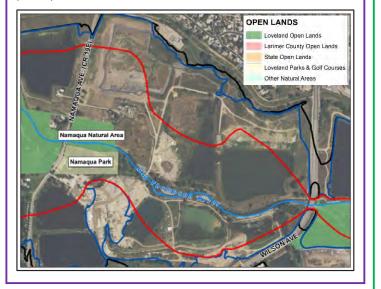
Reach 31 – Namaqua – Wilson: Namaqua Ave to Wilson Ave [1]

Open Lands and Natural Areas:

(Source: 2017 Field Observations by WWE)

The only publicly owned park/natural areas along this reach are Namagua Park and Namagua Natural Area, which are immediately east of Namaqua Avenue on the north and south banks of the river. Namagua Park and Namagua Natural Area includes a parking area, playground, picnic shelter and river access. Larimer County owns property that is just north of the river. Nearly all of the land that is further to the east along the reach is privately owned. While the privately owned areas are technically "natural areas," many of these areas are still being actively mined, which limits the habitat and wildlife value of the areas under current conditions. In the long term, these areas have high potential as open lands along the river corridor. Some of the privately owned areas may experience potential land changes in the future. If this change occurs, the City should seek to have areas that are within the floodway serve as buffers between development and the river.

The Open Lands figure below shows the Namaqua Natural Area and Namaqua Park along with the floodway (red), 100-year floodplain (blue), and 500-year floodplain (black).



2013 Flood Observations:

(Source: Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery, October 2013, Ayres Associates.)

Flow overtopping of the roadway north of the Namaqua Avenue Bridge caused extensive headcutting, gullying, sedimentation, and erosion downstream of the roadway and into the gravel pits. The Namaqua Road embankment was eroding during the flood and was temporarily repaired by October 2013. Flows overtopping Namaqua Road south of the bridge were conveyed through the gravel pit ponds just south of the river. No avulsions into the sand and gravel pits or significant erosion occurred south of the river along this reach.

An avulsion and additional overbank flows entered the gravel pit area upstream of the gravel pit access road bridge. Several headcuts and scour holes were formed upstream of the access roadway on the north side of the river as well. A 400-foot section of the access road was washed away during the flood as was temporarily fixed as of October 2013. The access bridge appeared to have no significant damage.

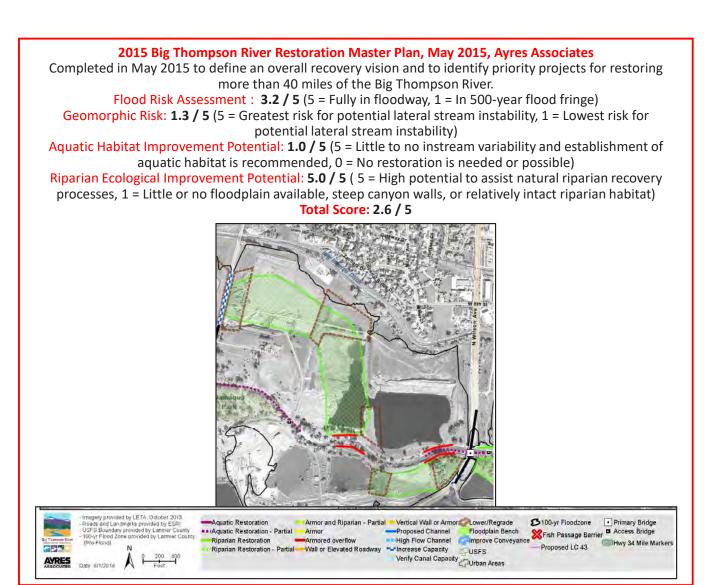
All the gravel pits north of the river were linked by avulsions. About 300 feet upstream of Wilson Avenue, flow in the north overbank gravel pit returns to the river channel. As of October 2013, minimal flow was coming out of the gravel pit and the main channel was still separated from the gravel pit by the narrow remnants of the embankment. Additional return flows caused areas of scour and headcutting along the left bank just upstream of the Wilson Avenue Bridge.

Overbank flows overtopped the Wilson Avenue roadway north of the bridge. It did not appear that flows overtopped the roadway south of the bridge.

Comparison between FEMA Effective 100-Year Floodplain (blue) and 2013 Flood Extents (red)



Reach 31 – Namaqua – Wilson: Namaqua Ave to Wilson Ave [2]



Fish & Macroinvertebrate Data:

(Source: Big Thompson River Water Quality Biosurvey Annual Reports, CSU Environmental Health Services)

Biosurvey conducted at Site #2, above Wilson Avenue bridge about 500 feet upstream of bridge

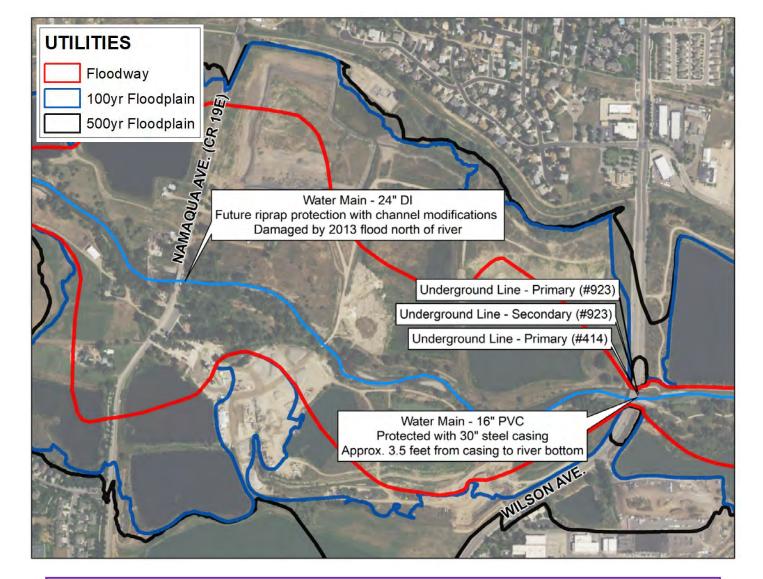
2012 – Benthic data demonstrated that the Big Thompson River was in good health. Data suggest that study site was only slightly-impaired. Based on the fish population data, study site is considered poor condition (however, data limited due to cold water and low flow).

2014 – Benthic data demonstrated that the Big Thompson River is in good health and only slightly-impaired. Based on the fish population data, study site is considered poor condition.

2016 – Benthic data demonstrated that the Big Thompson River was in moderately good health and are slightly impaired. Based on the fish population data, study site is considered fair condition.

Fish Populations Observed:

- Spottail Shiner
- Longnose Dance
- Yellow Perch
- Creek Chub
- White Sucker
- Brown Trout
- Longnose Sucker
- Johnny Darter Fathead Minnow
- Longnose x White Hybrid
- Largemouth Bass



Proposed Projects – Public Projects

Big Thompson River Watershed Coalition - Rossum to Wilson River Improvement Project

- Incorporating the need for the gravel pits to overflow in strategic locations in the event of future floods.
- Investigating options for improving water quality inputs from the Mariano Exchange Ditch.
- Stabilizing banks, reconnecting the floodplain, improving native vegetation growth, soils, aquatic habitat, root structure and overall river resilience.

Reach 32 – Wilson-Taft: Wilson Avenue - Taft Avenue

Reach Description: Reach 32 begins at the Wilson Avenue Bridge. Significant flood recovery work has been completed throughout this reach including a new pedestrian bridge, recreational trail realignment, bank grading and protection, thalweg realignment, floodplain benching and revegetation. The river is bordered by gravel pit ponds and undeveloped land. The Greeley Loveland Canal and the Big Thompson Ditch and Manufacturing Company diversion structure is located approximately 1,200 feet downstream of the Wilson Avenue Bridge. The USGS Big Thompson River Near Loveland stream gauge is located near the diversion structure. Reach 32 ends at the Taft Avenue Bridge which was overtopped during the 2013 flood.

Irrigation Ditches: The primary diversion structures along this reach are for the Loveland-Greeley Canal and the Big Thompson Ditch and Manufacturing Company. Both divert from the same location on the river approximately 1,200 feet downstream of Wilson Avenue. The diversion point for these two ditches is a legal dry-up point for the river. The diversion dam at this location is a barrier to fish passage and hazard to boating and tubing on the river.

Water Quality:

CDPHE river segment: COSPBT04b - Greeley-Loveland

Canal diversion to CR11H 303(d) Impairment: Se

Priority: Low

Fish Species Observed:

- Brown Trout
- Green Sunfish
- Creek Chub
- Spottail Shiner
- Largemouth Bass
 Yellow Perch
- Longnose Dace
- Fathead Minnow
- Johnny Darter
- Longnose X White Hybrid
- White Sucker
- Longnose Sucker
 Rainbow Trout

Land Use:

City of Loveland General Zoning – Low Density Residential, Developing Resource, Industrial, Business, High Density Residential, Planned Unit Development

Floodplain Mapping Summary Information:

Effective Date of FEMA Mapping: December 19, 2006

FEMA Panel: 08069C1188F Peak Discharge FIS: 19,000 cfs

CDOT July 2015 100-Year Peak Discharge: 18,900 cfs

FEMA Flood Zone: AE (Primary), X

BFE's from upstream to downstream: 4,993 ft – 4,970 ft



Fish & Macroinvertebrate Data:

(Source: Big Thompson River Preliminary Habitat Inventory Results, Miller Ecological Consultants, Inc., February 16, 2015)

Habitat inventory was conducted as part of the Wilson to Taft Avenue Flood Recovery Project to quantify preproject habitat conditions to provide a reference for design. Between Taft Avenue and Wilson Avenue, riffle habitat is dominant (98%) with almost no pool or glide habitat. A single, unidentified fish was observed during the survey. The dominant riffle habitat and shifting sand substrate provides very little aquatic habitat within the reach. The lack of habitat diversity and food base is likely the major limitations in the reach.

Restoration of the reach should include restoring a more diverse habitat structure including increased pool and glide habitats. Larger, stable substrate material is needed to promote colonization by benthic species. A range of substrate sizes is needed for successful reproduction of fish species within the reach. The large diversion structure blocks upstream fish passage. Consideration should be given to providing fish passage to provide continuous habitat.

Reach 32 – Wilson-Taft: Wilson Avenue – Taft Avenue [1]

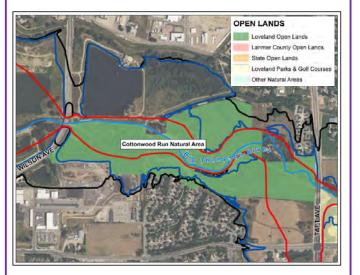
Open Lands and Natural Areas: (Source: 2017 Field Observations by WWE)

The Wilson to Taft reach includes City-owned natural areas along the entire southern bank of the river and along significant portions of the northern bank. This is known as the Cottonwood Run Natural Area. The natural areas on the south side of the river provide important habitat for wildlife and buffer the river from adjacent development to the north. A wide range of birds have been observed along this reach including herons, hawks, mallards, swallows and others. Amphibians and reptiles include garter snakes, frogs and turtles, and mammals in the area include deer, fox, and mink.

This natural area is connected via a concrete bike path, as well as a soft surface trail for hiking and biking. This area also includes trails that access the river off of the main bike path for fishing. Additionally, information kiosks and interpretive signs can be found at the Cottonwood Run Natural Area. Dogs are permitted at this natural area, but only if they are leashed. The Cottonwood Run Natural Area does not include a parking area, public restrooms, or picnic areas.

Recent improvements along this reach have included restoring the bike path, and improving connectivity between the floodplain and the channel. Because of the recent work along this reach, many areas are still becoming revegetated. Weed control along this reach will be especially important until desirable vegetation is established.

The Open Lands figure below shows the Cottonwood Run Natural Area along with the floodway (red), 100year floodplain (blue), and 500-year floodplain (black).



2013 Flood Observations:

(Source: Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery, October 2013, Ayres Associates.)

The pedestrian bridge downstream of Wilson Avenue was washed downstream about 850 feet and approximately 250 feet of path was destroyed along the right bank downstream of Wilson Avenue. The main channel was widened in this area from approximately 60 feet to 150 feet. Approximately 400 feet downstream of the Wilson Avenue Bridge, approximately 500 feet of the left bank was severely eroded.

The Greeley Loveland Canal and the Big Thompson Ditch and Manufacturing Company diversion structure is located approximately 1,200 feet downstream of the Wilson Avenue Bridge. Based on flood debris, the structure was inundated during the flood, but appeared to be stable and operational as of October 2013.

Approximately 1,000 feet downstream of the diversion structure is the beginning of an old meander channel where significant scour and erosion of the channel bed and banks occurred, exposing and rupturing an 18" sanitary sewer line, a 36" concrete pipeline, and a local PCP stormwater outfall that had been buried.

West of the Taft Avenue Bridge overbank, flood flows extended south and cross 1st Street prior to the Taft Avenue – 1st Street intersection. The south span of the Taft Avenue Bridge was substantially blocked. Taft Avenue and 1st Street as well as the

Comparison between FEMA Effective 100-Year Floodplain (blue) and 2013 Flood Extents (red)



Reach 32 – Wilson-Taft: Wilson Avenue – Taft Avenue [2]

Master Plan, May 2015, Ayres Associates Completed in May 2015 to define an overall recovery vision and to identify priority projects for restoring more than 40 miles of the Big Thompson River. Flood Risk Assessment: 3.0 / 5 (5 = Fully in floodway, 1 = In 500-year flood fringe) Geomorphic Risk: 2.8 / 5 (5 = Greatest risk for potential lateral stream instability, 1 = Lowest risk for potential lateral

2015 Big Thompson River Restoration

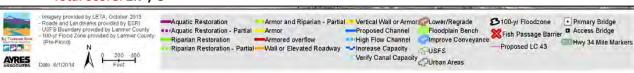
stream instability) Aquatic Habitat Improvement Potential:

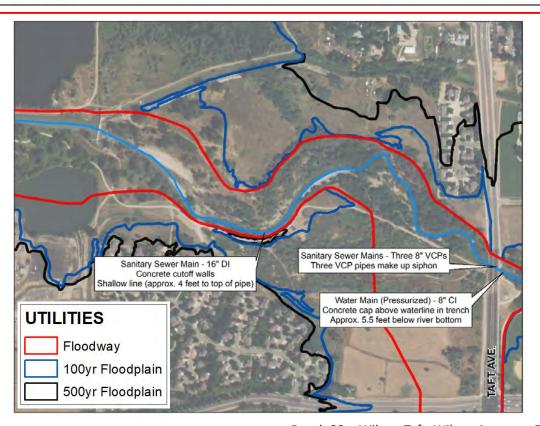
1.9 / 5 (5 = Little to no instream variability and establishment of aquatic habitat is recommended, 0 = No restoration is needed or possible)

Riparian Ecological Improvement

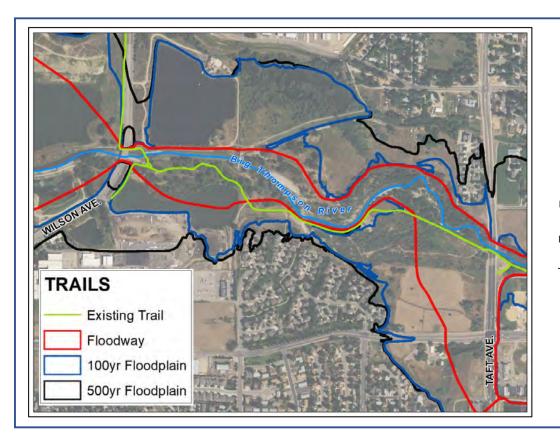
Potential: 3.0 / 5 (5 = High potential to assist natural riparian recovery processes, 1 = Little or no floodplain available, steep canyon walls, or relatively intact riparian habitat)

Total Score: 2.7 / 5





Reach 32 - Wilson-Taft: Wilson Avenue - Taft Avenue [3]



Recreation Trails:

There are existing recreation trails along the river within this reach. (Source: City of Loveland Recreation Trail & Bikeways Map)

Completed Projects (as of June 2017) – Public Projects

Wilson Avenue Pedestrian Bridge - Flood Recovery

- Part of the Wilson Ave to Taft Ave Flood Recovery Project.
- New 131-foot span pedestrian bridge, new abutments, trail realignment, bank grading and protection, creation of backwater area, thalweg realignment, and revegetation.
- Constructed in spring 2017.

Cottonwood Meadows Avulsion Area – Flood Recovery

- City flood recovery project to repair and protect existing utilities, realign and modify a major avulsion area, relocate the trail further from the channel, floodplain benching, lower the trail to provide better channel-floodplain connectivity, reconstruct a stormwater quality pond, clean up debris (car bodies) and concrete rubble from the channel, protect homes, reduce erosion potential, aquatic restoration, and revegetation.
- Construction started in December 2016 and was competed in May 2017.

Middle Trail - Flood Recovery

- Part of the Wilson to Taft Avenue Flood Recovery Project.
- Relocated trail away from the channel, removed debris (car bodies) and concrete rubble, regraded right bank, floodplain benching, bank protection, aquatic restoration, and revegetation.

Lower Trail – Flood Recovery

- Part of the Wilson to Taft Avenue Flood Recovery Project.
- Relocated a portion of trail that was too close to the channel and that was being undercut.
- Created a small floodplain bench, removed concrete rubble, bank protection, aquatic restoration, and revegetation.

Taft Avenue – Flood Recovery

- Part of the Wilson to Taft Avenue Flood Recovery Project.
- Regraded low area of overbank, installed culverts under the trail, and constructed a new trail connection to Taft Avenue.

Reach 32 – Wilson-Taft: Wilson Avenue – Taft Avenue [4]

Reach 33 - Taft-Railroad: Taft Avenue - Railroad Avenue

Reach Description: Reach 33 begins at the Taft Avenue Bridge. Flood recovery work was completed near the Taft Avenue Bridge, including filling a significant scour area from overtopping of Taft Avenue during the 2013 flood, regrading a small outfall channel, and constructing a new culvert under the recreational trail. The western end of this reach of the Big Thompson River borders Centennial Park to the south and private open land with just a few structures to the north. Portions of the recreational trail were replaced after the 2013 flood. As the river passes under the 1st Street Bridge, it is bordered by gravel pit ponds to the south, including River's Edge Natural Area, and industrial development to the north with sparse residential development. The Farmers Ditch diversion structure is located approximately 1,550 feet downstream of the 1st Street Bridge. Just west of Railroad Avenue, the river passes under a railroad bridge. Both the railroad bridge and the Railroad Avenue Bridge have small openings compared to other crossings upstream and downstream. A flood recovery project is proposed along Railroad Avenue, including raising part of Railroad Avenue. Reach 33 ends at Railroad Avenue.

Fish & Macroinvertebrate Data: Detailed fish and macroinvertebrate data have not been collected in this reach. Data collected within Reach 32 can be extrapolated to this reach since there are no fish barriers between reaches. See Reach 32 Fact Sheet for detailed fish and macroinvertebrate data.

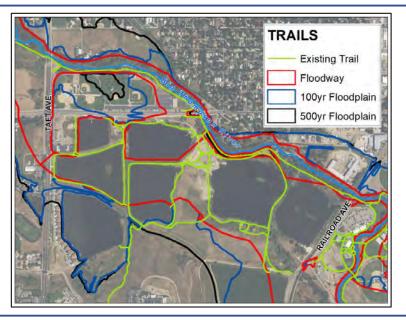
Floodplain Mapping Summary Information:

Effective Date of FEMA Mapping: December 19, 2006 FEMA Panel: 08069C1188F/08069C1189F 100-Year Peak Discharge FIS: 19,000 cfs CDOT July 2015 100-Year Peak Discharge: 18,900 cfs FEMA Flood Zones: Zone AE (Primary), AO, X BFE's from upstream to downstream: 4,970 ft – 4,950 ft

Irrigation Ditches: The Ryan Gulch Exchange returns water to the Big Thompson near the location of the Lake Loveland outlet return. Similar to the Mariano Exchange, the Ryan Gulch Exchange offsets storage in Lake Loveland and provides replacement water for changed shares of local mutual ditch companies. The Farmers Irrigation Canal diverts an average of 20 cfs from the Big Thompson just downstream of the Ryan Gulch Exchange return. The Jayhawker Ponds and River's Edge Natural Area ponds south of the Big Thompson are used primarily for fishing and recreation and managed by the City of Loveland Parks & Recreation Department.

Recreation Trails:

There are existing recreation trails within this reach.
There is an extensive soft trail network around the ponds in the River's Edge Natural Area (not shown in figure) (Source: City of Loveland Recreation Trail & Bikeways Map)



Land Use:

City of
Loveland
General Zoning
– Industrial,
Developing
Resource, Low
Density
Residential,
Business,
Planned Unit
Development,
Park, City
Natural Area
with Gravel
Pits

Water Quality:

CDPHE river segment: COSPBT04b Greeley-Loveland Canal diversion to CR11H

303(d) Impairment: Se

Priority: Low

Reach 33 – Taft-Railroad: Taft Avenue - Railroad Avenue [1]

Open Lands and Natural Areas:

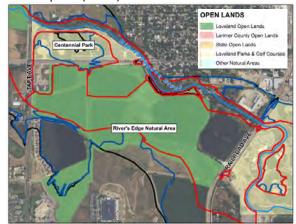
(Source: 2017 Field Observations by WWE)

This reach of the Big Thompson River consists almost entirely of parks and natural areas. Immediately downstream of Taft Avenue, Centennial Park occupies the south overbank of the river. This is a developed park with ball fields, paddle ball courts, restrooms, parking and other amenities. Currently, the park area is not oriented toward the river, and there are opportunities in this park area to encourage more river access.

Downstream from 1st Avenue on the south side of the river lie the Jayhawker Ponds and the River's Edge Natural Area. This natural area consists of multiple gravel pit ponds that provide excellent habitat for water fowl, fish, and other species. The Jayhawker Ponds and the River's Edge Natural Area were significantly affected by the 2013 flood when water spilled over Taft Avenue and flowed through the gravel pits in an uncontrolled manner. Conceptual plans have been developed to provide routing for flows through gravel pits in a way that will not cause severe erosion. The City owns nearly all of the natural areas in this gravel pit complex except for one gravel pit that is located immediately upstream from Railroad Avenue and Mineral Pond south of the Jayhawker Ponds.

The Jayhawker Ponds and the River's Edge Natural Area include amenities including parking lots, public restrooms, picnic areas, educational kiosks and interpretive signs, soft surface and concrete trails for hiking and biking, ADA fishing access, and wildlife viewing. Dogs are permitted in this natural area, but only if they are leashed.

The Open Lands figure below shows the Centennial Park and River's Edge Natural Area along with the floodway (red), 100-year floodplain (blue), and 500-year floodplain (black).



2013 Flood Observations:

(Source: Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery, October 2013, Ayres Associates.)

The bulk of the flood flows crossed over Taft Avenue in the vicinity of Taft Avenue and 1st Street intersection and passed south of 1st Street, bypassing the 1st Street Bridge. The left bank area and the central portion of the Centennial Park appear to be areas of high ground that were not significantly impacted by flood flows. For the most part, flood flows were confined between the Greeley-Loveland Canal and the Big Thompson Ditch.

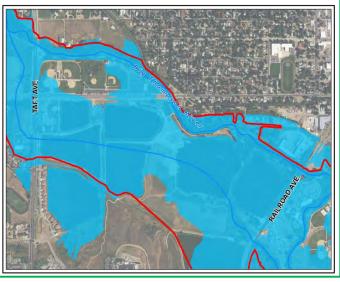
Extensive damage was done to 1st Street along Centennial Park. The medians, sidewalks, curbs, gutters, and other roadway features on 1st Street near Centennial Park experienced sedimentation and damage.

Overbank flows west of Taft Avenue and south of 1st Street caused headcutting along the west end of the gravel pits.

Overbank flow caused erosion, headcutting, and avulsions within the gravel ponds south of 1st Street. Extensive headcutting was caused by flows at the south of River's Edge Natural Area. Several underground utilities were exposed within this area.

Debris appears to have blocked portions of the Railroad Bridge. Some flow did overtop Railroad Avenue north of the bridge, as well as an overflow channel through River's Edge and across Railroad Avenue south of the private pond.

Comparison between FEMA Effective 100-Year Floodplain (blue) and 2013 Flood Extents (red)



Reach 33 - Taft-Railroad: Taft Avenue - Railroad Avenue [2]

2015 Big Thompson River Restoration Master Plan, May 2015, Ayres Associates

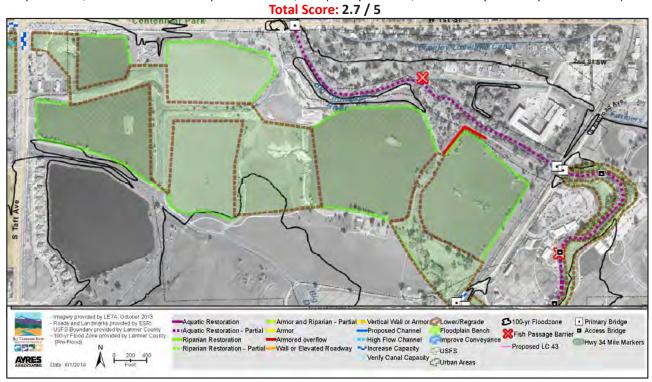
Completed in May 2015 to define an overall recovery vision and to identify priority projects for restoring more than 40 miles of the Big Thompson River.

Flood Risk Assessment: 3.7 / 5 (5 = Fully in floodway, 1 = In 500-year flood fringe)

Geomorphic Risk: 2.5 / 5 (5 = Greatest risk for potential lateral stream instability, 1 = Lowest risk for potential lateral stream instability)

Aquatic Habitat Improvement Potential: 1.2 / 5 (5 = Little to no instream variability and establishment of aquatic habitat is recommended, 0 = No restoration is needed or possible)

Riparian Ecological Improvement Potential: 3.5 / 5 (5 = High potential to assist natural riparian recovery processes, 1 = Little or no floodplain available, steep canyon walls, or relatively intact riparian habitat)



Completed Projects (as of June 2017) - Public Projects

Taft Ave Storm Sewer Outfall– Flood Recovery

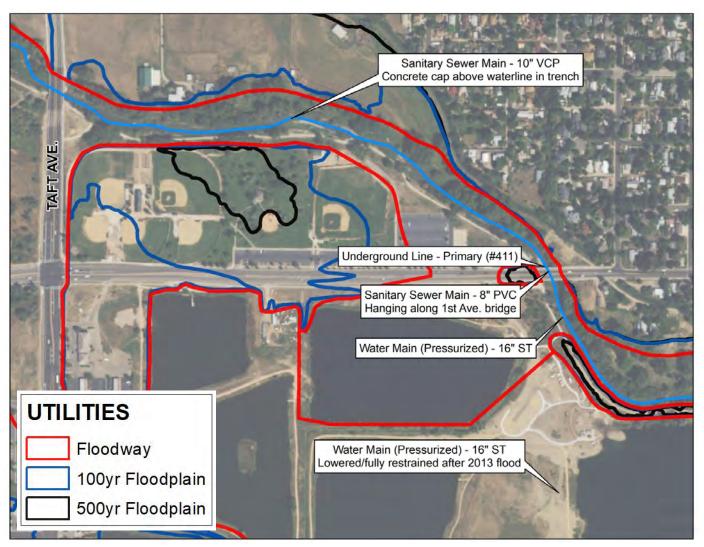
• Filled significant scour area from overtopping of Taft Avenue, regraded small outfall channel, and constructed new culvert under the trail.

Trail Replacement- Flood Recovery

• Replacement of destroyed pedestrian trail in various sections throughout the reach.

Rivers Edge Natural Area – Flood Recovery

- Entire park/natural area infrastructure was destroyed during 2013 flood.
- The flood recovery project redesigned it to better account for the flow paths and high velocities.





Reach 33 – Taft-Railroad: Taft Avenue - Railroad Avenue [4]

Reach 34 – Fairgrounds Park: Railroad Ave – Lincoln Ave (Hwy 287)

Reach Description: Reach 34 begins at the Railroad Avenue Bridge. Just downstream of the Railroad Avenue Bridge, the main channel runs from in a southeasterly direction by Fairgrounds Park. In the middle of this reach, the river bends and re-orients itself from west to east. A gravel pit pond borders the south side of the river, and a commercial property borders the north side of the river just west of Lincoln Avenue (Hwy 287). During the 2013 flood, some flow overtopped the Lincoln Avenue Bridge, but the majority of the flow overtopped Lincoln Avenue south of the main channel down to Highway 402. There is a proposed flood recovery project that consists of reconstructing a new bridge at Lincoln Avenue, raising of Lincoln Avenue, and significant channel floodplain benching. Reach 34 ends at Lincoln Avenue (Hwy 287).

Floodplain Mapping Summary Information:

Effective Date of FEMA Mapping: December 19, 2006

FEMA Panel: 08069C1189F

100-Year Peak Discharge FIS: 19,000 cfs

CDOT July 2015 100-Year Peak Discharge: 20,400 cfs FEMA Flood Zones: Zone AE (Primary), AO, X

BFE's from upstream to downstream: 4,950 ft – 4,933 ft

Irrigation Ditches: This stretch of the Big Thompson sees no diversions as it collects a minor amount of return flows from the ponds and canals nearby.

Water Quality:

CDPHE river segment: COSPBT04b - Greeley-Loveland

Canal diversion to CR11H 303(d) Impairment: Se

Priority: Low

Land Use:

City of Loveland General Zoning – Developing Resource, Industrial, Business, Planned Unit Development, Central Business, Parks

Fish & Macroinvertebrate Data: Detailed fish and macroinvertebrate data have not been collected in this reach.



Reach 34 – Fairgrounds Park: Railroad Ave – Lincoln Ave (Hwy 287) [1]

Open Lands and Natural Areas:

(Source: 2017 Field Observations by WWE)

As with Reach 33, Reach 34 contains public lands along most of the river corridor. In this reach, the Big Thompson River runs through Fairgrounds Park, which is a developed park with parking, restrooms, ball fields, picnic shelters, a "splash pad" and many other features. This is a heavily used portion of the river corridor. While most portions of the park consist of irrigated turf, the area along the river is more natural. Heavy vegetation exists along the river bank for most of the reach through the park, and access is provided to the river at several locations via social trails and a designated access point with concrete steps near the playground. The character of the river corridor is more natural on the southeastern portion of the site, and the buffer that is provided between trails and the river in this area provides some habitat benefits along the stream.

The figure below shows the Fairgrounds Park along with the floodway (red), 100-year floodplain (blue), and 500-year floodplain (black).



2013 Flood Observations:

(Source: Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery, October 2013, Ayres Associates.)

Because of the channel alignment and the fact that most of the flows are conveyed in the overbank, the channel appeared stable in this reach.

Most of the flood flows entered this reach by overtopping the railroad grade and Railroad Avenue. Both the railroad grade and Railroad Avenue roadway were impacted by scour and headcutting at multiple locations.

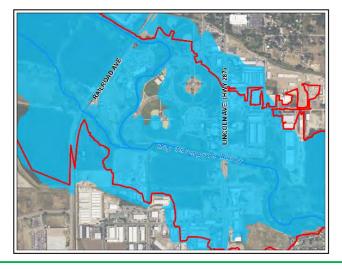
Fairgrounds Park was greatly impacted by the flooding with areas of sedimentation, debris, headcutting, and scour holes resulting in multiple areas of infrastructure damage.

Overtopping of Railroad Avenue occurred near a local drainage ditch south of Fairgrounds Park and extended along the roadway. The culverts under the roadway were blocked by debris and subsequently bent and destroyed on the upstream end which likely contributed to some of the overtopping.

South of Fairgrounds Park, overbank flows damaged the fire training grounds and began headcutting from flows overflowing into the gravel pond to the east.

Overbank flows returning to the main channel upstream of the Lincoln Avenue Bridge created pockets of scour on both banks. Stormwater pipes were exposed and damaged on the left bank area upstream of the bridge.

Comparison between FEMA Effective 100-Year Floodplain (blue) and 2013 Flood Extents (red)



Reach 34 – Fairgrounds Park: Railroad Ave – Lincoln Ave (Hwy 287) [2]

2015 Big Thompson River Restoration Master Plan, May 2015, Ayres Associates Completed in May 2015 to define an overall recovery vision and to identify priority projects for restoring more than 40 miles of the Big Thompson River. Flood Risk Assessment: 4.1 / 5 (5 = Fully in floodway, 1 = In 500-year flood fringe) Geomorphic Risk: 2.5 / 5 (5 = Greatest risk for potential lateral stream instability, 1 = Lowest risk for potential lateral stream instability) Aquatic Habitat Improvement Potential: 1.3 / 5 (5 = Little to no instream variability and establishment of aquatic habitat is recommended, 0 = No restoration is needed or possible) Riparian Ecological Improvement Potential: 4.0 / 5 (5 = High potential to assist natural riparian recovery processes, 1 = Little or no floodplain available, steep canyon walls, or relatively intact riparian habitat) Total Score: 3.0 / 5 Fish Passage Barrier Access Bridge Aguatic Restoration - Partial

Recreation Trails: There are existing recreation trails within this reach. There are also many sidewalks and soft trails within Fairgrounds Park. (Source: City of Loveland **Recreation Trail & Bikeways** Map)



High Flow Channel

Increase Capacity

UTILITIES Floodway ater Main (Pressurized) - 6" PVC 100yr Floodplain 500yr Floodplair nitary Sewer Main - 18" VC Sanitary Sewer Main - 24" CIP Concrete-cap Water Main (Pressurized) - 6" CI Pre-cast concrete anchors and concrete cutoff wall Approx, 4.5 feet below river bottom Vater Main (Pressurized) - 8" PVC Installed after 2013 flood Nater Main (Pressurized) - 8" PVC Installed after 2013 flood

Completed Projects (as of June 2017) – Public Projects

Fire Training Grounds/Barnes Park—Flood Recovery

- Exigent work to block a major avulsion at the northeast corner of the Fire Training Grounds then two phases of a flood recovery project to make permanent repairs.
- Work included removal of concrete rubble and debris, bank regrading and protection (buried riprap), grading of a backwater eddy area, lowering and erosion protection of the avulsion site, repair of the South Loveland Outfall Stormwater Channel, and replacement of trail.

Fire Training Grounds – Flood Recovery

- Extensive flood damage to this facility.
- The buildings and infrastructure was repaired after
- Approximately \$1M in damages and closure of the training facility for a year.

Fairground Park – Flood Recovery

- Extensive debris removal.
- Repair of damages to infrastructure (i.e. play areas, water feature, etc.).
- Removal of the old Larimer County Fairgrounds Grand Stands, which were destroyed.
- No work done in the channel or to the banks.

Proposed Projects – Public Projects

Hwy 287- Flood Mitigation Project

- This proposed project stems from the recently completed Hwy 287 Flood Mitigation Feasibility
- Project consists of constructing a new 240-foot highway bridge, raising of Hwy 287 from the bridge to approximately Hwy 402, and significant channel floodplain benching.

Railroad Ave – Flood Recovery Work

- Proposed project design is complete and waiting for final permitting clearances.
- The project consists of constructing a new 100foot span bridge over the south secondary channel (replacing existing 96-in culvert), raising part of Railroad Avenue to help protect Fairgrounds Park, shifting flow paths when the railroad tracks overtop, protecting the road grade from scour, removing Fire Engine Red Road to the Fire Training Grounds, re-establishing the confluence between the south secondary channel to the main channel, and building new entrances into the Fire Training Grounds.

Reach 34 – Fairgrounds Park: Railroad Ave – Lincoln Ave (Hwy 287) [4]

Proposed LC 43

Reach 35: Lincoln - St. Louis Lincoln Ave (Hwy 287) - St. Louis Ave

Reach Description: Reach 35 begins at Lincoln Avenue (Hwy 287). Just downstream of the Lincoln Avenue Bridge, the river is bordered by a large automobile commercial business to the north and King's Crossing Natural Area to the south. The south bank north of Waterford Apartments is protected by a conservation easement limiting development. The area in the immediate vicinity of the Lincoln Avenue Bridge is located in a high-risk flood zone with an inadequate floodplain corridor, undersized bridge, and developed floodplain. The City desires to change the direction of infrastructure and land use decisions in this area to a plan based on long-term resiliency by creating a more sustainable and economically stable environment for future community business development. Just west of St. Louis Avenue begins the transition from the urban segment of the Big Thompson River to the rural segment. Reach 35 ends at St. Louis Avenue.

Water Quality:

CDPHE river segment: COSPBT04b - Greeley-Loveland Canal diversion to CR11H

303(d) Impairment: Se

Priority: Low

Fish & Macroinvertebrate Data: Detailed fish and macroinvertebrate data have not been collected in this reach. Data collected within Reach 36 can be extrapolated to this reach since there are no fish barriers between reaches. See Reach 36 Fact Sheet for detailed fish and macroinvertebrate data.

Floodplain Mapping Summary Information: Effective Date of FEMA Mapping: December 19, 2006 FEMA Panel: 08069C1189F 100-Year Peak Discharge FIS: 19,000 cfs CDOT July 2015 100-Year Peak Discharge: 20,400 cfs FEMA Flood Zones: Zone AE (Primary), AO, X BFE's from upstream to downstream: 4,933 ft – 4,923 ft

Irrigation Ditches: This stretch of the Big Thompson sees no diversions as it collects a minor amount of return flows from the ponds and canals nearby.

Land Use:

City of Loveland General Zoning -Industrial, Developing Resource, Business, Planned Unit Development, Developing Resource



Open Lands and Natural Areas:

(Source: 2017 Field Observations by WWE)

The primary publicly-owned natural area along these streets is the King's Crossing Natural Area, which is just east of Lincoln Avenue on both sides of the Big Thompson River. This natural area is home to raptors and songbirds that like the large cottonwoods, and mammals including deer, fox and raccoons find habitat in the dense riparian vegetation and in shrub cover in overbanks. In recent years, removal of invasive Russian Olive trees has helped native vegetation to thrive. The King's Crossing Natural Area includes a parking area south of the river and a soft-surface trail for dog walking and wildlife viewing. On the north side of the river, the concrete bike path extends for several hundred feet and then turns north towards downtown. Currently, only social trails exist further to the east. The dense vegetation cover along the stream bank in this reach has made it a desirable location for the homeless population to congregate.

There is an existing gravel pit pond that lies east of the King's Crossing Natural Area. This is currently a privately owned natural area. This is an area where the City may want to consider acquiring an easement to allow a regional trail to connect through this reach to the old St. Louis Natural Area that is just downstream of St. Louis Avenue. The gravel pit that is just east of King's Crossing has high enhancement potential and could provide a good "pocket" park for development that will occur in this area.

The King's Crossing Natural Area includes parking areas, informational kiosks, soft trails for hiking and biking, fishing access, and wildlife viewing areas. Dogs are nermitted if they are leashed



2013 Flood Observations:

(Source: Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery, October 2013, Ayres Associates.)

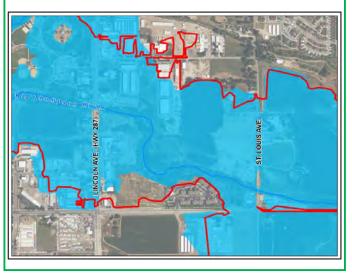
Some overbank flow crossed Lincoln Avenue north of the bridge and continued east through areas with several commercial buildings. Flow exiting the Lincoln Ave Bridge expanded abruptly causing some local erosion and sedimentation on both banks downstream of the bridge. Most of the flow was conveyed in the right overbank over Lincoln Ave. There was significant damage to the commercial area just east of the roadway.

Some erosion occurred along the top of the bank east of the business area as flows entered and crossed the main channel. Headcutting and erosion occurred from overbank flows into and through the gravel ponds on the left overbank area.

About 750 feet upstream of St. Louis Avenue there was a complete blockage across the channel.

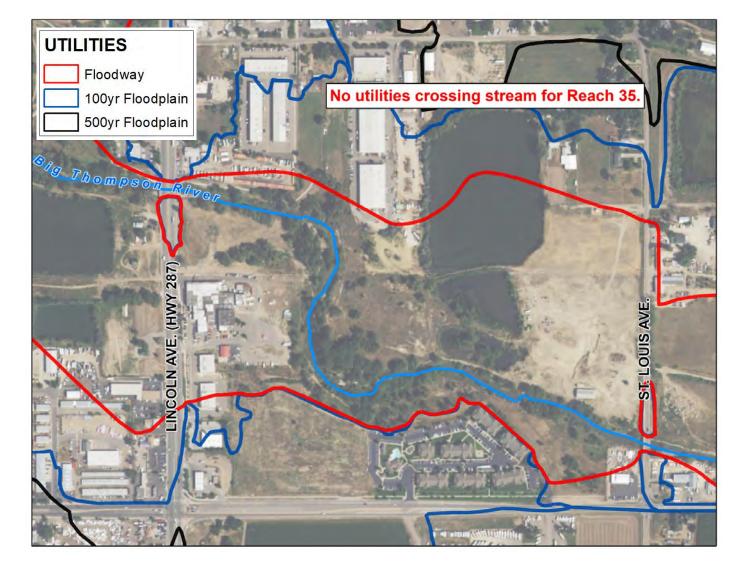
The right bank upstream of the St. Louis Ave Bridge experienced some erosion during the flood. At St. Louis Ave most of the flow overtopped the roadway north of the bridge. There is a new USGS radar type gage installed on the upstream side of the bridge.

Comparison between FEMA Effective 100-Year Floodplain (blue) and 2013 Flood Extents (red)



Reach 35 – Lincoln-St. Louis: Lincoln Ave (Hwy 287) - St. Louis Ave [1]

Recreation Trails – There are existing recreation trails within this reach. There is a soft trail on the southern portion of the King's Crossing Natural Area. (Source: City of **Loveland Recreation TRAILS** Trail & Bikeways Map) **Existing Trail** Floodway 100yr Floodplain 500yr Floodplair



Reach 35 – Lincoln-St. Louis: Lincoln Ave (Hwy 287) - St. Louis Ave [3]

2015 Big Thompson River Restoration Master Plan, May 2015, Ayres Associates

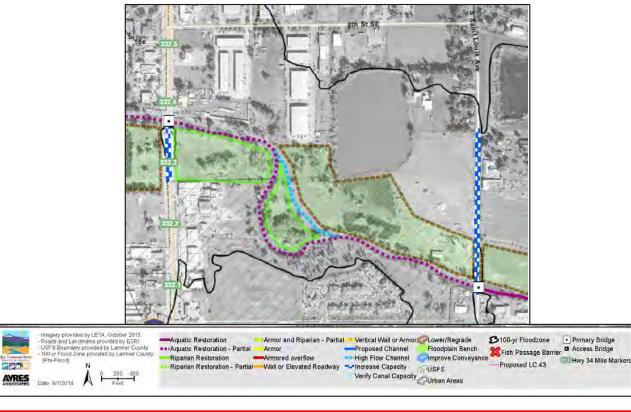
Completed in May 2015 to define an overall recovery vision and to identify priority projects for restoring more than 40 miles of the Big Thompson River.

Flood Risk Assessment: 3.5 / 5 (5 = Fully in floodway, 1 = In 500-year flood fringe) Geomorphic Risk: 2.5 / 5 (5 = Greatest risk for potential lateral stream instability, 1 = Lowest risk for potential lateral stream instability)

Aquatic Habitat Improvement Potential: 1.0 / 5 (5 = Little to no instream variability and establishment of aquatic habitat is recommended, 0 = No restoration is needed or possible)

Riparian Ecological Improvement Potential: 4.0 / 5 (5 = High potential to assist natural riparian recovery processes, 1 = Little or no floodplain available, steep canyon walls, or relatively intact riparian habitat)

Total Score: 2.8 / 5



Completed Projects (as of June 2017) - Public Projects

Lincoln Avenue Bridge – Flood Recovery

- Exigent work done by CDOT to repair significant scour damage to the bridge, including installation of scour countermeasures under the entire structure.
- The north abutment and both piers were undermined during the 2013 flood.
- The City replaced the destroyed pedestrian underpass.
- Work also included channel grading up and downstream, removal of many feet of deposition in the channel, opening the channel section upstream of the bridge, bank protection, removal of trees, and revegetation.

Proposed Projects – Public Projects

- **Highway 287– Flood Mitigation Project**
- This proposed project stems from the recently completed Highway 287 Flood Mitigation Feasibility Study.
- Project consists of constructing a new 240foot highway bridge, raising of Highway 287 from the bridge to approximately Highway 402, and significant channel floodplain benching.

Reach 36 – St. Louis-Boise: St. Louis Ave - Boise Avenue (CR 11)

Reach Description: Reach 36 begins at St. Louis Avenue. This segment of the Big Thompson River is within a rural portion of Larimer County. During the 2013 flood, most of the flow overtopped St. Louis Avenue north of the bridge. The USGS Big Thompson River at Loveland stream gauge is located approximately 700 feet downstream of the St. Louis Avenue Bridge. The main channel flows north midway through this reach between two gravel pit ponds and then back to the east. As the river turns back to the east, the Madison Avenue storm outfall enters from the north. During the 2013 flood, most of the flood flow overtopped Boise Avenue south of the bridge. Reach 36 ends at Boise Avenue.

Floodplain Mapping Summary Information:

Effective Date of FEMA Mapping: December 19, 2006 FEMA Panel: 08069C1189F/ 08069C1193F 100-Year Peak Discharge FIS: 19,000 cfs CDOT July 2015 100-Year Peak Discharge: 20,400 cfs FEMA Flood Zones: Zone AE (Primary), AH, X

BFE's from upstream to downstream: 4,923 ft – 4,912 ft

Water Quality:

CDPHE river segment: COSPBT04b - Greeley-Loveland

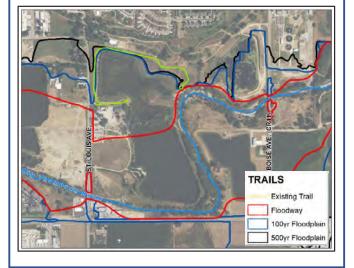
Canal diversion to CR11H 303(d) Impairment: Se

Priority: Low

Land Ownership Land Ownershi

Irrigation Ditches: This stretch of the Big Thompson sees no diversions as it collects a minor amount of return flows from the ponds and canals nearby. The Big Thompson River at Loveland, Colorado USGS gage is located on the stretch of river just north of Colorado Highway 402.

Recreation Trails: There are some social trails within the Old St. Louis Natural Area. (Source: City of Loveland Recreation Trail & Bikeways Map)



Land Use:

City of Loveland General Zoning – Developing Resource, Multiple Gravel Pits along River

Reach 36 – St. Louis - Boise: St. Louis Ave - Boise Avenue (CR 11) [1]

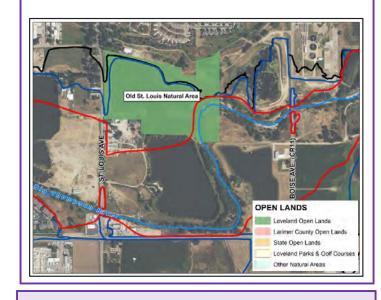
Open Lands and Natural Areas:

(Source: 2017 Field Observations by WWE)

The City owns the Old St. Louis Natural Area that lies just east of St. Louis Avenue and north of the river. Willows and small cottonwoods are establishing on the site, providing habitat for amphibians and songbirds. Deer, fox, raccoons and mink have been observed on this site. The gravel pit lake is currently empty. The natural area/gravel pit located to the south of the Old St. Louis Natural Area is privately owned, as well as the pond and river banks west of Boise on the south side of the river. These are two areas where the City could consider obtaining an easement for a trail and/or maintenance of the river in the future or acquiring property for City open

The Old St. Louis Natural Area includes amenities such as a parking area, informational kiosks, soft surface trails for hiking and biking, fishing access, and wildlife viewing. Dogs are permitted in this natural area as long as they are leashed.

The Open Lands figure below shows the Old St. Louis Natural Area along with the floodway (red), 100-year floodplain (blue), and 500-year floodplain (black).



Proposed Projects – Public Projects

Madison Avenue Outfall- Flood Repair and Water Quality

- City currently designing a replacement of the failing grouted riprap/rubble drop structure into the river.
- Includes a large stormwater quality treatment BMP for the Madison Avenue outfall.

2013 Flood Observations:

(Source: Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery, October 2013, Ayres Associates.)

Flows expanded downstream of the St. Louis Avenue Bridge causing erosion along the left bank and the removal of several large cottonwood trees that were deposited downstream. Most flow overtopped the St. Louis Avenue north of the bridge.

The USGS gaging station located about 700 feet downstream of the bridge was damaged during the flooding. Existing bank protection along the south bank east of the USGS gage remained intact during the flood.

Flood waters did access the floodplain south of Highway 402 but there did not appear to be any overtopping of the roadway through this reach.

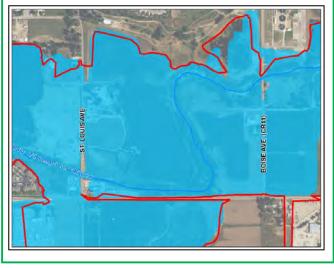
Left overbank flows entering and crossing the channel along this section caused several areas of erosion and headcutting.

As flows crossed the main channel and overtopped the right bank into the eastern gravel ponds, additional headcutting and erosion occurred on the western edge of the pond.

Flows eroded the right bank upstream of the Boise Avenue Bridge shifting the bank south by about 40 feet at its apex. The upstream right abutment of the bridge experienced significant abutment scour.

As flows crossed Boise Avenue, most of the flood flow overtopped the roadway south of the bridge.

Comparison between FEMA Effective 100-Year Floodplain (blue) and 2013 Flood Extents (red)



2015 Big Thompson River Restoration Master Plan, May 2015, Ayres Associates

Completed in May 2015 to define an overall recovery vision and to identify priority projects for restoring more than 40 miles of the Big Thompson River.

Flood Risk Assessment: 3.8 / 5 (5 = Fully in floodway, 1 = In 500-year flood fringe)

Geomorphic Risk: 2.0 / 5 (5 = Greatest risk for potential lateral stream instability, 1 = Lowest risk for potential lateral stream instability)

Aquatic Habitat Improvement Potential: 1.4 / 5 (5 = Little to no instream variability and establishment of aquatic habitat is recommended, 0 = No restoration is needed or possible)

Riparian Ecological Improvement Potential: 4.0 / 5 (5 = High potential to assist natural riparian recovery processes, 1 = Little or no floodplain available, steep canyon walls, or relatively intact riparian habitat) Total Score: 2.8 / 5





Fish & Macroinvertebrate Data:

(Source: Big Thompson River Water Quality Biosurvey Annual Reports, CSU Environmental Health Services) Biosurvey conducted at Site #3 at Wastewater Treatment Plant - River Mile 24.4

2012 – Benthic data demonstrated that the Big Thompson River was in good health. Data suggest that study site was only slightly-impaired. Based on the fish population data, study site is considered fair condition (however, data limited due to cold water and low flow).

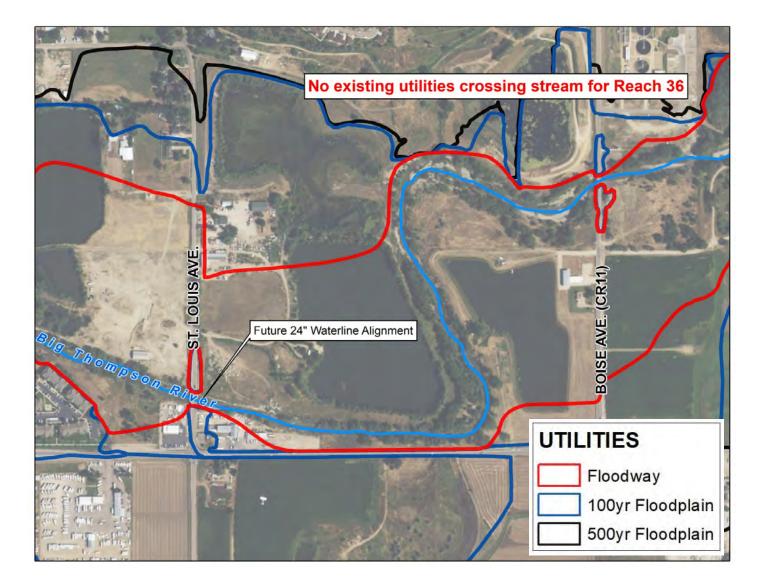
2014 - Benthic data demonstrated that the Big Thompson River is in good health and only slightly-impaired. Based on the fish population data, study site is considered good condition.

2016 – Benthic data demonstrated that the Big Thompson River was in moderately good health and are slightly to moderately impaired. Based on the fish population data, study site is considered fair condition.

Fish Species Observed:

- Brown Trout
- White Sucker
- Central Stoneroller
- Sunfish
- Creek Chub
- Fathead Minnow
- Black Crappie
- Johnny Darter
- Largemouth Bass
- Green Sunfish
- Longnose Dace
- Brook Stickleback
- Longnose Sucker
- Bluegill

Reach 36 – St. Louis - Boise: St. Louis Ave - Boise Avenue (CR 11) [3]



Reach 37 – Boise-CR 9E: Boise Avenue (CR 11) – CR 9E

Reach Description: Reach 37 begins at Boise Avenue. Downstream of the Boise Avenue Bridge, the pre-2013 flood channel was approximately 40 feet wide, and the new channel is approximately 100 feet wide in places. The Wastewater Treatment Plant is located on the north side of the river just east of Boise Avenue with a sanitary return flow channel back into the Big Thompson River. There is a slight floodplain constriction about 900 feet east of Boise Avenue caused by high ground to the north and south. The Denver Avenue outfall discharges just as the river bends to the south. This outfall was destroyed during the 2013 flood, and since the City does not own the property around the outfall, proper stabilization of the bank has not yet been conducted. There is a large gravel pit pond along the west side of the river. 2013 flood flows did not appear to overtop CR 9E south of the bridge. Most of the flow overtopped the roadway north of the bridge. Reach 37 ends at CR 9E.

Floodplain Mapping Summary Information:

Effective Date of FEMA Mapping: December 19, 2006 FEMA Panel: 08069C1193F/ 08069C1194F 100-Year Peak Discharge from FIS: 19,000 cfs

CDOT July 2015 100-Year Peak Discharge: 20,400 cfs

FEMA Flood Zones: Zone AE (Primary), X

BFE's from upstream to downstream: 4,912 ft – 4,885 ft

Irrigation Ditches: The City of Loveland Wastewater Treatment Plant returns flows to the river downstream of Boise Avenue. The City of Loveland Waste Water Treatment Plant has been approved for an expansion to treat 10 million gallons per day (MGD) and allowing for up to 12 MGD for an additional 10 to 15 years of growth in the area.

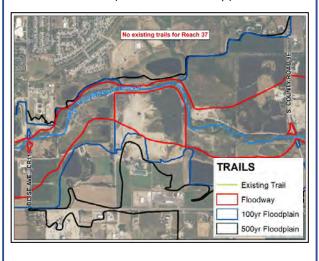
Water Quality:

River segment not listed as a CDPHE impaired water.

Land Ownership



Recreation Trails: There are no existing recreation trails within this reach, but there are some soft trails within the Willow Bend Park and Natural Area and within the Simpson ponds State Wildlife Area (not shown on map).



Land Use:

City of Loveland General Zoning -Developing Resource, Multiple **Gravel Pits along River**

Fish & Macroinvertebrate Data:

(Source: Big Thompson River Water Quality Biosurvey Annual Reports, CSU Environmental Health Services)

Biosurvey conducted at Site #4 below Wastewater Treatment Plant to River Mile 23.1

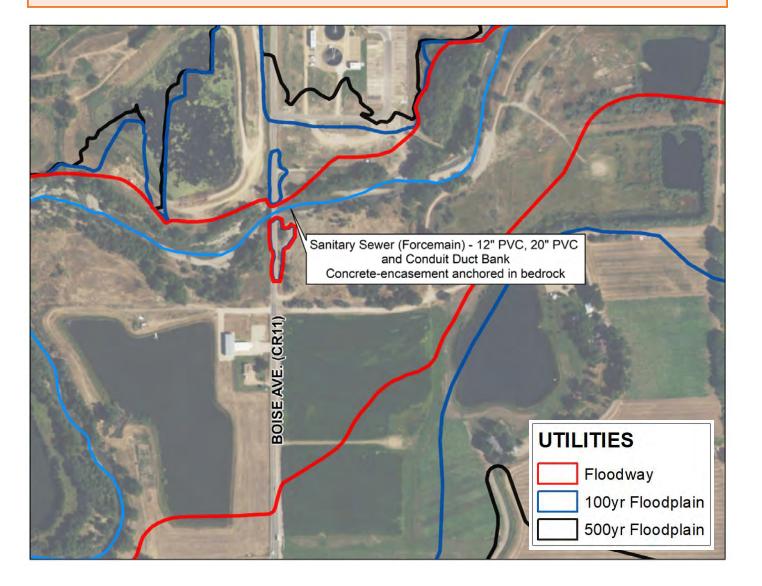
2012 – Benthic data demonstrated that the Big Thompson River was in good health. Data suggest that study site was only slightlyimpaired. Based on the fish population data, study site is considered poor condition (however, data limited due to cold water and low flow).

2014 – Benthic data demonstrated that the Big Thompson River is in good health and only slightly-impaired. Based on the fish population data, study site is considered poor condition.

2016 – Benthic data demonstrated that the Big Thompson River was in moderately good health and are slightly to moderately impaired. Based on the fish population data, study site is considered fair condition.

Fish Species Observed:

- Bluegill
- Black Crappie
- Brown Trout
- Central Stoneroller
- Common Carp
- Creek Chub
- Johnny Darter
- Largemouth Bass
- Longnose Dace
- Rainbow Trout
- Yellow Perch
- White Sucker
- Green Sunfish
- Longnose Sucker
- Spottail Shiner
- Longnose x White Hybrid
- Fathead Minnow



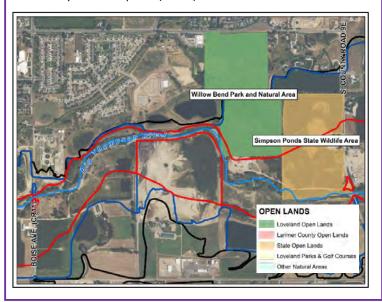
Open Lands and Natural Areas

(Source: 2017 Field Observations by WWE)

There are two significant natural areas along this reach of the Big Thompson River: the Willow Bend Park and Natural Area and the Simpson Ponds State Wildlife Area. The Willow Bend Park and Natural Area is a new City natural area, and plans for public access are currently being developed. The City is working with the local community to obtain input on potential amenities such as trails, community gardens, outdoor classrooms, biking features, fishing and river access. Developing a trail that will connect this natural area to other areas further to the west will be important for the long-term use of this area.

The Simpson Ponds State Wildlife Area is adjacent to the Willow Bend Park and Natural Area and provides additional opportunities for fishing and wildlife viewing. There is a good parking area for the Simpson Ponds State Wildlife Area off of CR 9E, but other facilities and amenities benefiting both of these areas may need to be considered as use increases in the future.

The Open Lands figure below shows the Willow Bend Park and Natural Area and Simpson Ponds State Wildlife Area along with the floodway (red), 100-year floodplain (blue), and 500-year floodplain (black).



2013 Flood Observations

(Source: Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery, October 2013, Ayres Associates.)

The channel downstream of the Boise Avenue bridge was widened by the erosion of the right bank. The pre-flood channel was approximately 40 feet wide and the new channel is 100 feet wide in places. This erosion caused the failure of the sewer main crossing under the river.

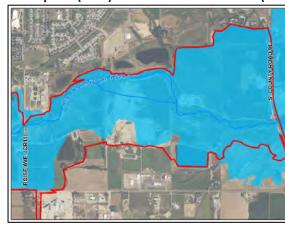
The overbank flows that overtopped Boise Avenue moved east through corn fields and then north towards the abandoned gravel pits. Significant erosion occurred as flow passed through a floodplain constriction 900 feet east of Boise Ave followed abruptly by the deposition of the eroded material. Overbank flows caused headcutting and the failure of the local access road north of the private pond.

The main channel avulsed into the gravel pits just downstream of the sanitary return flow channel. As the river bends to the south, the left bank eroded back about 50 feet causing the storm outfall pipe and headwall to fail into the shifted channel.

As the flood continued downstream flows spilled into the left overbank and headed north in to the gravel ponds and abandoned pits. The private residences/commercial buildings in this area received a large amount of flow and sedimentation.

Flow did not appear to overtop CR 9E south of the bridge. Most of the flow overtopped the roadway north of the bridge. The CR 9E Bridge did experience pressure flow during the flood.

Comparison between FEMA Effective 100-Year Floodplain (blue) and 2013 Flood Extents (red)



Reach 37 - Boise-CR 9E: Boise Avenue (CR 11) - CR 9E [3]

2015 Big Thompson River Restoration Master Plan, May 2015 Ayres Associates

Completed in May 2015 to define an overall recovery vision and to identify priority projects for restoring more than 40 miles of the Big Thompson River.

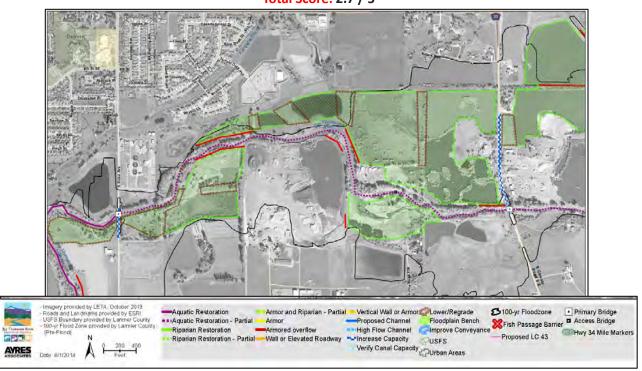
Flood Risk Assessment: 2.3 / 5 (5 = Fully in floodway, 1 = In 500-year flood fringe)

Geomorphic Risk: 2.5 / 5 (5 = Greatest risk for potential lateral stream instability, 1 = Lowest risk for potential lateral stream instability)

Aquatic Habitat Improvement Potential: **0.9 / 5** (5 = Little to no instream variability and establishment of aquatic habitat is recommended, 0 = No restoration is needed or possible)

Riparian Ecological Improvement Potential: 5.0 / 5 (5 = High potential to assist natural riparian recovery processes, 1 = Little or no floodplain available, steep canyon walls, or relatively intact riparian habitat)

Total Score: 2.7 / 5



Completed Projects (as of June 2017) – Public Projects

Denver Ave Outfall – Flood Recovery

- Channel migrated north-northeast and destroyed this 48-inch storm sewer outfall due to severe bank erosion on the outside of this bend.
- Outfall was reconstructed back into the bank.
- FEMA funding was not available for stabilizing the bank/bend around the outfall because the City does not own the property (City has an easement for the outfall).

Reach 37 – Boise-CR 9E: Boise Avenue (CR 11) – CR 9E [4]

Reach 38 – Downstream of CR 9E

Reach Description: Reach 38 begins at CR 9E. The north side of the river is bordered by gravel pit ponds and the south side is bordered by rural development with a few residential properties. The Boyd Lake Outlet discharges into the Big Thompson River approximately 4,000 feet downstream of CR 9E. The downstream study limit is just downstream of the Boyd Lake Outlet. In the future, Boyd Lake Avenue is expected to extend to the south at the downstream end of this study reach. The future road alignment runs on an embankment between two gravel pit ponds.

Floodplain Mapping Summary Information:

Effective Date of FEMA Mapping: December 19, 2006

FEMA Panel: 08069C1194F

100-Year Peak Discharge from FIS: 19,000 cfs CDOT July 2015 100-Year Peak Discharge: 21,000 cfs

FEMA Flood Zones: Zone AE (Primary), X

BFE's from upstream to downstream: 4,885 ft – Limit of Detailed Study

Land Use:
City of Loveland
General Zoning –
Developing Resource,
Multiple Gravel Pits

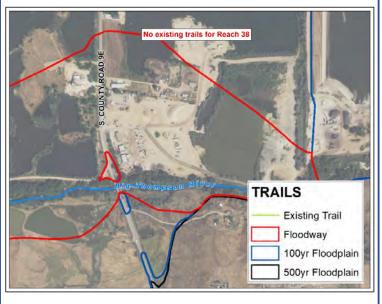
along River

Land Ownership



Irrigation Ditches: The City of Evans delivers water for its municipal use and to maintain historical return flows that have been treated by the City of Greeley back to the Big Thompson River approximately 4,000 feet downstream of CR 9E. The Boyd Lake Reservoir Outlet has returned an average of approximately 100 cfs of water when releases are made to the Big Thompson.

Recreation Trails: There are no existing recreation trails within this reach. (Source: City of Loveland Recreation Trail & Bikeways Map)



Water Quality:

River segment not listed as a CDPHE impaired water.

Fish & Macroinvertebrate Data:

(Source: Big Thompson River Water Quality Biosurvey Annual Reports, CSU Environmental Health Services)

Biosurvey conducted at Site #4 below Wastewater Treatment Plant to River Mile 23.1

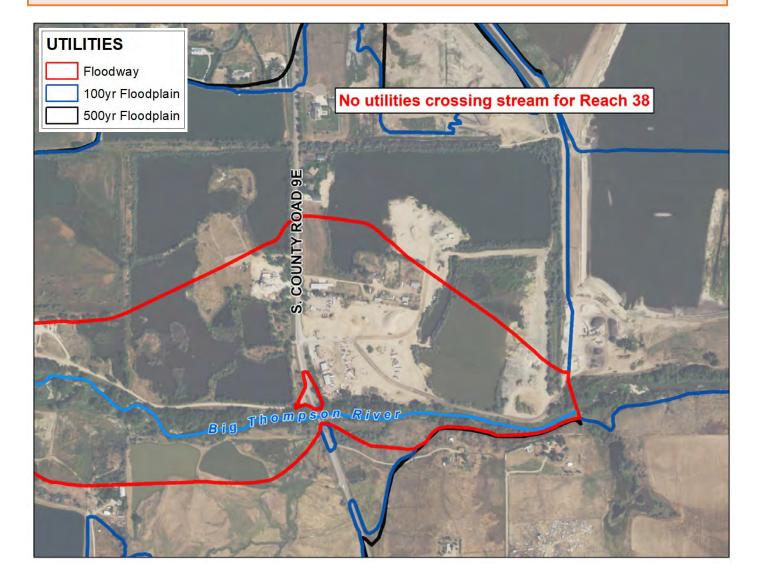
2012 – Benthic data demonstrated that the Big Thompson River was in good health. Data suggest that study site was only slightly-impaired. Based on the fish population data, study site is considered poor condition (however, data limited due to cold water and low flow).

2014 – Benthic data demonstrated that the Big Thompson River is in good health and only slightly-impaired. Based on the fish population data, study site is considered poor condition.

2016 – Benthic data demonstrated that the Big Thompson River was in moderately good health and are slightly to moderately impaired. Based on the fish population data, study site is considered fair condition.

Fish Species Observed:

- Bluegill
- Black Crappie
- Brown Trout
- Central Stoneroller
- Common Carp
- Creek Chub
- Johnny Darter
- Largemouth Bass
- Longnose Dace
- Rainbow Trout
- Yellow Perch
- White Sucker
- Green Sunfish
- Longnose Sucker
- Spottail Shiner
- Longnose x White Hybrid
- Fathead Minnow

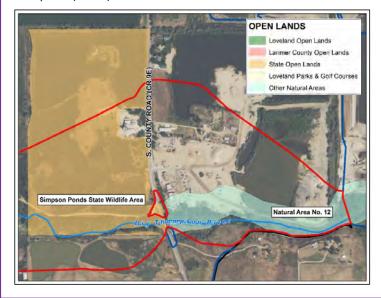


Open Lands and Natural Areas:

(Source: 2017 Field Observations by WWE.)

Natural Area Number 12, along the Big Thompson River east of County Road 9E, has a good overall habitat rating and high potential for enhancements. This is a linear section of land with multiple owners that runs along the river from County Road 9E to the east. This is a privately owned natural area, but is an area where it would be desirable to have a trail extending further to the east in the future. In addition, if an easement or future purchase can be worked out to provide access to some of the gravel pits, that could provide good wildlife viewing opportunities and passive recreational benefits.

The Open Lands figure below shows the Simpson Ponds State Wildlife Area and Natural Area Number 12 along with the floodway (red), 100-year floodplain (blue), and 500-year floodplain (black).



2013 Flood Observations:

(Source: Geomorphic Assessment of the Big Thompson River Through the City of Loveland: 2013 Post-Flood Recovery, October 2013, Ayers Associates.)

As flow overtopped CR 9E it caused erosion and headcutting along the road embankment and into the Kauffman and Sons business. Overbank flows spread throughout all of the ponds north of the river downstream of this location. High ground along the south bank of the river forced all of the flow into the channel and north floodplain.

As flows continued east it avulsed through multiple gravel pits and through the Boyd Lake outlet ditch about 2,400 feet north of its confluence with the main channel. Additional erosion occurred south of the avulsion and almost eroded around a culvert. Flooding also flowed from the main channel north through the Boyd Lake outlet. The left bank of the ditch failed about 550 feet north of the confluence with the main channel. As the canal nears the main channel both embankments are not longer present and the canal passes through a small, partially filled, culvert under an access road. About a 300 foot section of the canal needs to be reconstructed at the avulsion site, including the reinforcement of the culvert under the local access road.

Comparison between FEMA Effective 100-Year Floodplain (blue) and 2013 Flood Extents (red)



2015 Big Thompson River Restoration Master Plan, May 2015, Ayres Associates

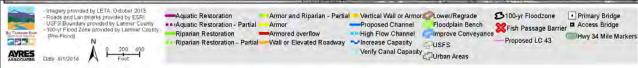
Completed in May 2015 to define an overall recovery vision and to identify priority projects for restoring more than 40 miles of the Big Thompson River.

Flood Risk Assessment: 3.2 / 5 (5 = fully in floodway, 1 = in 500-year flood fringe) Geomorphic Risk: 2.0 / 5 (5 = Greatest risk for potential lateral stream instability, 1 = Lowest risk for potential lateral stream instability)

Aquatic Habitat Improvement Potential: 1.0 / 5 (5 = Little to no instream variability and establishment of aquatic habitat is recommended, 0 = No restoration is needed or possible)

Riparian Ecological Improvement Potential: 5.0 / 5 (5 = High potential to assist natural riparian recovery processes, 1 = Little or no floodplain available, steep canyon walls, or relatively intact riparian habitat) Total Score: 2.8 / 5



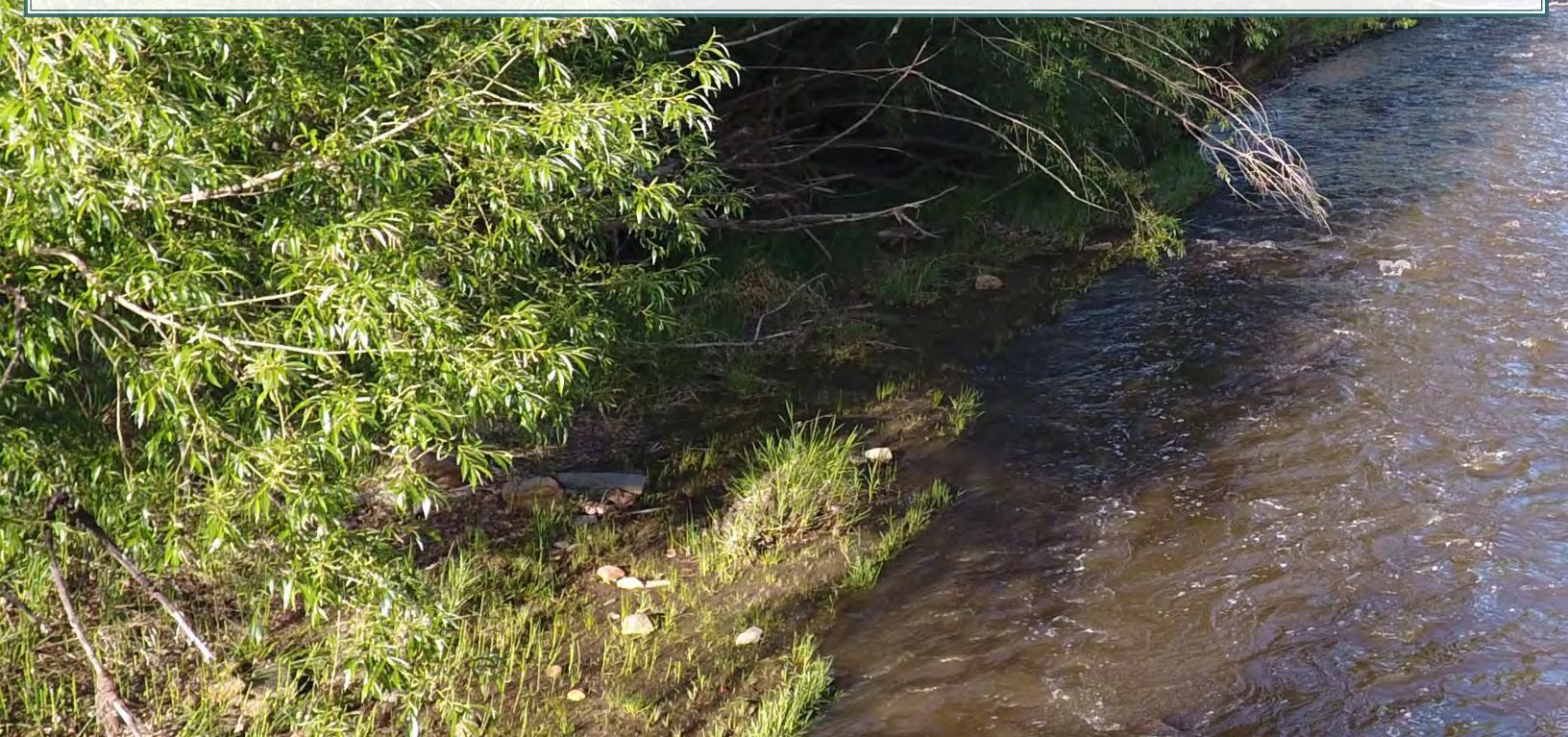


Reach 38 – Downstream of CR 9E [3] Reach 38 – Downstream of CR 9E [4]



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3.0 BASELINE RESILIENCE ASSESSMENT

While the preservation of natural areas along the Big Thompson River helped to avoid extensive flood damages in September 2013, some portions of the Big Thompson River Corridor lack resilience due to past infrastructure decisions, encroachments, and manmade modifications to the river channel and floodplain. The 2013 flood and previous smaller floods have proven that the river corridor cannot sufficiently handle even moderate-sized flood events without damages and significant negative impacts to infrastructure along the corridor. One of the major goals of this Master Plan is to lay the groundwork for increasing resilience within the Big Thompson River Corridor through the Loveland area so that the Big Thompson River Corridor can better absorb, adapt to, and recover from future large flood events.

3.1 RESILIENCE SCORECARD

Resilience metrics were developed to evaluate the baseline condition of each reach. A list of resilience metrics was provided in the request for proposals for the Master Plan. The project team used this list as a starting point and refined the resilience metrics by modifying and combining some and adding some additional metrics. The resilience metrics were grouped into the following general categories:

Flood Hazards

Natural Areas/Open Space

Geomorphology

Aquatic Habitat

Parks & Recreation

Trails

Utilities

Water Quality

Gravel Pits

• Land Use.

Within each resilience assessment category, there are between two to twelve quantitative or qualitative metrics. Raw scoring criteria ranging from zero to 10 were defined for each resilience metric for consistency between all metrics. A raw score of zero is indicative of no resilience and an increase in the raw score is indicative of the increase in resilience, to a maximum score of 10, indicating the maximum resilience. Therefore, the higher the score, the more resilient the reach is. Resilience score cards for existing conditions are located in Appendix C, including scoring criteria/questions and raw scoring data. Reference to the resilience score cards in Appendix C is necessary to understand the types of information that the resilience scoring was based on.

Rank	Resilience Assessment Area	Weighting Factor
1	Flood Hazards	3
2	Water Quality	3
3	Geomorphology	3
4	Gravel Pits	3
5	Natural Areas/Open Space	2
6	Land Use	2
7	Utilities	2
8	Aquatic Habitat	1
9	Trails	1
10	Parks and Recreation	1

Table 3-1. Resilience Assessment Category Weighting Factors



None of the roadways within the Loveland area have 100-year capacity, including Rossum Drive. There are ten road crossings between the Morey Wildlife Reserve and the downstream study limit. While it would be ideal to improve all of these road crossings to remain passable in a 100-year event, it would be extremely expensive given the magnitude of the 100- year peak discharge, Therefore, the Master Plan recommends improvements for major arterials on a prioritized basis to improve north-south connectivity in a major flood in the most cost effective way.



Project team members, including engineers, planners, biologists, and geomorphologists, floating down the Big Thompson River. Floating the river provided a vantage point that was not achievable from road crossings, bike paths, and pedestrian trails, and helped the project team gain a much better understanding of the existing conditions of the Big Thompson River Corridor.

The scoring criteria for the quantitative metrics (i.e., number of structures in the 500-year floodplain) were developed by taking the minimum and maximum value for the criterion for all of the reaches evaluated and using the minima and maxima to bracket the scoring of all reaches between zero and 10. The scoring criteria for the qualitative metrics (i.e., channel aesthetics) were determined based on the difference between the "worst" reach and the "best" reach evaluated for each criterion. The scoring criteria were assigned after reviewing each of the individual reaches to be able to "calibrate" the scoring criteria to actual observations of the Big Thompson River Corridor.

In addition to the general resilience assessment categories described above, an additional category was added to address the potential for flood damages to urban infrastructure/2013 observations. This category is based on actual observations from the 2013 flood and the potential for flood damages to urban infrastructure. This category differs from the Flood Hazard category since the Flood Hazard category is comprised of more quantitative metrics (i.e., assessed value of structures in 100-year floodplain). The potential for flood damages to urban infrastructure is qualitatively scored based on knowledge of the corridor. For this category, each of the reaches were scored based on a score of zero having the highest potential for damages to urban infrastructure and extreme damage during the 2013 flood and a score of 10 having the lowest potential for damages to urban infrastructure and no damage during the 2013 flood.

3.2 BASELINE FOR RESILIENCE SCORES

Extensive research was conducted to assign a score for each of the resilience metrics. For the quantitative metrics, many scores could be assigned based on desktop analysis of information available from the GIS database (i.e., number of structures in floodplains, area of floodplains, area of natural areas, number of utility crossings, etc.). Some of the quantitative metric scores were assigned based on results from the effective HEC-RAS floodplain models for the Big Thompson River (i.e., frequency of out-of-bank flow, depth of roadway overtopping, flow velocities, etc.).

The qualitative metric scores required much more research and comparison between each of the reaches. In addition



Floating the Big Thompson River provided the opportunity to observe the conditions between road crossings from the level of the river. Severe bank erosion with cut banks of ten feet or more were observed in some areas. In other areas, banks support healthy riparian vegetation with more connection between the channel and the floodplain. The Master Plan provides recommendations for bank stabilization along portions of some reaches based on other recent plans and field observations in the summer of 2017.



Project team members rode their bikes along all of the accessible trails along the Big Thompson River Corridor within the study limits. This helped the project team identify gaps and potential enhancements that could be made to the trail system as part of the Master Plan. Based on conversations with members of the public at summer outreach events, the bike trails are one of the most popular recreational features of the corridor.

Resilience Assessment Category	Reach 29: Morey-Rossum	Reach 30: Rossum- Namaqua	Reach 31: Namaqua-Wilson	Reach 32: Wilson-Taft	Reach 33: Taft-Railroad	Reach 34: Railroad-Hwy 287	Reach 35: Hwy 287-St. Louis	Reach 36: St. Louis-Boise	Reach 37: Boise-CR 9E	Reach 38: CR 9E-D/S Limit
Flood Hazards	18	18	21	17	17	16	12	22	14	24
Aquatic Habitat	5	4	5	5	8	9	8	8	7	7
Natural Areas/Open Space	11	8	8	11	12	7	8	8	10	9
Geomorphology	22	18	12	15	12	18	18	18	21	20
Parks and Recreation	5	2	3	5	9	10	2	4	3	3
Trails	3	3	3	8	10	9	4	3	3	3
Utilities	9	10	12	9	12	9	15	15	10	15
Water Quality	20	24	3	11	11	11	11	14	15	18
Gravel Pits	24	0	0	0	0	0	24	0	0	0
Land Use	13	7	9	11	14	11	5	9	6	8
Potential for Flood Damages to Urban Infrastructure/2013 Observations	25	25	30	25	10	0	0	35	35	40
Reach Total Score	70	53.9	48.1	53.8	52	45	48.4	62	56	67

Table 3-2. Baseline Resilience Assessment Results (Green shading indicates a reach had the highest resilience score in a category; pink shading indicates the lowest score in a category. There are many ties for highest and lowest scores among similar reaches)

to reviewing previous reports and planning documents, mapping, and review of the reach Fact Sheets, extensive field research was conducted to gain a much better understanding of the river corridor. Initially, field research was limited to being able to see the river from looking upstream and downstream at road crossings and from traveling the bike and pedestrian trails along the river. While this provided a good overview of some portions of the river, there were many portions of the river, especially on the west and east ends of the project limits, that are not easily accessed except by going down the river.

Therefore, in early July 2017, after notification to individual property owners adjacent to the Big Thompson River Corridor within the project limits, members of the project team floated the nine-mile stretch of the Big Thompson River Corridor using a variety of water craft including a kayak, two paddle boards, and inner tubes. Project team members included engineers, planners, biologists, and geomorphologists which allowed for an evaluation of the Big Thompson River from multiple disciplines. During the float trip, all of the project team members were struck by the hidden beauty of the Big Thompson River along any of the reaches. While there is still some work to be done, many portions of the river have recovered well from the 2013 flood. In order to best understand the project area, photographs and videos of the conditions along the river were taken and geo-referenced to document observations from the float trip. The observations from the float trip were documented on a photographic "storyboard" that shows geo-referenced photos by reach in a spatial graphical user interface. The "storyboard" is available on the project website (www.ABetterBigT.com) and is electronically archived in files provided to the city. Project team members took notes during the float trip, and over lunch at Fairgrounds Park, the project team discussed observations during the float trip and provided some preliminary scoring to the qualitative metrics.

In addition, members of the project team rode their bikes along all of the accessible trails along the Big Thompson River Corridor within the study limits, gaining a much better understanding of the gaps and potential enhancements that could be made to the trail system. Geo-referenced photographs were also taken during the bike trail tour allowing for documentation of the existing conditions of the trail systems. A "storyboard" is also provided for photos from the bike tour on www.ABetterBigT.com. This bike trail tour provided good information to be able to score the resilience metrics within the trail assessment category.

Based on all of the data collection and field reconnaissance, raw scores were assigned to each of the resilience metrics. The scoring of the resilience metrics was reviewed by multiple team members of varying disciplines to provide a collaborative agreement on the scoring based on observations from the field.

3.2.1 Resilience Assessment Area Weighting

The cumulative raw baseline scores for each of the reaches are not indicative of the baseline resilience of the reaches because the assessment categories have different numbers of questions and different potential total scores for each resilience category. In addition, some categories, such as flood hazards, are of greater significance to public safety than others. During the July 14, 2017 TAC and Stakeholder meetings, the project team asked the TAC and the Stakeholders to rank the 10 assessment categories based on resilience with a one having the highest resilience and 10 having the lowest resilience. The results of this exercise helped determine the associated weighting of the assessment categories to calculate the cumulative baseline resilience score for each reach.

To develop weighting factors, the results from the TAC and Stakeholder rankings were used to assign a "high," "medium," or "low" weight to each resilience assessment category. The "high" weighting factor assessment categories were assigned a weighting factor of three, the "medium" weighting factor assessment categories were assigned a weighting factor of two, and the "low" weighting factor assessment categories were assigned a weighting factor of one. Table 3-1 summarizes the resilience assessment category weighting factors.

Additionally, the Potential for Flood Damages to Urban Infrastructure/2013 Observations category was assigned a weighting factor of 5 since this category is based on actual observations during the 2013 flood.

The raw baseline resilience scores were normalized for each resilience category, multiplied by the resilience assessment category weighting factors, and normalized again to a scale of zero to 100 to provide a weighted cumulative baseline resilience score for each reach.

3.3 BASIS RESILIENCE ASSESSMENT RESULTS

Rank (Based on Highest Score)	Baseline Resilience Assessment Score	Reach
1	70	Reach 29: Morey - Rossum
2	67	Reach 38: CR 9E - D/S Limit
3	62	Reach 36: St. Louis - Boise
4	56	Reach 37: Boise - CR 9E
5	53.9	Reach 30: Rossum - Namaqua
6	53.8	Reach 32: Wilson - Taft
7	52	Reach 33: Taft - Railroad
8	48.4	Reach 35: Hwy 287 - St. Louis
9	48.1	Reach 31: Namaqua - Wilson
10	45	Reach 34: Railroad - Hwy 287

Table 3-3. Ranking of Baseline Resilience Assessment Scores

The cumulative baseline resilience score is based on a maximum score of 100. Table 3-2 provides a summary of the weighted baseline resilience assessment results. The cells highlighted in pink indicate that they are the lowest score within the resilience assessment category. The cells highlighted in green indicate that they are the highest score within the resilience assessment category. This color designation provides a quick overview of some of the resilience assessment category deficiencies within each reach and/or the resilience assessment categories that scored high compared to other reaches.

The rankings of the reaches based on the baseline resilience assessment scores appears to be consistent with what can be expected based on the desktop analysis of each of the reaches and the observations from the field. The following summarizes major factors that affect the baseline resilience assessment score for each reach:

• Rank #1 - Reach 29: Morey Wildlife Reserve - Rossum Drive:

Reach 29 ranked the highest in the geomorphology assessment category although during the September 2013 flood, a lot of deposition occurred in this reach. The river bed and bank is very stable and has an open floodplain with good connectivity with the channel along most of the reach. Within Reach 29 there are no gravel pits (one gravel pit in the Morey Wildlife Reserve was filled in during the September 2013 flood). Reach 29 also has little development and is bordered by City of Loveland-owned Mariana Butte Golf Course along the southern bank of the Big Thompson River. Reach 29 ranked the lowest (along with several other reaches which had the same score) in the trails assessment category since there is no regional trail extending to this reach.

• Rank #2 - Reach 38: CR 9E - D/S Limit:

Reach 38 ranked the highest in the flood hazard assessment category. This reach has the least amount of land in the floodplain, but it is also the shortest reach. There are very few structures in the floodplain and there are no roads within this reach, all of which result in a higher flood hazard assessment category score. Reach 38 also ranked the highest in the utility assessment category (along with several other reaches which had the same score) since there are no utility crossings of the Big Thompson River within this reach. Reach 38 ranked the lowest in the gravel pit assessment category (along with the majority of the other reaches which had the same score) since there was extensive damage to the gravel pits during the 2013 flood. All of the property in this reach is privately owned with the exception of the future Boyd Lake Avenue right-of-way. In addition, there are no trails along this portion of the river causing this reach to have the lowest score in the trail assessment category (along with several

other reaches with the same score). The reach also scored the highest for potential for flood damages to urban infrastructure/2013 observations since there is little development along this reach with no road crossings and there was little damage during the 2013 flood.

• Rank #3 - Reach 36: St. Louis Avenue - Boise Avenue:

Reach 36 scored the lowest in the trails assessment category (along with several other reaches which had the same score) since there are no existing trails along this reach. It also scored the lowest (along with the majority of the other reaches) in the gravel pit assessment category since the gravel pits were affected by the 2013 flood. There are no utility crossings of the Big Thompson River in this reach which results in the highest utility assessment score, along with several other reaches. Reach 36 ranked the second-highest in the flood hazard assessment category since there is very little development in the floodplain. This reach scored the second highest in the potential for flood damages to urban infrastructure/2013 observations since there is little urban development and minimal damages during the 2013 flood.

Rank #4 - Reach 37: Boise Avenue - CR 9E:

Reach 37 scored the lowest in the trails and gravel pit assessment categories and scored the second lowest in the flood hazard assessment category since there is a lot of land within the 100- and 500-year floodplains and the depth of overtopping of CR 9E during a 100-year event. There are no existing trails within this reach. During the 2013 flood, the main channel avulsed into the gravel pits and the pond side of the embankment was fractured and sloughing.

Rank #5 - Reach 30: Rossum Drive - Namaqua Avenue:

Reach 30 scored the lowest in the aquatic habitat assessment category since the Big Barnes Ditch at the downstream end of Reach 29 can divert the entire flow from the Big Thompson River and cause a dry-up point within this reach. In addition, there is a diversion structure upstream of Namaqua Avenue that is not a fish passable structure. There is no data available on the fish and macroinvertebrate counts and species within Reach 30. Reach 30 also scored the lowest within the trail assessment category (along with several other reaches with the same score) since there is an existing trail for only a portion of this reach. During the 2013 flood, there was avulsion into the sand and gravel pit on the left bank. Avulsion into the pit captured all of the in-bank river flow and abandoned the old channel for a significant distance downstream. Flow in the pit avulsed into and out of the next pit and back into the channel. Therefore, this reach also scored the lowest for the gravel pit assessment category, along with the majority of the other reaches with the same score. In addition, Reach 30 scored the lowest in the parks and recreation assessment category since there are no parks along this reach, access to the river is via steep banks, and there is a diversion structure just upstream of Namaqua Avenue. Reach 30 scored the highest in the water quality assessment category since there is low turbidity and this reach is listed for a single impairment of medium priority.

• Rank #6 - Reach 32: Wilson Avenue - Taft Avenue:

Reach 32 had scores in the middle of all of the other reaches for most of the assessment categories. Reach 32 scored the lowest in the utility assessment category (along with one other reach with the same score) since there are approximately five utility crossings of the Big Thompson River, some of which there is no existing information on the protection of the utility. This reach also scored low in the gravel pit assessment category since the gravel pits experienced avulsion during the 2013 flood.



Reach 29: Morey Wildlife Reserve – Rossum Drive ranked the highest in the baseline resilience assessment. This reach has a very stable river bed and bank and has an open floodplain with good connectivity with the channel along most of the reach.



Reach 36: St. Louis Avenue - Boise Avenue had many areas of trees and debris accumulated along the channel banks which can create hazards. Reach 36 has a broad floodplain with very little development in the floodplain. The benefits of woody debris in the channel for aquatic habitat must be balanced with potential for debris to cause issues downstream and safety. In more rural reaches, debris like this is of lower concern than in more urban areas where use of the river by the public is more common and there is more infrastructure that can be affected by debris.



Reach 37: Boise Avenue – CR 9E ranked fourth in the baseline resilience assessment. This reach scored the lowest in the trail and gravel pit assessment categories (along with several other reaches) and the flood hazard assessment category because of the amount of land within the 100-year and 500-year floodplains. This reach also contains several areas of bank erosion.



Reach 30: Rossum Drive - Namaqua Avenue includes the Rist-Goss Ditch diversion dam, which is a barrier to fish passage. The BTWC has funds for design and implementation of improvements to the Rist-Goss ditch and associated infrastructure. At the time of the development of this Master Plan, the BTWC is working with Otak on an 80% conceptual design from Rossum Drive to Wilson Avenue, which focuses on channel restoration and conceptual plans for avulsion areas. In addition, Larimer County is working on the Namaqua Bridge Replacement Project which consists of widening the Namaqua Avenue Bridge and removal of the grade control structure immediately downstream of the bridge.

• Rank #7 - Reach 33: Taft Avenue - Railroad Avenue:

Reach 33 had the highest score in the natural areas/open space assessment category and the trails assessment category because of the River's Edge Natural Area which is one of the most developed and utilized natural areas within the project limits with an abundant presence of wildlife habitat and trails. This reach also ranked the highest in the land use assessment category (along with one other reach with the same score) since all but one parcel is owned by the City of Loveland within this reach. This reach had a moderate score in the flood hazard assessment category since there are few structures in the 100- and 500-year floodplains, but there is overtopping of 1st Street and Railroad Avenue during flooding events.

• Rank #8 - Reach 35: Lincoln Avenue - US Highway 287 - St. Louis Avenue:

Although Reach 35 ranked the lowest in several of the assessment categories including flood hazards, parks and recreation, and land use, it scored the highest in the gravel pit assessment category (along with Reach 29 which had the same score) since the one gravel pit in this reach was not significantly affected during the 2013 flood. Reach 35 also scored the highest (along with several other reaches which had the same score) in the utilities assessment category since there are no utility crossings of the Big Thompson River in this reach. This reach ranked the lowest in the flood hazard assessment category due to the number of structures in the 100-year and 500-year floodplains and the assessed value of the structures in the 100-year floodplain. This reach also scored the lowest in the potential for flood damages to urban infrastructure/2013 observations assessment category, which has the highest weighting, since this reach has a lot of structures and had the greatest cost of flood damages during the 2013 flood.



Reach 32: Wilson Avenue - Taft Avenue ranked #6 in the baseline resilience assessment. This reach ranked the lowest in the utility assessment category since there are approximately five utility crossings of the Big Thompson River, some of which there is no existing information on the protection of the utility.



Reach 33: Taft Avenue – Railroad Avenue ranked seventh in the baseline resilience assessment. The majority of this reach is owned by the City of Loveland, including the popular River's Edge Natural Area. 1st Street and Railroad Avenue both overtop during major flooding events. The City has plans for a new Railroad Avenue Bridge and southern overflow channel to convey flows from the gravel pits west of Railroad Avenue back to the main channel of the river in Fairgrounds Park.



Reach 35: Hwy 287 - St. Louis Avenue ranked eighth in the baseline resilience assessment. However, this reach ranked the lowest in the flood hazard assessment category due to the number of structures in the 100-year and 500-year floodplains.

Rank #9 - Reach 31: Namaqua Avenue - Wilson Avenue:

Reach 31 had the second lowest overall baseline resilience score of all of the other reaches. One of the main factors affecting the baseline resilience score is that this reach has the lowest score for the water quality assessment category. The Mariano Exchange Ditch discharges fine sediment from Boedecker Reservoir into the Big Thompson River just upstream of Wilson Avenue (there are times when a sediment plume can be seen in the Big Thompson River). This discharge not only increases the turbidity for all of the downstream reaches, but it also increases the temperature of the Big Thompson River. Reach 31 also scored the lowest within the geomorphology assessment category since the river is leveed on both sides and not connected to the floodplain and there are areas of bank erosion that are currently stabilized with concrete rubble. During the 2013 flood, all of the gravel pits along the north side of the river were linked by avulsion, giving this reach the lowest score (along with the majority of the other reaches with the same score) for the gravel pit assessment category.

• Rank #10 - Reach 34: Railroad Avenue - Lincoln Avenue - US Highway 287:

Out of the ten assessment categories, Reach 34 either had the highest score or the lowest score for six of the assessment categories. Reach 34 scored the highest in the aquatic habitat, parks and recreation, and land use (along with one other reach with the same score) assessment categories. In terms of aquatic habitat, this reach has very diverse macroinvertebrate species, good shade, good planform and structure, and no fish passage barriers. Reach 34 scored the lowest in the natural areas/open space assessment category because there are no city-owned natural areas within this reach since the reach is predominately Fairgrounds Park. There is also little wildlife within this reach due to the higher level of use by the community. Reach 34 also scored the lowest in the utility assessment category (along with one other reach with the same score) since there are approximately six utility crossings of the Big Thompson River within this reach. This reach scored low for the gravel pit assessment category since there was avulsion into a gravel pit during the 2013 flood. Lastly, this reach scored lowest for the potential for flood damages to urban infrastructure/2013 observations assessment category since there are a lot of structures within this reach and this reach had the highest cost in flood damages as a result of the 2013 flood.



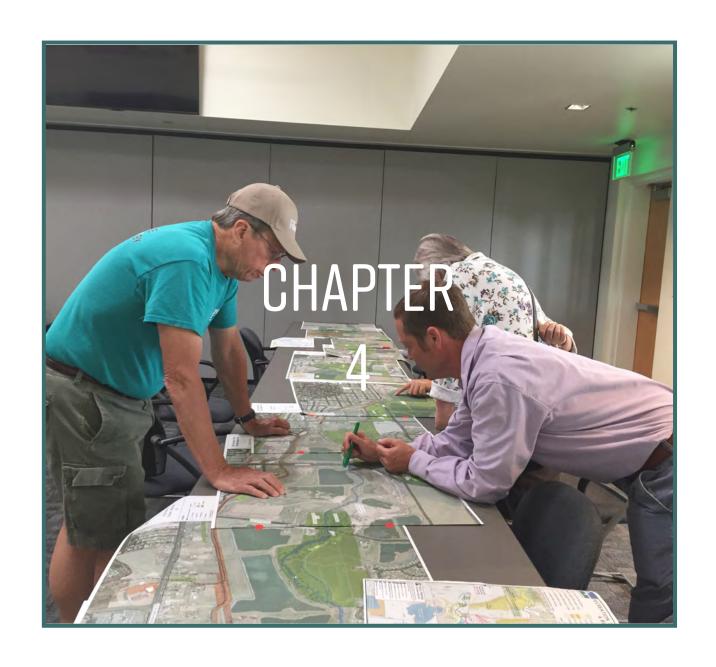
Reach 31: Namaqua Avenue – Wilson Avenue ranked ninth in the baseline resilience assessment. The Mariano Exchange Ditch discharges fine sediment from the Boedecker Reservoir into the Big Thompson River just upstream of Wilson Avenue, significantly affecting the water quality of the Big Thompson River downstream.



Reach 34: Railroad Avenue – Hwy 287 is dominated by Fairgrounds Park which provides pedestrian trails and water access locations. This is the only current formalized river access location along the Big Thompson River within the study limits. This is a heavily used area in the summer. To provide more opportunities for the public to interact with the river, the Master Plan proposes several additional designated areas for the public to access the river.

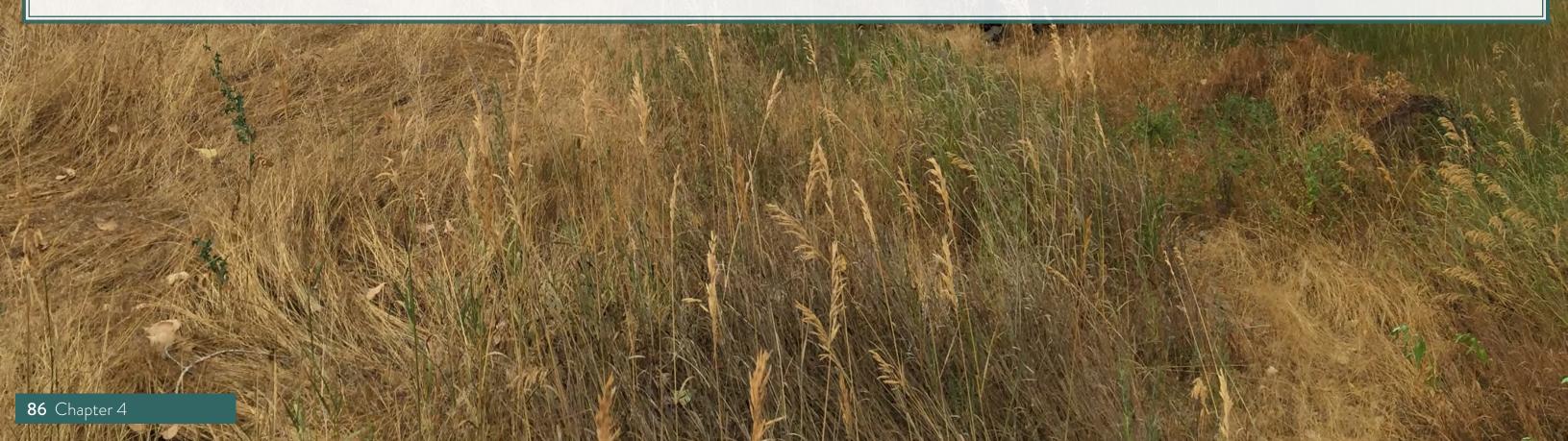


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4.0 PUBLIC OUTREACH

At the beginning of the planning process, a comprehensive public outreach strategy was developed in order to reach residents of the City of Loveland and surrounding areas and to facilitate productive engagement between these residents and the project team. This strategy included the following elements and ran through the duration of the project:

- Participation in major City summer events including the 4th of July Celebration, The Cherry Pie Festival, and the Corn Roast Festival, as well as select Farmers' Markets and Foote Lagoon concerts
- Organizing and conducting a two-day Strategic Planning Workshop to obtain public input as plans were being formulated
- Creation and operation of a project website with information on public outreach events, project updates, and a news blog
- Creation and distribution of an online public survey through Open City Hall, social media, and the website.

Together, these elements gave members of the public the platform to voice their opinions and ideas about design decisions along the corridor and provided the project team with valuable local knowledge upon which design decisions could be based. The goals of this process were as follows:

- 1. Give the community a voice to share their perception of the value of the Big Thompson River Corridor and develop local knowledge of the river corridor for key members of the project team.
- 2. Promote awareness of the Master Plan vision and excite community awareness for the potential of this plan to provide additional wide-ranging benefits to the public from flood hazard reduction to recreation to environmental restoration.
- 3. Foster a consensus for a shared future vision of the Big Thompson River Corridor.

Transparency was essential in achieving these goals and maintaining community support for this project. Summaries of the events, site analysis, and design decisions were published on the project website, and members of the public were encouraged to contact the project team with questions and comments about the project. This approach, along with intensive personal engagement with community members, lead to an open public outreach process and helped foster community consensus for this Master Plan.

4.1 COMMUNITY EVENTS

The public outreach process included participation in a series of community events. At these events the master planning effort was introduced, preliminary site analysis information was shared, and master planning concepts were discussed. The project team developed a series of exhibits mounted on foam board to introduce the project to the public and gather input. These exhibits are included in Appendix B of the Master Plan. Public input was encouraged through comment slips, interaction with presentation boards, and opportunities to sign up for the e-mail newsletter.

4.1.1 National Bike and Trails Day

The first community event took place at the City of Loveland's National Bike and Trails Day on Saturday, June 3rd at Fairgrounds Park. Parks and Recreation staff, Public Works staff and the Youth Advisory Commissioners combined efforts to initiate summer festivities with this family-friendly bicycling event. The Wilson Pedestrian Bridge was officially inaugurated with a ribbon cutting that morning, and events such as a youth bike rodeo, skate park demos and live music took place. City staff and the project team presented the current status of the master planning process to the public at one of the informational booths at Fairgrounds Park.



Jodi Lessman of the City Public Works Department explains boards that provide an overview of the river corridor and Master Plan objectives to interested citizens. Project team members and City staff attended multiple summer events to solicit input from the public and to explain major goals of the Master Plan to local residents.

4.1.2 North Lake Park 4th of July

Public outreach continued with an information booth set up at the 4th of July celebration at North Lake Park in Loveland. Presentation boards of potential site amenities were presented with photo images showing existing conditions and proposed conditions. This allowed community members review project information and talk about different ideas that they would like to see along the river corridor. The celebration included a wide variety of vendors and food, a car show, a concert band and a spectacular fireworks display to cap off the night.

4.1.3 Cherry Pie Celebration

On July 8th, the Cherry Pie celebration took place in front of the Loveland Museum Gallery. Presentation boards were was once again displayed to the public in order to share project information, spur discussion about local perception of the river corridor and generate ideas of potential site amenities. This event provided several community activities that included vendor booths, live music and large slices of pie.

4.1.4 Loveland Downtown District Live

The Loveland Downtown District Live event took place on July 29th. The City provided a location for an informational booth so community members enjoying the downtown street event could stop by to review the project information to ask questions and provide insight on knowledge of the corridor from residents. The event was held right in the heart of Downtown Loveland between 4th street from Lincoln Ave. to Cleveland Ave. and contained a variety of local music artists, and local shopping opportunities.

4.1.5 Corn Roast Festival

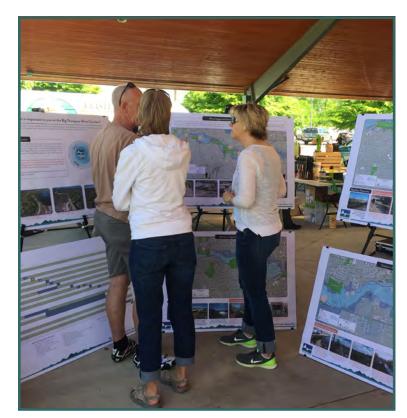
The Corn Roast Festival is an annual end-of-summer celebration of corn harvest. The festival includes a parade, copious amounts of fresh corn, a charity Rubber Duck Race, children's activities and many vendors selling crafts and food. By the end of the summer, the project team had begun to develop many of the details of the Master Plan. While the team continued to gather input, we also had chance to explain to some return visitors how the plans were shaping up. We were honored to have high-level City officials such as the City Administrator and the Mayor of Loveland visit our information booth over the course of the summer.

4.1.6 Farmers' Markets

The City of Loveland Farmers' Market is held every Sunday during the summer at Fairgrounds Park. This market helps connect community members with local agriculture producers and artisans selling fresh produce and handmade items. This is a very popular summer event and rain or shine, many Loveland residents and visitors attend the market. On July 9th, August 6th, and August 20th, the City hosted a booth at the Farmers' Market where City staff and the project team were able to engage with the attendees and obtain valuable public input.

4.1.7 Foote Lagoon Summer Concerts

The Thursday night summer concert series at the Foote Lagoon in Loveland was a great setting to garner public input. The project team was present at the July 6th and July 20th concerts. The upbeat music and atmosphere made it easy to engage with residents of Loveland and visitors from the surrounding areas. By participating in a variety of events from concerts to the Farmers' Market to summer festivals, the project team reached out to a broad cross-section of the public attending different types of community events.



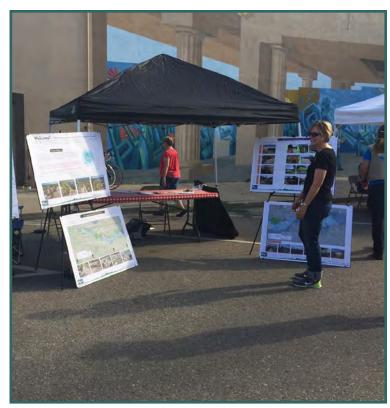
Project team members and City staff discuss the vision for the river corridor with citizens at National Bike and Trails Day, June 3, 2017, at Fairground Park. Many local residents who visited the public outreach booth over the course of the summer said that they frequently use the trail along the river for walking and biking.



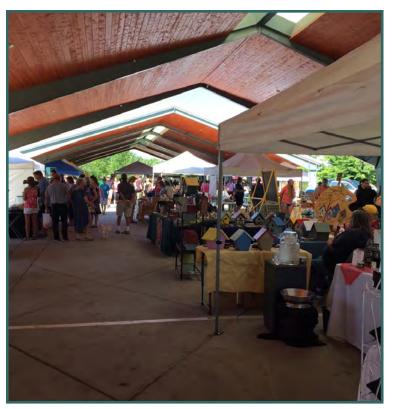
City Project Manager Chris Carlson, P.E. visits with attendees of the 4th of July festivities at North Lake Park. At major events such as this, the City and project team members gathered comment cards, provided handouts for upcoming project activities and advertised and encouraged participation in the project on-line survey.



The parade is one of the many highlights of the Corn Roast Festival, which was held on August 25 & 26, 2017. In the past, the Corn Roast Festival was held at Fairgrounds Park closer to the Big Thompson River. This was convenient for the Rubber Duck Race. The idea of a summer festival along the river should be revisited, as it would be nice to have a festival draw crowds to the river to celebrate an occasion and to celebrate the river.



Jodi Lessman of the City Public Works Department steps back to check the set up of project information boards the morning of the Cherry Pie Festival. The public outreach effort was a collaborative one between the City and project team, with City employees and/or team members attending events roughly every two weeks throughout the summer.



The Loveland Farmers' Market is held every Sunday throughout the summer and draws crowds in search of locally grown produce and meats as well as a variety of crafts. The City and project team attended the market three times over the course of the summer to gather public input and describe key aspects of the project.



The Foote Lagoon Summer Concert Series draws a large crowd with popular acts. The busy summer calendar of events in Loveland provided many opportunities to meet with local residents and discuss their ideas about how to improve the Big Thompson River Corridor. This input significantly shaped this Master Plan.vv

4.2 Stakeholder Meeting & Technical Advisory Committee Meetings

A stakeholder meeting was held at the Loveland Public Works building on July 13, 2016. The invite list for this meeting was comprised of stakeholders identified by the City, local residents who signed up for the project email list, and representatives from multiple City departments. This meeting consisted of a presentation and an open discussion period to obtain input from stakeholders in attendance. The primary objectives of this meeting were to provide an update on progress roughly halfway through the planning process and to obtain stakeholder input.

Over the course of the project, three meetings were held with a Technical Advisory Committee (TAC). The TAC consisted of representatives from multiple City departments and programs, as well as staff and board members from the BTWC and Big Thompson Watershed Forum. An initial meeting was conducted in June to introduce the project and to facilitate information exchange. A second meeting was held on July 13, prior to the Stakeholder Meeting, which included a progress update. The third TAC meeting was held on November 17, 2017 to obtain feedback on the draft Master Plan. Meeting minutes from Stakeholder and TAC meetings are provided in Appendix E.

Final adoption of the Master Plan will require presentation of the plan to different boards within the City and ultimately the City Council. Larimer County also plans to carry this Master Plan through their county process of endorsement and/or adoption. This work will occur in 2018 to formally adopt the Master Plan.

4.3 Two-Day Strategic Planning Workshop

A two-day Strategic Planning Workshop was conducted on July 25 – 26, 2017 at the City of Loveland Public Works Building. The purpose of the planning session was to engage with the public about the Big Thompson River Corridor and provide a platform for the public to give input on the master planning process. A series of presentation boards, maps and comment sheets were presented to foster this input. During the planning session, the project team introduced the project, presented current research, conducted site visits, developed preliminary plans and presented the plans to the public. The following provides a summary of the planning session schedule:

The introductory presentation provided an overview of the project limits, purpose, summary of work conducted to-date, calendar of community events, information on the project-specific website and survey, river corridor management, and upcoming tasks.

Immediately following the introductory presentation, a public workshop was conducted. Two large maps showing the existing conditions along the corridor were presented, and presentation boards showing potential improvements were displayed around the room. Community members were encouraged to mark existing information on these maps and delineate areas where potential improvements could occur, based on local knowledge. The group was also asked to review the presentation boards and mark which features they preferred with green dots. This was a valuable way to increase public participation in the planning process, gather additional information on the existing conditions, and gain an understanding on which potential improvements the public preferred.

The open houses in the afternoon of July 25th and morning of July 26th were informal opportunities for the public to engage with the project team at their convenience. The maps and presentation boards were displayed throughout the entire two-days, and members of the project team were continuously present to engage with anyone who showed up.

The project team also conducted a series of site visits in order to gain a deeper understanding of specific areas identified for improvement during the team work sessions and "ground truth" design ideas with on-site observations. The following summarizes the site visits that were conducted during the planning session by the project team:

- Access to river and potential parking area near Wilson Avenue,
- Access to river and potential parking area near Boise Avenue,
- Access to river and potential parking area near County Road 9E,
- Access to river and potential parking area near the north end of Fairgrounds Park, and
- Taft Avenue and First Street 2013 overtopping areas and flow paths.

Based on community input and technical understanding, conceptual plans were developed during the workshop sessions. These plans formed the foundation for this Master Plan. A public meeting was then conducted on the evening of July 26th where proposed plans within each reach of the project were presented for public comment.

A total of sixteen people attended the planning session over the two-day period. The following summarizes the major comments that were received:

- Strong desire to maintain the natural character of the Big Thompson River, including limiting commercial development along the western portion of the corridor.
- Concerns regarding the transient community, associated trash, and safety concerns.
- Water quality concerns over turbidity created by water from Boedecker Reservoir that is discharged to the Big Thompson River via the Mariano Exchange Ditch.
- Desires for more opportunities for the public to access the river.
- Interest in community events along the corridor such as providing a place for a flea market or other events, along the lines of the Farmers' Market.
- Provide additional trash and recycling stations and benches along the river corridor.
- Remove debris within the river to reduce risk of debris dams and blockages in future flood events and to improve safety for recreational river users such as tubers.
- Natural areas are great assets to the community, and the participants value the environmental and passive recreational benefits of these areas as counterparts to the more formal parks in the central part of the corridor.
- Desires for more opportunities for community groups to clean up trash along the river corridor through an Adopta-Stream Program.
- Increase the focus on the river and provide additional river-related recreational opportunities between Wilson
 Avenue and US Hwy 287 Existing parks that are oriented away from the river, such as Centennial Park, should
 include additional features to encourage interaction with the river in addition to existing programmed recreational
 activities.

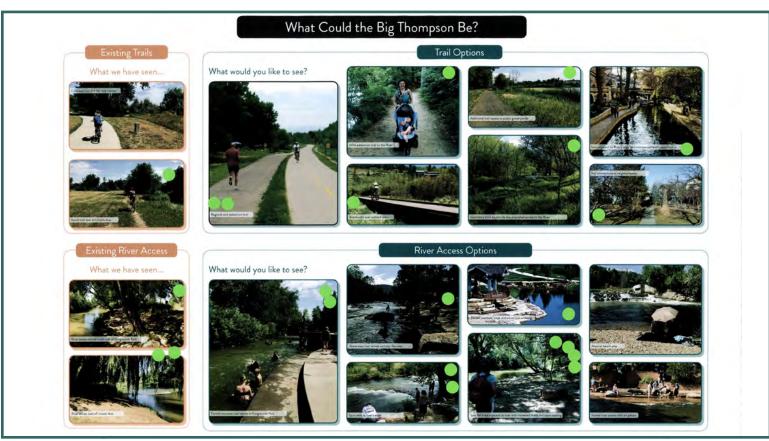
For more information on the Two-Day Strategic Planning Workshop please see Appendix E for summary meeting minutes.



Project Manager Dr. Andrew Earles, P.E. works with local residents to review existing conditions and explore potential concepts for the corridor during the July 25, 2017 public workshop. This type of direct input from the public drove the planning process and aided in the development of conceptual Master Plan concepts.



Discussion of potential Master Plan recommendations for reach from the Morey Wildlife Reserve to Rossum Drive. After two days of the workshop, the final evening presentation was an interactive reach-by-reach planning session, reviewing and refining concepts based on public input.



Presentation boards showing potential Trail and River Access Options were presented to the public for comment. Members of the public were asked to place green dots on images depicting concepts they would like to see incorporated into the Big Thompson River Corridor. These concepts were then used to inform design decisions during the Master Planning process.



Project Manager Dr. Andrew Earles, P.E. takes input from the public during the July 26, 2017 presentation. Input from the public was recorded and incorporated into Master Plan Concepts in real time. This process allowed community members to engage in the planning process and directly contribute the development of the Master Plan concepts.

4.4 Public Input Survey

An on-line public input survey was created to allow the City of Loveland residents and surrounding community members an opportunity to share their concerns and ideas for the Big Thompson River Corridor Master Plan. The survey was developed with input from City staff and members of the consultant team. It consisted of multiple-choice questions and free response questions where the public was invited to share their experience and ideas in their own words. The questions were specifically sculpted to capture data that would help the project team better understand the following:

- Who currently uses the Big Thompson River Corridor?
- How often do they use it?
- What sections of the corridor do they access the most?
- What activities do people currently engage in?
- How do people view the current condition of the corridor?
- How would they like to see it develop in the future?
- What additional improvements would they like to see?

The survey was hosted on the City of Loveland's Open City Hall platform through the City of Loveland's website. Links to the survey were posted on the project website and multiple email and social media posts were distributed through the City's and the BTWC network to invite people to participate. Additional information on how to access the survey was presented at community events and the two-day Strategic Planning Workshop to further raise awareness for the survey.

The survey was open from June 29th– August 10th allowing sufficient time for members of public to participate at their convenience. A total of 520 people responded to the survey. The final survey results, including all public comments, totaled 770 pages. While it is not possible to include every comment in this document, many common themes emerged during this process. In order to capture these themes, a word cloud was created from the free response question "What is most important to you about the Big Thompson in Loveland?" The larger the word appears in the cloud, the more prevalent it was in the survey responses.

These types of correlations aided the planning effort by demonstrating which areas were most utilized by the public and therefore dictated where the most emphasis on specific design elements should be placed. A selection of public responses are shown in as shown in Figures 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, and 4-7.

Given the balance of natural areas and programmed recreational space along the corridor it was important for the City and project team to understand what activities and features the public would like to see incorporated into the corridor. Overwhelmingly, the survey results showed that people prefer a natural aesthetic with passive recreation activities and features.

The results of this survey were used to help guide the development of this Master Plan and inform the details of the design. A full overview of the on-line public survey can be found in Appendix F - Summary of On-line Survey Results.

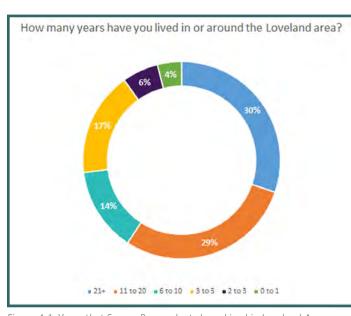


Figure 4-1. Years that Survey Respondents have Lived in Loveland Area



Figure 4-2. Word Cloud from the free response question "What is most important to you about the Big Thompson in Loveland?"

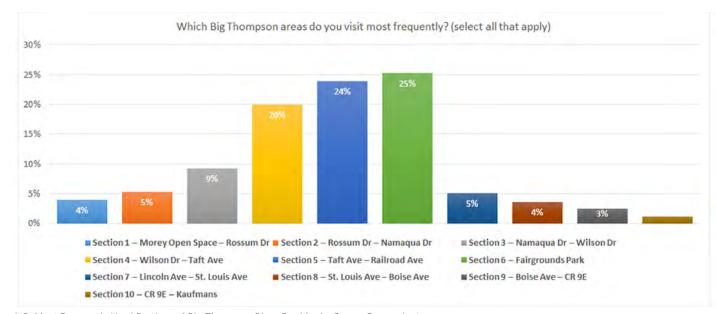


Figure 4-3. Most Frequently Used Portions of Big Thompson River Corridor by Survey Respondents

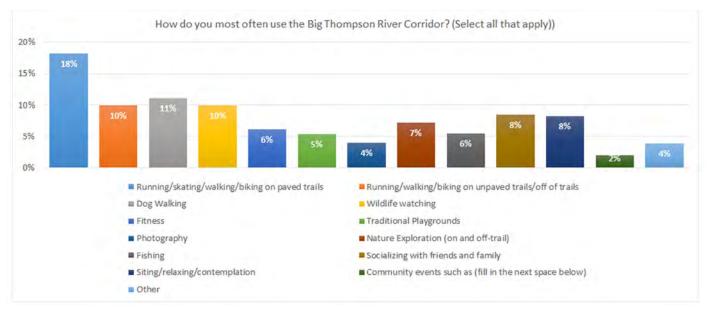


Figure 4-4. Frequency of Different Types of Activities and Uses

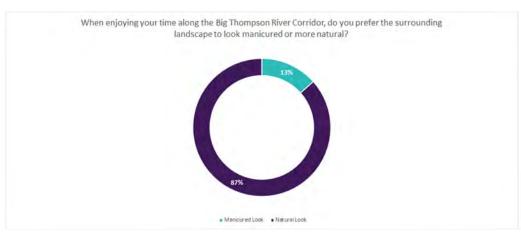


Figure 4-5. Survey Respondents' Preference for Natural versus Manicured Look for River Corridor

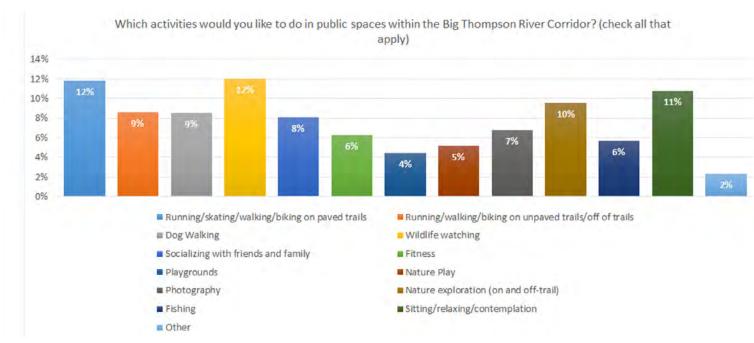


Figure 4-6. Most-desired Activities in Public Spaces along Big Thompson River Corridor

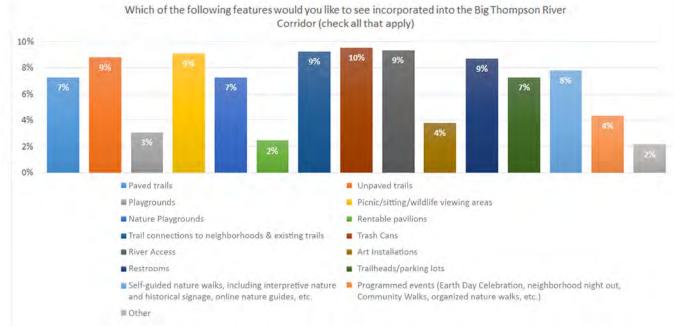


Figure 4-7. Most desired Features Identified by Survey Respondents

4.5 Project Website

To create forward momentum and recognition for the project, a project website was created. The website was launched at the beginning of the planning process and provided a platform in which the public can learn more about the project, stay up to date with current planning efforts, learn of upcoming public events and workshops, take the on-line survey, and directly connect with the project team.

The project website also served as a communication channel for community members interested in the Big Thompson Corridor and invested in how it develops. The website gave residents, such as those unable to attend the community events, a way to still connect with the project team and have their vision for the corridor heard. It maintained transparency throughout the master planning effort, further increasing public awareness of the project.

By coining the slogan "A Better Big T," the website also helped to establish a "brand" or memorable character for the Master Plan which reflected the purpose of the project. This slogan is the underpinning of all the branding material including the new Big Thompson River Corridor Logo and project poster discussed in detail in Section 4.6.

The format of the website was direct, sharing information such as upcoming events the project team would be attending, recaps on events attended and updates on the Master Plan tasks as the project team completed planning steps. All this information is a precursor to the creation of a successful Master Plan and the website allowed for the team to share this process step by step.

The website also includes extensive photographic documentation of the river from the project team float trip and from a bike tour of the corridor. Georeferenced photos were collected using a Go-Pro camera for the float trip and bike tour. These photos were uploaded to the website to create "storyboards" where photos were displayed reach-by-reach, linked to a map showing each photo location. These storyboards are a valuable snapshot in time of river conditions, especially since it is not often anyone floats the full ninemiles of the Big Thompson River through the study area, much less with a camera.

The website was enlisted as a communication device and a "living document" to be updated as the Master Plan process continued to evolve. We recommend that this document live on as an analogous electronic version of the Master Plan, continuing to be used as a form of communication to progress the vision and intent of this project. The true intent behind this process is to provide the groundwork of something implementable for our community in the near future and this requires maintenance and perseverance of this cause; the website can be a tool used by the City to champion this Master Plan.



Figure 4-8. Home Page of Project Website, ABetterBigT.com

4.6 Branding

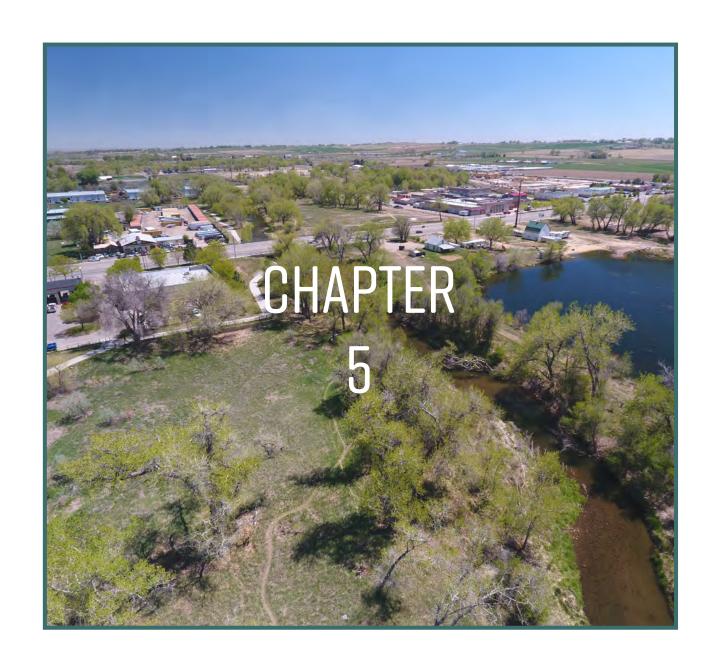
"A Better Big T" sums up the Master Plan's goal to create a resilient and connected corridor that will serve as a long term asset for the City of Loveland. This 'brand' was created through the public process which establishes "A Better Big T" as a credible brand that the people of Loveland can support. This public support will increase the public use and appreciation for the corridor and help the City acquire more funding for future projects in the corridor.

The concept of "A Better Big T" has been illustrated into the following graphic to represent the vision of the corridor. This image can be used for advertisements, events or marketing materials to help inform the public about the Big Thompson River Corridor and build momentum for future projects.



Insert Branding Image

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5.0 MASTER PLAN IMPROVEMENTS

The recommended plan of proposed improvements for the nine-mile stretch of the Big Thompson River from the Morey Wildlife Reserve to the gravel pit ponds east of County Road 9E include projects in varying stages of planning and design. This Master Plan is a "snapshot" in time for a corridor that is actively changing from river restoration activities under design by the BTWC to Namaqua Avenue road and bridge improvements by Larimer County, to active natural area acquisition by the City. The proposed improvements for each reach are a blend of projects identified in previous plans and additional projects identified as a part of the public outreach effort.

The recommended improvements in this Master Plan will take many years to implement and will occur hand-in-hand with growth of the City in the eastern portion of the corridor and increased recreational pressure on the overall river corridor. Implementation of this plan will require public and private investment in the river corridor, funding from grants and cooperating agencies, and prioritization of improvements that have the greatest public benefit. Currently, there is no dedicated funding for most of the improvements identified in this Master Plan, and economic conditions are not currently favorable for funding additional multi-million dollar floodplain and river improvement projects. Therefore, this plan should be viewed as a menu of potential public improvement projects along the river corridor and as a tool for guiding future land use, recreational, trails, wildlife, and natural area related decisions and planning.

For purposes of presentation, improvements for each reach are grouped in the following categories, roughly based on resilience categories:

- Flood Hazard Reduction,
- Gravel Pits,
- Aquatic Habitat,
- Geomorphology,
- Utilities,

- Water Quality,
- Natural Area/Open Space,
- Parks & Recreation, Trails, Land Use, and
- Community Involvement.

The following sections discuss the approach to developing recommendations for each of these categories of improvements. Plan sheets and tabular summaries of proposed improvements for each reach follow in Section 5.10.

5.1 FLOOD HAZARD REDUCTION

Effective floodplain and floodway mapping along the Big Thompson River, along with delineation of the area inundated in the September 2013 flood is shown in Figure 5-1. The Colorado Water Conservation Board (CWCB) is currently in the process of revising the Big Thompson River floodplain mapping through the Loveland area. CWCB's floodplain mapping project is using both HEC-RAS and SRH-2D for the hydraulic analysis along with updated watershed hydrology. New LiDAR aerial mapping was also flown in November 2016 to support the floodplain mapping. As of the date of this Master Plan, the new regulatory floodplain mapping is not yet available, so planning as a part of the Master Plan has been conducted using effective mapping and models. While there will be some changes to the effective mapping as a result of the efforts by CWCB, dramatic changes in floodplain and floodway delineations or base flood elevations are not expected. The concepts presented in this chapter can be refined using the new effective mapping during preliminary and final design stages of the proposed projects.

The most effective flood hazard reduction tool employed by the City is the preservation of natural areas along the Big Thompson River Corridor. The City's approach of working with property owners to acquire land in the floodplain and floodway keeps development out of poorly suited locations while providing a natural greenway for the community. The major flood hazards that exist along the study corridor today are primarily related to road crossings and avulsion of the river into adjacent gravel pits. The City has developed conceptual plans for road improvements for Lincoln Avenue – U.S. Hwy 287 (Hwy 287), Railroad Avenue, and Wilson Avenue that are summarized below and shown conceptually on Master Plan sheets. Flood hazard reduction improvements are conceptually illustrated on the corridor mapping in Appendix A and on the 11" x 17" sheets in Section 5.10 of this chapter. Gravel pit improvements and criteria for embankment stability are presented in Section 5.2 and Appendix D.

5.1.1 Namaqua Avenue - Bridge Improvements

Namaqua Avenue is classified as a major collector roadway in the 2035 Transportation Plan. The Namaqua Avenue Bridge Replacement Project will replace the existing, aging bridge with a new two-span bridge with a single drilled caisson pier. Each span has a length of 76.5 feet for a total span of 153 feet. The preliminary design section has a 14-foot wide trail bench on the south side of the river. The project will provide protection for an existing waterline crossing the Big Thompson River that will be modified as a part of the project. The new bridge will increase the cross-sectional area available for flow significantly since the existing bridge spans only approximately 100 feet. The new bridge will include sidewalks and bike lanes.

The existing vertical drop structure immediately downstream of the bridge will be removed. There has been at least one drowning downstream of the existing vertical drop structure due to a reverse roller, so replacement of this hazardous vertical drop will improve public safety. Design of the bridge and channel improvements are in progress as this Master Plan is being finalized.



Vertical drop on downstream side of Namaqua Avenue Bridge. While this drop dissipates energy and aids in grade control, under some flow conditions, the drop creates dangerous hydraulic currents. At least one drowning death is known to have occurred at this location. This drop will be removed and replaced with a more gradual drop as a part of the Larimer County bridge replacement project, which will improve public safety in this location.

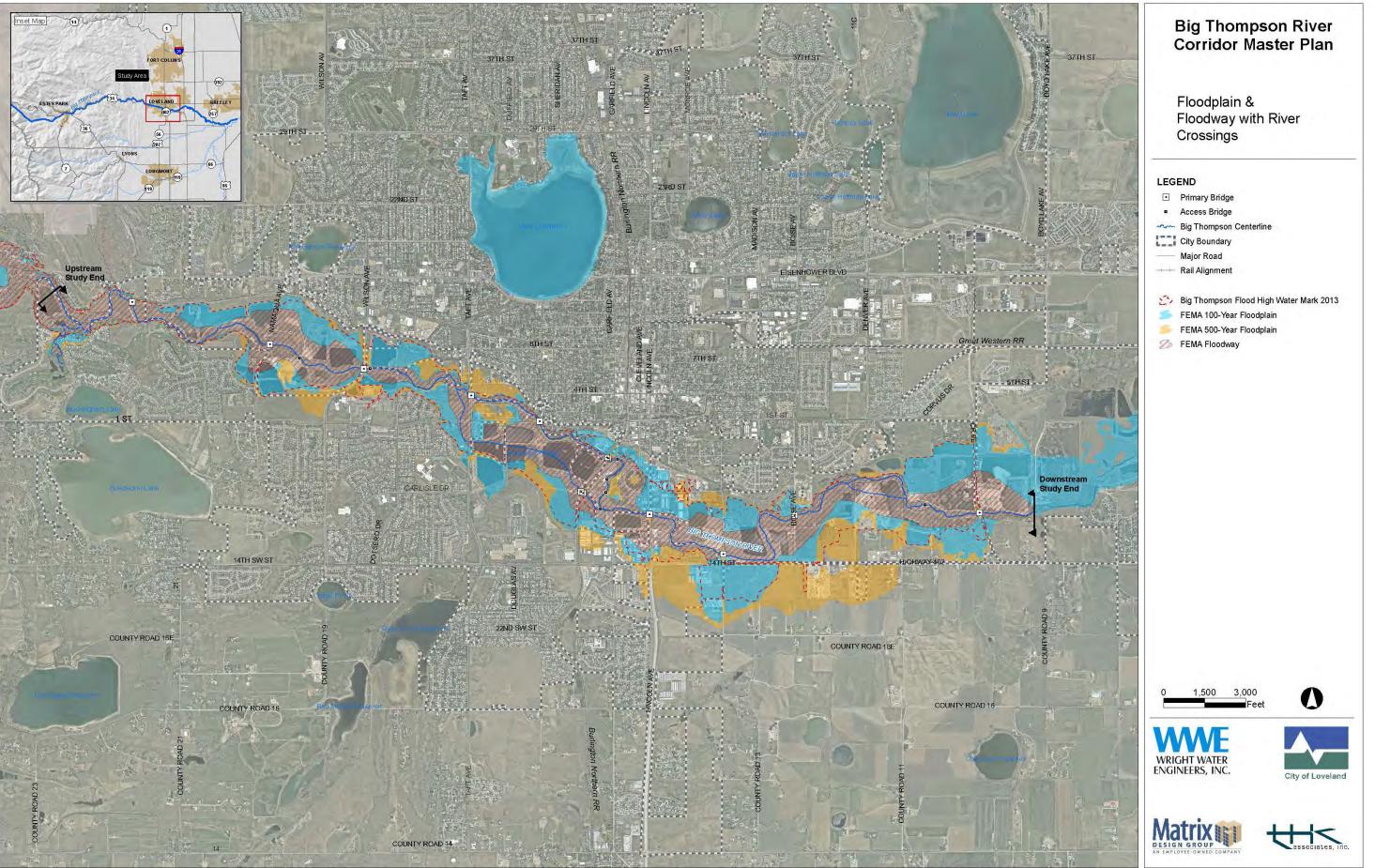


Figure 5-1. Floodplain and Floodway with River Crossings

While the new bridge will have increased conveyance capacity to convey in excess of a 50-year flow based on available design information, Namaqua Road will continue to overtop in large flood events to the north of the bridge. The projected depth of overtopping based on preliminary design information is approximately 1.5 feet, somewhat less than the approximately 2-foot overtopping depth in the effective HEC-RAS model for the reach.

At some point in the future, improvements could be considered to eliminate overtopping of Namaqua Avenue including elevating the road and providing culverts beneath the road to the north of the existing bridge. However, these improvements are not included in the Master Plan at this time due to the need for such improvements on primary arterial routes including Wilson Avenue, and Hwy 287.

Because this project is currently being designed by Interwest Consulting Group (Interwest) and Anderson Consulting Engineers (Anderson) for Larimer County, proposed improvements are shown conceptually in this Master Plan. Interwest is coordinating their design with the BTWC, which is investigating the potential for improving sediment, fish and recreational passage for the Rist-Goss Diversion Dam, while maintaining the ability to divert the decreed water right.

5.1.2 Wilson Avenue - Elevation of Roadway Approaches to Bridge

Wilson Avenue is classified as a major arterial roadway in the 2035 Transportation Plan. Of all the river crossings in Loveland, Wilson Avenue was the last to overtop and the first to reopen after the 2013 flood. It is generally the highest road with the best existing bridge capacity and is the most cost-effective crossing to improve in either Larimer or Weld County so that at least one crossing can remain open in a major flood event. This project will significantly improve energy response capability during future floods.

This project, currently under design by Interwest, will raise both roadway approaches to the existing Wilson Avenue Bridge over the Big Thompson River in order to prevent roadway overtopping in a 100-year (1% annual exceedance probability) or slightly larger flood. The bridge itself is perched, doesn't overtop, and has adequate capacity for



Comparison of 100-year floodplain (blue dashed line) with September 2013 inundation (red dashed line) in vicinity of Wilson Avenue. While the effective FIRM shows that flows would not overtop Wilson Avenue, flows did overtop the road to the north and south of the bridge. Elevating the approaches to the bridge, as currently under design, will eliminate overtopping in up to the 100-year event.

approximately 24,000 cfs. Therefore, the bridge will not be modified and only the approach roadway will be improved with this project.

The project limits generally begin approximately 1,450 feet north and run 1,450 feet south of the Wilson Avenue Bridge over the Big Thompson River. Wilson Avenue is a four-lane arterial road contained within a 100-foot wide right-of-way with a mixed cross section of rural and urban mostly without curb, gutter, or sidewalk. The roadway will continue to be a four-lane arterial section but will include curb and gutter on both sides of the road north of the Wilson Bridge and curb and gutter only on the east side of the road south of the bridge. Future development would ultimately drive installation of curb and gutter on the west side south of the bridge. Bike lanes will be included both directions.

A sidewalk will be installed along the east side of the road from its current terminus at the Big Barnes Ditch Bridge south to the City of Loveland Service Center entrance. The sidewalk will have a connection to the existing concrete bike/pedestrian trail that runs under the north side of the bridge. The west side will have a sidewalk from the existing terminus south of the Big Barnes Ditch Bridge to the existing bike/pedestrian trail underpass. This sidewalk on the west side of Wilson Avenue should be upgraded to a trail as a part of the Recreational Trail loop system. Sidewalk is not currently proposed for the west side of the road south of the bridge.

The approach roadway to both the north and south of the Wilson Avenue Bridge is outside of the floodway. Additionally, areas along the road are within ineffective flow areas because of the contraction and expansion caused by the bridge. The design project includes analysis to understand what level of overtopping protection can be achieved within the project budget and hydraulic analysis to understand the potential hydraulic impacts to the Wilson Avenue Bridge during larger than 100-year flood event if those flows are forced through the bridge without overtopping the road as they would under existing conditions. The project also includes design of additional scour countermeasures, as needed based on hydraulic analysis.

This is the highest priority road crossing project in the Master Plan because it is the most economical way to establish a north south arterial with better than 100-year crossing capacity. This project is currently in the design stage. It is anticipated that this project will be constructed in 2018.

5.1.3 Taft Avenue

Taft Avenue and 1st Street both overtopped during the 2013 flood, sending overflows into the River's Edge Natural Area. Taft Avenue is classified as a major arterial roadway in the 2035 Transportation Plan. The floodway includes approximately 1,800 linear feet of Taft Avenue and extends approximately 900 feet south of the intersection of Taft and 1st Street. The uncontrolled overflows in 2013 cut off traffic on Taft Avenue and 1st Street during the flood and caused significant damage to the River's Edge Natural Area as flood flows found their way through gravel pit ponds and back to the main channel of the river downstream of Railroad Avenue in Fairgrounds Park.

To address issues with roadway overtopping, the project team evaluated the following potential improvements:

- Clean out north cell of Taft Avenue Bridge. The north cell of the bridge is not functional and has sediment and woody vegetation blocking flow.
- Improved hydraulic entrance and exit conditions for the existing bridge so that the full conveyance capacity of the bridge is used in a large flood.
- Installation of reinforced concrete box culverts (RCBCs) or bridges beneath Taft Avenue and 1st Street to help to convey overflows from the northwest corner of the intersection of Taft and 1st Street to the southeast corner, discharging to North Jayhawker Pond.
- Construction of a high flow path for flood flows leaving the stream to the entrance to the culverts or bridge at the northwest corner of the intersection and construction of an armored open channel from the culvert outlet to North Jayhawker Pond at the southeast corner.

Hydraulic analysis indicates that in a 100-year event a total of 16,150 cfs is conveyed in the main channel beneath the Taft Avenue Bridge and through Centennial Park north of the ball fields. Split flow occurs to the southeast overtopping Taft Avenue and 1st Street with an estimated overflow of 2,850 cfs. This flow is then conveyed through the River's Edge Natural Area to Railroad Avenue. The potential improvements listed above, including additional



View of intersection of 1st Street and Taft Avenue during September 2013 flood. Taft Avenue runs south to north from the top to the bottom of the photo, and 1st Street runs east to west from left to right. This photo shows overtopping in the intersection and to the north. These overflows spilled into North Jayhawker pond and cascaded through the River's Edge Natural Area. Flow through the Taft Avenue Bridge can be seen in the bottom left corner of the photo.

conveyance capacity beneath Taft Avenue and 1st Street in the form of large box culverts and/or bridges, could effectively eliminate overtopping of Taft and 1st Street and remove some properties south of 1st Street and west of Taft Avenue from the floodplain. However, the costs of these improvements are on the order of \$20M or more, including large box culverts beneath the intersection of Taft and 1st Street or secondary bridges, an overflow channel from the river to the intersection and downstream of the intersection, and other associated infrastructure.

Costs of this magnitude outweigh potential benefits, especially considering that there are currently plans for conveyance improvements for Wilson Avenue and Hwy 287 that will provide 100-year conveyance and allow for north-south travel across the river corridor in a major flood event. Therefore, recommendations for Taft Avenue are limited to cleaning out the existing north cell of the bridge to more-fully utilize existing infrastructure. When the Taft Avenue Bridge is eventually replaced, it is recommended that increasing capacity of the crossing be considered as a part of design, as has been done with the Namaqua Avenue Bridge replacement project. This would not need to be upgraded to 100-year conveyance capacity, but if additional conveyance can be incorporated into the replacement bridge design without significant additional cost, it would be an opportunity to lessen the flooding potential from the overflows from the channel in large events.

5.1.4 Railroad Avenue - Road & Bridge Improvements (summarized from Ayres Floodplain Modeling Report, November 2016)

Railroad/Roosevelt Avenue is a major collector street generally running north south, paralleling the Burlington Northern – Santa Fe (BNSF) Railroad tracks, crossing the tracks at Fire Engine Red Road, and crossing the entire Big Thompson River floodplain. It is an important collector roadway that provides a secondary route parallel to Hwy 287, and it provides the only access to the City of Loveland's Fairgrounds Park, the Loveland Fire Rescue Authority's Fire Training Grounds, and a number of industrial businesses.

The roadway crosses roughly two thirds of the Big Thompson River floodplain along the east side of the BNSF Railroad tracks (downstream side of the tracks), crosses the tracks at a 39-degree skew angle, then runs across the southern third of the floodplain along the west side of the tracks (upstream side). Consequently, it experiences



View along Railroad Avenue looking south from bridge. This photo illustrates the elevation difference between the railroad and the road to the east. The railroad acts like a dam, backing up floodwaters due to existing bridge and culvert conveyance limitations. Fairgrounds Park lies immediately east of the road, and in 2013, flows overtopping the railroad and flowing through ballast material caused significant damages in the park.



Aerial photo illustrating primary and secondary flow paths at Railroad Avenue. The primary flow path is through the bridge, and the secondary flow path is through a culvert. The flows along the secondary flow path are those that spill over into the River's Edge Natural Area upstream due to overtopping of Taft Avenue and First Street. The two flow paths merge downstream of Railroad Avenue in Fairgrounds Park.

two different types of flood damages during a large event. The northern portion is initially protected by the railroad tracks, which sit approximately four feet higher than the road, until those tracks overtop. The tracks effectively act like a levee or dam.

Overtopping flows accelerate to a high velocity when they reach the road and continue eastward across Fairgrounds Park. If the railroad embankment fails, like it did during the 2013 flood, the damage is even more catastrophic to the local infrastructure. The southern portion of the roadway lies along the upstream side of the tracks, and consequently, sees flood waters first. This creates a typical roadway-overtopping scenario where the road crest acts as the initial hydraulic control. There is a secondary large channel that splits off from the main river channel approximately 1,500 feet upstream of Railroad Avenue. The secondary channel is a historic flow path that was even shown on a 1906 USGS map and existed long before gravel pit mining or a County road, the precursor to Railroad Avenue, was constructed. Consequently, the railroad company built a relatively large bridge over this secondary channel. However, as development, gravel pit mining, and Hwy 287 were constructed over time, the secondary channel was gradually filled in and removed in all areas except for immediately up and downstream of Railroad Avenue. Today, the railroad bridge still exists over the only remaining portion of the secondary channel.

Historically, a roadway bridge existed at the crossing over the secondary channel. The Flood Information Report from the 1976 Big Thompson River flood clearly shows a bridge in its aerial images. Remainders of what appear to be buried concrete bridge abutments still exist at the crossing today. Unfortunately, and for reasons unknown to the City, sometime after 1976 the bridge was replaced with a far undersized 96-inch diameter corrugated metal pipe (CMP) culvert. It is unknown what kind of bridge was there or whether it was damaged during the 1976 flood. Judging from the 1976 aerials, the bridge had approximately the same total length and capacity as the existing railroad bridge immediately downstream. In both the major floods of 1976 and 2013, a large amount of water followed the secondary flow path. The current 96-inch diameter culvert does not meet minimum hydraulic standards, a situation which likely contributed to the damages experienced in 2013.

Evidence from the flood indicated that a significant portion of the flow followed the old secondary channel flow path and across the southern portion of the floodplain, but it was blocked by the CMP culvert and railroad embankment. The culvert proved to be significantly undersized and was severely damaged when its upstream end collapsed. This occurrence increased overtopping of the railroad embankment. Neither the culvert nor the main Railroad Avenue Bridge over the river has adequate capacity, so the majority of floodwaters spilled over the railroad embankment and over Railroad Avenue.

Either by overtopping scour (headcutting from the downstream side), by a piping failure, or by both, the railroad embankment washed out. This massive and likely sudden change in hydraulic conditions further concentrated flow through the failed embankment, over Railroad Avenue, and through Fairgrounds Park. The damage was severe to all affected infrastructure.

Ironically, the existing Railroad Avenue Bridge over the main channel was not significantly damaged, nor was the flood inundation as wide as it would have been otherwise had the railroad embankment not failed. However, damage to facilities in the breach area were substantial. Railroad Avenue was closed for 455 days before it was reopened using temporary repairs and emergency measures on December 11, 2014.

The proposed work for the Railroad Avenue includes the following hydraulically significant features:

- A new 100-foot span Railroad Avenue Bridge will be built over the secondary channel to replace the existing CMP culvert.
- The roadway will be elevated from just south of the secondary channel to just south of the main channel bridge. The profile of the roadway will be higher by up to 4 feet over roughly a 700-foot section.
- The Fire Engine Red Street crossing over the secondary channel will be removed and channel regraded to transition to the main channel.
- The secondary channel from the new Railroad Avenue Bridge through the BNSF Railroad Bridge will be regraded to provide additional conveyance.
- Rock riprap protection placed across the new Railroad Avenue Bridge channel and BNSF Railroad Bridge channel for scour protection.

A new primary access into the Fire Training Grounds will be constructed from Garfield Avenue.

Analysis shows that the proposed improvements will generally result in decreases in base flood elevations upstream of Railroad Avenue. These decreases in base flood elevations range from several hundredths of a foot to more than a foot in some locations. Most decreases in base flood elevations are on the order of 0.25 to 0.5 feet. There were two cross sections in the hydraulic model downstream of Railroad Avenue where 100-year water surface elevations increased, due to increased conveyance through the crossing. These increases in base flood elevations do not affect any insurable structures.

Based on information from the City, this project is ready to be bid, but the City is still waiting on an approval from the BNSF Railroad. Funding could potentially be lost if the BNSF does not issue approval in time.

5.1.5 Lincoln Avenue - U.S. Hwy 287 - Road & Bridge Improvements

The Hwy 287 crossing experienced severe flooding in 2013, cutting off the major arterial and U.S. Highway. Commercial properties along the corridor flooded. Conceptual plans have been developed for improvements to the crossing as outlined in the 2017 Hwy 287 Flood Mitigation Feasibility Study prepared by Ayres for the City of Loveland. This plan calls for creating a wider riparian corridor with more transient floodplain storage, replacing the Hwy 287 Bridge and raising the highway south of the bridge. This concept is illustrated in Figure 5-2 and is reflected conceptually on the Master Plan sheets in Section 5.10 and Appendix A.

Major project components illustrated in Figure 5-2 include: (1) replacement of the existing bridge with a new 240-foot span bridge and raising the roadway south of the bridge by as much as four feet; (2) creating lowered and widened floodplain benches through Fairgrounds Park, with some minor top-of-bank berming; (3) reducing the size of the pond south of the channel and west of Hwy 287 so that a low floodplain bench can be constructed on the south side of the channel; and (4) construction of a lowered and widened floodplain bench downstream of Hwy 287.

The 2017 Ayres study evaluated potential funding sources for the roughly \$17M proposed project and performed FEMA cost-benefit analysis to see if the project could be eligible for FEMA funding. The cost-benefit ratio did not support FEMA funding because the new bridge was so expensive; however, other state and federal highway funding sources, with additional local funds could potentially finance this project. It is also possible that a portion of the project, excluding the new bridge, could qualify for FEMA funding. This is a high priority crossing for improvements since it is a major arterial and a U.S. Highway.

The benefits of this flood mitigation project are numerous. Analysis by Ayres indicates that 47 insurable structures would be removed from the current conditions floodplain and 23 structures would be removed from the floodway. The capacity of the bridge (with 3 feet of freeboard) would increase from the current capacity of 4,500 cfs to the proposed capacity of 20,000 cfs, adequate to convey the 100-year event. The proposed bridge would convey flows in excess of 35,000 cfs at the threshold for pressure

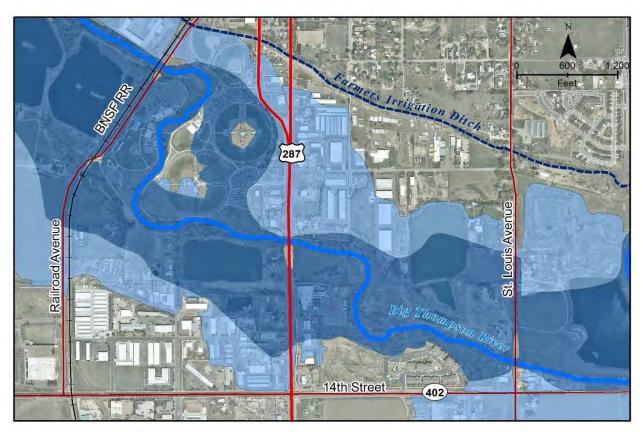
Floodplain Restoration & Flood Hazard Reduction

Creating a lowered riparian corridor with floodplain benches adjacent to the channel will help reduce flooding, improve river function over a range of discharges, and provide an opportunity for ecological restoration. A lowered riparian corridor provides more area to convey floodwater. Increasing the conveyance adjacent to the channel removes flow from the developed floodplain and provides an undeveloped area for floodwater to expand onto and flow through. Riparian vegetation within the lower benches will help provide long-term stability to the river corridor and improve ecological services.

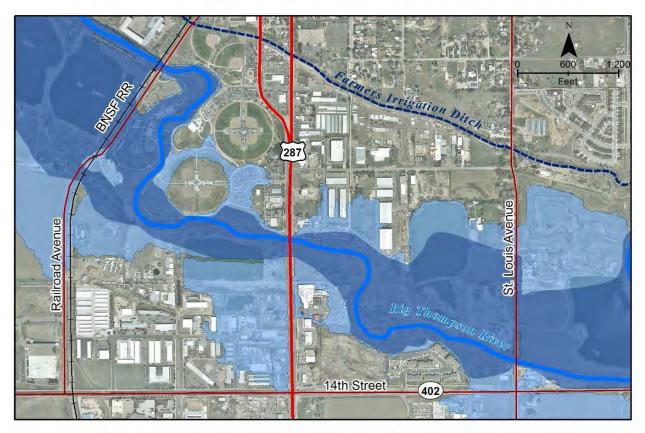
In combination with a longer and higher Hwy 287 Bridge and raised roadway south of the bridge, the proposed solution creates an improved area outside of the riparian corridor for redevelopment by reducing the flood risk within the developed floodplain. – US Hwy 287 Flood Mitigation Feasibility Study.



Figure 5-2. Conceptual Plan for Improvements to US Hwy 287 Crossing (Ayres 2017)



Effective FEMA 100-year floodplain and floodway in vicinity of U.S. Hwy 287



Proposed project floodplain and floodway in vicinity of U.S. Hwy 287

Figure 5-3. Effective and Proposed 100-Year Floodplain and Floodway for Proposed Hwy 287 Crossing Improvements, Reference: Ayres Associates Lincoln Ave./US Hwy 287 Flood Mitigation Feasibility Study, March 2017

Metric	Existing*	Proposed
No. of Insurable Structures in 100-yr Floodplain	114	67
No. of Insurable Structures in Floodway	35	12
Area of 100-yr Floodplain (acres)	634	552
Area of 500-yr Floodplain (acres)	808	754
Area of Floodway (acres)	191	112
No. of Properties with Improved Redevelopment Potential		43
Hydraulic Capacity of Bridge with 3 feet of Freeboard (cfs)	4,500	20,000
Hydraulic Capacity of Bridge at Imminent Pressure Flow (cfs)	8,900	35,000+
Amount of Flow Overtopping U.S. Hwy 287 During 100-Year Event (cfs)	10,000	0

Table 5-1. Improvements Associated with Proposed Hwy 287 Flood Mitigation Project (adapted from Ayers 2017), Based on Ayres Existing Conditions Model, not FEMA Effective Model

flow. Figure 5-3 shows the current and proposed 100-year floodplain and floodway boundaries in the area around the Hwy 287 crossing.

5.1.6 St. Louis Avenue and State Highway 402 - Road & Bridge Improvements

St. Louis Avenue is a major collector roadway in the 2035 Transportation Plan, and Hwy 402 is a State Highway and 4-lane major arterial. Improvements in this area are recommended to eliminate overtopping of Highway 402. Currently, St. Louis Avenue overtops north and south of the bridge in a major flood event, and flows that are backed up by the bridge overtop Hwy 402.

The primary improvement recommended in this area is to raise Hwy 402 from the intersection with St. Louis Avenue approximately 2,000 feet to the west, elevating 1 foot above the adjacent base flood elevations. For purposes of the Master Plan it is estimated that approximately 2,000 linear feet of road would need to be raised, on average approximately 2 feet. This is in the flood fringe and not in the floodway; however, a 0.00-foot rise would need to be assured if any insurable structures could potentially be affected. If this is the case, some additional conveyance capacity beneath St. Louis Avenue in the form of a bridge expansion or relief culverts may be needed. A culvert, with backflow prevention measures, beneath Hwy 402 would be needed to convey flows from the drainage area to the south. The area that is currently to the south of Hwy 402 that is in the flood fringe could potentially be filled and developed since it does not provide active conveyance of flood flows. A portion of the area that is currently in the flood fringe should be reserved to provide full spectrum detention and water quality treatment for future development south of Hwy 402. Approximately 100 acres are mapped in the 100-year floodplain south of Hwy 402, and much of this area could be removed from the 100-year floodplain with a combination of raising the road and fill.

The project team also evaluated increased conveyance capacity for the St. Louis Avenue crossing. The existing bridge at St. Louis Avenue has a span of approximately 100 feet, and the effective HEC-RAS model shows a flow split representing the road overtopping in a 50-year event with a maximum overtopping depth of 2 feet. Currently, St. Louis has adequate capacity to pass the 10-year event; however, to fully convey the 100-year design flow without overtopping, it would require a massive bridge with a span greater than 250 feet. A bridge of this size would not be justified on a cost-benefit basis. Therefore, no improvements are recommended for the St. Louis Avenue Bridge at this time unless they are needed to offset rises associated with elevating Hwy 402 out of the 100-year floodplain.

While upgrades to eliminate 100-year overtopping of St. Louis Avenue are not required, some increased conveyance capacity may be needed if Hwy 402 is elevated out of the 100-year floodplain to help to offset any rises in flood elevations due to fill for the highway. Additional engineering to evaluate overtopping frequency of St. Louis Avenue and Hwy 402 for a range of flood conditions using a two-dimensional model is recommended. This should occur at a conceptual level early in design to see how the frequency of overtopping of St. Louis Avenue may be reduced in

conjunction with a future replacement of the existing bridge and/or a project to elevate Hwy 402 out of the 100-year floodplain.

5.1.7 Boise Avenue, County Road 9E and Future Boyd Lake Avenue

These three roads in the eastern portion of the study reach have several common characteristics and are discussed collectively. Commonalities include:

- All three are arterial roads. Boise Avenue and County Road 9E are minor arterials, and Boyd Lake Avenue is planned to be a major arterial. Based on Larimer County design criteria, 100-year conveyance capacity is needed for arterials, minor and major.
- The peak discharge for the 100-year event is similar at all three locations.
- All three crossings have broad 100-year floodplains, and it is generally infeasible to funnel the full flow of the river through a single crossing location. Secondary bridges and/or large relief culverts would be needed to avoid road overtopping in the 100-year event.
- The roads approaching primary bridges will need to be raised to eliminate road overtopping in a 100-year event.

Based on a conceptual HEC-RAS evaluation of improvements required to prevent 100-year overtopping with no rises, three main improvements are needed at each of the crossings:

- 1. Increased bridge capacity for the primary conveyance channel. Boise Avenue and County Road 9E currently overtop between the 10- and 50-year events.
- 2. Secondary bridge or culvert capacity for overflows traveling through gravel pits upstream of road crossings. In general, the magnitude of the secondary flows would make a secondary bridge a more realistic method for conveyance than multiple large culverts. The floodplain and floodway are very wide upstream of these crossings, and funneling all of the 100-year peak discharge through the bridge for the primary channel is not practical.
- 3. Raising the roadway approaches to the bridge. Bridge approaches need to be raised at Boise Avenue and County Road 9E since the approaches overtop well before the bridges overtop. Boyd Lake Avenue, when constructed in the future should be elevated and bridged to avoid having "perched" bridges such as those at Boise and County Road 9E.

As noted above, there are significant needs for road crossing improvements throughout the Big Thompson River Corridor. Given limitations on funding it simply does not make sense to have three road crossings with 100-year capacity in this close proximity. Since roughly 400 feet of total bridge span and over 1,000 linear feet of roadway elevation are required at each crossing, overall costs could be on the order of \$20M or more for each crossing. Therefore, it is recommended that 100-year crossing capacity be prioritized for the future Boyd Lake Avenue, which in combination with Hwy 287 and Wilson Avenue would give the City three major north-south corridors, west, central and east, that would be passable in a 100-year event.

The Boise Avenue and County Road 9E Bridges are aging and will require replacement or rehabilitation within the next decade or two. When these bridges are replaced, engineering should be conducted to evaluate potential costs and benefits of raising approach roads, in combination with increased conveyance capacity to avoid creating adverse floodplain rises, to reduce the frequency of roadway overtopping even if it is not economically feasible to upgrade these crossings to 100-year conveyance capacity.

5.2 GRAVEL PITS

Gravel pits are present in nearly every reach in the Master Plan study area. In the 2013 flood, there were many locations where flow overtopped the riverbanks and flowed through gravel pits. This caused significant erosion and overtopping of roads that served as downstream embankments for gravel pits. The avulsions from the 2013 flood are documented in reports including 2013 Geomorphic Assessment of the Big Thompson River through the City of

Loveland prepared by Ayres for the City and the 2015 River Restoration Master Plan and are not repeated in detail herein. Many areas of the 2013 avulsions have been repaired; however, the repairs were made under emergency conditions and did not include an engineering assessment of potential for avulsions, erosion, scour, and deposition in future floods. In many cases, repairs were made by private property owners, using available on-site materials, and were not engineered to withstand the forces of a major flood.

Figure 5-4 shows gravel pits along the corridor with ownership information. Avulsion of river flows into gravel pits creates the potential for uncontrolled release of water from a gravel pit to the river if an embankment fails and creates an unpredictable situation for protection of surrounding infrastructure. Cascading failure of gravel pits is another potential hazard if embankments fail.

A major recommendation of this Master Plan is for improved overflow spillways between the river and gravel pits and improved embankment protection for gravel pits bordering the river channel. Figure 5-5 conceptually illustrates a spillway constructed of riprap. For improved aesthetics, soil riprap, which can be vegetated, may be used; however, the underlying structural integrity of such a spillway is critical for stability. Details for concrete spillways are also provided. Additional design details and criteria are provided in Appendix D. The Master Plan presents conceptual overflow paths and provides additional recommendations on spillways between gravel pits and the river and embankments. Conceptual plans for gravel pit improvements are provided on the 11" x 17" sheets in Section 5.10 and are also illustrated on the maps in Appendix A.

While the City owns several gravel pit ponds in the Jayhawker Ponds/River's Edge complex, many other gravel pit ponds are privately owned. This Master Plan outlines conceptual plans for gravel pit pond improvements for Cityowned parcels including the River's Edge Natural Area, Old St. Louis Natural Area, and Willow Bend Park and Natural Area. For privately owned gravel pit ponds, the 2015 River Restoration Master Plan provides information on overflow locations that private property owners could use to design and implement embankment stability and spillway improvements. As a part of this Master Plan, Technical Guidelines for Gravel Pit Berms have been developed based on Colorado Division of Reclamation Mining and Safety (DRMS) requirements and Urban Drainage and Flood Control District (UDFCD) gravel pit criteria. The technical guidelines are provided in Appendix D. Public and private projects to improve gravel pit embankment stability and repairs following any future damaging floods should

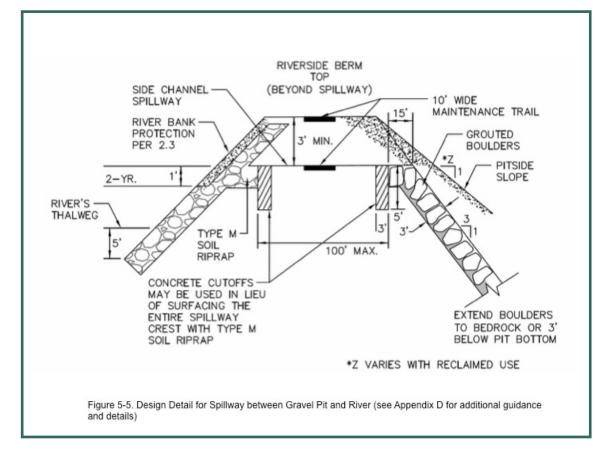


Figure 5-4. Design Detail for Spillway Between Gravel Pit and River (see Appendix D for Additional Guidance and Details)

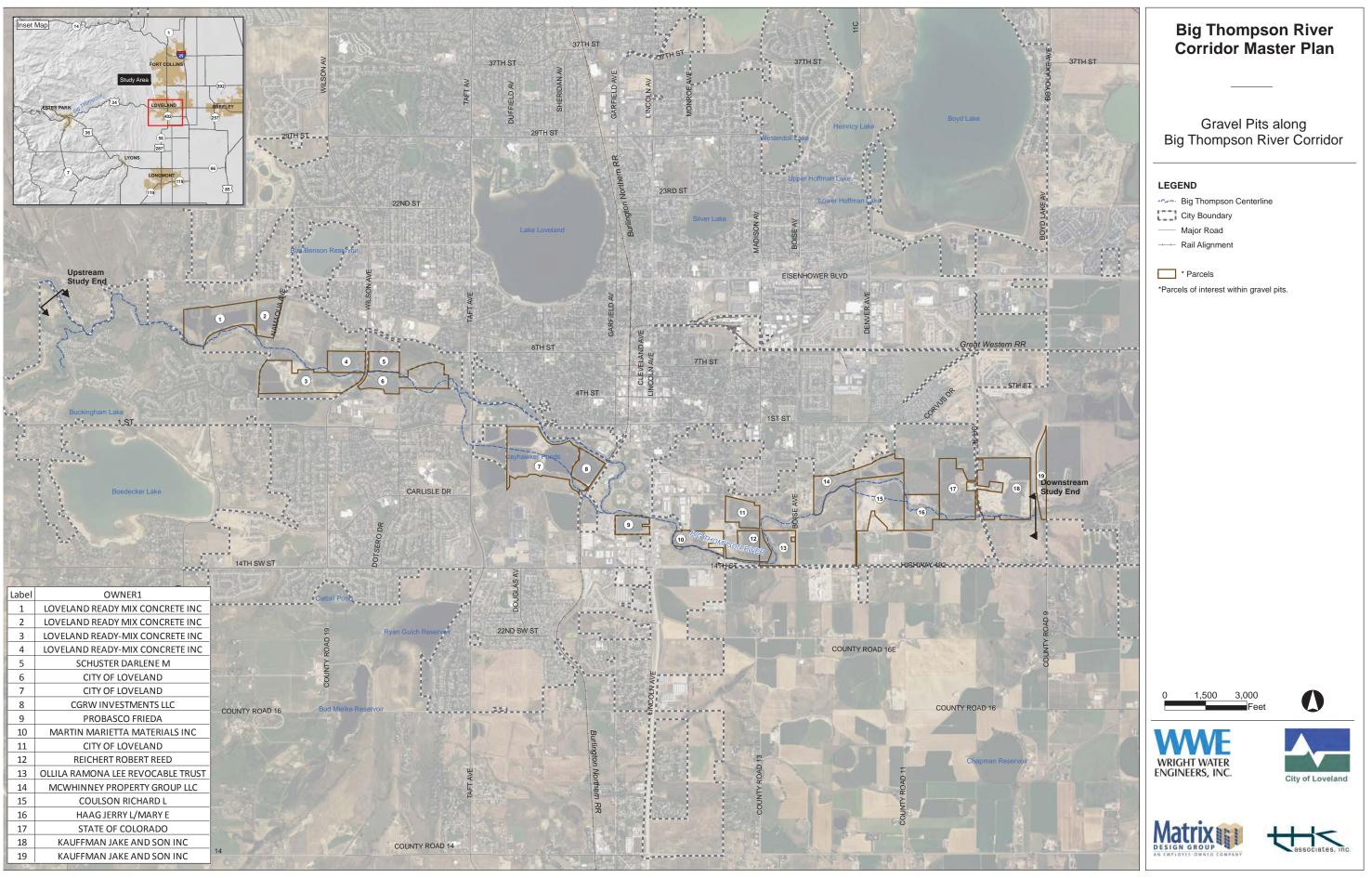


Figure 5-5. Gravel Pits Along Big Thompson River Corridor

follow these guidelines to the extent practical.

For cost projections and prioritization, only projects on publicly owned lands are evaluated in the Master Plan. There are many areas where improvements on private property would reduce risks of embankment erosion and potential failure; however, any work on private property would require the consent and cooperation of the property owners and likely would need to be a collaborative effort involving the property owners, the City and partners such as BTWC and/or CWCB. BTWC has established relationships with many property owners and could help facilitate partnerships for improvements to gravel pits.

Overflows, Berms and Engineered Spillways

Many of the repairs implemented following the 2013 flood were simple embankment repairs with non-engineered fill. These types of repairs have a high likelihood of failure in the next significant flood event.

To safely allow for transfer of water between the river and gravel pits and vice versa in a large flood, engineered spillways that are hydraulically sized and armored to resist the erosion potential of high velocity flows are essential. Non-engineered embankment repairs and berms will not likely be capable of resisting erosive forces in a large flood.



Figure 5-6. Comparison of Aerial Photos of Morey Wildlife Reserve from 2012, 2014, and 2017

5.2.1 Reach 29 - Upstream Study Limit to Rossum Drive

The only gravel pit pond along this reach was the pond at the Morey Wildlife Reserve. In the 2013 flood, an avulsion from the river flowed through this pit, filling the pit with sand and gravel. This pond has not been re-excavated and restored, and there are currently no near-term plans to do so. A pond restored in this location would be susceptible to filling in a future large flood event, just as occurred in September 2013. Figure 5-6 compares aerial photos of the gravel pit pond from 2012, 2014 and 2017.

Because high flows from the river are expected to pass through the Morey Wildlife Reserve during future large flood events, full restoration of the gravel pit pond is not recommended by this Master Plan. Recommended improvements in this area include armoring the banks of the river where overtopping and return flows are expected, and creating a high flow channel in between. The high flow channel should be a wide conveyance path with very mild side slopes, creating a broad wetland channel to convey overflows.



View of remnants of former gravel pit pond on the Morey Wildlife Reserve. The gravel pit was filled in with sediment during the 2013 flood. Wetlands are reestablishing in some of the lower-lying areas around the former pond. The groundwater is shallow in this area, presenting opportunities for establishing new wetlands.

Although full restoration of the gravel pit pond is not recommended, the former pond provided the western-most open water habitat along the study reaches. This open water benefited birds and terrestrial wildlife. Because there is shallow groundwater across the Morey Wildlife Reserve, the City should evaluate establishing several smaller open water areas fringed with wetland vegetation to restore some of the habitat that was lost when the flood filled in the gravel pit pond. To the extent feasible, these areas should be located outside of the wetland high-flow channel to reduce the potential that re-established open water areas would be filled in by future floods.

The shallow groundwater in this area also provides potential opportunities for wetland creation, such as the proposed high flow channel. The City should investigate the potential for wetland mitigation banking within the Morey Wildlife Reserve. There are many projects proposed along the river corridor that could potentially require wetland mitigation under Section 404 of the Clean Water Act, and creating or enhancing wetlands at the Morey Wildlife Reserve potentially could provide multiple benefits for high-flow conveyance, habitat, and wetland mitigation.

5.2.2 Reach 30 - Rossum Drive to Namagua Avenue

As illustrated in Figure 5-4, this reach has gravel pits on the north side of the river for almost the entirety of the reach. These gravel pits are owned by Loveland Ready Mix. In September 2013, the river avulsed into a gravel pit on the left (north) bank of the river downstream of Rossum Drive. The avulsion into the pit captured all of the in-bank river flow and abandoned the old channel for a significant distance downstream. Additionally, the flow in the pit avulsed into and out of the next pit and returned back to the channel as well as into the eastern pit just upstream of Namaqua Road. The pre-flood channel was abandoned for almost 3,500 feet from the upstream avulsion site to its return point downstream, and its bed is approximately 4-5 feet above the current bed level at the upstream avulsion site.

The river channel from Rossum Drive to the diversion dam upstream of Namaqua Road is strictly confined by the large gravel pits to the north of the river. The north bank of the river along the pits was reinforced with concrete rubble and other materials, while bedrock and the higher southern valley wall confine the south bank of the river. The capacity of the main channel of the river through this reach is significantly smaller than the flood flows that passed through the reach, so in future large floods, flows through gravel pits should be expected, with spillways provided for overflows from the channel to the pits and vice-versa.

The BTWC is currently developing conceptual designs for improvements to this reach related to aquatic habitat and geomorphology. The overall intent of BTWC is to plan, design, and implement multi-functional projects that increase resilience of the river corridor and the watershed. In addition to grant funding to develop designs, BTWC has obtained funding to construct some of the improvements identified by their planning and design efforts. BTWC has been coordinating plans for improvements with the owners of Loveland Ready Mix.

5.2.3 Reach 31 - Namagua Avenue to Wilson Avenue

This reach has gravel pits on both side of the river for almost the entirety of the reach as shown on Figure 5-4. These gravel pits are owned by Loveland Ready Mix. Loveland Ready Mix has been working with the BTWC to make improvements to the property to mitigate damages from future flooding. Loveland Ready Mix is amenable to protected spillways as suggested by this Master Plan and BTWC, although, so far, they have only reviewed conceptual designs. BTWC and Otak have included Loveland Ready Mix in meetings on this topic and will continue to involve them in the process of developing mitigation measures to reduce future flood risk.

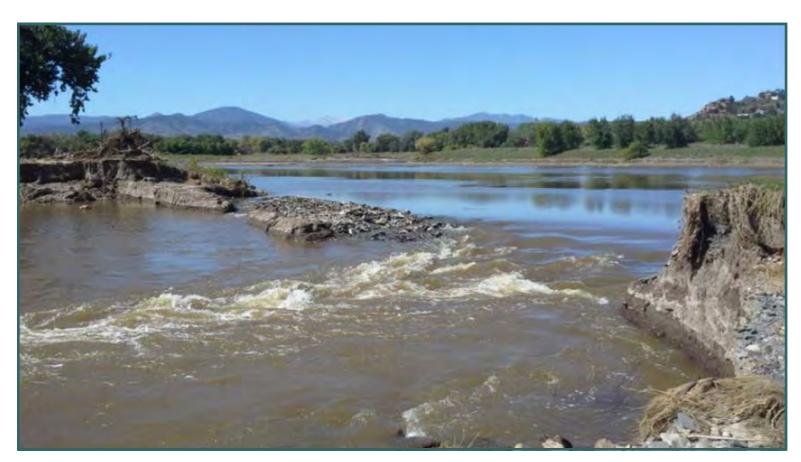
5.2.4 Reach 32 - Wilson Avenue to Taft Avenue

There are three gravel pit ponds on the western portion of this reach shown on Figure 5-4. Two lie to the south of the river on City property, and the other lies north of the river on private property (Schuster Pond). The smaller of the two ponds to the south receives runoff from a portion of the City of Loveland Service Center, and the larger pond on the south receives runoff from the City of Loveland Recycling Center. The larger pond is aerated in an effort to control algal growth and improve water qualityand is stocked with fish. The Schuster pond is privately owned and maintained.

In 2013, a roughly 500-foot section of the north bank along the Schuster property was severely eroded starting about 400 feet downstream of the Wilson Avenue Bridge. The erosion was caused by a combination of high velocities exiting the bridge and return flows overtopping the access road from the pond into the main channel. Without proper protection, this embankment, which separates the river from the pit lake to the north, could fail in a future flood event due to a combination of continued toe erosion from the river and seepage and pressure from the pit lake north of the embankment.

Flood flows overtopping Wilson Avenue south of the bridge flowed through the pond adjacent to the Recycling Center and created headcutting in the overbank areas east of the pond and bike trail as the flows reentered the main channel. At this location, downstream of the Schuster Pond and pond next to the Recycling Center, the main channel widened from approximately 40 feet to 170 feet.

The raising of the approaches to the bridge on Wilson Avenue will decrease the frequency of overtopping of Wilson Avenue and flood flows into the Schuster pond and the pond to the south of the channel next to the Recycling Center. In large events, beyond the 100-year event, overtopping may still occur. Therefore, embankment protection is



Flow returning to main channel from avulsion into gravel pit via embankment breach on reach between Rossum Drive and Namaqua Road. Armored overflow spillways between the river and adjacent gravel pits are called for in locations such as this to avoid the uncontrolled erosion and flood hazards from avulsions between the river and aravel pits and between adjacent gravel pits.



Return point of south overbank and avulsed flow from gravel pits to the main river channel approximately 400 feet upstream from Wilson Avenue. The main channel of the river is shown on the left and the gravel pit is on the right. An exposed utility line can be seen in the foreground. Providing armored spillways meeting the criteria in Appendix D are recommended to avoid these types of damages in future large flood.

still recommended for the embankments between the gravel pit ponds and the river in accordance with the technical guidelines in Appendix D.

On the eastern end of this reach overbank flows south of the channel overtopped of Taft Avenue and 1st Street and flowed into the Jayhawker ponds south of 1st Street and east of Taft Avenue causing significant damage in the River's Edge Natural Area. Improvements to gravel pits in the River's Edge Natural Area to better convey these overflows are described in the next section.

5.2.5 Reach 33 - Taft Avenue to Railroad Avenue

There are eight gravel pit ponds along this reach on the south side of the river as illustrated in Figure 5-7. Five of these ponds are contained within the River's Edge Natural Area (North and South Jayhawker Ponds, Dragonfly Pond, Sandpiper Pond and Bass Pond). In September 2013, overbank flows caused erosion, headcutting, and avulsions along the west end of the gravel pits and within the gravel ponds south of 1st Street. Several underground utilities were exposed within this area. Additional flood flows entered the gravel ponds by overflowing the south bank of the river downstream of 1st Street. The flows through the gravel pits south of the channel overflowed Railroad Avenue to the south of the river, rejoining the main channel in the southern portion of Fairgrounds Park, east of Railroad Avenue.

The Master Plan calls for improvements to the ponds in the River's Edge Natural Area, consistent with the 2015 River Restoration Master Plan. Within the River's Edge Natural Area, a series of spillways between ponds is proposed to convey flows to South Jayhawker Pond, Sandpiper Pond, the Bass Pond, and then a privately-owned pond and downstream beneath the Railroad and Railroad Avenue to meet the main channel of the river on the southern portion of Fairgrounds Park. This was the path that water overflowing Taft Avenue and 1st Street in the 2013 flood



Figure 5-7. Gravel Pit Ponds in Rivers Edge Natural Area (Adapted From Map by Loveland Open Program, CPW, and GOCO)

took through the River's Edge Natural Area. The embankments between ponds in the River's Edge Natural Area would be lowered and armored to resist erosion during overflow events. The 2013 flood caused significant damages, and the proposed improvements are intended to lessen the future potential for these damages by providing controlled overflow paths between ponds. Conceptual calculations indicate that 200- to 300-foot long soil riprap spillways between ponds in the River's Edge Natural area could convey the 100-year overflows between the ponds with a weir overflow depth of 3 feet or less.

To the extent practical given constraints imposed by existing conditions, the Technical Guidelines for Gravel Pit Berms in Appendix D should be followed for implementation of these improvements.

5.2.6 Reach 34 - Railroad Avenue to Lincoln Avenue - U.S. Hwy 287

There are only two gravel pit ponds along this reach, south of the river and west of Hwy 287. The larger of the two gravel pits sits immediately south of the channel, and the second pit, which is less than ½ the size of the larger pond, lies to the south of the larger pond. These gravel pit ponds are privately owned and are within the 100-year floodplain. Under flood conditions, these ponds are inundated by backwater from Hwy 287. In September 2013, overbank flows damaged the Fire Training Grounds south of Fairgrounds Park and caused erosion in the gravel pit immediately south of the channel (Uncle Benny's pond) at the northeast corner of the Fire Training Grounds. The City repaired this erosion following the flood. Overbank flows across the Fire Training Grounds caused considerable erosion and headcutting from Uncle Benny's pond west toward the Fire Training Grounds. High velocities caused erosion on the left bank (orientation looking downstream). Return flow to the channel just upstream of the Hwy 287 Bridge also caused some erosion.

As a part of the Hwy 287 flood mitigation improvements, significant grading to create floodplain terraces is proposed within Fairground Park, Barnes Park, and the King's Crossing Natural Area to the east. This grading is proposed along the channel to increase the area available for conveyance and transient storage of floodwaters. The proposed plans include filling approximately half of the gravel pit south of the channel to create a floodplain bench. An armored overflow spillway between the remaining portion of the pond and the channel is also proposed.

5.2.7 Reach 35 - Lincoln Avenue - U.S. Hwy 287 to St. Louis Avenue

As shown in Figure 5-4, there is only one large gravel pit pond along this reach, located north of the King's Crossing Natural Area and to the east of commercial and industrial development south of 8th Street and east of Hwy 287. During the 2013 flood, some erosion occurred along the top of the bank east of the business area as flows entered and crossed the main channel. Headcutting and erosion occurred from overbank flows into and through the gravel pit pond on the north overbank area.

The area between the river and the gravel pit to the north of the river is proposed to be regraded and lowered to create a floodplain bench and for flows to travel easily between the river and gravel pit during a flood event and to mitigate erosion and avulsion. A high flow channel is also proposed in this reach, which is intended to provide a designated area within the floodplain for increased conveyance during flooding.

5.2.8 Reach 36 - St. Louis Avenue to Boise Avenue

Overbank flows north of the main channel caused areas of erosion and headcutting around the gravel ponds in multiple locations. Return flows coming from both western gravel ponds caused significant headcutting and almost avulsed into the main channel in multiple locations. As flows crossed the main channel and overtopped the right bank into the eastern gravel ponds additional headcutting and erosion occurred on the western edge of the pond.

In this reach, the 2015 River Restoration Master Plan called for proposed lowering and regrading of the area between the river and gravel pit near the intersection of St. Louis Avenue and Highway 402. Since the river turns ninety degrees to the north and then again to the east in this segment, armored overflow areas are proposed as well. The lowered embankment in conjunction with the stabilized downstream face will reduce potential for headcutting and avulsion into the gravel pit in future floods. This land is currently privately owned, as indicated on Figure 5-4, so any improvements would need to be implemented in cooperation with the landowner.

5.2.9 Reach 37 - Boise Avenue to County Road 9E

Gravel pit mining is abundant throughout this reach of the river. Due to this historic land use, the main channel is mostly cut off from the floodplain, and water is confined to the main channel during a flood event. This reach experienced multiple avulsions during the September 2013 flood, including a major flow path through the Coulson Excavating property. The overbank flows that overtopped Boise Avenue moved east through the cornfields and then north towards the abandoned gravel pits. Overbank flows caused headcutting and the failure of the local access road north of the private pond. The main channel avulsed into the gravel pits just downstream of the wastewater treatment plant outfall channel. The return flow avulsed back into the main channel at the far northeast corner of the northern gravel pit.

The angle of flow returning to the main channel from the avulsion caused the left bank to erode and shift to the north. The flow was then redirected into the right bank and severely eroded the gravel pit access road. The road embankment is only a few feet wide at the narrowest section, and the pond side of the embankment is fractured and sloughing. The river will likely continue to erode this bank unless toe and bank protection measures are constructed.

Right overbank flows overtopped the north-south access road east of the gravel pits and continued east through the Coulson Excavating property. Overbank flows continued through the gravel pond and overtopped the eastern access road causing several areas of erosion and headcutting along the road. Overbank flows also avulsed through this embankment at the southeast corner of the pond. The flow out of this avulsion caused extensive erosion and sedimentation of the field downstream.

As the flood continued downstream, flows spilled into the left overbank and headed north into the gravel ponds and abandoned pits. The private residence and commercial buildings in this area received a large amount flow and sediment.

The 2015 River Restoration Master Plan recommends floodplain benching to lower embankments between gravel pits and the channel as well as armored overflows in areas susceptible to avulsion and between pits. Many of the gravel pits along this reach are privately owned, so implementation of improvements identified in the 2015 River Restoration Master Plan will require landowner cooperation.

5.2.10 Reach 38 - County Road 9E to Downstream Study Limit

Overbank flows spread throughout all of the ponds north of the river downstream of CR 9E. As the flow continued east it avulsed through multiple gravel pits and through the Boyd Lake outlet ditch about 2,400 feet north of its confluence with the main channel.

The recommended improvements for this reach in the 2015 River Restoration Master Plan include lowering embankments between gravel pits and providing armored spillways at areas with high avulsion potential. The gravel pits along this reach are privately owned, so implementation of proposed improvements would require landowner cooperation. Because the alignment of the future extension of Boyd Lake Avenue runs on the east end of this reach between existing gravel pits, the potential for gravel pit avulsions and overflows will need to be addressed to provide a safe route for the road, free from overtopping in a 100-year event.

The major landowner along this reach is Kauffman and Sons, and the September 2013 flood caused significant damage to their property. The flooding resulted in the loss of mined material. Following the flood, embankments that breached were rebuilt using fill material from onsite. According to a representative of Kauffman and Sons, they maintain the embankments to protect themselves from overflows from the river.

Mining activities at the Kauffman and Sons property are complete; however, the property is now used for recycling concrete and asphalt. Most of the ongoing reclamation activities are away from the river but within the 100-year floodplain. Currently, a bike path near the river is not feasible because of the heavy equipment traffic used for concrete and asphalt recycling activities and space constraints due to the pond on the northern side of the access road. However, once current activity on the property no longer requires the use of heavy equipment, it is possible a bike path near the river could be feasible. The property near the future Boyd Lake Avenue has been sold to the City, and once recycling operations are no longer occurring, the City should see if the property owners would be amenable to selling or granting a conservation easement for all or some of the area within the floodway to allow for recreational use and preservation of the land as a natural area.



Avulsion into gravel pits just downstream of wastewater treatment plant outfall channel. Gravel pits stored significant quantities of runoff during the September 2013 flood; however, due to the extreme amount of total precipitation, runoff volume, and the uncontrolled nature of flows between the river and the gravel pits and return flows, the effects of this storage were diminished in the 2013 flood.



Return flow back into main channel from gravel pits (on left) between Boise and County Road 9E. Note clear skies shown in the photo – return flows from gravel pits took several days to drain back to the river. It is not prudent to account for effects of gravel pit storage for flood attenuation unless the gravel pits are designed for that purpose and assured to be operated and maintained for that use for perpetuity.

5.3 GEOMORPHOLOGY

The 2013 flood caused significant geomorphic changes and erosion along the Big Thompson River Corridor. In order to plan to avoid such extensive damages in future floods, the current geomorphic characteristics of the river must be evaluated along with understanding what happened during the flood to learn from this real-world event. During the flood, there were many significant avulsions and areas of scour/erosion that have been repaired since the flood; however, impacts from the flood linger in depositional areas in the channel, and some of the avulsion repairs would likely avulse again in a large flood. The 2015 River Restoration Master Plan provides recommendations for geomorphic improvements including bank stabilization, floodplain terracing, gravel pit conveyance paths, and aquatic restoration. The BTWC is currently working on a multi-objective project from Rossum Drive to Wilson Avenue that will include geomorphic and aquatic habitat improvements. This work is ongoing, and it is incorporated into this plan by reference. Because river restoration and geomorphic work to the west of Wilson Avenue is already in design phases, this section of the Master Plan focuses on the reaches downstream of Wilson Avenue and refines the concepts in the 2015 River Restoration Master Plan.

While City parks and natural areas provide access to a significant portion of the river from Wilson Avenue to Hwy 287 and there are natural areas downstream of Hwy 287 that provide a patchwork of access, there are many privately owned sections of the river. This section identifies conceptual improvements, including bank stabilization, for some of these reaches; however, implementation of these measures would require cooperation of private property owners. In terms of developing prioritization and conceptual costs, the focus of the Master Plan is on publicly owned reaches.

5.3.1 Overview

The Big Thompson River through the City of Loveland has relatively similar patterns of geomorphic characteristics throughout. The most fundamental factor affecting the geomorphology is the regulated nature of the river. There are numerous diversions and return flows through the study area that have dramatically altered hydrology from natural conditions, which have not truly existed along this river for a hundred years or more. Encroachments into the floodplain due to historic sand and gravel mining activities create many reaches where a narrow channel is confined on both sides by gravel pit embankments, and roads and bridges associated with urbanization encroach on the channel and floodplain. These characteristics tend to increase the velocities and tractive forces of flows in the river, which has led to bank erosion in a number of locations. The gravel mining activities have created a channel that is disconnected from the floodplain in many locations, and when flood flows occur, the channel has inadequate capacity, and avulsions occur where embankments are not adequately armored to pass flows from the river to gravel pits and vice versa. Further flooding and geomorphic hazards are created at constrictions caused by bridges and at bends by the significant amount of woody debris in the stream that accumulates and impedes flow, much of which comes from collapse of bankside trees into the stream during large floods.

Diversion dams also have significant geomorphic effects on the river upstream and downstream of the points of diversion. These effects are due to the physical changes in hydraulics from the diversions and return flows, the decreased energy grade slope upstream of dams that leads to deposition, and the steepened energy grade slope downstream of the dams that increase potential for erosion.

The geomorphic characteristics of the upper reaches of the study area are slightly different than the downstream reaches, because the upper reaches have a somewhat steeper longitudinal slope as the river exits the canyon. As the river enters Loveland, the valley and river slope become milder, causing a reduction in the overall energy of the system, which reduces the erosion and sediment transport potential of the stream. Diversion dams also act to flatten the energy grade slope in the middle reaches through the City. In general, the longitudinal grade of the stream is relatively stable throughout without any major areas of downcutting. The main sources of instability occur during high flows, when avulsions occur between the river and adjacent gravel pits. Gravel pits are a part of the overall geomorphology of the river corridor and are referred to frequently in this section. Due to the importance of hazards of gravel pit avulsions and breaches, this topic is discussed in detail in Section 5.2 of this chapter.

As the river flows through the City the number of gravel pits, crossings and diversions increase, limiting the potential for overall shifts in channel geometry, planform and/or profile. The middle reaches of the river are confined by parks, roads, and other types of urban development rather than gravel pits, but the effects are similar - the channel has

few if any opportunities to migrate laterally, and the channel capacity is far less than the peak discharge of the 100-year flood. The channel is incised and disconnected from the floodplain along many portions of the middle reaches. Gravel pits and farmland replace urban land uses to the east of Hwy 287 and to the downstream extent of the study area.

The upper reaches also have lower width to depth ratios and greater overall pool depths than the middle and lower reaches, therefore providing greater depth of water in the low flow channel along pools to provide additional habitat during low water times. This greater depth also provides greater capacity and competency to entrain and transport sediment downstream. Moving downstream, the width of the river increases, with a reduction in flow causing decreased water depth, especially where aggradation has occurred upstream of diversions and in backwater areas on the upstream side of bridges.

The Big Thompson River through the majority of the project area is not well connected to its floodplain. This is due to multiple factors including gravel pits, roads and bridges, and high bedrock outcrops along some sections of the banks. In areas where the river channel is connected to the floodplain it must be understood that these floodplain areas will be depositional zones as the flows recede and lose their ability to transport material downstream, which was evident after the flood. It was also seen after the flood that as the floodwaters receded from the overbank areas, headcuts and gullies were formed which de-stabilized the banks. For some reaches, this is an intractable issue since constriction and confinement or the channel due to gravel mining activities, roads, etc. and private property constraints leaves virtually no room to provide more complex planform or to modify the channel to better connect the channel and the floodplain. In these confined locations, the best strategy is to armor embankments and provide spillways to allow flow to pass between the river and the gravel pits and between adjacent gravel pits without causing significant erosion or breaching of embankments. See Section 5.2 and Appendix D for recommendations and guidelines on embankment protection and spillways.

5.3.2 General Geomorphology Recommendations

There are several overarching concepts to provide better geomorphic stability and a more resilient river corridor that should be implemented throughout the study area where feasible. These include development of stabilized overflow



There are natural and manmade constrictions along the Big Thompson River Corridor that influence geomorphology. In the upper reaches of the study area bedrock outcrops constrict flows in several locations. In reaches further downstream, manmade restrictions including many gravel pit embankments, confine the river channel and prevent lateral migration unless by avulsion.

spillways between the river and gravel pits and high flow channels to convey flood flows while minimizing erosion and avulsions, increasing the capacity of bridges and/or the use of relief culverts, use of multi-stage channels with a low flow channel or inner berm where practical, re-connection of the floodplain through use of floodplain benches, and improving overall conveyance capacity and connectivity of the river corridor. Some of these tactics can be easily applied to the study corridor, while others are more difficult due to property ownership, existing land uses, geology, and associated space constraints. This Master Plan provides conceptual plans from the 2015 River Restoration Plan and also takes into consideration other master planning objective. The highest priority recommendations are those that also provide flood hazard reductions, ecological benefit, and are on publicly-owned portions of the river.

5.3.2.1 Channel Re-alignment

There were many areas during the 2013 flood where the channel migrated laterally or avulsed into gravel pits. The Big Thompson River channel is constrained in most reaches by gravel pit embankments, roads and/or adjoining land uses. While construction of overflow channels is recommended in some locations, major channel realignment of the Big Thompson River is not feasible or needed. Given existing constraints and land uses along the corridor, some of the greatest geomorphic improvements would come from spillways between gravel pits and the river to avoid the types of avulsions that occurred in 2013. Some realignment of low flow channels could occur for purposes of habitat improvements; however, no major channel realignments are proposed.

5.3.2.2 Multi-Stage Channel Concepts

Development of a multi-stage channel can be one of the most efficient ways to provide a resilient river corridor by connecting the river channel with floodplain terraces that are inundated with varying levels of streamflow. In a system such as the Big Thompson River that is highly regulated, many low flow characteristics are fairly predictable because of the way water rights are administered on the river. On the other end of the spectrum, the Big Thompson River Watershed has proven its ability to generate tremendous flood flows. By developing a channel that has multiple stages, each stage can be designed for a specific range of flows that have different volumes and velocities. Part of a multi-stage channel is a low flow channel or inner-berm that is based upon normal flows which allows the river to function properly during the average day, and continuity to provide adequate capacity, depth, conveyance, and stability. Additional stages above that are activated as flows increase, but allow the flow to dissipate over a greater cross-sectional area, therefore reducing velocities and consequently erosion. This is illustrated in Figure 5-8.

Figure 5-8 presents an idealized cross section, and implementation of this approach requires sufficient lateral space to lay back slopes and create terraces. In many areas, the Big Thompson River is too constrained to implement a multi-stage channel approach; however, these concepts should be applied in areas where there is adequate space and can be partially implemented by constructing terraces rather than a full multi-stage channel as shown in Figure 5-8.

5.3.2.3 Floodplain Benches/Connectivity

This is a similar concept to the multi-stage channel; however, it can be simpler to implement, either lowering a section of the floodplain adjacent to the river or raising the invert of the river to reduce the separation between the low flow channel and the overbank. This technique was successfully applied as a part of the Wilson to Taft Flood Recovery Project and was conceptually identified in many areas in the 2015 River Restoration Master Plan. Floodplain benches can be constructed by regrading or lowering the banks of the river to a level between the 1- and 2-year streamflow levels. Activation of the floodplain allows flood flows to dissipate over a greater area, consequently reducing the depth and velocity of the flow, and reducing the potential for erosion. Floodplain benches also have the benefit of increasing transient overbank storage in flood events, which plays an important role in peak attenuation in a floodplain as broad as the Big Thompson's. Floodplain benches also allow for greater riparian benefits by reducing the vertical separation between the vegetation and the water table, leading to increased growth that can dissipate flood energies and trap sediment and debris. Floodplain benching should be careful to avoid areas with mature trees. In general, these areas are more connected with the floodplain than grassed uplands where benching is more appropriate.

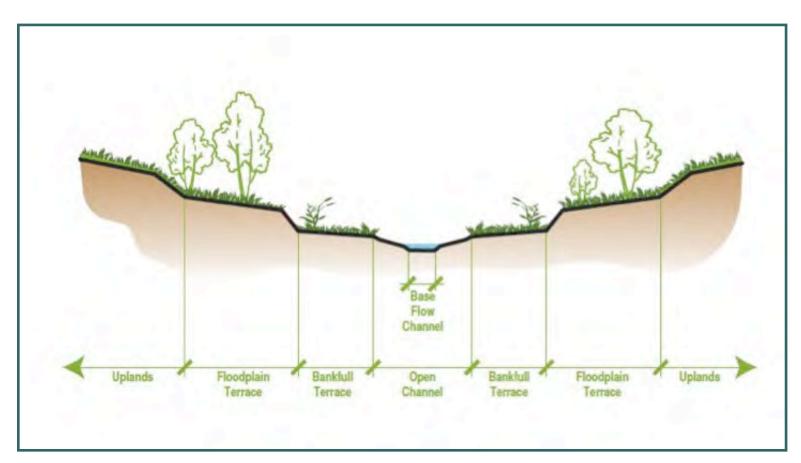


Figure 5-8. Concept of Healthy Multi-Stage Channel with Terraces for Bankfull and Flood Eventsv



Floodplain relief culverts are a good way to provide excess capacity at road crossings for infrequent events, especially in a wide floodplain like the Big Thompson's where flows spread out hundreds of feet in some locations and develop split flow paths through gravel pits.

5.3.2.4 Floodplain Relief Culverts

Increasing the capacity of the channel at roadway crossings is another technique to develop a more resilient stream system. Throughout the corridor there are a number of road crossings that cause the flood flows to be constricted and then expand again rapidly once through the crossing. The contraction and expansion forces can cause aggradation on the upstream end of a crossing and degradation on the downstream side of a crossing. By increasing the conveyance of the crossing these contraction and expansions forces can be minimized. While increasing the capacity of the bridge itself is a way to address this problem, there are still contraction issues when going from a 500-foot-wide floodplain to a 100-foot-wide bridge, for example. Using floodplain relief culverts is a way to reduce that constriction by not forcing the entire flood flow through the bridge opening. Floodplain relief culverts can be set at the invert of the floodplain so that they are only activate during large flood events, which can reduce maintenance. Floodplain relief culverts also reduce the amount of debris in the main channel by keeping the flood flows out the floodplain bench and reduce the chance for blockages of the main crossing.

5.3.2.5 High Flow Channels

High flow channels, or overflow channels, are areas within the floodplain that are designed to provide conveyance of major flood flows safely without causing excessive erosion or headcuts. These overflow channels are designed to flow only during major floods, allowing flows to be conveyed down valley and safely back to the river. Overflow channels usually include a stabilized crest made of rock that will resist the erosive forces of a channel avulsion, while also providing a stabilized rundown where the overflow returns the main channel to reduce the potential for headcuts moving up the overflow channel.

The project team developed geomorphology recommendations for reaches downstream of Wilson Avenue based on field observations, the 2015 River Restoration Master Plan, and the concepts above. Conceptual plans are illustrated on the river corridor mapping in Appendix A and on the 11" x 17" sheets in Section 5.10 of this chapter.

5.3.3 Bank Stabilization

There were many areas along the Big Thompson River that experienced excessive bank erosion and destabilization due to the 2013 flood. This was due to multiple factors, including the sheer volume of water that passed through the corridor, the high flow rates and velocities, and the extended duration of flows. The extended duration of the flood event caused soils to become saturated and lose their cohesive properties, which was compounded when the floodplain and banks started to dry and eroded even more material as the flows receded back into the creek causing sloughing and mass wasting.

Bank stability is of concern due to loss of property and potential damage to existing infrastructure in an area. The natural tendency to place utilities along a river corridor, either parallel or crossing, elevates the need for bank stabilization in these areas. The Big Thompson River in particular needs stable banks due to the number of gravel pits and potential for avulsions into these pits. These banks also need to be designed to not erode on the pitside when water is overtopping the banks.

While extreme events can cause massive erosion, it is normal for a channel to laterally migrate across a valley over time even under less dramatic flow conditions. Consequently, banks must be stabilized for extreme events as well as under more typical flow regimes. Stabilized banks, supporting healthy riparian vegetation, also provide ecological benefits along the corridor.

There are many different techniques to stabilize banks either before or after an extreme event like the 2013 flood. The specific techniques selected should be evaluated based upon the hydraulics, hydrology, and geomorphology of the site along with other site criteria such as space, permits, property ownership, nearby infrastructure or open space, along with desired intent and level of predictability of results. A number of different treatment techniques can be applied to stabilize banks, but there are also modifications to the channel geometry, planform and profile that can reduce or limit bank erosion.

The following sections present a variety of bank stabilization techniques that should be considered to repair eroding areas along the stream corridor. While many of these recommended techniques are vegetative in nature, given the magnitude of the discharge, flow depths and velocities in a 100-year flood on the Big Thompson River,

bank stabilization measures that do not have an adequate structural underpinning to resist erosive forces will fail in a large flood event. Any of the techniques described below can be used in conjunction with soil riprap that will provide structural stability beneath a layer of vegetation that provides ecological and aesthetic benefits. If the goal is to stabilize the channel for lesser flood events, the riprap requirements can be scaled back and a softer approach can be used; however, more frequent maintenance to repair erosion when flows in the river exceed the design tractive forces should be anticipated.

Throughout the corridor there are a number of places where old concrete chunks, railroad ties, and other non-engineered bank protection have been placed along the banks. While some of this was completed as emergency repair work, other areas have historical evidence of concrete being used as bank stabilization for a long time. In many cases this creates an eyesore, and in others, the inadequate bank protection is failing. In areas where banks are failing, repairs are recommended using the techniques described below; however, in areas where banks appear to be relatively stable despite the unconventional armoring, willow staking of the rubble areas is recommended to better lock the rubble together, improve aesthetics and habitat, and increase bank stability.

5.3.3.1 Bank Shaping and Re-Grading

Problems Addressed:

- · Channel Stability,
- Scour,
- Sediment Control,
- Bank Terracing,
- Wetland Creation,

- Conveyance,
- Water Quality,
- Riparian/Upland Habitat,
- Vegetative Communities.

Where possible, degraded or unstable banks should be re-shaped to more stable design geometry with the use of channel grading and laying back of banks prior to using any of the other measures listed here. A bankfull channel with an inlaid low flow channel and terraced floodplain should be used to accomplish this goal. The dimensions of the various channel parameters are set by the hydraulics associated with the specific site. By reducing the vertical stress, the erosive forces on the banks can be reduced, therefore stabilizing the banks naturally. Planting the reshaped bank will provide further stability. The shape of the bank should provide consistency with the cross-sectional geometry of the rest of the channel reach. In some areas bank shaping might not be necessary and in those locations additional stabilization features in the form of vegetation and rock could be used.

5.3.3.2 J-hooks, Root Wads and Log Vanes

Problems Addressed:

Channel Stability,

Riparian/Upland Habitat,

Scour,

Aquatic Habitat.

Sediment Control.

The J-Hook is a boulder structure that is located on the outside bend of a channel to redirect the flows back toward the center of the creek, thereby reducing erosive near-bank velocities and preventing avulsions. These are upstream facing structures that span about 2/3 of the channel. The arc of the hook is typically centered at the channel thalweg, forcing the flow towards the center and inside of the channel bend. Although similar to the design of the cross vane, the J-Hook does not span the width of the channel and is often constructed along a bend. To diversify channel materials, the J-Hook arm can be constructed with trees and other woody structures. J-Hooks can also create additional habitat in the creek and cover for aquatic species because they create deeper pools within the channel and reduce velocities.

5.3.3.3 Bendway Weirs

Problems Addressed:

Channel Stability,

Sewdiment Control,

Scour,

Aquatic Habitat.

Similar to the J-Hook, a bendway weir is a structure that is located on the outside of a bend to redirect flow back toward the center of the channel, reducing high velocities around the outer bank that can cause a bank to become unstable. Bendway weirs span about 2/3 of the channel; however, unlike the J-Hook, they do not curve back around in the center of the channel and are typically designed to be fully submerged in a bankfull event. Bendway weirs can also provide critical habitat and deep pools to form on its downstream side for aquatic habitat. Bendway weirs are composed of either larger riprap or boulders that can resist movement.

5.3.3.4 Log Toe

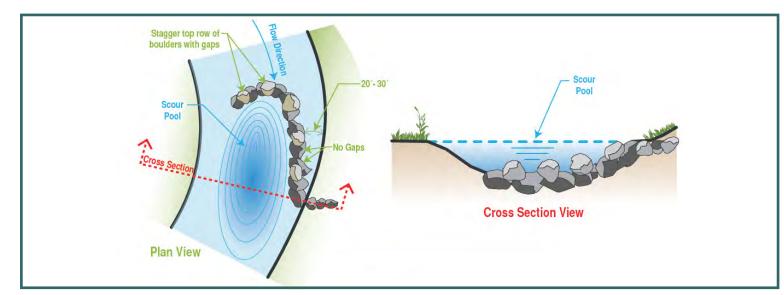
Problems Addressed:

- Channel Stability,
- Scour,
- Sediment Control.

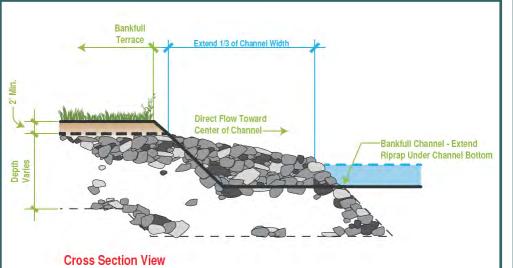
- Flood Risk Reduction,
- Bank Terracing,
- Aquatic Habitat/Fish Passage.

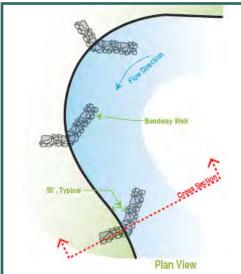
A log toe uses the trunks of trees to stabilize riparian habitat along waterways and reduce bank erosion. Existing large-diameter trees that are removed as a part of maintenance potentially could be reused to create a log toe nearby, making them a cost-effective bank stabilization method. Log toes are less permanent than boulder toes and typically last between 10-20 years.

Log toes are constructed by partially burying a log into the creek bank to resist moderate velocities. The species and diameter of the logs will vary based on availability onsite and height of the banks. A log toe can consist of multiple logs stacked on top of each other to achieve the desired height. At least 2/3 of the log toe structure should be buried into the existing grade to reduce the chances of undercutting. Log toes will help prevent bank erosion, thus giving vegetation enough time to establish along the channel and riparian benches. Log toes can be used in combination with boulders to lock the structures in place.

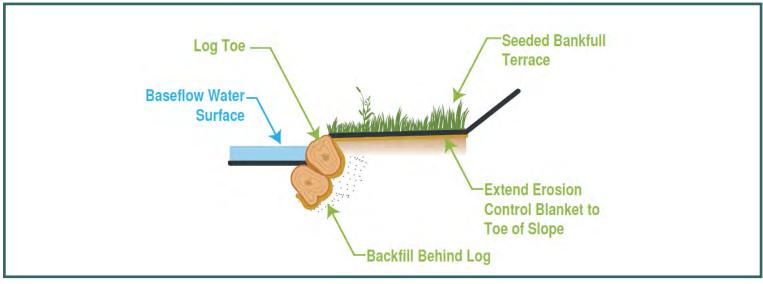


J-Hooks are used to deflect flow and velocity away from bank areas susceptible to erosion. They also often have the benefit of creating a downstream scour pool that provides deeper water and slower velocities for fish habitat.





Plan view and profile view of typical bendway weir. These weirs are intended to deflect high-velocity flows away from the banks. Bendway weirs are good control measures to consider for outer edges of bends.



A log toe is a natural method for stabilizing erosion at the toe of the bank. Log toes are often used in conjunction with boulders to help to secure logs in place while bank vegetation becomes established.

5.3.3.5 Boulder Toe

Problems Addressed:

- Channel Stability,
- Scour,
- Sediment Control,

- Flood Risk Reduction,
- Bank Terracing,
- Aquatic Habitat/Fish Passage.

Boulder toes are bank-stabilizing tools that can resist high velocities and are usually positioned on the outside bends of the channel. Boulder toes consist of 1, 2 or 3 boulders of varying sizes stacked on top of each other and buried 2/3 into the exiting grade. In cobble soils, the bottom of boulder toes can be installed on existing bed material. In sandy soils, structural fill or geotextile fabric should be installed underneath the boulder toe to prevent the structure from sinking or moving. Boulder toes will reduce erosion along banks and allow vegetation to re-establish and take hold. Willow stakes can be installed in-between the boulders during construction to mitigate the visual impact, provide additional habitat and increase the strength of the boulder toe over time.

5.3.3.6 Brush Layer (and Soil Lifts)

Problems Addressed:

- Channel Stability,

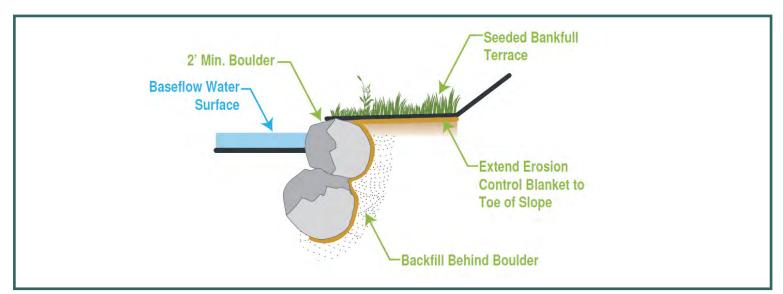
Scour,

Sediment Control,Bank Terracing,

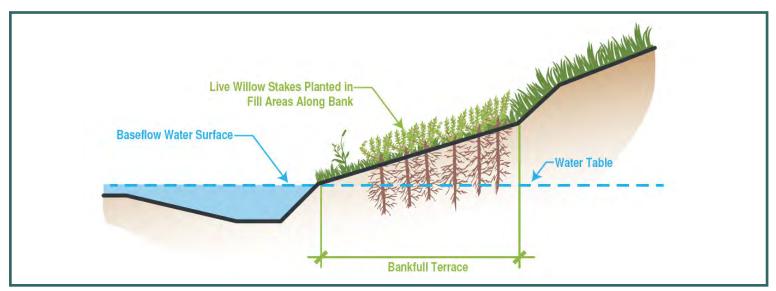
- Water Quality,
- Riparian/Upland Habitat,
- Vegetative Communities.

Brush layering is an option for bank stabilization when velocities and flows are less erosive. Installed on the outside bend of a curve, this tool is inexpensive and is easier to vegetate than soil riprap, but the installation can be quite labor intensive. Brush layering is desirable because of its natural look; however, if large flows or debris flow is experienced, the brush layering can tear and result in erosion and additional loss of bank or channel material. This technique can be complimented with the installation of large woody materials, such as trees, at the toe of the bank. This application is especially desirable if the design goals pertain to aquatic habitat restoration.

Brush layering can also be installed to provide strong bank stabilization/re-construction through the use of vegetated soil lifts. Vegetated soil lifts consist of lAyres of soil wrapped in geotextile fabric and stacked along the creek to form the new bank. Willow stakes are layered in between the soil lifts, and cottonwood poles are often used to pin the geotextile fabric down on top of the lifts.



Boulder toe protection is more expensive than log toe protection but it is also much more durable and less likely to fail if a high-flow event occurs during the period of re-establishing vegetation. A boulder-log hybrid approach may provide some cost savings, while providing greater stability than a log toe.



A brush layer is a vegetative bank stabilization measure that relies on willow staking and root establishment to provide stability. This can be an effective practice in conjunction with wrapped soil lifts to create a stable bank.

5.3.3.7 Willow Stakes and Cottonwood Poles

Problems Addressed:

- Channel Stability,
- Sediment Control,
- Wetland Creation,
- Water Quality,

- Aquatic Habitat/Fish Passage,
- Riparian/Upland Habitat,
- Vegetative Communities.

Planting live willow stakes and cottonwood poles along degraded stream banks not only increases stream stability but improves riparian habitat. This approach is applicable where banks experience relatively low shear stresses and velocities. Typically, cottonwood and willow stakes/poles can be harvested on-site or on nearby sites. This provides a higher probability of survival.

Planting willow and/or cottonwood stands along banks also provides excellent bird and small mammal habitat, as well as shades the water, which cools temperatures and creates healthier habitat for aquatic organisms. This is one of the lowest costing and easiest to install bank stabilization methods. It is so easy that willow/cottonwood pole plantings are often done by volunteer groups.

5.3.3.8 Soil Riprap

Problems Addressed:

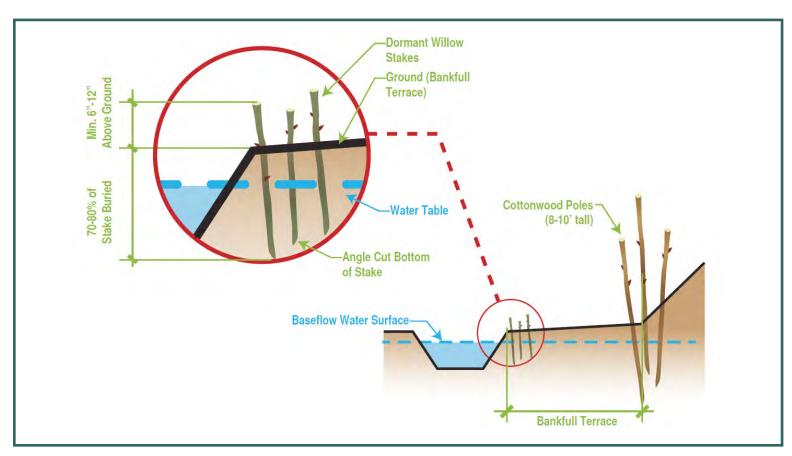
- Channel Stability,
- Scour,
- Sediment Control.

- Stream Crossing,
- Bank Terracing,
- Vegetative Communities.

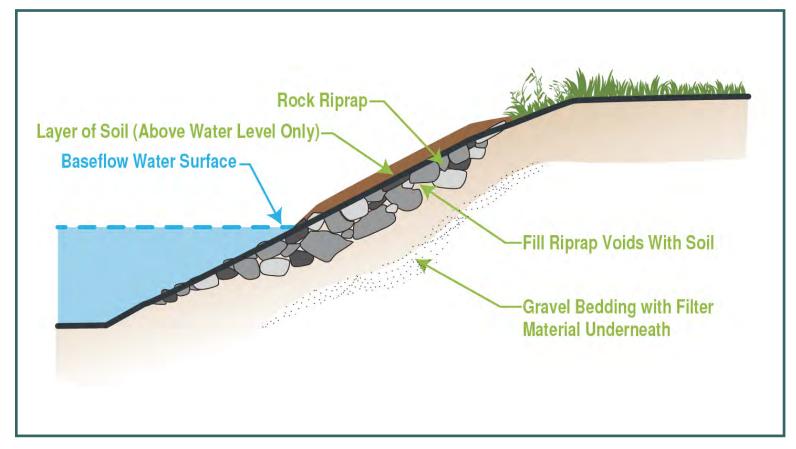
Soil riprap consists of a mixture of rocks and soil used to stabilize banks. This material is less costly than rock riprap alone, and can be just as effective if installed properly when designed for the right conditions. The rock and soil mixture allows for placement of more erosive, finer material, and generates greater slope and channel stability than backfill alone. Soil riprap is sometimes viewed as more aesthetically pleasing than rock or boulder riprap and has a greater chance of establishing vegetation to acquire the aesthetic look associated with natural channel design.

Soil riprap can be placed along the banks of a stream in an area that needs added protection, which can be offered by the riprap itself, but also allows for the placement of a soil mixture that can be used to provide vegetation. While the vegetation is used to support aesthetic aspects along with resistance to erosive flows during more frequent events, the riprap acts to provide underlying stability during large storm events.

Void-filled riprap is an alternative to soil riprap that is designed to emulate natural rock riffle material found in steep gradient streams. It contains a well-graded mix of cobbles, gravels, sands, and soil that fills all voids and acts as an internal filter, therefore a separate bedding layer between subgrade and rock is not required. In applications where it is difficult to establish vegetation, void-filled riprap is better able to resist the direct, prolonged impingement of water on the riprap installation compared to soil riprap. However, void-filled riprap is more difficult to properly mix and install compared to soil riprap. UDFCD recommends review of the technical paper titled Demonstration Project Illustrating Void-Filled Riprap Applications in Stream Restoration (Wulliman and Johns 2011). This paper provides background on the derivation of void-filled riprap and its applications in stream restoration and is available on the UDFCD website.



Willow stake and cottonwood poles are vegetative bank stabilization measures that provide habitat as well as stability benefits. These are inexpensive measures that can provide a stable bank with a natural appearance.



Soil riprap combines the structural benefits of riprap with the "softer" appearance of a vegetated surface. Soil riprap is suitable for bank stabilization and also can be used for constructing overflow spillways between the river and gravel pits and between adjoining gravel pits to safely convey flood flows.

5.3.3.9 Riprap Revetment

Problems Addressed:

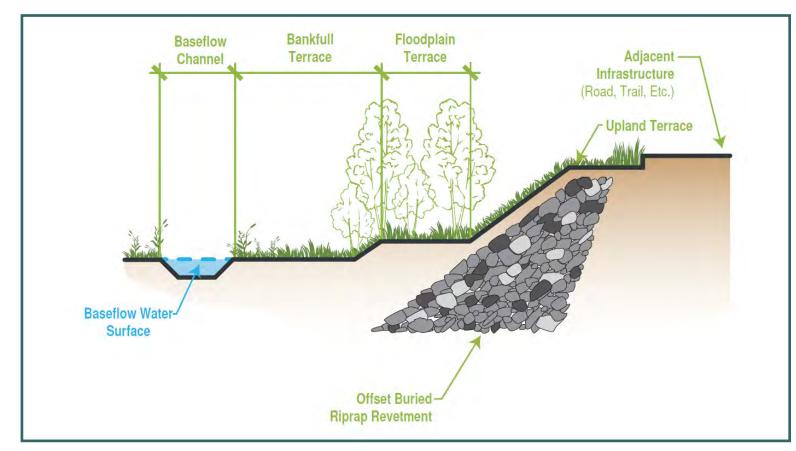
- Channel Stability,
- Scour,
 Bank Terracing.
- 6 1: 1 6 1
- Sediment Control,

Riprap, while typically the most expensive option for bank stabilization, allows for a detailed design using rock of a specific size to accommodate scouring and erosion associated with high velocities and meandering bends throughout a channel. Contractors tend to be familiar with the installation of this material, however there are greater costs associated with hauling and placing the rock when compared to other options. When using riprap consisting of larger rocks or boulders, void spaces must be properly filled and the use of granular bedding or an appropriate geotextile should be used to prevent scouring. This material is usually not suitable for vegetation, and thus isn't able to acquire the aesthetic look associated with a natural channel design.

Stream Crossing,

A riprap revetment can also be buried offset of the channel location to provide protection when the stream corridor migrates laterally. This type of technique can also be used as structural underpinning of more soft engineering strategies to provide an additional level of protection while also using natural channel design. Offset buried riprap size, depth, and area of coverage would be calculated in the same way a normal riprap revetment would be designed.

Offset buried revetment can be used as a last line of defenses to protect infrastructure in the channel migration zone. As the channel laterally migrates over time the offset, buried revetments can act as a protection for the infrastructure to allow time to perform routine maintenance and relocate channel or infrastructure projects as necessary.



A riprap revetment can be constructed to armor the streambank, or when floodplain terraces are used, can be offset from the main channel.

5.3.4 Flow Duration and Sediment Transport Potential

The Big Thompson River carried a tremendous sediment load in the 2013 flood, actively eroding and depositing sediment as the flood flows cut through the Loveland area. Flood recovery efforts repaired many areas along the corridor that were eroded; however, there are a number of areas along the river where aggradation remains. It is not economically viable to remove sediment deposits in the more than 9 miles of channel, and following flood repairs, the channel appears to be relatively stable in most areas after several years of post-flood flows. As time progresses and lower frequency, high flow events occur, the sediment deposits remaining from the flood will be remobilized and transported downstream.

To provide a quantitative way to estimate the likely persistence of sediment deposits, the project team performed a flow frequency analysis using data from United States Geological Survey (USGS) gauge 06741510 (located near 14th St SE, ~ 0.5 miles east of US Hwy 287), the only gauge within the study reach with recent annual peak flow data (1979 – 2017). These peak flow data were used to estimate flow magnitudes for various return intervals following the procedures of FEMA Bulletin 17b. A HEC-RAS model was then used to estimate average shear stresses along the study reach for each of these flows . The maximum grain size mobilized for each flow was then calculated as follows:

Where D is the grain size (mm), τ is the shear stress estimated from HEC-RAS (Pa), ρ_s and ρ are sediment and water density (2650 and 1000 kg/ m³, respectively), g is gravitational acceleration (9.81 m/s²), and τ_* is the dimensionless shear stress for particle mobilization. Values for τ_* vary. τ_* values of 0.021, 0.024, and 0.036 were used to account for uncertainty in this variable. Table 5-2 and Figure 5-9 show the calculated grain size mobilized for each flow (including upper and lower bound estimates). These data can be used to estimate the magnitude of the flow required to mobilize sediment deposits. For example, in the upper part of the project area, the median grain size is ~100 mm (Table 5-2). Sediment of this size would be mobilized during approximately a 5to 10-year event.

$$D = \frac{\tau}{(\rho_s - \rho)g\tau_*}$$

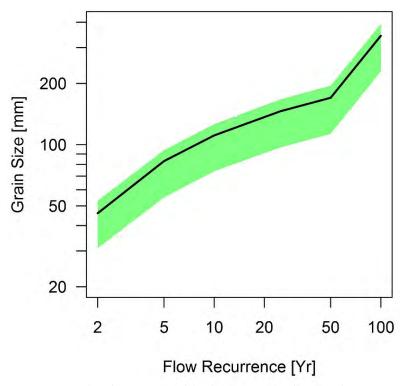


Figure 5-9. Plot of Maximum Mobilized Grain Size (mm) versus Flow Recurrence (year) - green shading indicates upper and lower bounds for grain size estimate

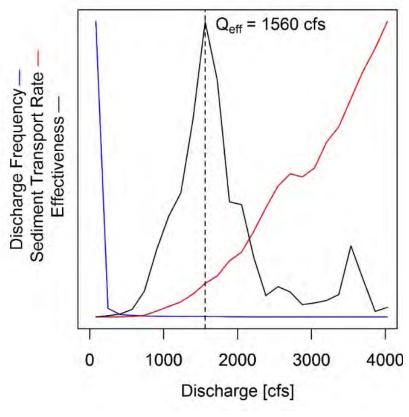


Figure 5-10. Effective Discharge Plot with Curves of Discharge Frequency, Magnitude of Sediment Transport Rates, and Effectiveness (product of first two curves)

	Annual		Maximun	n Mobilized Grain S	Size (mm)
Return Interval (year)	Exceedance Probability	Flow (cfs)	Middle	Lower	Upper
2	0.5	700	46	31	53
5	0.2	1,900	83	55	94
10	0.1	3,400	111	74	126
25	0.04	7,100	146	97	167
50	0.02	11,900	170	113	195
100	0.01	19,600	343	229	392

Table 5-2. Maximum Mobilized Grain Size (mm) for Flows of Various Return Intervals

¹Obviously, flows, especially on the more frequent end of the spectrum, vary considerably from one location on the river to another due to the highly regulated nature of the river. This analysis uses data from the USGS gauge located near 14th Street SE, about 0.5 miles east of US Hwy 287 and results presented are most accurate for that location. The results of analyses provide insight into sediment transport for other portions of the river; however, they should be interpreted with some caution due to differences in hydrology and hydraulics.

To supplement this analysis, the project geomorphologist also calculated the effective discharge. This is the discharge that is responsible for transporting the most sediment over time and is calculated as the product to the sediment transport capacity at a series of flow rates and the frequency of those flows. 15-minute discharge data from the same USGS gauge (available from 1986 - 2017) were used to estimate flow frequency. The geomorphologist then estimated reach average shear stresses using HEC-RAS. These data were then used to calculated sediment transport rates using the Wilcock and Crowe (2003) bedload equation. Otak generously provided grain size data for four locations between Rossum Drive and Wilson Avenue. These data were relatively similar (Table 5-3) so only data from Reach 1 were used for calculations. The calculated effective discharge was ~1560 cfs (Figure 5-10). Based on the flow frequency analysis at this gauge, the effective discharge has a return interval of approximately 3.6 years.

	Location	D ₁₆ (mm)	D50 (mm)	D84 (mm)	D _{mean} (mm)	Fs (%)
Reach 1	DS of Rossum	17.5	111.5	209	69.5	9.8
Reach 2	Between Rossum and Namaqua	26.4	98.3	173	63	11.6
Reach 3	DS of Namaqua	44.2	123	210	94	4.1
Reach 4	US of Wilson Ave	15.1	79	119	51.9	4.4

Table 5-3. Summary of Bed Grain Size Data provided by Otak. (Dx is the grain size for which x% of the distribution is finer, Dmean is the geometric mean, and Fs is the fraction sand)

5.4 AQUATIC HABITAT

Two of the primary issues with aquatic habitat along the reaches of the Big Thompson River studied in the Master Plan are related to diversion dams. Diversion dams create barriers to passage of fish and aquatic organisms, and they also divert water, leaving less in the river (none in some cases) for use by aquatic species. There are three legal dry up points within the project area. Other effects from diverted flows include increased temperatures in the river and less water to dilute in-stream concentrations of metals such as selenium, copper and arsenic, which are sources of impairment for some reaches of the river. Given the existing hydrologic stresses on the aquatic organisms in the river from diversions, the best ways to improve aquatic habitat along the Big Thompson River are to increase flow in the river during low-flow periods, create low flow channels and interconnected pockets of deeper water, and improve the continuity of the system throughout.

Recommendations for aquatic habitat improvements include modifying dams that are barriers to passage of aquatic organisms when they undergo a major repair or replacement, to allow for fish passage and in stream work to improve aquatic habitat, especially during low flow conditions. The 2015 River Restoration Master Plan identified many of the reaches within the project area for aquatic habitat enhancement. The BTWC, working with Otak, is in the process of developing design plans for geomorphic and aquatic habitat improvements from Rossum Drive to Wilson Avenue. For other reaches, the project team developed recommendations using the 2015 River Restoration Plan as guidance and providing additional detail based on field observations and other Master Plan objectives.

If additional water can be released through the project area, aquatic habitat recommendations should be reevaluated. There are at least eight fish passage barriers currently along the Big Thompson through the City of Loveland. It can be assumed that since the downstream reaches of the river don't have great aquatic habitat, successful spawning is not taking place downstream and most fish are moving from the canyon downstream into our project area. In order to allow fish to move back upstream during warmer times of the summer when there is less water, diversion dams should be retrofit to include fish ladders or similar measures when dams undergo significant repair or replacement. In practical terms, fish passage should focus only on areas upstream of the Greeley-Loveland Canal diversion dam. This is due to several factors including the dry up point immediately downstream of the Greeley-Loveland Canal diversion dam, the temperature effects of the Mariano Exchange Ditch, and the size of Greeley-Loveland Canal dam and cost of retrofitting it for fish passage.

The existing water quality of the river is also a concern for the aquatic habitat of the Big Thompson. As identified in the Fact Sheet in Chapter 2, some reaches within the study area are on the 303(d) List for impaired waters due to copper, arsenic, and/or selenium. When significant amounts of water are diverted, leaving little remaining in the the stream, water quality stressors to aquatic organisms from metals, temperature, and stormwater runoff increase. Furthermore, through Reach 31 the Mariano Exchange Ditch returns to the Big Thomson River with a considerable amount of turbidity, which causes a notable change in the appearance and temperature of the river. This turbidity reduces the habitat for fish that find food visually, and with decreased flows this sediment load is even more concentrated.

Another aquatic habitat concern is that aggraded fine sediment has accumulated in the river. Due to the many diversions and the inadequacy of the channel and flows to convey sediment downstream, fine sediment particles have accumulated upstream of diversion dams and in other locations through the study reach. Coarser substrate, like what is found on the downstream side of diversion dams, is the most suitable substrate for aquatic habitat. The coarse substrate provides better bedding habitat along with increased roughness in the channel bottom that provides for better aquatic habitat hydraulics.

The most advantageous way to provide additional aquatic habitat along selected stretches of the Big Thompson River is to construct a low flow channel or inner berm to connect remaining pockets of water under low flow conditions. A low flow channel provides pockets of depth throughout the year that provides habitat for aquatic organisms while also providing continuity of the river system throughout the corridor. The main benefits of increased depth are more cover and reduced water temperatures. The low flow channel could be coupled with excavated deep pools that allow for holding areas during the winter or dry months of summer. As discussed previously, the multi-stage channel has many other benefits including sediment transport, bank stabilization, and vegetation establishment. Establishing vegetation to provide shading is also an important component of improving aquatic habitat.

In summary, while the Big Thomson River through Loveland is not the greatest fishery in the state, it still has a lot of potential. The more upstream reaches have a better chance of continuous flow with increased depth for the aquatic system. If additional flow or a minimum in-stream flow amount could be obtained for this river, many simple techniques could be applied to provide improved aquatic habitat. Since the current conditions allow for complete dry up of the river downstream of the Big Barnes Ditch and Greeley-Loveland Ditch, even a few cubic feet per second of in-stream flow would be an improvement that could benefit habitat. General restoration techniques should try to increase the habitat diversity with increased pool depths, larger stream substrate material and removal of fish barriers.

5.4.1 Minimum In-Stream Flow

One of the greatest limitations on aquatic habitat for the Big Thompson River through the Loveland area is the heavily regulated nature of the river and scarcity of water for in stream flows. The Big Barnes Ditch and the Greeley-Loveland Canal each can divert the entire flow of the Big Thompson River during low flow periods. Some of the reaches are replenished in a small way by return flows; however, these low-flow and near-dry out conditions are extremely stressful for aquatic organisms. While many locals report catching fish from nearly every reach within the study area, increasing in stream flows during low flow periods would significantly benefit aquatic habitat.

While there are many options available for water supply acquisition that could achieve the goal of increasing low flows, only some will be feasible as a result of physical, financial, political and/or logistical limitations. Additionally, during periods of drought it cannot be expected that the City would be able to provide sufficient water in the Big Thompson to fully meet aesthetic, fishery, and recreational goals. Some conceptual approaches that could be further considered to increase low flows for aquatic habitat include:

- 1. Chimney Hollow Reservoir is expected to be completed by 2021 and to store water for 13 participants in northern Colorado including the City of Loveland. Collaboration with participants could facilitate the release of stored water during average to wet years throughout the latter part of the irrigation season to enhance aquatic life and recreation along the river.
- 2. An exchange agreement that would pay for water to be left in the river between major diversions along the Big Thompson between the relevant ditch water right owner and the City of Loveland could improve low flows within the identified reaches.
- 3. Snowpack and streamflow projection tools could allow for underutilized regional water supplies or large irrigation companies, such as the Greeley-Loveland Irrigation Company, to make water available for exchange to supplement the City's low-flow reaches.

Further development of these and other concepts is recommended working with the City's water attorney and water engineer, including initial meetings with representatives of the relevant ditches and the Division 1, District 4 Water Commissioner to identify other potential ways to increase low flows in the Big Thompson River through Loveland.

5.4.2 Diversion Dams

Diversion dams are prominent features on the Big Thompson River. They are necessary infrastructure on a "working river" that delivers water to multiple downstream users, but they create barriers to fish passage and also present potential hazards to boaters/tubers. BTWC is currently evaluating alternatives for the Rist-Goss diversion dam upstream of Namaqua Avenue, and Larimer County plans to remove the low head dam immediately downstream of Namaqua Avenue as a part of their bridge replacement project. Both of these projects will improve public safety and fish passage.

Some of the diversion dams along the river are aging and will need to have significant repairs or be replaced in the not-too-distant future. These include the Big Barnes and Farmer's Ditch diversion dams. At the time that these dams undergo significant repair or replacement, the dams should be retrofit to provide fish passage and boat chutes if feasible. The largest diversion dam on the nine-mile stretch of the river is for the Greeley-Loveland Canal. Making this diversion passable to fish is less critical as it sits below the cold-water/warm-water transition, which is typically controlled by return flows to the river from the Mariano Exchange and Ryan Gulch Exchange Ditches.

Regardless of the presence/absence of boat chutes, all diversion dams along the river corridor should have areas



This low head dam at Namaqua Avenue is one of two fish barriers over a short distance of the river. The Rist-Goss diversion dam is another, just upstream of Namaqua Avenue. Larimer County has plans to replace the low head dam shown with a new drop that will allow for fish passage, and BTWC is evaluating options for the Rist-Goss diversion dam.

for boaters/tubers to take out upstream of the dam, portage around the dam on land, and put in downstream of the dam. Signage should be provided upstream a distance sufficient to allow boaters/tubers to get to the take out area. As discussed below, river activities will be encouraged downstream of the Greeley-Loveland Canal diversion dam since many areas further to the west are privately owned. Warning signs and take-out areas are needed upstream of diversion dams for public safety regardless of whether the surrounding land ownership is public or private.

5.5 CITY UTILITIES

Loveland Water and Power is a municipally owned utility that provides Loveland customers with power, water, and wastewater utility services. Loveland Water and Power provided the project team with information on the 2013 flood repairs to utilities crossing the Big Thompson River, as well as information regarding the extent of the protection of these utilities. This section addresses City-owned utility crossings of the Big Thompson River, including information on the post-2013 flood repairs, as well as utilities that need additional protection based on as-built information or need additional evaluation since no protection information was provided or known. Figure 5-11 shows primary City-owned water, wastewater, and stormwater utility lines along the project reach. The mapping in Appendix A and on the 11" x 17" sheets in Section 5.10 illustrates these utility lines and recommended improvements.

5.5.1 Stormwater Outfalls

There are many stormwater outfalls throughout the project limits. For the most part, these outfalls have some sort of armoring (concrete rubble, riprap, etc.), and therefore, do not have significant erosion problems. Repairs are currently in design stages for two stormwater outfalls that were damaged by the 2013 flood:

• Within the reach from St. Louis to Boise Avenue (Reach 36), the City is currently designing a replacement of the failing grouted riprap/concrete rubble drop structure into the river from the Madison Avenue Outfall, including a large stormwater treatment best management practice (BMP).

• Within the reach from Boise Avenue to CR 9E (Reach 37), severe bank erosion in the 2013 flood destroyed the 48-inch diameter Denver Avenue Stormwater Outfall. This unprotected outfall was previously set back about 60 feet from the primary channel, yet failed during the 2013 flood as a result of significant bank erosion along the outside of a sharp, 90-degree bend. The outfall was reconstructed in November 2013, but it was not set back from the channel at an appreciable distance. Tetra Tech was retained by the City to develop a bank stabilization design to protect the outfall. The selected alternative consisted of riprap revetment upstream and downstream from the outfall. Please note that FEMA would not fund the proposed bank protection, so this outfall remains unprotected, and significant damages would likely occur in the next flood event. Bank protection is still needed and is recommended for the Denver Avenue outfall.

Some of the stormwater outfalls, including the stormwater outfall downstream of Namaqua Avenue, have been vandalized with graffiti, affecting the aesthetics along the corridor. Graffiti is a maintenance issue, and removal of graffiti is recommended as a part of a routine maintenance program. Outfalls that are visible from roads and trails should be the highest priorities for graffiti removal.

5.5.2 Water & Sewer

Many of the City's water and sewer utility crossings of the Big Thompson River were constructed with protection including an installation depth of more than four feet below the channel bottom and concrete encasement with a 6-inch minimum wall thickness. Despite these protection measures, during the 2013 flood, erosion and channel migration affected many utility lines along the river corridor. The Fact Sheets provided in Chapter 2 of this report illustrate utility crossings and provide information on alignments and pipe sizes.

The following summarizes some of the major repairs that were conducted on the water and sewer utilities along the project limits as a result of the 2013 flood:

• Reach 29: MM 87.7 - Rossum Drive:

Approximately half way along this reach, a 12-inch diameter PVC sanitary sewer line experienced damage on the section of pipe that runs parallel to the river. Repairs included an overflow weir structure for the river and riprap to protect the sanitary sewer.

• Reach 31: Namagua Avenue - Wilson Avenue:

The City's 24-inch diameter waterline on the east side of Namaqua Avenue was damaged by the flood north of the river over a length of approximately 500 to 750 feet. The pipe was exposed and the polywrap was torn off of the pipe. This utility crossing is in the vicinity of the Larimer County Namaqua Avenue Bridge Replacement project. As part of this project, the utility crossing will not be changed, but the channel bottom is to be elevated, and riprap protection of the waterline will be added.

• Reach 33: Taft Avenue - Railroad Avenue:

Approximately 850 feet of the 16-inch diameter waterline that runs through the gravel pit ponds to the south of 1st Avenue was lowered and all joints were restrained after 2013 flood damage.

• Reach 34: Railroad Avenue - Hwy 287:

A 6-inch diameter PVC waterline crossing of the Big Thompson River upstream of Hwy 287 was destroyed during the 2013 flood. This was replaced with an 8-inch diameter PVC waterline that was directionally drilled to a depth of approximately 17 feet. Additionally, an 8-inch diameter cast iron waterline under Lincoln Avenue – Hwy 287 was destroyed in the 2013 flood. A new 8-inch PVC waterline was directionally drilled in 2014 to a depth of approximately 23 feet.

Reach 37: Boise Avenue - CR 9E:

During the 2013 flood, the high-flow channel downstream of the bridge widened due to erosion of the right bank. The pre-flood channel was approximately 40 feet wide, and the post-flood channel was approximately 100 feet wide in places. This erosion caused the failure of the sewer main crossing under the river near Boise Avenue. As a result, the City placed a 12-inch diameter PVC sanitary sewer force main, a 20-inch diameter PVC sanitary sewer

force main, and a conduit duct bank in a common concrete encasement anchored in competent bedrock.

As described above, many of the water and sewer utility lines were repaired and protected following the 2013 flood. However, based on as-built information provided by Loveland Water and Power, several additional water and wastewater utility crossings of the Big Thompson River are lacking protection or there is nothing known about how the utility lines are protected.

For the following utilities that are lacking protection or need additional protection, potential protection alternatives include realigning the utility farther away from the river, concrete encasement with a minimum thickness of 6 inches, or deepening the line to below the potential scour depth. Each crossing should be evaluated to determine which conceptual protection alternative would be the most feasible and provide the necessary protection for the utility line.

Reach 34: Railroad Avenue - Lincoln Avenue - US Hwy 287:

A 24-inch diameter cured-in-place pipe (CIPP) sanitary sewer crossing of the Big Thompson River just south of the Fairgrounds Park pavilions and splash pad has a concrete cap, but the cap can be seen along the river bottom. This sanitary sewer crossing should be armored to mitigate the potential for scour.

In addition, a 6-inch diameter cast iron waterline crossing of the Big Thompson River located east of the Fairground Park Dog Park has approximately 4.5 feet of cover below the river bottom. This waterline was built with pre-cast concrete anchors to prevent flotation and concrete cutoff walls. However, the City has indicated that this utility line is not very well protected and additional protection measures are necessary.

There are several utility lines along the river corridor that are approximately 5 to 6 feet deep with six-inch concrete caps that only cover the utility lines for the width of the installation trench (24 inches, typical). These include an 8-inch diameter waterline in Reach 32 and a 10-inch sanitary sewer line in Reach 33 as examples. While the depth and protection are not as robust as some of the other utility crossings, these lines did not incur significant damage in the 2013 flood. Therefore, additional protection and/or lowering of these utility lines are not called for.

Loveland Water and Power did not have information regarding the protection of several of the utility lines. These utility crossings should be investigated further to determine whether the utilities are adequately protected or if additional protection is needed:

• Reach 32: Wilson Avenue - Taft Avenue:

Three 8-inch diameter vitrified clay pipe sanitary sewers under Taft Avenue make up the siphon under the Big Thompson River. Information on the protection of these vitrified clay pipe sanitary sewers was unavailable. In addition to the vitrified clay sanitary sewer lines, there is a pressurized water main immediately downstream of the Wilson Avenue Bridge. This water line was exposed in the 2013 flood when riprap washed away from the bridge abutments. Surprisingly, this water line did not wash out, but the 2013 flood emphasized the need to better protect this water line.



Denver Avenue stormwater outfall, reconstructed in November of 2013.

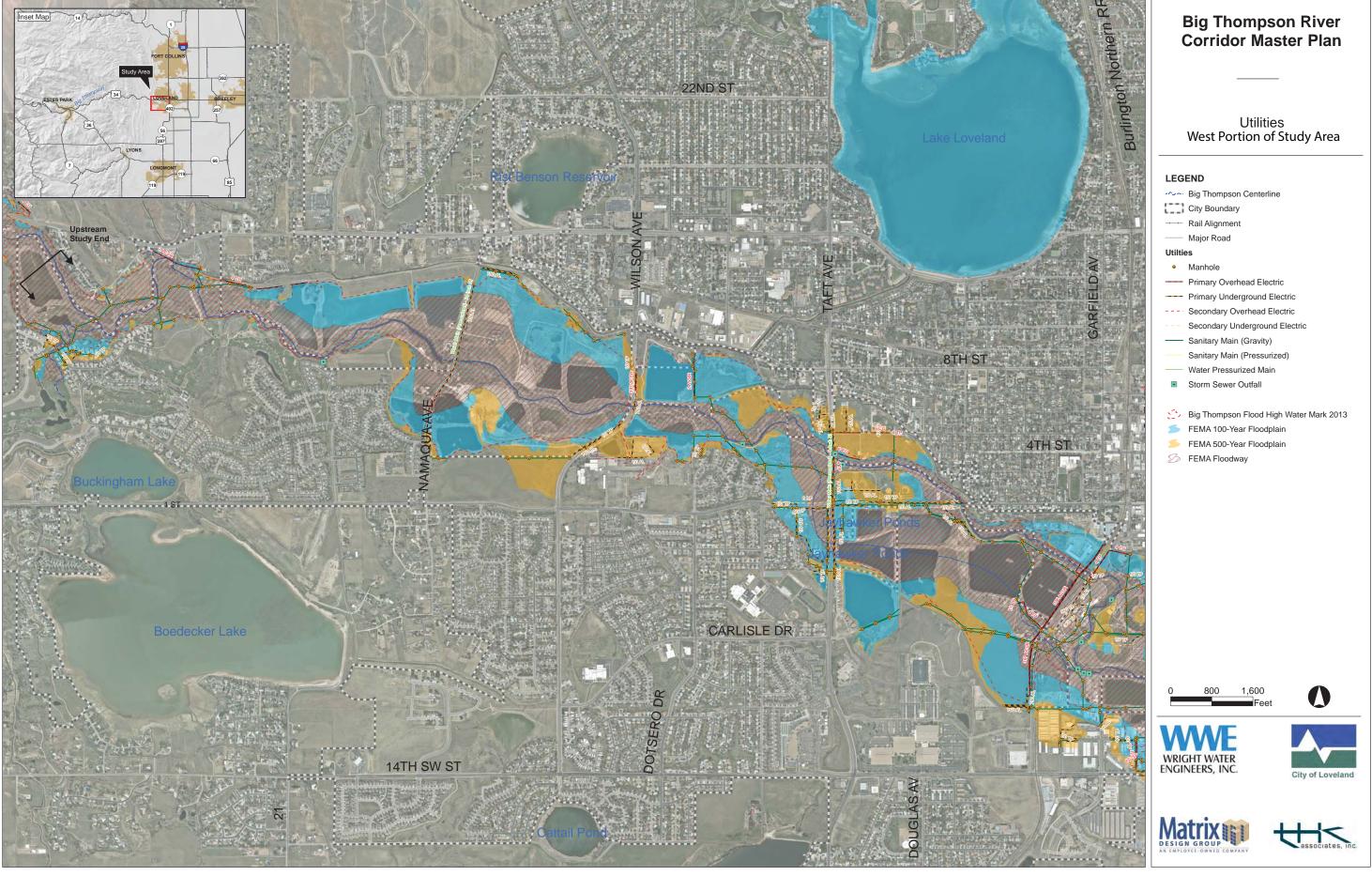


Figure 5-11a. Utilities Along Big Thompson River Corridor

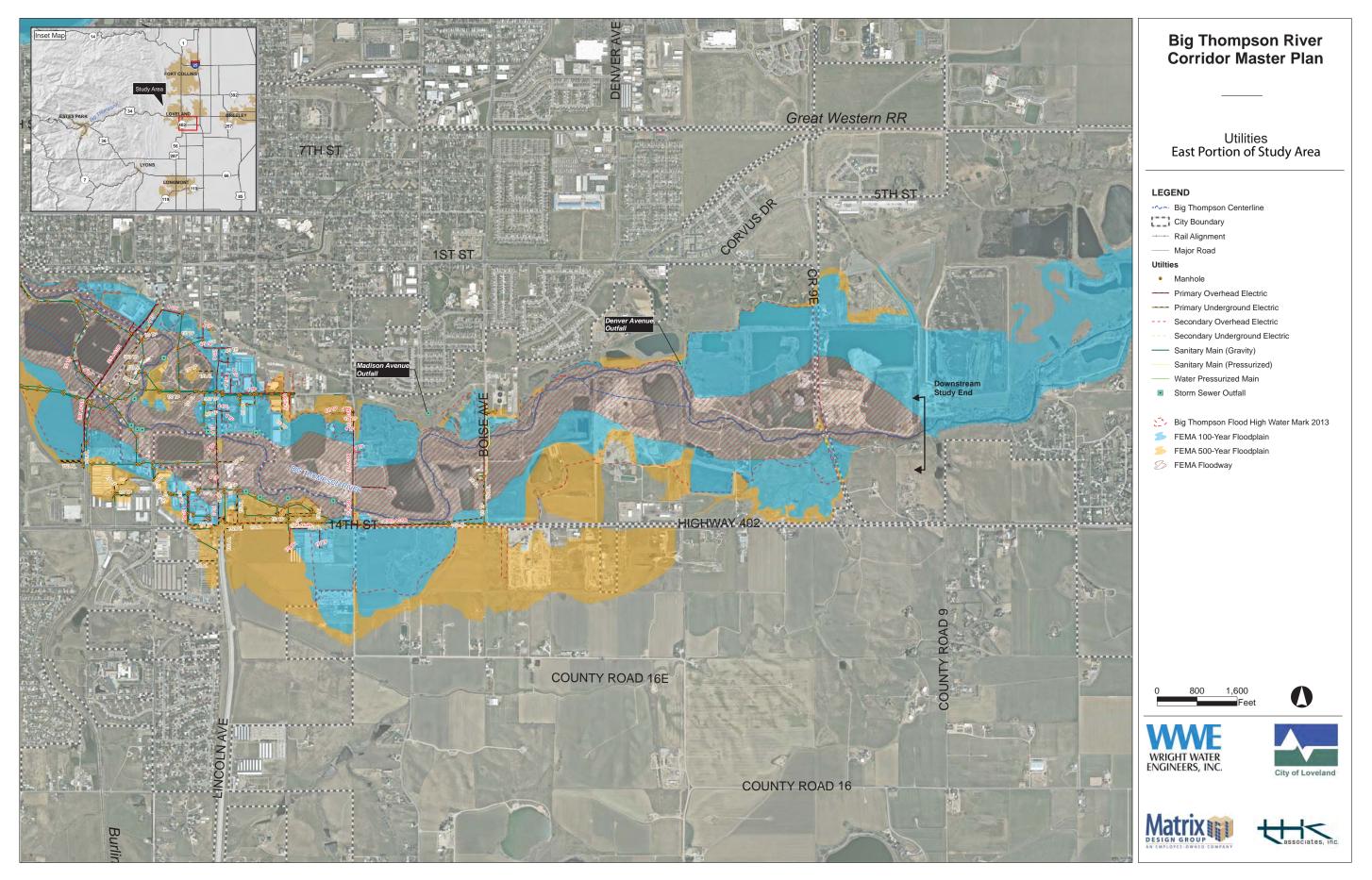


Figure 5-11b. Utilities Along Big Thompson River Corridor

Reach 33: Taft Avenue - Railroad Avenue:

Little is known about the 16-inch diameter waterline crossing of the Big Thompson River just south of 1st Street, including the level of protection.

These utility lines were not affected by the 2013 flood. If repairs are not needed sooner, these utility lines may be replaced and re-installed beneath the projected scour depths as a part of improvements to the Taft Avenue Bridge and overflow spillway improvements in the River's Edge Natural Area south of 1st Street.

5.6 WATER QUALITY

The water quality of the Big Thompson River through the City of Loveland is heavily influenced by external sources including Buckhorn Creek, the Mariano Exchange Ditch, and the Loveland Wastewater Treatment Plan outfall downstream of Boise Avenue, to name only a few. In addition, urban stormwater runoff affects the river during wet weather events downstream of major stormwater outfalls. Diversions and return flows lead to a heavily modified flow regime, and aquatic life is affected by temperature changes and water quality of return flows.

Selenium is a primary source of impairment for reaches of the Big Thompson River from the Big Barnes Ditch diversion upstream of Rossum Drive to Boise Avenue. Although not listed as a source of impairment, the increases in stream temperatures due to return flows released from reservoirs cause noticeable temperature effects under low flow conditions.

One of the most significant and visual water quality effects along the Big Thompson River is the spike in turbidity that occurs where the Mariano Exchange Ditch enters the river. When the ditch is running and is turbid, the river goes from having good transparency upstream of the Mariano Exchange Ditch to being cloudy downstream, as shown in Figure 5-12. Based on evaluation of aerial photos, this effect extends downstream through the entire study area. Hydrosphere Resource Consultants, Inc. (Hydrosphere) prepared a study in 2005 for the Big Thompson Watershed Forum (BTWF) to evaluate the causes of the turbid discharges from the ditch and outlined several potential solutions related to water rights and/or stabilizing the ditch to reduce erosion.

Based on the previous analysis and current plans, two measures for reducing turbidity in ditch return flows to the river are proposed for further evaluation:

- 1. Evaluate the outlet structure configuration for Boedecker Reservoir and modify the outlet to allow it draw water from upper IAyres of water stored in reservoir. Long-time Loveland residents report that discharges from the Mariano Exchange Ditch have been causing noticeable changes in the turbidity in the river for roughly the past 20 years. The conditions have reportedly worsened somewhat over time. Given the age of the reservoir, it is likely that significant sediment has accumulated in the reservoir over the years. If the reservoir outlet can be modified so that sediment is not drawn off the bottom, conditions in the river would be expected to improve.
- 2. The second component of the recommended approach is to run the ditch return flows through an inactive gravel pit adjacent to the Big Thompson River on the west side of Wilson to allow for sedimentation prior to discharge to the river. Loveland Ready Mix owns the gravel pits west of Wilson and south of the river, and routing ditch flows through these pits would require their cooperation. Another option to consider is routing ditch flows through the pond on the left (south) bank of the ditch, just before it crosses under Wilson Avenue. The main storm drain from the Service Center discharges to this pond. While this is a relatively small pond and would not likely solve the issue, it could provide some benefits. The pond on the right bank of the ditch upstream of Wilson Avenue was also considered as an option to provide greater residence time; however, this pond is stocked by Colorado Parks and Wildlife (CPW) and aerated, so using this pond for treatment is not advised.

In addition, the BTWC has plans to run the ditch through settling ponds near the mouth of the ditch before it discharges to the river. The available area for these settling ponds is relatively small, as with the Service Center pond, so the ability to remove fine sediments will be limited. Nonetheless, settling ponds near the mouth of the ditch in combination with the Service Center pond would provide some incremental water quality benefits.

The Mariano Exchange Ditch is a potential source of sediment itself, and the previous study by Hydrosphere for BTWF identified eroding sections of the ditch as sources of sediment and turbidity. As a result of the Hydrosphere study, the City conducted work along the ditch to address erosion around stormwater outfalls. Despite this work, the turbidity of the discharges from the ditch persists. Based on observations in the summer of 2017, there are some areas of erosion along the ditch; however, these are not believed to be the root cause of the problem because water samples collected in the ditch just downstream or Boedecker Reservoir and at the ditch discharge point to the river had similar appearance.

One of the alternatives identified in the previous study for the BTWF was to re-route the Mariano Exchange Ditch to a downstream diversion to avoid the discharge flowing through the river. While this alternative would address the issue with sediment in the discharge, the flow from the ditch is valuable to the river under low flow conditions, so it is preferable to look for ways to reduce sediment in the return flows rather than rerouting return flows to bypass the river.

Boedecker Reservoir is a State Wildlife Area and is managed jointly by CPW and the Consolidated Home Supply Ditch and Reservoir Company (Home Supply). The project team interviewed representatives from both of these organizations in preparing this Master Plan. CPW leases recreational rights to Boedecker Reservoir to provide access for hunting, fishing and wildlife viewing. Home Supply is the owner of Boedecker, and manages the water operations from the reservoir. Home Supply owns the dam, the outlet structure, and the ditch.

CPW staff members, including the District Wildlife Manager and Aquatic Biologist, are familiar with the concerns about sediment from the Mariano Exchange Ditch. To date, CPW has not observed any impact to the fishery in this reach of the Big Thompson River due to turbidity. The reach in question is transitional between cold water and warm water and does not contain significant spawning grounds or quality habitat for trout.

City of Loveland Stormwater Management

The City of Loveland discharges stormwater from urban areas to the Big Thompson River and other receiving waters under the CDPHE General Permit for Municipal Separate Storm Sewer Systems (MS4s). The MS4 consists of the storm sewer and drainage network of the City, including gutters, inlets, drainage ditches, open channels, and outfalls to the Big Thompson River. The MS4 General Permit requires the City to implement programs to manage stormwater quality from construction activities, new development, redevelopment and municipal operations. The MS4 General Permit also has requirements for public education and outreach.

Effects from stormwater runoff tend to be acute increases in concentrations of urban pollutants such as total suspended solids, nutrients, and metals following runoff events. Chlorides and sand are additional pollutants of concern in winter months. While the effects of stormwater discharges occur at the outfalls and downstream, meaningful treatment of stormwater at outfalls is generally not feasible since the outfalls discharge stormwater from large tributary areas, and there is typically little room for adequately sized treatment along the bank of the river. Therefore, watershed-based approaches are essential for stormwater quality treatment and reduction of the rate and volume of runoff that reaches the river.

While there are many stormwater control measures (SCMs) or BMPs in the City that improve stormwater quality, many portions of the City developed prior to modern stormwater quality regulations. As older portions of the City eventually redevelop, MS4 requirements will lead to additional treatment.

Continued adherence to the City's MS4 program requirements and ongoing public education and outreach activities such as the annual river clean up day in the fall are important ways to strengthen the public's awareness of the connection between the urban watershed and the river.



Figure 5-12. Effect of Mariano Exchange Ditch on Big Thompson River Turbidity, September 2016, Google Earth.

CDPHE recently adopted a policy to evaluate bedded-sediment impacts to macroinvertebrates and nesting sites for trout that could be helpful for evaluating sediments impacts from the Mariano Exchange Ditch. CPW is not aware of any investigation into the potential impact to benthic macroinvertebrates from sediment settling on the river bottom. If there are parties interested in funding an effort to characterize the potential sediment impacts to the macroinvertebrate community, CPW could provide assistance in developing a sampling plan and/or assist with sample collection. CPW has the equipment and experience to collect the data to evaluate sediment impacts to macroinvertebrates. CPW can collect the bugs and measure the sediment, but other parties would need to fund the analysis. In addition to turbidity and sediment impacts, additional data could be collected to determine selenium concentrations from the ditch since downstream river segments are on the 303d list for this parameter, and samples could be collected and tested for bacteriological parameters since the reach the ditch discharges to and downstream reaches are classified and actively used for recreation.

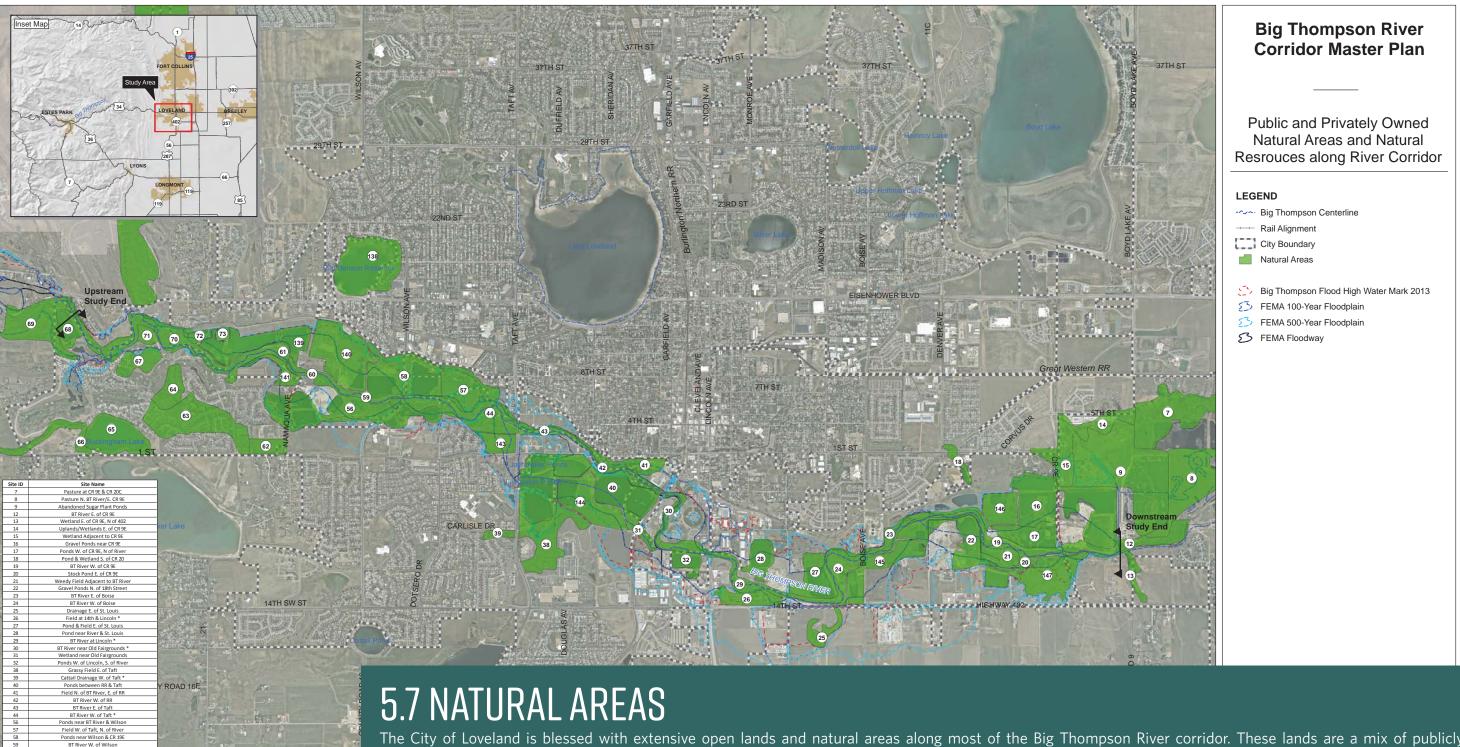
The potential measures to reduce the turbidity of return flows from the ditch should be further evaluated and discussed with Home Supply and relevant stakeholders to see if a cooperative solution to this significant water quality issue can be found.



Comparison of sample from Mariano Exchange Ditch with sample from river just upstream of discharge point. The ditch has elevated levels of sediment and is noticeably turbid in comparison with the river upstream. The Consolidated Home Supply Ditch and Reservoir Company operates the ditch and Boedecker Reservoir, which is the source of water in the ditch.



Mixing zone where the Mariano Exchange Ditch discharges to the Big Thompson River. The discharge from the ditch affects the clarity and temperature of the river downstream of the discharge. Conditions similar to what is shown in this photo were observed throughout the summer of 2017 when the ditch was flowing.



The City of Loveland is blessed with extensive open lands and natural areas along most of the Big Thompson River corridor. These lands are a mix of publicly and privately-owned parcels that provide significant benefits to wildlife. Figure 5-13 is a map showing all of the natural areas and open lands identified in the City's 2008 Natural Areas Inventory. The City has a very active Open Lands/Natural Areas Program and has done an excellent job of acquiring natural areas along the river corridor, preserving many floodplain areas, providing habitat for wildlife and providing recreational opportunities for resident. Over the course of conducting this Master Plan, the City has acquired two new natural area parcels including the Oxbow East Natural Area and the Willow Bend Park and Natural Area. In addition to City-owned parcels, the Simpson Ponds State Wildlife Area upstream of County Road 9E provides excellent habitat and recreational opportunities for fishing and hunting. Figure 5-14 shows publicly owned natural areas along the corridor.

While additional natural areas will be acquired in the future along the river corridor, this Master Plan focuses primarily on City-owned natural areas where the City has the ability to design and implement changes. Many of these recommendations also could be applied to nearby privately owned natural areas; however, the cooperation and consent of the landowners would be required. The following sections provide an overview of current conditions for City-owned natural areas and recommendations for enhancing natural characteristics and public benefits provided by these areas.

Figure 5-13. Public and Privately Owned Natural Areas and Natural Resources along River Corridor

the Nature of Things: City of Loveland Natural Area Sites

BT River W. of CR 19

Ponds S. of 34 & West Ridge Dr.

Upland Grassland & Trees

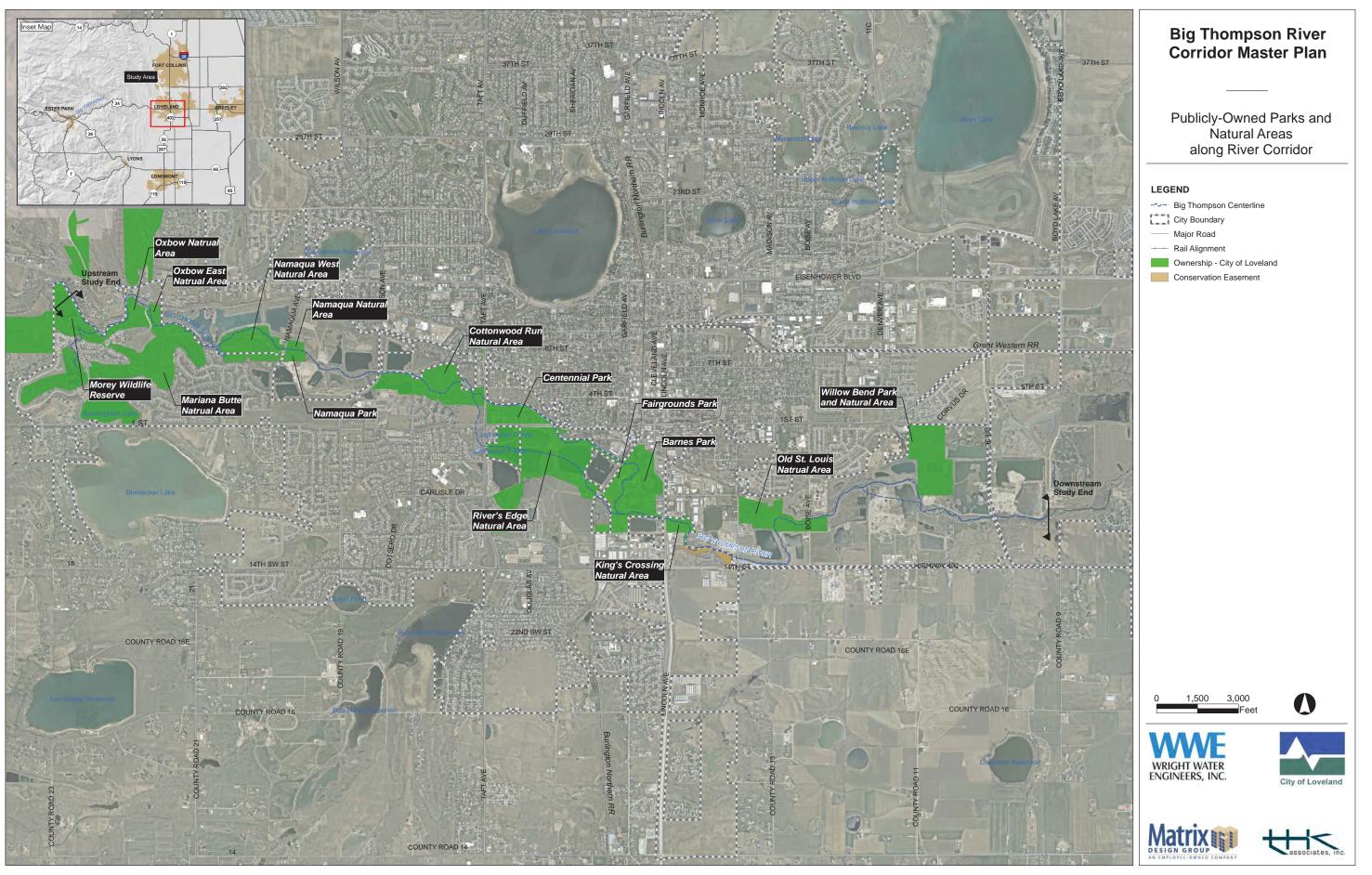


Figure 5-14. Publicly-Owned Parks and Natural Areas along River Corridor

5.7.1 Morey Wildlife Reserve

5.7.1.1 Overview of Current Conditions

The Morey Wildlife Reserve is an approximately 20-acre natural area located in the Mariana Butte neighborhood, just northwest of the golf course along the Big Thompson River. This natural area is bordered by the Marianna Butte golf course and subdivision to the south, the river to the east and north, an open natural area and agricultural land to the west. The majority of this wildlife reserve (approximately 10 acres) was an open water gravel pit pond prior to the 2013 flood. As discussed above, the flood filled this pond with sediment. Four years later, as evidenced by August 2017 fieldwork, upland and riparian vegetation is establishing within the majority of this area.

The majority of this remnant lake is now an upland area with cottonwood (Populus deltoides) and peachleaf willow (Salix amygdaloides) trees establishing over willow (Salix spp.), upland and riparian grasses, herbaceous and weedy species. In the southern portion of the remnant lake, white sweetclover (Melitotus alba), which is a nitrogen fixing plant, predominates the area. Slowly over time this upland will become well vegetated with upland and riparian area trees, shrubs and underlying grasses and herbaceous species. There are low-lying areas around the perimeter of and within the remnant lake that contain wetland species such as cattail (Typha latifolia), bulrush (Schoenoplectus spp.), sedge (Carex spp.), and rush (Juncus spp.). Weedy species such as kochia (Kochia scoparia), thistle (Cirsium spp.), and mullein (Verbascum thapsus) are located along the trail and sporadically through the upland areas.

The Morey Wildlife Reserve is protected from abundant human interaction since it is bordered on the north, east and west by the river, the existing golf course, existing residential homes, open space, or agricultural farm fields. Currently there is little parking and limited site access, and mainly local residents utilize the area. Because of this relatively low level of human use, wildlife such as black bear also utilize this natural area. Black bear scat was seen throughout the wildlife reserve during the August 2017 fieldwork. Elk, white tailed deer, mule deer, small mammals, amphibians, reptiles, and an abundance of bird life also visit the wildlife reserve.

There is open upland grassland, which connects this wildlife reserve to open space, agricultural fields and riparian



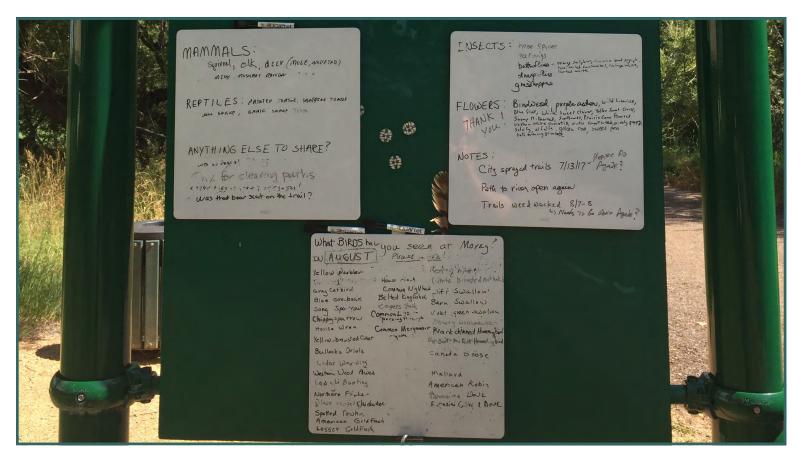
Riparian trees along the Big Thompson River in the Morey Wildlife Reserve. There are many large riparian trees and shrubs around the perimeter of the natural area and along the river. Large cottonwoods and peachleaf willows are also located along the western perimeter of the natural area.

habitat to the west. This is likely the route wildlife use to access the Morey Wildlife Reserve while searching for food and cover. In addition, there are many birds, which can be seen flying, roosting and hunting for prey from the numerous trees located in this area.

5.7.1.2 Recommendations

There are good opportunities to create wetlands in a portion of the remnant gravel pit pond because ground water is shallow, as evidenced by the former pond. Excavation of 2 to 3 feet of sediment may be ample to create a wetland feature within the remnant lake feature. These wetlands could be planted with a variety of native bulrush, rush, sedge and other appropriate wetland species. In addition, riparian trees and shrubs should be planted on the perimeter of the wetland area increasing plant diversity in this location and creating wildlife habitat. The high flow channel through this area discussed in Section 5.2.1 could be designed as a wetland channel to provide conveyance and habitat benefits.

In the remaining portion of the Morey Wildlife Reserve, the Master Plan calls for planting upland and riparian area shrubs, which provide cover and food for black bear, deer, elk and other mammals (see Tables 5-4 and 5-5). This enhanced wildlife habitat would be especially beneficial to wildlife (deer and elk) during the winter months. Because there are many cottonwoods and peachleaf willows already established or establishing within and around the wildlife reserve, the Master Plan does not suggest that additional upland or riparian trees be planted. Dead standing trees should be retained, as they are excellent snags for bird habitat. Continued treatment of weeds is recommended for this area.



Wildlife observation board at Morey Wildlife Reserve. Many bird species use the reserve as well as mammals including black bear, elk and deer. Residents and City naturalists record observations of many different species of birds as well as mammals on this board near the entrance of the reserve.

SHRUBS		
Common Name	Scientific Name	
Chokecherry	Prunus virginiana	
Serviceberry	Amelanchier alnifolia	
Squawapple	Peraphyllum ramosissimum	
Elderberry	Sambucus spp.	
Hawthorn	Crateagus spp.	
Gambel Oak	Quercus gambelii	
Wild rose	Rosa woodsii	
Willow	Salix spp.	
Buffaloberry	Shepherdia canadensis	
Huckleberry	Vaccinium cespitosum	

HERBACEOUS SPECIES		
Common Name	Scientific Name	
Meadow rue	Thalictrum spp.	
Cow parsnip	Heracleum sphondylium	
Pea vine	Lathyrus spp.	
Sedge	Carex spp.	
Lovage	Ligusticum porteri	
Woodland strawberry	Fragaria vesca	

SHRUBS		
Common Name	Scientific Name	
Fourwing saltbush	Atriplex canescens	
Gambel Oak	Quercus gambelii	
Antelope Bitterbrush	Purshia tridentata	
Native (American) Plum	Prunus americana	
Chokecherry	Prunus virginiana	
Rocky Mountain Maple	Acer glabrum	
Serviceberry	Amelanchier alnifolia.	
Tobacco-brush	Ceanothus velutinus	
Juniper	Juniperus spp.	
Golden currant	Ribes aureum	
Nanking cherry	Prunus tomentosa	
Sumac	Rhus spp.	
Woods rose	Rosa woodsii	

GRASSES/HERBACEOUS SPECIES		
Common Name	Scientific Name	
Wheatgrass	Agropyron spp.,Elymus spp.,Thinopyrum spp.	
Wildrye	Elymus spp.	
Bluegrass	Poa spp.	
Fescue	Festuca spp.	
Indian ricegrass	Achnatherum hymenoides	
Big bluestem	Andropogon gerardii	
Blue grama	Bouteloua gracilis	
Nodding brome, mountain brome	Bromus spp.	
Buffalograss	Buchloe dactyloides	
Mountain muhly	Muhlenbergia montana	
Switchgrass	Panicum virgatum	
Little bluestem	Schizachyrium scoparium	
Prairie cordgrass	Spartina pectinata	
Clover	Trifolium spp.	
Engelmann's aster	Eucephalus engelmanii	
Mountain bluebell	Mertensia ciliata	
Richardson's geranium	Geranium spp.	
Rush	Juncus spp.	
Sedge	Carex spp.	
Sainfoin	Onobrychis viciifolia	
Penstemon	Hedysarum boreale	
Swamp verbena	Verbena hastata	
American vetch	Vicia americana	
Mule-ears	Wyethia amplexicaulis	

5.7.2 Oxbow Natural Area

5.7.2.1 Overview of Current Conditions

The Oxbow Natural Area is an approximately 8-acre site located in an oxbow of the Big Thompson River adjacent to Rossum Drive just east of the Morey Wildlife Reserve. This natural area is north of the Mariana Butte golf course and subdivision. Well-established riparian trees and shrubs are located along both the northern and southern portions of the natural area. To the south there is a high flow channel, which supports an established riparian area with trees and shrubs with a riparian understory.

The majority of this natural area appears to be a historic agricultural field dominated by non-native grasses on either side of the entry trail. Weeds are located along this entry trail and within the non-native grass established areas. The main grasses are smooth brome (Bromus inermis) and a variety of wheatgrasses (Agropyron spp.), (Elymus spp.), (Pascropyrum spp.) and crested wheatgrass (Agropyron cristatum). Weeds include kochia, Canada thistle (Cirsium arvense), and a few Russian olive trees.

5.7.2.2 Recommendations

The Master Plan recommends that this natural area be used for native upland and riparian area shrub, grass and herbaceous species seeding, and planting experimentation. The north side of the natural area from the entry trail should be sprayed with herbicide to kill off the existing non-native grasses and herbaceous species. Soil samples should be analyzed to determine necessary soil amendments. Once soil amendments are added, the soil should be ripped especially where compacted. The area should then be seeded and mulched with a native upland and riparian area seed mix including native grasses, wildflowers and other herbaceous species. In addition, native upland and riparian shrubs should be planted. This seeding and planting exercise could assist in determining which species might best establish along the river corridor through Loveland. Bare areas should be seeded with a variety of seed mixes to determine what would best assist with natural area revegetation along the river.

The non-native upland area located south of the entry trail, which is a smaller area, could be left as a comparison



Looking west into the Oxbow Natural Area from the entrance off of Rossum Drive. This aid in reestablishing native vegetation on this site and as an educational opportunity, the Master Plan recommends experimentation with different types of native grasses, herbaceous plants and wildflowers along the path through this natural area.

to the newly seeded and planted areas. Signage along the entry trail should be provided to describe different native species establishing on the north side of the trail with non-native species on the south side of the trail. The public might be interested in the seeding and planting process and could potentially be recruited to assist in monitoring.

5.7.3 Oxbow East Natural Area

5.7.3.1 Overview of Current Conditions

The newly acquired natural area across Rossum Drive from the Oxbow Natural Area is an approximately 12-acre site. The ditch rider road on the north side of the property is the primary access to the site. There is an existing, abandoned building site. The natural area to the east of the building is dominated by thick, lush upland and riparian area vegetation including large trees, some shrubs and an understory of grasses and herbaceous species. There are pockets of weeds throughout this natural area. Large riparian trees line the river through this natural area.

5.7.3.2 Recommendations

The Master Plan recommends that this natural area receive continued weed control and spot seeding or interseeding with a native upland seed mix of grasses and wildflowers where needed. The majority of existing vegetation should remain as a scenic backdrop to this natural area. This area is excellent habitat for birds, small mammals, amphibians, reptiles and occasional larger mammals. Upland and riparian shrubs should be planted in select locations around the site to further enhance the wildlife habitat (see Tables 5-4 and 5-5).



Big Thompson River adjacent to the Oxbow East Natural Area. This natural area was only recently acquired by the City and is directly across Rossum Drive from the Oxbow Natural Area. This is a spectacular natural area that, with minor improvements, will provide an excellent passive recreational area to be enjoyed by people and wildlife alike.

5.7.4 Namagua West Natural Area

5.7.4.1 Overview of Current Conditions

Namaqua West is an approximately 58-acre historic farm and set of agricultural fields located south of the river. There are several lakes and/or gravel ponds located to the north of the river on the Loveland Ready Mix property. Namaqua Avenue is the eastern boundary of this natural area, and Namaqua Park lies to the east. Namaqua Park provides opportunities for families to picnic, play and recreate. A residential subdivision lies to the south and west of the natural area.

Namaqua West is currently under agricultural production; however, a strip of land directly along the river has been left natural with riparian trees, shrubs and a grassy understory. The remainder of the area includes agricultural farm fields, a farmhouse, and farm outbuildings. These agricultural fields are likely planted in non-native grasses, with few to no existing trees or shrubs. Through public outreach, the project team learned that elk are known to winter in these farm fields.

5.7.4.2 Recommendations

Based on discussions with City staff, this area will continue to be farmed for the near term, and Open Lands and Natural Areas staff has not yet developed long-term plans for this property. This property would be well suited to be developed as elk wintering habitat because elk are known to utilize this area for this purpose. This would include improving the agricultural fields through continued weed control, soil sampling and addition of soil amendments as necessary, spot or interseeding with an appropriate seed mix of native grasses and herbaceous species. The Master Plan also recommends the planting of native upland and riparian shrubs preferable to elk around the agricultural fields (see Tables 5-4 and 5-5). Trees should also be planted to improve shading during the summer months.

The more natural portion of this property, located along the river on the northern edge of the property, would benefit from the planting of additional riparian trees and shrubs, and upland trees and shrubs farther from the river. Continued weed control and bare area spot seeding with a native grass and herbaceous species seed mix is also recommended. This would also aid in the goal of establishing a better vegetative buffer between farming activities and the river.

5.7.5 Cottonwood Run Natural Area

The Cottonwood Run Natural Area includes an approximately 4,800 linear foot corridor of the river located between Taft and Wilson Avenues. This natural area is approximately 1,000 feet wide in the eastern half and 300-400 feet wide in the western half. A concrete trail for cycling and pedestrian runs along the south side of the river through this natural area. The sections below describe the eastern and western portions of the Cottonwood Run Natural Area since each of these areas has unique characteristics.

5.7.5.1 Overview of Eastern Portion of Cottonwood Run Natural Area

The eastern portion of the Cottonwood Run Natural Area is approximately 1,000 feet wide, including the river corridor itself. It is directly adjacent to additional open space along the river to the north, agricultural land and Centennial Park to the east, an agricultural field to the south, and the river corridor to the west. This eastern portion contains remnant oxbows of the river, which create low-lying riparian tree and shrub corridors and wetland pockets throughout this section. The Cottonwood Run Natural Area provides excellent wildlife habitat for birds, small mammals, reptiles, amphibians, and larger mammals such as elk, which use the southern part of this section during the winter months.

The concrete trail generally bisects the 1,000-foot-wide natural area and follows the general course of the river. A triangular upland area is located approximately 1,000 feet west of Taft Avenue north of the pedestrian trail within the natural area. This approximately 1-acre area has upland grasses such as brome and wheatgrasses with some weedy species.

Wetlands are located south of the trail closer to the middle of the natural area, which are likely remnant oxbows of the river. A good variety of wetland species and occasional snags of fallen trees are located in the wetlands. Many riparian trees such as plains cottonwood and peachleaf willow are also present, which form excellent canopy along the river and remnant oxbows. The riparian trees and shrubs create excellent wildlife habitat especially for birds and larger mammals moving through the corridor.

The project team's wildlife biologist spoke with people along the pedestrian trail and was told that the area located south of the trail, which is filled with dense riparian trees and an understory of shrubs and grasses and other herbaceous species, is excellent elk refuge during the winter months. There is an existing soft trail winding through this area, and the public often observes wildlife.

5.7.5.2 Recommendations for Eastern Portion of Cottonwood Run Natural Area

The Master Plan recommends continued weed control in this eastern half of the Cottonwood Run Natural Area along and adjacent to the concrete trail. Soil samples should be taken to determine if soil amendments are needed before seeding and mulching occurs. The soil should be ripped before seeding, as it is compacted on both sides of the pedestrian trail. Additional upland and riparian area shrubs should be planted in bare areas along the trail (see Tables 5-4 and 5-5). Approximately 1,000 feet west of Taft Avenue, along the trail, is a triangle of mowed grassland. Spot weed control and reseeding or interseeding with a native grass and wildflower seed mix is recommended to improve aesthetics.

Elk are reported to overwinter in the large portion of the natural area located south of the trail. This area has excellent wildlife habitat, which includes a combination of upland trees and shrubs, riparian trees and shrubs, and low-lying pockets of wetlands. These wetland areas could potentially be expanded through excavation and then seeding/planting with an appropriate native wetland species mix. Weeds have established in pockets throughout, including thistle, kochia, mullein, and cheatgrass. These weeds should be removed and areas either planted or seeded with desired native upland, riparian and/or wetland species. There are many Russian olive trees located both along the river and in the overbank area, to the south. These trees should be removed and stumps treated. Russian olives are aggressive and can fill in an area rapidly if not removed.



Some sections of the multi-use path through the Cottonwood Run Natural Area were reconstructed as a part of the City's Wilson to Taft Flood Recovery Project. Many weeds exist along both sides of the pedestrian trail throughout this section, including kochia, thistle, cheatgrass (Bromus tectorum), mullein, and other weedy species. Continued weed control and revegetation are recommended for these areas.

5.7.5.3 Western Portion of Cottonwood Run Natural Area

The western half of the Cottonwood Run Natural Area contains large cottonwood and peachleaf willow trees and is located just south of the river. This approximately 2,000 linear foot stretch of natural area is between 300-400 feet wide and is bordered by gravel ponds/lakes to the south and the river corridor to the north.

The majority of this portion of the natural area is excellent for bird watching due to the predominance of large mature riparian trees with an understory of shrubs, upland grasses, and other herbaceous species. Some weeds exist on either side of the concrete trail west of the proposed river access location. Overall, this is a well-vegetated stretch of natural area, providing excellent habitat for birds and small mammals.

5.7.5.4 Recommendations for Western Portion of Cottonwood Run Natural Area

The Master Plan recommends a proposed river access area downstream of the Greeley-Loveland Canal. The river access "trailhead" will be accessed via the existing Recreational Trail from the Wilson Avenue Trailhead. Currently the Wilson Avenue parking area is high above the floodplain and trail below. Pedestrians and parking present conflicts with Recycling Center traffic. Reconfiguration of the Wilson Avenue trailhead is recommended to provide easier access to the Recreational Trail, as discussed below.

The area for the river trailhead, approximately 2000 feet east of Wilson Avenue, should be ripped to loosen soil and treated for weeds. This area then should be seeded with an appropriate native seed mix containing upland grasses, and wildflowers and be mulched. A combination of upland and riparian shrubs should be planted in this location to improve wildlife habitat (see Tables 5-4 and 5-5).

The natural area located west of river access area should be left in its current well-vegetated condition. Some weed control and reseeding or planting with desirable native species is possible, however not as necessary as in the central portion of this natural area. Dead tree branches, which pose a hazard, should be removed; however, standing snags provide excellent bird habitat and should be retained. Some native upland and riparian area shrubs could be planted

The western portion of the Cottonwood Run Natural Area contains a gravel pit pond south of the river. This pond, in combination with large cottonwood and peachleaf willow trees along the river, make this an area of excellent habitat for many types of birds and small mammals.

in this location to further improve the wildlife habitat (see Tables 5-4 and 5-5).

5.7.6 King's Crossing Natural Area

5.7.6.1 Overview of Current Conditions

King's Crossing is an approximately 7-acre natural area located east of Lincoln Avenue and south of the river. A parking area is located in the southwest corner of the site, and soft trail provides access to the river to the north. There are many weeds such as kochia and thistle established along on either side of this trail.

King's Crossing has a perimeter of large, mature cottonwoods and peachleaf willows located along the northern, western and southern edges of the natural area. Established upland grasses and herbaceous species are located in the interior of the natural area, along with some weeds. The site has excellent habitat for birds, small mammals, reptiles and amphibians. It is unlikely that it would be used much by larger mammals due to its position in the urban area and being surrounded by commercial development and vehicular traffic.

5.7.6.2 Recommendations

The Master Plan recommends continued weed control for King's Crossing, along with soil sampling, to determine if soil amendments are needed. After amending and ripping the soil, bare areas should be seeded with a native and wildflower upland seed mix. The Master Plan recommends planting additional native upland and riparian shrubs along the northern edge of the natural area to visually buffer the commercial development to the north. A river access area is proposed in this area on the south bank of the river, and if usage increases, signage should be posted advising visitors to avoid disturbing vegetation within the natural area and along the river.



The King's Crossing Natural Area is immediately east of Hwy 287 and is in a more urbanized section of Loveland, which limits the potential usage of the site by large mammals. Further to the east however, large, mature cottonwoods and peachleaf willows grow along the river and provide excellent habitat for birds.

5.7.7 Old St. Louis Natural Area

5.7.7.1 Overview of Current Conditions

The Old St. Louis Natural Area is an approximately 36-acre area comprised of sizable wetlands in the center with uplands around the perimeter. This area is located just west of an oxbow bend of the river. The majority of this natural area is a concave bowl, with a variety of riparian trees and shrubs, willows, wetland grasses and herbaceous species. A parking area is located in the southwest corner adjacent to St. Louis Avenue. An existing soft trail follows the southern edge of the natural area and terminates on a nice overview of the wetland. The same trail goes from the parking area north around the western and northern perimeter of the wetland. An abundance of weeds is present around the parking area and trail system. Kochia is the predominant weed species; however, there are some Russian olive trees in and around the wetland area. The northeastern section of the natural area is upland with grasses and herbaceous species.

5.7.7.2 Recommendations

The Master Plan recommends that the majority of this diverse, thriving wetland be left as is. There are some upland areas located within the wetland area that could be excavated to further enlarge and enhance this wetland area. In addition, where cattails are dominant, they could be treated and removed and a greater diversity of native wetland plants seeded and/or planted to increase overall wetland plant diversity. The trail, which is located around the perimeter of the wetland, should be extended further to the east and down to the south on an upland finger located above the wetland.

Continued weed control is needed around the parking area and trails, likely due to recent trail construction. Soil sampling and amendments should be added before ripping compacted soil and seeding with an upland seed mix including native upland grasses and wildflowers.



A large portion of the Old St. Louis Natural Area is an old gravel pit that forms a concave bowl filled with wetland riparian trees and shrubs, willows, wetland grasses and herbaceous species. The area provides habitat for many types of birds that can be observed from the soft trail system around a large portion of the perimeter.

5.7.8 Willow Bend Park and Natural Area

5.7.8.1 Overview of Current Conditions

The Willow Bend Park and Natural Area is an approximately 79-acre area comprised of uplands to the south, wetlands and a pond in the center and agricultural lands in the north. Currently, there is no access to the natural area and no parking. The natural area is surrounded by agricultural land, open water lakes, gravel ponds and some limited residential development to the east, north and west. Commercial activity is located to the south, and the river has a bend, which is located in the southwestern corner of the natural area. This natural area has an excellent combination of uplands located in the southern portion and a pond and wetlands located in the central and northern portion of the natural area.

Riparian trees and shrubs and wetland grasses and herbaceous species are located in the wetland area and around the pond. The wetland is dominated by cattail and has less plant diversity because of this dominant species. This natural area provides good habitat for waterfowl and other wildlife and is a sanctuary during the hunting season.

An upland field dominated by grasses with trees and shrubs is located in the southern portion of the natural area. Weeds such as thistle, Russian olive, and kochia are located sporadically throughout.

5.7.8.2 Recommendations

The wetland area on this site should be treated for cattail removal and control and be planted with more diversity of wetland species such as bulrush, rush and sedge. In addition, the pond has the potential to be an excellent warm water fishing spot. If fishing access to the pond located in the north is provided, a container for fishing line and a place for garbage should also be provided. Signage providing information on birds and wildlife known to frequent this area is recommended.

Continued weed control is needed throughout the upland area and around the perimeter of the wetland area where Russian olive trees have established. Weeds should be spot sprayed and then bare areas reseeded and/or planted



The Willow Bend Park and Natural Area, one of the most recent acquisitions by the City, provides a sanctuary for waterfowl and other wildlife during the hunting season. A large wetland on the northern portion of the site has riparian trees and shrubs and wetland grasses and herbaceous species. Control of cattails would help to increase the vegetative diversity of the wetland.

with either a native wetland, riparian, or upland plant mix depending on location. Russian olive trees should be cut out, with stumps treated.

Existing signage on the dirt road to the south highlights that hunting is prevalent in this general location. The project biologist met and spoke to CPW representative Clayton Brossart, who further explained that this natural area is excellent refuge for waterfowl, especially during the hunting season.

5.7.9 Additional Recommendations

5.7.9.1 Natural Area Access and Parking

The Master Plan recommends that limited parking and access be provided for the Morey Wildlife Reserve, Namaqua West, and the Willow Bend Park and Natural Area. Limiting parking and access will keep these three natural areas from having more intense human use. This will increase the potential for more and varied wildlife uses of the natural areas. It is important to provide some areas for greater wildlife use, which visitors will find slightly harder to access with more limited parking. If too many people use the natural area it will discourage wildlife use (such as black bear and elk), which will lessen the wildlife benefits of the natural areas.

Morey Wildlife Reserve is the only location where the project wildlife biologist saw evidence of black bear in the eight City-owned natural areas visited. One reason that black bear use this natural area is that it is more isolated with no easy parking and limited access. If additional parking and improved access is provided for Morey Wildlife Reserve, it should be kept to a modest scale, or the character of the natural area will change.

The Namaqua West Natural Area may be enhanced for elk and overall wildlife habitat, and the Willow Bend Park and Natural Area will become a sanctuary for bird and mammal life year-round, especially during the hunting season. Limited parking and access are recommended for these natural areas to retain their character as wildlife habitat and to be enjoyed by the public but with less human presence. The remaining five natural areas, reviewed by the project biologist, are more suitable for readily available parking and easy public access.

5.7.9.2 Fishing Locations

consequences to wildlife.

The Master Plan recommends creating well signed and maintained fishing spots along the river at the Oxbow and Oxbow East Natural Areas, the Cottonwood Run Natural Area, King's Crossing, and the Willow Bend Park and Natural Area. These five natural areas are proposed to have more available public parking and easy access and are well suited for dedicated fishing access. The Master Plan recommends that fishing locations be well marked and that signage clearly outlines fishing requirements and safety rules. In addition, plastic tubing for fishing line disposal and trash containers are essential. Loose abandoned fishing line can have fatal

5.7.9.3 Wetland Creation Opportunities

There are excellent wetland creation opportunities at Morey Wildlife Reserve, Cottonwood Run Natural Area, Old St. Louis Natural Area, and Willow Bend Park and Natural Area. Additional wetlands could be established at all four natural areas by excavation of upland areas adjacent to existing wetlands. These created wetlands could then be planted and seeded with a variety of native riparian and wetland species. Existing wetlands at these four natural areas could also be enhanced through planting and seeding additional wetland and riparian species in the wetlands. Cattails are dominant in most of the existing wetlands and can be treated and removed. The bare areas can then be seeded and planted with a greater diversity of wetland species with riparian species around the perimeter. The City of Loveland could potentially receive wetland credits from the U.S. Army Corp of Engineers (USACE) for creating and enhancing wetlands in these natural areas. The wetland credits could then be used to offset wetland impacts at other City projects. Early coordination with the USACE would be needed to realize wetland mitigation credit benefits for wetland creation in these areas.



A fish line collection tube can be constructed with a PVC pipe, cap and elbow. If not disposed of properly, fishing line can be deadly to wildlife due to entanglement or ingestion, so collection tubes such as these are recommended at all fishing access locations within City-owned natural areas.

5.8 PARKS & RECREATION, TRAILS, AND LAND USE

Loveland Parks and Natural Areas comprise a significant portion of the core of the river corridor from the Oxbow Natural Area near Rossum Drive to the new Willow Bend Park and Natural Area on the eastern end of the study area. Parks include many ball fields, courts, bike and pedestrian trails, picnic and restroom facilities. Natural areas offer some of the same amenities but are typically geared to more passive recreational uses.

This section outlines general recommendations for parks & recreation, trails, and land use for the river corridor based on public input during the master planning process and input from City staff. This section first presents general recommendations and then provides reach-by-reach recommendations. The 11"x17" figures in Section 5.10 illustrate parks, trails and land use recommendations outlined in the following sections, along with other improvements recommended by this Master Plan.

5.8.1 General Recommendations

5.8.1.1 Aquatic Recreation

Aquatic recreation takes place throughout the Big Thompson River Corridor but at the time of this Master Plan, it was not heavily regulated or monitored by the City. This lack of regulation poses a safety issue for participants and liability for the City. The Master Plan recommends embracing aquatic recreation throughout the corridor and developing it in a safe way that helps visitors interact with the river responsibly. To accomplish this, the Master Plan has developed the following recommendations needed to develop safe aquatic recreation:

Public safety and municipal liability were two important topics discussed by the TAC with regard to river access, tubing, and boating. Some expressed concern with improved river access or appearing to "encourage" tubing or boating. Others identified concerns with trespassing.

Throughout the summer, project team members and City staff observed and talked to many different citizens who access the river. Even with relatively few existing formal access points, there is significant public use for fishing, swimming, tubing, and related activities. During the public outreach campaign, improved river access and water-based recreational opportunities were some of the most commonly expressed desires for the river corridor. Ultimately, the group concurred that because it is clear that the public already is accessing the river in designated and unintended areas, providing additional and improved access points would provide safer river access.

Concerns with public safety and municipal liability are valid and must continue to be a part of discussions as the plans presented in this Master Plan are ultimately refined, designed, and implemented. Many municipalities in Colorado have found ways to balance safety and liability concerns with water-based recreation, and there are models for river recreation on the Poudre River in Fort Collins and Boulder Creek that could help to inform efforts to provide additional recreational opportunities along the Big Thompson River.

An essential companion of improved river access is improved river maintenance. Currently, there are many large fallen trees remaining from the 2013 flood that form strainers or snags and are hazardous to swimmers and tubers. Improved river maintenance in areas where access is encouraged is critical and also would provide flood hazard reduction benefits.

- The City could consider establishing a River Season from mid-June (after runoff) to September, when flows and weather are conducive for aquatic recreation. The City could develop advertising and branding to promote this River Season and encourage aquatic recreation only during this time. Similar to the City of Boulder's Tube to Work Day, river events could be created during the River Season that get people excited about using the river and further establish River Season as a unique time in the City of Loveland.
- Establish a well-defined Main River Route from Wilson Avenue to the King's Crossing Natural Area. This section of river borders downtown Loveland. It is the most visited section of the river in the corridor and contains majority City owned property, which makes making it ideal for established aquatic recreation, such as tubing. The Master Plan recommends that this route be shown on City maps installed in the corridor. To further delineate it as part of the Main River Route, themed signage is recommended at each river access point within this section. This "branding" will encourage the majority of the tubing and other water-based recreation to occur in this reach. While

the City does not have a way to prevent access to other reaches where users can put in within the right-of-way at road crossings, providing a preferred route that is regularly maintained to reduce hazards from fallen trees with improved access may help to reduce use of other reaches that have larger portions of private river frontage.

- Establish well-defined swimming holes. Currently, residents swim in a variety of locations throughout the corridor, which makes monitoring and regulation difficult. The Master Plan recommends that prominent swimming holes be located and marked on City maps installed in the corridor. This Master Plan does not envision the City playing an active role in monitoring or enforcing safety along the river corridor to any greater extent than currently done by the City Police Department. The City may consider posting information on inherent risks of water-based recreation and potentially a disclaimer on signage at primary river access points.
- Remove potentially dangerous recreational elements such as the "ledge jump" at Fairgrounds Park and the rope swing near Centennial Park. While these elements can be fun for visitors, they are a potential liability for the City. It is recommended that the City remove these elements and/or post signage warning of risks.
- In order to successfully implement these recommendations, there will need to be participation from the multiple governmental departments. The Parks and Recreation Department should develop rules and regulations for aquatic recreation in the corridor. The Public Information Department should utilize email and social media to notify the public to river quality, flows and suitability for aquatic recreation. This could serve as both a marketing tool to invite people to the corridor and serve as a valuable safety protocol to alert people as to when they should stay away when river conditions are too dangerous for aquatic recreation.



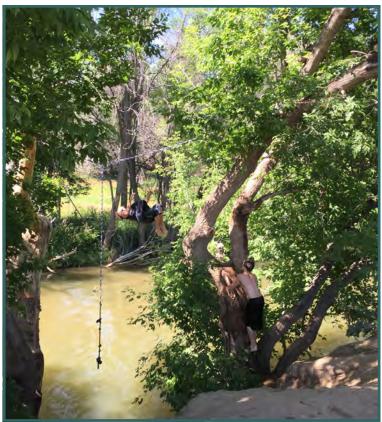
Providing designated access and safety precautions along the most visited section of the river will help to establish a Main River Route.



Holding an event in one of the parks along the Big Thompson River will afford visibility for the river corridor and its amenities through the City of Loveland and awareness of River Season.



Locating and marking designated swimming areas along the River will create aquatic A rope swing near Centennial Park creates a hazardous access to the River. recreation opportunities and safe river use.



5.8.1.2 Signage

At the time of this Master Plan, the City of Loveland Parks and Recreation Department is conducting an inventory of existing signage along the Loveland Recreational Trail. This inventory will provide a baseline assessment of the condition of existing signage and identify where gaps in wayfinding signage exists. Once complete, this inventory should become the primary reference for the installation of new signage throughout the corridor.

While this inventory will provide specific recommendations for future trail signage, this Master Plan has developed the following general signage recommendations.

Wayfinding Signage:

- Install Recreational Trail Information Maps at all new and existing trailheads.
- Install mile marker signs at ¼ mile increments along the corridor to increase the accuracy of emergency response personnel.
- Install signs on roadway bridges and at underpasses stating the street name.
- Install directional signs along the trail identifying adjacent land uses and elements such as neighborhoods, downtown and natural areas.
- Install staff gauge near the Wilson Avenue trailhead to provide a visual cue on river stage. The Wilson Avenue Bridge or the pedestrian bridge immediately downstream should be equipped with a staff gauge. The Taft Avenue Bridge or the Hwy 287 Bridge would also be good candidates for installation of a staff gauge.

Other Signage:

- Install additional signage at all new and existing trailheads and wildlife overlooks.
- Develop themes for signage to correspond to the wildlife, vegetation and ecosystem processes that are present in the specific area.
- Style and design of signage should vary to create interest.

5.8.1.3 Landscape Improvements

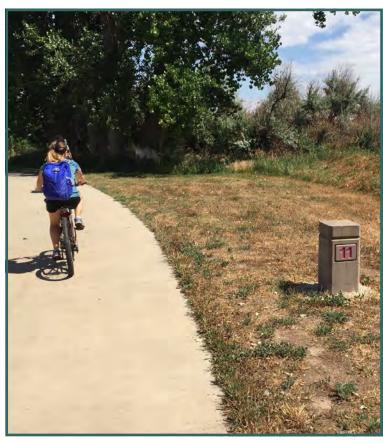
87% of individuals surveyed during this Master Plan



Signage along the river corridor should show Recreational Trail information and aid trail users with wayfinding.



Interactive signs that give information about the surrounding flora and fauna connect trail users with the River Corridor.



Example of mile marker along the Big Thompson River Corridor Trail.





Example of a natural looking landscape as preferred by the survey population.



Ornamental plant material and sod areas should be reserved for parks and areas adjacent to high-density land use.

stated that they prefer a natural looking landscape, as opposed to a manicured look. Based on this public input and environmental concerns, this Master Plan recommends planting primarily native vegetation throughout the corridor. Some ornamental plant material can be installed but it should be reserved for park settings and areas adjacent to high-density land uses.

5.8.1.4 Site Furnishings

Site furnishings installed along the Big Thompson River Corridor should adhere to the following City of Loveland Parks and Recreation Departments preferred standards for site amenities. Natural materials such as boulders and logs can also be adapted into seating elements and installed in natural areas along the Big Thompson Corridor to further promote the natural aesthetic which the community desires.

5.8.2 General Trails Recommendations

The City of Loveland has done an excellent job of developing their trail system. The Loveland Recreational Trail provides good multi-use access around the City. A series of soft surface and concrete trails in the City's Parks and Natural Areas provides a range of diverse recreational opportunities.

The Master Plan has developed the following general recommendations to improve the existing trail system:

- Increase the amount of soft surface trails, as shown in Appendix A.
- Encourage ADA accessibility on all new trails.

- Create trail connections to adjacent neighborhoods and high-density land uses.
- Create trail connections between existing trail systems.
- Encourage the use of environmentally safe materials, such as crusher fines, when constructing new soft surface trails.

5.8.3 General Land Use Recommendations

Following the 1976 Big Thompson flood, the City of Loveland embarked on an ambitious open space program to protect land in the Big Thompson River Corridor. The City was proactive in acquiring land adjacent to the river and developing guidelines that regulate development in the Floodway and Flood Fridge. The City now exceeds the requirements for National Flood Insurance Program (NFIP) and is currently Class 6 under FEMA's Community Rating System (CRS) (Community Rating System 2016). This is an indication that the City's open space program works in reducing the impact of floods on infrastructure. It was this foresight and proactive planning that resulted in more limited infrastructure damage and loss of life in Loveland during the 2013 floods.

The City Municipal Code establishes a Floodway District or Flood Fringe District within the City. The City Code describes the permitted and non-permitted uses allowed in the floodway and flood fringe as well as areas of special hazard, information required for special review applications, standards and criteria or the review, nonconforming buildings or uses and the non-liability of the City. Land use mapping is provided in Appendix B.

The uses permitted without special review in the floodway are as follows:

• Agricultural uses, including general farming, grazing of horses and livestock, forestry, sod farming, crop harvesting,



Boulders can serve as a place to sit and rest but also maintain a natural look in the setting.



Boulders can serve as a place to sit and rest but also maintain a natural look in the setting

raising of plants and flowers, and open-air nurseries,

- Recreational uses including, but not limited to, golf courses, golf driving ranges, swimming pools, parks and recreation areas, picnic grounds, horseback riding and hiking trails,
- Wildlife and nature preserves, game farms and fish hatcheries.

All uses permitted by right in the underlying zoning district are permitted in the floodway with the exception of outside storage.

The City Code also regulates building activities within the floodway and flood fringe. The City Code prohibits development within the floodway but allows for structures within the flood fringe if they are permitted through the underlying zoning district. No Critical Facilities are allowed in either the floodway of flood fringe.

This Master Plan recommends that all new development adhere to the City Code. The City should continue to pursue acquisition or easements of land within the flood fringe and floodway and designate such land as open space.

The Growth Management Area (GMA) is the area into which urban development and annexation shall be directed and urban level services to support urban development will be needed (Intergovernmental Agreement 2014). Prior to development, the land in the GMA must be annexed into the City. Local roads, sewer, utilities, etc. are typically constructed by the developer and then dedicated to the City.

The City has plans to prepare a corridor plan for Highway 402 to transform the highway into a corridor like Harmony Road in Fort Collins. This can be accomplished by extending the Loveland Intergovernmental Agreement (IGA) between Larimer County, Johnstown and Loveland to implement a realistic vision for the Highway 402 corridor that will help property owners realize the highest and best use of their property. Large portions of the Big Thompson River Corridor are within the GMA and the Highway 402 Corridor. All development within each area must adhere to the regulations of the GMA and the expansion of the Loveland IGA Overlay Zone that may result from this plan.

5.8.4 Reach 29 - Morey Wildlife Reserve to Rossum Drive

5.8.4.1 Parks & Recreation

Reach 29 is characterized by the healthy natural ecosystems of the Morey Wildlife Reserve and Oxbow Natural Area. Spacious residential development along Mariana Butte Golf Course incorporates natural ecosystems into the neighborhood design. While there are no formal parks in this reach, the parks and recreation recommendations reflect the natural character of this area and build upon current recreational opportunities to enhance the overall experience.

Existing Features:

No existing parks or park elements exist in Reach 29.

In order to provide people with easy access to the Morey Wildlife Reserve and the Ward Trust 2 Natural Area, a new trailhead is proposed on the western edge of the Morey Wildlife Reserve. This trailhead will be located on high ground north of Cedar Valley Drive and will include the following amenities:

- Small soft surface parking lot made with road base or recycled asphalt,
- Restrooms raised out of the 100-year floodplain,
- Shade structures and small picnic areas,
- Educational and wayfinding signage,
- A wildlife overlook of Morey Wildlife Reserve,
- Seating at the overlook and signage locations.

Increased recreational features at Morey Wildlife Reserve will be tailored to focus on passive recreational uses for

wildlife observation and environmental interaction. Figure 5-15 shows an initial design concept for improvements to the Morey Wildlife Reserve. Additional design is needed to evolve this concept but the following recommendations should be included in the final design:

- Modification to the existing trail system to provide more access to the newly created wetlands and open water features in the high flow channel. This trail system will include both crusher fines trails and boardwalks to access sensitive environments.
- Wildlife viewing areas constructed in strategic locations along the new trail system. Wildlife viewing area should be located in areas that have a unique or healthy ecosystem to maximize the potential for wildlife sightings.
- Additional benches for wildlife viewing and placement of signage regarding existing birds, reptiles, amphibians and mammals that utilize this beautiful wildlife reserve should be placed at the wildlife viewing areas.
- One wildlife viewing platform is recommended within the new wetland area to provide all visitors safe ADA access to this sensitive environment that is inaccessible along the rest of the corridor. This platform will greatly increase the wildlife viewing opportunities, specifically bird watching, which is currently a popular activity in the Reserve.
- The trail to the existing fishing access point along the north edge of the Reserve should be improved to offer connect the main loop trail to the river's edge. This could be accomplished with a minor amount of fill and/or light grading.

A new river access point is proposed on the west side of the Oxbow Natural Area, downstream of Morey Wildlife Reserve. Each river access point should include the following:

- Cobble or sand beach made of the existing stream substrate,
- Gradual slope to the river bottom to allow easy access for fishing and wading,
- Signage and buoys are recommended upstream of the Big Barnes diversion dam to warn the public of the potential hazard ahead.

A new trailhead is proposed on the east side of the Oxbow Natural Area to provide visitors an access point for the Oxbow Natural Area and links to new improvements on the east side of Rossum Drive. This trailhead could include the following amenities:

- Soft surface parking lot made with road base or recycled asphalt,
- Educational signage along the entry trail that describes the different native species establishing along the trail,
- Trail linkages to new river access points and improvements on the east side of Rossum Drive.

5.8.4.2 Trails

To provide increased circulation throughout the area and safe access to a variety of different ecosystems, a series of new crusher fines and boardwalk trails is recommended for the Reach 29. The majority of the new trail improvements will take place at Morey Wildlife Reserve and will include the following:

- Trail access from the new trailhead to Morey Wildlife Reserve, including a new pedestrian bridge that will cross over the drainage way in the southeast portion of the Reserve.
- Maintenance, vegetation removal and weed management of the existing crusher fines trail on the western and eastern edge of the Reserve.
- Two boardwalk trails on the north and south end of the Reserve to cross the proposed high flow channel and constructed wetlands.
- A small crusher fines loop trail on the western edge of the proposed high flow channel to connect to the existing crusher fines trail on the western end of the Reserve.
- A boardwalk section to tie into the crusher fines loop trail and extend across the high flow channel where a wildlife viewing platform is recommended in the constructed wetlands.
- Secondary crusher fines trail that extends down to the river's edge, providing safe river access for fishing on the north end of the Reserve.

An existing crusher fines trail extends west from Rossum Drive into the Oxbow Natural Area. To provide better access to the designated fishing area on the west side of the natural area and develop a safe river access, it is recommended that this trail remain in place but extend to the banks of the Big Thompson River.

This crusher fines trail in this area should connect to the existing sidewalk along Rossum Drive. An at grade crossing north of the river was recently installed by the City to connect the Oxbow Natural Area with the west end of the Loveland Recreational Trail.

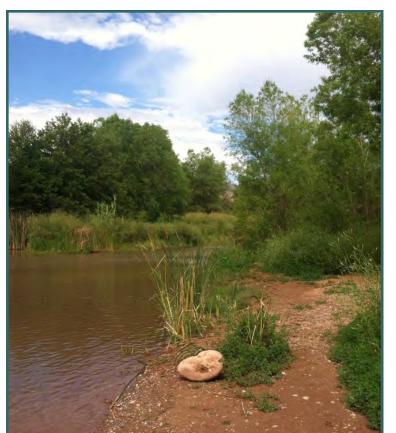


A raised wooden platform with seating furnishes access to sensitive areas for all types of user groups and a safe place to view wildlife

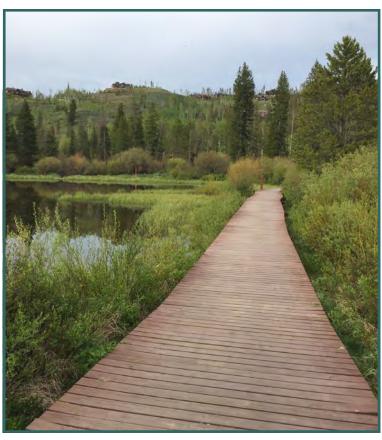
5.8.4.3 Land Use

Reach 29 includes large sections of land within the City of Loveland and Larimer County. The land within the City is currently zoned primarily for Planned Unit Development, with small portions devoted to Developing Resource, Business and Low Density Residential. Land within the County is zoned primarily for Farming, with small areas devoted to Tourist, Commercial and Residential. This is consistent with its current land use being overwhelmingly residential housing. However, per the City's Municipal Code development cannot occur within the floodway. Preventing development in the floodway will result in a healthy riparian corridor along the Big Thompson River.

It is recommended that the current land use remain and new development take into account the healthy environment in this area and take efforts to minimize disturbance and embrace natural systems as a community amenity.



Cobble or sand beaches along the river can be maintained to be free and clear of vegetation to preserve a low-impact, informal access to the river.



Boardwalks act as water crossings to connect trails across proposed high flow channels and wetlands.

MOREY WILDLIFE RESERVE **PLAN VIEW**



Legend



Proposed Trail Head



Proposed Wildlife Overlook



Existing Fishing Access



Figure 5-15. Morey Wildlife Reserve Plan View

5.8.5 Reach 30 - Rossum Drive to Namaqua Avenue

5.8.5.1 Parks & Recreation

Similar to Reach 29, Reach 30 contains no formal parks.

Existing Features:

Instead of formal parks, Reach 30 contains large amounts of healthy riparian habitat within the existing public lands of Oxbow East Natural Area, Mariana Butte Golf Course and Namaqua West. These public lands provide the primary areas for increased park and recreation opportunities in this reach.

Currently, Oxbow East Natural Area includes an existing building and good fishing opportunities. It is recommended that the existing building be refurbished into an interpretive center. As part of the redevelopment, a restroom and picnic shelter should be included adjacent to the building. If possible, both the restroom and picnic shelter should be raised out of the floodplain.

A combination of formal and informal fishing access points are also recommended along the river. Access points should be constructed using natural materials. Formal access points should be located in close proximity to the interpretive center and should include the following:

- Good in-stream structure for fish habitat,
- Large boulders for bank protection and seating,
- Cobble or other native stream bed material to act as an artificial point bar or beach area,
- Shade from existing or planted trees,
- ADA accessibility, if feasible.

Informal access points are intended to look as natural as possible. They may be accessed by small crusher fines

Clear Creek in Golden Colorado is a prime example of more formalized river access that still reflects the natural setting by being constructed of native materials.

or compacted earth trails and may be no more than an opening in the existing vegetation, allowing a person to reach the river. These access points may be located further away from the interpretive center and may include the following:

- Good in-stream structure for fish habitat.
- Small cobble or compacted earth access points cut into the existing vegetation,
- Shade from existing trees.

Since much of this reach runs through private property, only limited river access is recommended. River access areas for fishing could be established for the east parcel of the Oxbow Natural Area and along the reach through the Namaqua West Natural Area upstream of the Rist-Goss diversion dam.

5.8.5.2 Trails

The Loveland Recreational Trail is the only trail that currently exists in Reach 30. This trail runs from the middle of this reach to Namaqua Avenue in the east. An extension of this trail to connect it west to Rossum Drive is currently under construction.

This Master Plan recommends additional crusher fines to allow visitors better access to the river and public lands. One crusher fines trail will connect to the atgrade crossing at Rossum Drive, on the north side of the river. This trail will extend south to connect to the new interpretive center and associated site amenities discussed in the previous section. An old pedestrian bridge currently exists near the proposed interpretive center. A structural inspection of this bridge has been conducted. The bridge will not be used for public access and will likely be removed due to structural instability.

The new crusher fines trail on the north side of the river should be connected to a proposed crusher fines trail on the south side of the river. This crusher fines trail will run south along the bank of the river until connecting to the existing Mariana Butte Trail. This connection will be an important step in establishing a fully connected river corridor. It will bring people from the surrounding neighborhoods into the corridor and allow them access to the complete trail network and natural areas.



Existing informal river access point at Fairgrounds Park is a good example of how additional informal river access points should be constructed.



Signage and buoys help to warn River users of dangerous dams and irrigation diversions that exist downstream.

5.8.5.3 Land Use

The land within Reach 30 is zoned primarily for Planned Unit Development, within the City and Farming within the County. Small amounts of land zoned for Developing Resources is included on City land and small amounts of county land zoned for Residential and Multi-Family exist north of the Loveland Ready Mix property. Much of land zoned for Planned Unit Development, Residential and Multi-Family has already been developed but potential development is possible on the north side of the Loveland Ready Mix property, outside of the floodway.

In this reach, Loveland Ready Mix is by far the largest landowner so the mining of gravel represents the largest single land use for Reach 30. Like any mining, this land use has a lifespan. When mining is completed, it is recommended that the City work with the owners of Loveland Ready Mix to see if they may be interested in selling the land in the floodplain to the City as a natural area or negotiate an easement for areas in the floodway and floodplain to allow for trails and recreational uses. New development on the Ready Mix property is only recommended to occur outside of the flood fringe.

To separate the river from farming operations, a minimum 50-foot native riparian buffer is recommended for the Namaqua West Natural Area. Livestock should be excluded from this buffer.

5.8.6 Reach 31 - Namagua Avenue to Wilson Avenue

5.8.6.1 Parks & Recreation

East of Namaqua Road, Reach 31 includes Namaqua Park on the south side of the river and Namaqua Natural Area on the north side of the river. Namaqua Park is a neighborhood park that includes the following:

Existing Features:

- A parking lot,
- A handicap accessible park shelter (seats 48; reservable for up to 50 people) six 8-foot tables, six electrical outlets, 2 small grills, light,
- Playground,

- Horseshoe court,
- Fishing (from the shore of the Big Thompson River),
- Restroom (port-o-let),
- Lawn area.

In many locations, the river can be accessed along the north end of the park but the accesses are generally informal and can involve steep slopes and poorly defined earthen paths.

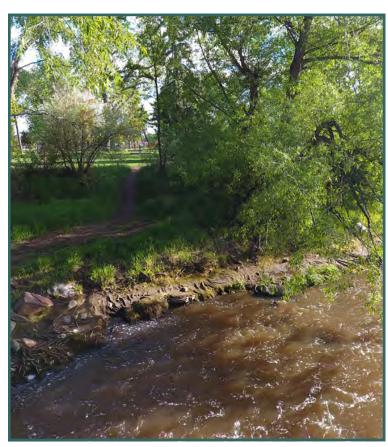
It is recommended that one of the river access points be improved on the south bank of the river to provide access for fishing. The improved river access point could include the following:

- ADA accessible trail to the river's edge,
- Small gathering space along the edge of the river,
- Shade from existing cottonwood trees.

At the downstream end of this reach signage is recommended on the upstream side of the Wilson Avenue Bridge to warn river users of the Greeley-Loveland Canal Diversion.

5.8.6.2 Trails

If appropriate easements can be obtained, it is recommended to extend the Loveland Recreational Trail through Reach 31 to connect Namaqua Avenue to Wilson Avenue. Construction of a trail along the ditch rider road alignment is recommended and would benefit cyclists, pedestrians, and the ditch company with improved access. Desirable views exist along the ditch rider road so it is recommended that the new trail include a pull-off for wildlife viewing, if feasible.







The ditch rider road located along the Big Barnes Ditch between Namaqua Avenue and Wilson Avenue offers an excellent view of the river corridor.

Namaqua Park currently has a series of earthen paths that provide access to the river and native riparian and upland grasslands. A crusher fines trail is recommended along the north edge of the park to formalize the access to the river and allow visitors to experience the different ecosystems in the park.

5.8.6.3 Land Use

The majority of the land within Reach 31 is in the County. The land is zoned primary for Farming with one parcel zoned Heavy Industrial east of Namaqua Avenue.

Loveland Ready Mix owns almost all of the land within Reach 31. Similar to Reach 30, the City should work with the owners of Loveland Ready Mix to see if they may be interested in selling the land in the floodplain to the City as a natural area or negotiate an easement for areas in the floodway and flood fringe to allow for trails and recreational uses. This land with the floodway and flood fringe cannot be developed so acquiring it for recreational use and open space preservation would be a beneficial land use once the mining in the area is completed. Potential development may occur within the flood fringe.

5.8.7 Reach 32 - Wilson Avenue to Taft Avenue

5.8.7.1 Parks & Recreation

Reach 32 is the western extent of the "Urban Sector" of the Big Thompson River Corridor and is the third most frequently visited reach in the corridor despite not having any formal parks.

Existing Features:

No existing parks or park elements exist between Wilson and Taft Avenues.

Due to its frequent visitation, this reach has the opportunity to become a significant amenity for the community.

A trailhead currently exists on the south side of Wilson Avenue to service the Cottonwood Run Natural Area in Reach 32. It is recommended that the Wilson Avenue trailhead be improved to increase parking, minimize vehicular and bicycle conflicts, improve ADA access to the Loveland Recreational Trail and the river. The following recommendations should be included in the Wilson Avenue Trailhead improvements.

- Reconfigure parking at the existing gravel parking area to increase parking spaces.
- Provide one entry and exit point to the parking area to reduce vehicle conflicts with cyclist using the existing bike lane.
- Include handicap parking spaces at the southern end of the parking area near the Recreational Trail.
- Plant vegetative screening between the parking area and Wilson Avenue.
- Add Recreational Trail Information Map at the southern end of the parking area to promote use of the Recreational Trail and connect people to the river.
- Construct a stone staircase at the center of the parking area to connect to the Recreational Trail.
- Add restrooms raised out of the 100-year floodplain.

Currently, the river downstream of the Greeley-Loveland Canal Diversion is accessed via a maintenance road off of the existing Recreational Trail. Steep riverbanks make the river difficult to access and over time, a lack of healthy vegetation along the banks has led to increased erosion.

A newly designed river access point downstream of the Greeley-Loveland Canal Diversion is recommended. Because the public currently accesses the river in this area and through publicly owned parks and natural areas from this location downstream to King's Crossing on the east side of Hwy 287, the Master Plan recommends providing improved river access for recreational uses including fishing, wading, swimming, tubing and boating. The intent of this strategy is to direct the public away from reaches running through private property or areas where diversion dams pose potential hazards. Further planning is needed for signage related to safety, the City's role in managing the river corridor, and the river maintenance for areas that are used by the public.

The new river access point could include:

- ADA trail access to the river,
- Stone staircase to the river,
- Incremental rest areas along the stairs and trail complete with additional seating elements,
- Gathering spaces along the edge of the river,
- Stone bank armoring that will protect the river bank from erosion caused by increase traffic and could double as a seating area for visitors,
- Cottonwoods to provide shade.

In addition to the river access point downstream of the Greeley-Loveland Canal Diversion, a new river access point is recommended upstream of Taft Avenue. The river in this area has migrated laterally to the north, creating a natural point bar and terraced riparian benches. The point bar provides a natural river access point but a crusher fines or compacted earthen trail is recommended to access the point bar.

Directly upstream of Taft Avenue, restoration work has taken place as a part of the City's Wilson to Taft Flood Recovery Project. A wildlife viewing location is recommended for this area to capitalize on the restored riparian ecosystem.



A steep, difficult incline downstream of the Greely-Loveland Canal Diversion serves as the only River access in this area.



Proposed river access point downstream of the Greeley-Loveland Canal Diversion.

5.8.7.2 Trails

The existing Loveland Recreational Trail runs for the entirety of the reach from Wilson to Taft Avenue. One alteration of its current alignment is recommended to accommodate the new trailhead. It is recommended that the trail be realigned to run through the existing cottonwood gallery, closer to the river. This will provide easier ADA access to the new river access point and a more aesthetically appealing experience.

As stated in the previous section, one additional crusher fines or compacted earthen trail is recommended to provide access to the river upstream of Taft Avenue.

5.8.7.3 Land Use

Reach 32 is zoned for Developing Resource, Low Density Residential, High Density Residential and Industrial within the City. However, the majority of the land zoned for Developing Resource is designated Open Space and should remain that way. Land within the County is zoned only for Farming.

Potential development may occur within City property on an Industrial zoned parcel between the Loveland Recycling Center and the Dotsero neighborhood. Potential business and low-density residential development may also occur on a parcel south of the river, west of Taft Avenue. Potential development in the County may occur on a parcel, currently zoned for Farming on the north side of the river and directly west of Taft Avenue. This parcel must be rezoned prior to development.



A pedestrian bridge was installed at Wilson Avenue in the summer of 2017 to accommodate access across the river.



The restored riparian ecosystem will serve as an opportune location for wildlife viewing

5.8.8 Reach 33 - Taft Avenue to Railroad Avenue

5.8.8.1 Parks & Recreation

This reach is the most visited reach along the Big Thompson Corridor. It includes Centennial Park, River's Edge Natural Area and Centennial Natural Area. It is this diversity of programmed and natural spaces, in addition to its close proximity to high-density land uses that drives the high visitation to this reach. The Master Plan does not recommend major alterations to the existing park or natural areas. Instead, the recommendations for focus on promoting natural play and providing safe access to the river.

Centennial Park is the western bookend of this reach. It is a highly programmed regional park that draws visitors from all over northern Colorado by offering the following elements:

Existing Features:

- Shelter (seats 72; reservable for up to 150 people),
- Six 12-foot tables,
- Two grills,
- Playground,
- Lawn park area,
- Restrooms (flush).
- Lights,
- Restrooms (port-o-lets),
- Lighted baseball fields, with programs by the Loveland Baseball Association (LBA),

- Inline hockey rink,
- Drinking fountain,
- Concessions/Vending City concessions trailer may be on-site for games,
- Horseshoe pits,
- Recreational Trail access,
- Sculpture,
- Ponds (fishing) at Jayhawker Ponds and River's Edge Natural Area.
- Handicap accessible.

Despite the large amount of amenities at Centennial Park, no formal river access exists. The Master Plan recommends lowering one section of land in-between the baseball fields, north of the shelter and two smaller areas on either side of the parking lot to promote additional safe access to the river. This will have a hydraulic, ecologic and recreational benefit for Centennial Park.

A natural play area is recommended in the areas lowered on either side of the parking lot. As natural play features, this area should reuse trees that are removed when the areas are lowered. Other natural materials, such as boulders, found onsite should be incorporated wherever possible to promote sustainability and environmental education. Creating a natural play area will provide a transition from the more developed portions of the park and parking lots to the more natural environment of the riverbank.

Two river access points currently exist upstream and downstream of the Farmer's Ditch Diversion. Each river access is in good condition and heavily used. However, the soft surface trails to these areas should be regraded to ensure ADA access and resurfaced with crusher fines. Boulders should be placed around each access to provide seating. Signage and buoys should be provided at the upstream river access to alert people of the Farmer's Ditch Diversion directly downstream and to direct them to portage around to the downstream river access point.

5.8.8.2 Trails

Most of the Recreational Trail through Reach 33 is in good condition. In the past, the river has undercut the concrete trail on the north side of Centennial Park. Increasing separation between the top-of-bank and the trail is recommended when the trail is repaired or reconstructed. This can only be accomplished to a limited extent in some areas due to the limited space between the creek and the embankment leading up to the ball fields. Therefore, bank protection may be required along some sections to keep the trail from being further undercut. The trail could be rerouted to provide separation between the parking lot and the proposed natural play area on the bank upstream



from the 1st Street Bridge.

A chain link fence separates the Recreational Trail from a private parcel south of the Recreational Trail, between the Farmer's Diversion Ditch and Railroad Avenue. Vegetative screening is recommended in front of this fence to reduce its visual impact on trail users.

5.8.8.3 Land Use

The land currently within the Reach 33 is zoned Developing Resource, Industrial, High Density Residential, Low Density Residential, Business and Planned Unit Development within the City. Much of the land zoned for Developing Resource and Low Density Residential on the south side of the river is a part of Centennial Park of the Rivers Edge Natural Area. No adjustments to the land use for Centennial Park and Rivers Edge Natural Area are recommended. The County property within reach 33 is zoned Farming, Planned Development and Industrial.

Potential development in the County may occur on land zoned for Farming, Planned Development and Industrial. Prior to development, land zoned for Farming should be rezoned. A portion of the land zoned Planned Development is within the FW and the FF and should follow the Municipal Code requirements for development within these districts. All potential development in Reach 33 should consider incorporating connections to the river, existing trails and Rivers Edge Natural Area. When developed responsibly, these natural and trail amenities will add value to a potential development and increase residents' quality of life.



Play areas can be made of native, found materials to promote sustainability and characterize a natural setting for children to learn and play.



Existing river access points around the Farmer's Ditch Diversion are in good condition, but can be enhanced with regrading and resurfacing to maintain this amenity.

5.8.9 Reach 34 - Railroad Avenue to Lincoln Avenue - US Hwy 287

5.8.9.1 Parks & Recreation

This reach has the opportunity to connect downtown Loveland with the Big Thompson River Corridor. This would provide people visiting and living in downtown the ability to experience Loveland's natural spaces and connect corridor users to downtown retail opportunities. Throughout the public process, a safe and unique connection to downtown arose as a top priority for Loveland residents.

Currently, the main connection between downtown and the corridor is via Railroad Avenue. From a planning perspective, this remains the most viable route. However, a lack of lighting, signage, pedestrian access or sense of arrival makes this connection unsafe and undesirable to City residents.

The old Loveland Waste Water Treatment Plant is also located on the north end of Fairgrounds Park along Railroad Avenue. While the plant has long been decommissioned, the majority of the site remains open to the public and is now used as a storage facility for the City. A variety of aging equipment and old building materials are stored here, making this site an unsafe and highly underutilized City-owned property.

The Master Plan recommends transforming Railroad Avenue, from 1st Street to the Big Thompson River, into the "Gateway to the Big Thompson River Corridor." The Gateway will increase safety and pedestrian access along Railroad Avenue and redevelop the old Loveland Waste Water Treatment Plant site as the southern bookend of this connection by establishing a new vibrant public space. By establishing this area as the "Gateway to the Big Thompson River Corridor," a strong connection can be established between downtown Loveland and the Big Thompson River Corridor.

In order to create the "Gateway to the Big Thompson River Corridor," the following streetscape improvements to Railroad Avenue are recommended:

- Add an 18-inch wide curb and pan to the west side of Railroad Avenue from 1st Street to the river.
- Restripe the lanes to remove the existing shoulders.
- Provide two 11-foot wide travel lanes where the right of way (ROW) is 40-feet.
- Provide two 11-foot wide travel lane plus a turn lane where the ROW is 60-feet, near the intersection of 1st Street and Railroad Avenue.
- Add an 18-inch wide curb and pan to the east side of Railroad Avenue from 1st Street to the river.
- Add a 5-foot wide vegetative median to the east side of Railroad Avenue, in-between the travel lanes and concrete bike trail.
- Include vertical sculptural elements at varying heights in the vegetative median.
 - Add a 10-foot wide concrete bike trail on the eastern side of the median.

By reconfiguring the streetscape, pedestrians will be safely separated from traffic and consolidated on one side of the street. Landscape and site amenity recommendations from the City of Loveland's HIP Streets Master Plan can be followed during the final design of the "Gateway to the Big Thompson River Corridor."

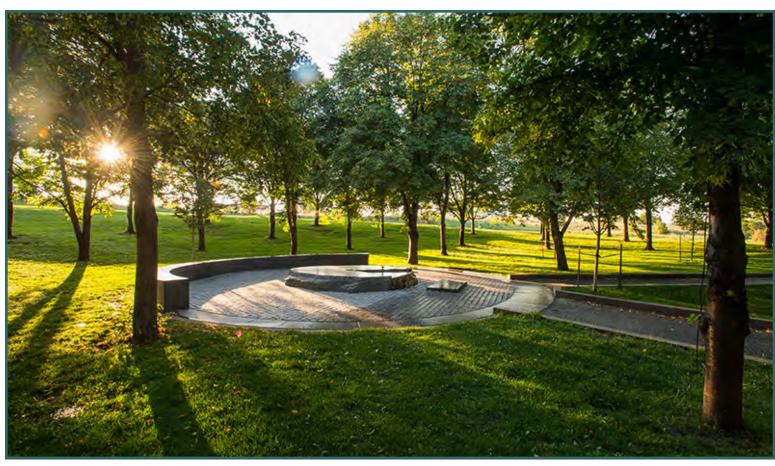
The Master Plan recommends redeveloping the old Loveland Waste Water Treatment Plant site as a new public space to activate the boundary between downtown and the River. This new public space will include:

- A sculptural entryway feature off of Railroad Avenue,
- Bike rental facility at the entryway,
- 10-foot wide concrete bike trail on the eastern side of the site,
- A large plaza and overlook at the entryway, complete with a shade structure and signage,
- A water feature to pay homage to the Big Thompson River,
- Landforms to screen Railroad Avenue and create topographic interest,

- A series of terraces and seat walls to step down to Farmer's Ditch on the south end of the site,
- Native grasslands and irrigated lawn space,
- Small gathering spaces placed throughout the park to provide different experiences throughout the area,
- Native tree galleries to provide shade and ecological benefit,
- A new trail along the existing Farmer's Ditch.



A water feature at the old Loveland Waste Water Treatment Plant can serve as a visual cue and inference to the nearby Big Thompson River.



Defined spaces within the landscape afford a place to stop and experience the surroundings in a different way.

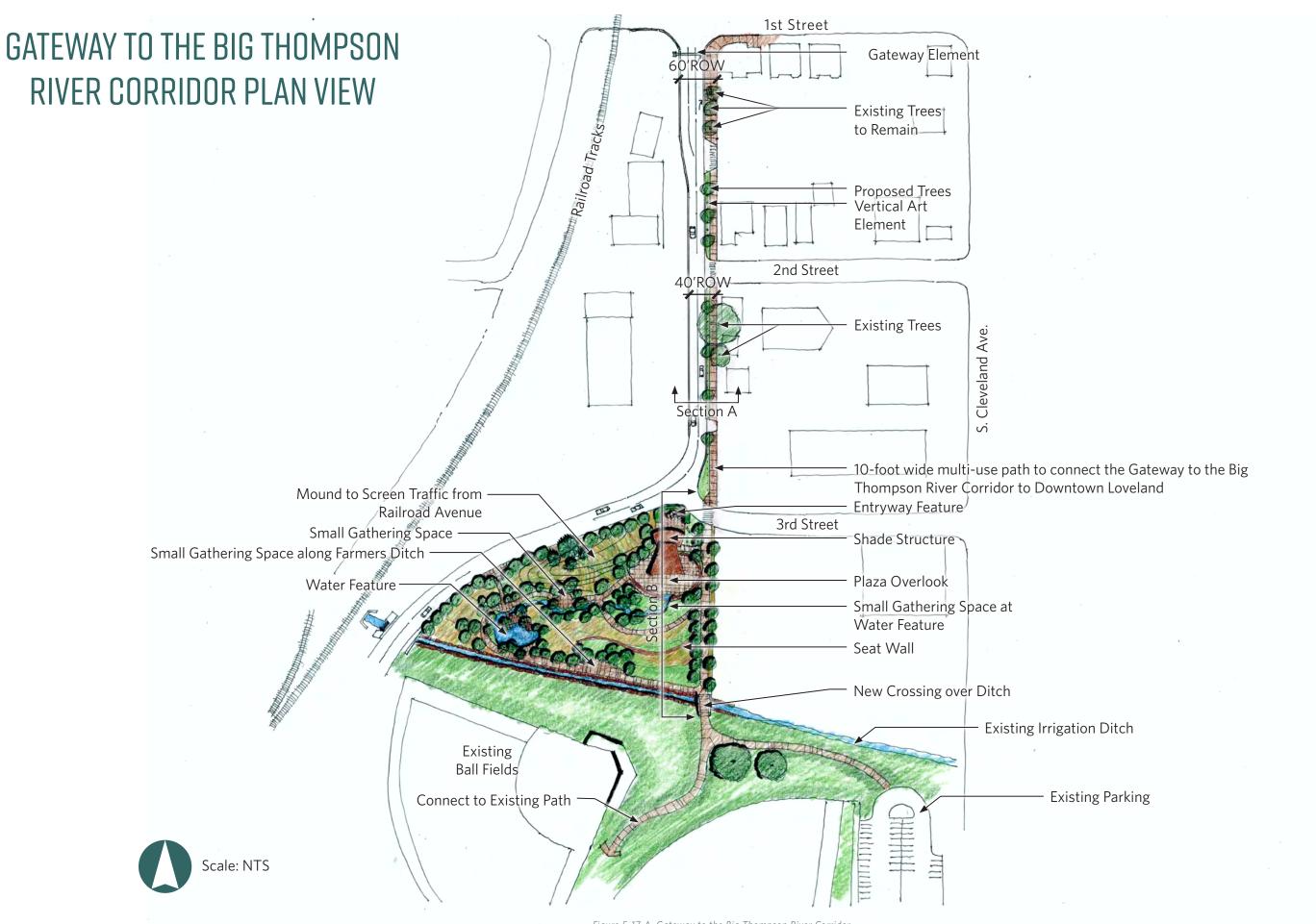


Figure 5-17-A. Gateway to the Big Thompson River Corridor

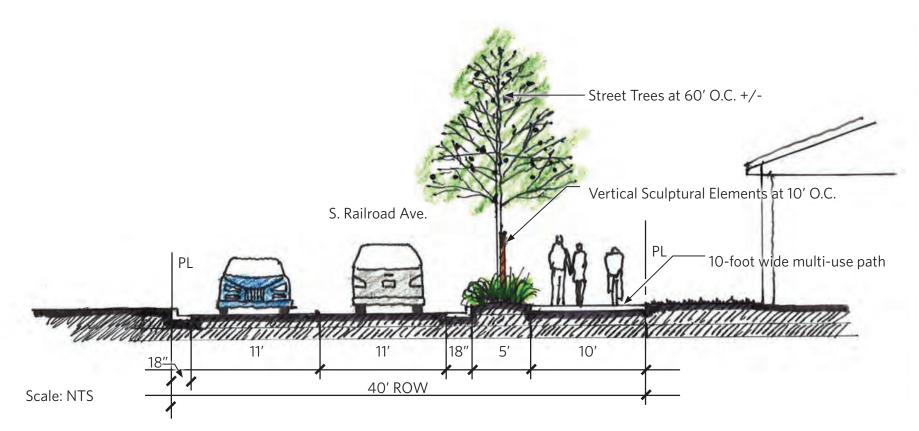


Figure 5-17-B. Section A: Looking North on S. Railroad Ave

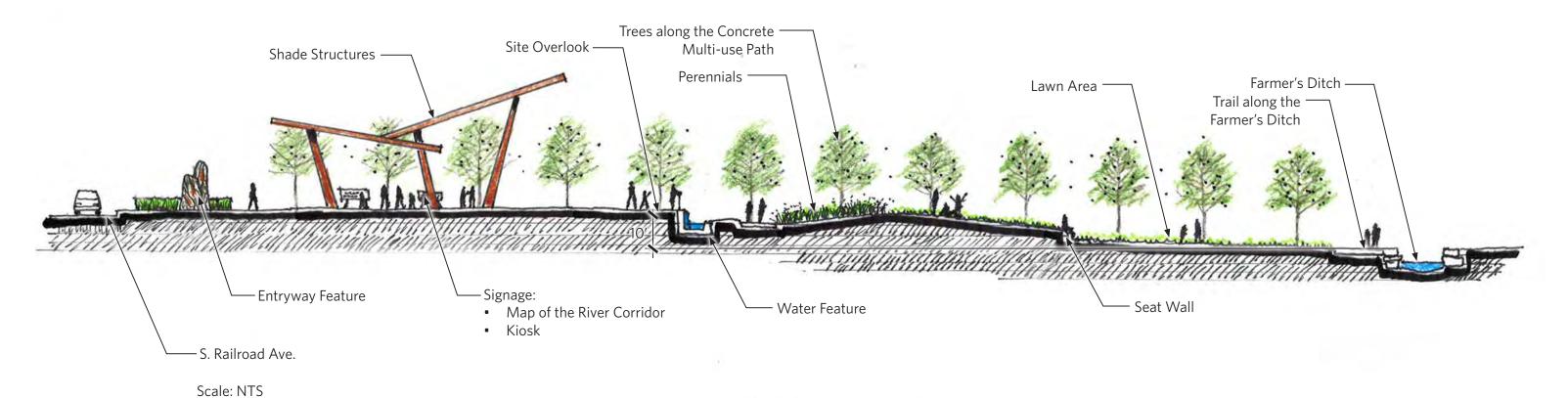


Figure 5-17-C. Section B: Old Loveland Waste Water Treatment Plant Site

The Master Plan has provided an initial concept for this space in Figure 5-17. Additional design is needed to evolve this concept but design recommendations and elements included in this concept should be included in the final design.

Reach 34 is also home to Fairgrounds Park, including the Barnes Complex within Fairgrounds Park. Together, the Fairgrounds Park Complex is the largest park in the Big Thompson River Corridor. Largely due to the amenities in Fairgrounds Park, Reach 34 is the second most visited reach in the study area. Seasonal events, such as baseball tournaments and farmers markets, are held there throughout the summer and year-round amenities, such as a dog park, skate park, basketball court, etc., bring people to the park throughout the year. Fairgrounds Park includes the following:

Existing Features:

- 2 Large pavilions (seating for up to 200 each),
- Picnic tables & handicap accessible tables,
- 3 Large grills at each pavilion,
- Skylights/lights,
- 1 Pavilion/tot lot play area,
- 1 Picnic shelter near the skate park and baseball fields,
- Park areas,
- Dog park,
- Basketball courts,
- Skate park,
- Seasonal spray park/playground,
- Playgrounds (2),

- Fishing access,
- River plaza,
- Recreational Trail/trailheads,
- Solar powered air pump on Recreational Trail,
- Concessions/vending,
- Batting cages at the Barnes Complex,
- Baseball/softball fields at the Barnes Complex,
- Sculptures,
- Historical buildings/bridges,
- Drinking fountain,
- Handicap accessible,
- Flush restrooms.

In addition to the existing amenities, the Master Plan recommends the inclusion of a new trailhead, improved river access and a bike skills park at Fairgrounds Park.

The new trailhead should be constructed on the north end of the existing Fairground Park parking lot, off of Railroad Avenue. Existing parking spaces have been allocated here for a trailhead, although no amenities have been provided. It is recommended that a new gathering space be constructed with seating, signage and shade features. The inclusion of these amenities will help to activate this area and make it a destination for people using Recreational Trail.

An existing river access point on the northeast side of the park, next to the skate park, is a perfect example of how other river access points should be designed. This river access point is made up of a large compacted earthen area, stabilized by existing tree roots, seat boulders selectively placed throughout the area and large mature trees shading the site. In this area, the only improvements recommended in the Master Plan are a better trail connection to this point. The existing trail is steep and eroded in some places by poor drainage. This trail should be regraded to decrease the slope, improve drainage and resurfaced to provide ADA access.

One additional river access point is recommended on the existing point bar on the south-western end of the park, across the river from the dog park. This area is a natural river access point; however, currently there is no trail present. To increase floodplain capacity and riparian health, his area should be lowered. To bring people to this river access point, an ADA crusher fines trail should be constructed off of the Recreational Trail.

On the downstream end of the park, there is a large grassy upland area between the Barnes Park parking lot and the river. This area is flat, dry and lacking shade. There are no formal trails in this area, although informal social trails



A flat location near the edge of the River is present in Fairgrounds Park that serves as an example to emulate for further river access locations along the River.



Existing point bars are natural deposition areas with shallow slopes that make low-impact river access easy.



A bike skills park with features for all level of riders can serve as a tremendous recreational amenity and economic draw for the City of Loveland.

have developed over time. It is recommended that this area be converted into a bike skills park. There is no bike skills park anywhere in Loveland and bicycling is becoming an increasingly popular past time among residents. Bicycling was ranked the second most popular recreational activity among the people surveyed in the City of Loveland Parks and Recreation Master Plan. While this statistic also includes road or trail cycling, when asked "what types of open lands should be the highest priority for acquisition and development?" respondents overwhelmingly chose places that support outdoor recreation (e.g. hiking, mountain biking, camping opportunities) as the highest priority. A bike skills park would fulfill a desire for the residents of Loveland and should include features for all levels of riders, including a pump track for younger kids. Creating a small bike skills park is compatible with floodplain benching that is recommended in this area, and the landscaping and trail design would incorporate natural features (rocks, logs, etc.) and native vegetation would be used to create a low maintenance area.

Given the interest in cycling in Loveland, providing a larger bike park such as the Valmont Bike Park in Boulder would likely have good public support. To create such a park, existing vertical relief is desirable. While the floodplain of a river corridor generally does not provide a lot of vertical relief, in some areas where mining has been completed or that will be mined out in the future, gravel pit excavations, with access off the recreational bike trail, could be considered as potential sites if there is civic interest in a larger bike park in the future.

5.8.9.2 Trails

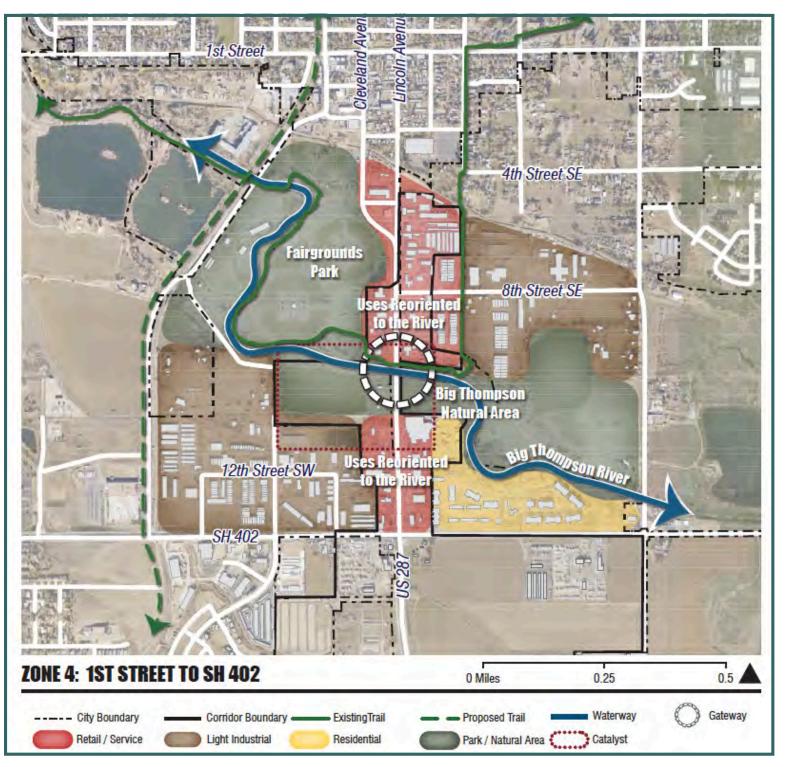
The new "Gateway to the Big Thompson River Corridor" will provide increased trail access between downtown Loveland and the Big Thompson River Corridor. A new 10-foot wide concrete bike trail will connect with the existing trail system at the north end of Fairgrounds Park and extend north to connect to the bike lane 1st Street.

The Loveland Recreational Trail extends throughout Fairgrounds Park. The trail is in good condition and only one alteration in the trail's current alignment is recommended. The Master Plan recommends realigning the Recreational Trail in the southwestern end of the park, by the new river access point. The trail should be realigned to run along the backside the baseball fields. It is recommended that this area be lowered so rerouting the Recreational Trail will reduce the risk of flooding and the need for increased maintenance. To bring people to the new river access point, an ADA crusher fines trail should be constructed off of the realigned Recreational Trail.

5.8.9.3 Land Use

City land within Reach 34 is zoned for Industrial, Business, and Developing Resource and abuts the Central Business district of Downtown Loveland. This area is the retail center of the City and will play an important role in connecting people to the corridor. Small pockets of County property exist in this reach that are zoned for Industrial and Commercial.

Potential development is proposed with the 287 Strategic Planning Area and should adhere to the generally designated land uses adopted by the Loveland 287 Strategic Plan for this area. It is important to note that there are significant constraints to redevelopment of this area due to the floodway and floodplain of the Big Thompson River and "no-rise" requirements for floodwater elevations on existing structures in the area. If bridge improvements are implemented at the Hwy 287 crossing, some properties would be removed from the floodplain, increasing opportunities for redevelopment; however, the redevelopment potential of properties remaining within the floodway and adjacent to the river would be more limited and challenging.



Zone 4: 1st Street to SH 40 from the Loveland 287 Strategic Plan for the proposed land use for the area.

5.8.10 Reach 35 - Lincoln Avenue - US Hwy 287 to St. Louis Avenue

5.8.10.1 Parks & Recreation

Lincoln Avenue or US Hwy 287 on the west side of this reach creates an important north-south connection for the City of Loveland and is the main thoroughfare through downtown. Despite this prominent position no formal parks currently exist in Reach 35.

Existing Features:

Along this route, businesses downtown rely on people stopping to shop. It is recommended that a "Gateway to Downtown" be constructed along Hwy 287 south of the Big Thompson River. This gateway should be a strong architectural element that celebrates the Big Thompson River Corridor and downtown Loveland. It should provide a strong first impression for downtown and a sense of arrival to people traveling through. This will encourage visitors to stop and experience everything Loveland has to offer, including a vibrant downtown and natural river corridor.

This reach includes the King's Crossing Natural Area. A trailhead is proposed in the southwestern corner of the site off, of Lincoln Ave. This trailhead will include the following amenities:

- Small soft surface parking lot made with road base or recycled asphalt,
- Restrooms raised out of the 100-year floodplain,
- Educational and wayfinding signage,
- Seating and shade elements.

A river access point is recommended on the north end of King's Crossing Natural Area. This river access point should be more formal in nature and include the following elements:

- ADA trail access to the river,
- ADA river access for tubing and boating take out,
- Small gathering space along the edge of the river,
- Stone bank armoring to protect the river bank from erosion caused by increase traffic and could double as a seating area for visitors.
- Signage with explanations on how to properly access the river to keep the general public from damaging the vegetation in the natural area,
- Cottonwoods to provide shade.

Tubing or boating recreationalists and their parties could also utilize the existing gazebo for resting and enjoying the natural features of this site.

5.8.10.2 Trails

The reach from Hwy 287 to St. Louis Avenue contains portions of the Loveland Recreational Trail and a soft surface loop trail in King's Crossing Natural Area. The Recreational Trail runs along the north bank of the river, parallel to Big T Auto Brokers & Big T Storage. Vegetative screening is recommended between Big T Auto Brokers & Bit T Storage and the Recreational Trail. This screening will mitigate the negative visual impact caused by the chain link fence and the storage equipment.

The Recreational Trail turns sharply north and heads away from the river, east of Big T Auto Brokers & Big T Storage. A pedestrian bridge crossing is recommended to connect the Recreational Trail with the King's Crossing Natural Area to the south. This bridge should be installed west of the point in which the trail deviates from the river and an existing river access point.



The Centerra Gateway in Loveland can serve as an example of a strong architectural element that could be adapted for the "Gateway to Downtown". A vertical architectural element such as this would provide a strong first impression for downtown Loveland.



Vertical sculptural elements installed along 287 could provide a sense of arrival for the river corridor while form and color of the architectural element could celebrate the Big Thompson River Corridor.



Example of a river access point that could serve the downstream limits of the Main River Route where people will be exiting the river with watercrafts.

Larimer County recommends extending the Recreational Trail on private property, east along the north side of the river to Boyd Lake Avenue. This recommendation has been adopted by this Master Plan and will help to create a fully connected trail system throughout the Big Thompson River Corridor.

A crusher fines trail is recommended along the south side of the river. This trail will connect to the soft surface loop trail, King's Crossing Natural Area and extend through the Waterford Place Conservation Easement. This new crusher fines trail will increase trail and river access for residents living in the multifamily developments along Highway 402.

5.8.10.3 Land Use

This reach borders Downtown Loveland and includes City land zoned for Developing Resource, Industrial, Business and Planned Unit Development on the south side of the river. The land in the County is primarily located on the north side of the river and is zoned for Industrial, Commercial and Farming.

Potential development may occur within the 287 Strategic Planning Area and should adhere to the designated land uses adopted by the Loveland 287 Strategic Plan for this area. Additional development may occur south of Highway 402 and should adhere to regulations of the Loveland GMA and the Highway 402 Corridor.

An extension of the Loveland Recreational Trail is proposed through majority private property on the north side of the river. This Master Plan recommends acquiring these properties to establish this trail connection and increase open space opportunity. If acquisition is not possible the City should seek a conservation easement to establish the trail extension.



An existing river access is located near where the Loveland Recreational Trail turns sharply north and heads away from the River. A pedestrian bridge should be installed just west of this location.

5.8.11 Reach 36 - St. Louis Avenue to Boise Avenue

5.8.11.1 Parks & Recreation

This Reach includes the Old St. Louis Natural Area and a City owned parcel west of Boise Avenue that will be incorporated into the Old St. Louis Natural Area. No formal parks are located in Reach 36, so these natural spaces are the only public accessible lands in the area. For the purposes of this Master Plan this parcel will be referred to as the Boise Avenue site.

Existing Features:

The Old St. Louis Natural Area is near the Mirosol senior living center. The programming of the natural area should be geared towards the elderly population for enjoying wildlife such as birds, small mammals, reptiles and amphibians. To increase the ability for the elderly to enjoy this natural area, a shelter is recommended on the southern trail that accesses an overlook just a short distance east of the existing parking area. A shelter in this location would provide excellent views, as it overlooks the entire natural area. Signage regarding birds and other animals that use this natural area should be placed at the shelter and along the trail. An upland area extends into the existing wetland area like a peninsula, making it ideal for wildlife viewing. A second shelter is recommended in this location for people to rest and enjoy the wildlife and scenery. Upland trees should be planted around the shelters for shade and a restroom facility should be constructed at one of the shelter locations.

The Boise Avenue site has a great opportunity to become a recreational and environmental amenity for the City of Loveland. It was previously used for farming, so a large flat upland area takes up the majority of the site. This upland area does not support healthy native grasses and a lack of shade creates a harsh environment. Multiple healthy riparian terraces step down from this upland area and run along the river. These areas include healthy cottonwood galleries, willow stands and lush riparian grasses. A heron rookery is present in a grove of cottonwood trees on the west side of the property.

The Master Plan recommends that this site be programmed for passive recreation that will allow people to



Existing healthy riparian terraces are located near a large flat upland area at Boise Avenue provide great environmental habitat. This upland area can serve as a recreational amenity for the City of Loveland in the future.

experience this unique environment without disturbing it. Programmed activities could include walking/running, biking, fishing, wildlife observation and picnicking. An initial concept has been provided for this space, as shown in Figure 5-18. Additional design is needed to evolve this concept but the following design elements should be included in the final design:

- Resurfacing and expansion of an existing access road off of Boise Avenue,
- A new parking lot,
- Restrooms elevated outside of the 100-year floodplain,
- Picnic shelter,
- Educational signage about heron rookery and the environment of the site,
- A raised mound and overlook for wildlife observation,
- New crusher fines trail network through the upland and riparian ecosystems,
- 3 wildlife overlooks along the new crusher fines trail,
- One ADA accessible river access point with stone seating and a gathering space under existing cottonwoods,
- 2 to 3 informal access points,
- Increased riparian terracing to create new wetland and riparian habitat.

Over the years, people have dumped rubble and debris along the outer bank of the river. Exposed concrete and rebar can be seen from the Boise Avenue site. This material is unsightly and should be removed as part of construction for the Recreational Trail extension or the Boise Avenue site improvements. Riverbank stabilization measures would need to be implemented if the concrete and debris were removed along this bank.

5.8.11.2 Trails

Larimer County recommends extending the Recreational Trail on private property east along the north bank of the river throughout Reach 36. This alignment has been adopted by this Master Plan, although an alternative alignment is proposed on County property, if ownership or easement issues arise with the recommended alignment. The alternative alignment would run north along St. Louis Avenue and cross the road to connect to the Old St. Louis Natural Area. It will then be routed through the natural area and connect back to the Recreational Trail, at the east end of the site. A new trail underpass is recommended at Boise Avenue to provide safe pedestrian access across the street and connect to the proposed Recreational Trail in Reach 37. This new trail underpass could be constructed when the existing bridge is replaced.

A new pedestrian bridge is recommended to cross the Farmer's Ditch on the north end of the Old St. Louis Natural Area and to connect to the Mirosol senior living center and the neighborhood along Madison Avenue. The trail connection to the bridge and the neighborhood should be ADA accessible. To provide ADA access throughout the site, the trail around Old St. Louis Natural Area can also be improved from the parking area north and east around the wetland. For additional views, a crusher fines trail is recommended to extend down the upland peninsula that goes into the wetland area. Additional benching is recommended along this trail.

To screen the site from development to the south, vegetative screening is recommended along the southern border of the Old St. Louis Natural Area. Vegetative screening is also recommended along the outer bank of the river, north of the Boise Avenue site where rubble and debris are present.



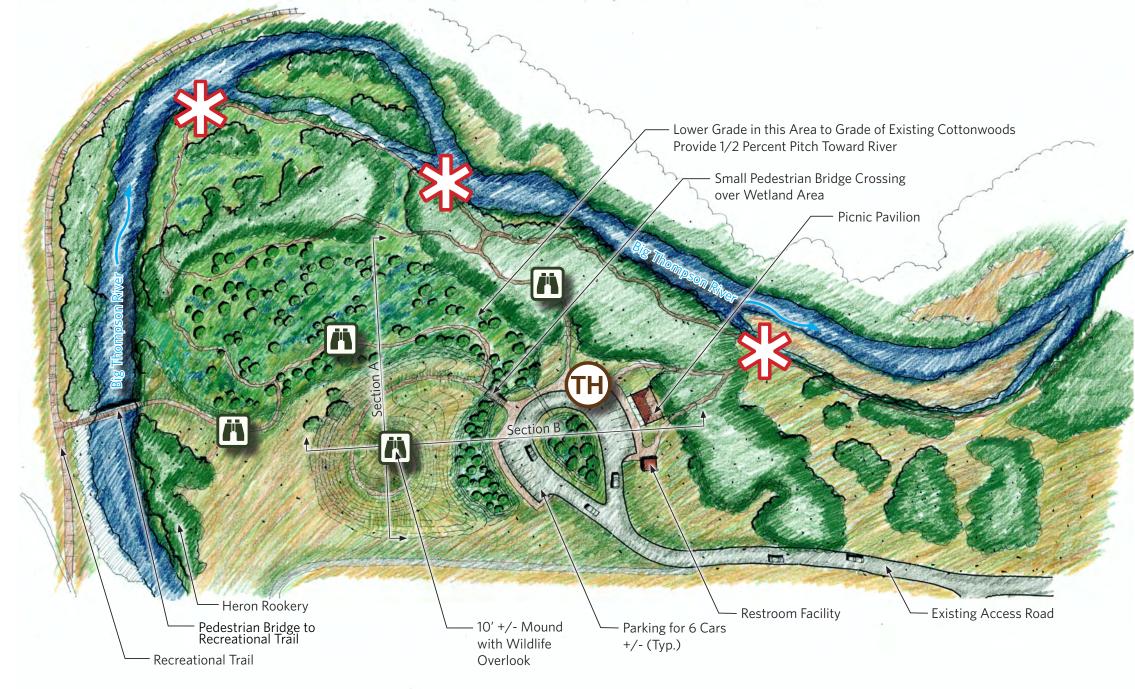
Example of a wildlife overlook with educational signage and seating that can accommodate trail users



Exposed concrete and debris creates an unsightly and potentially hazardous riverbank condition that should be removed prior to construction.

BOISE AVENUE SITE

PLAN VIEW







Proposed Trail Head



River Access Point

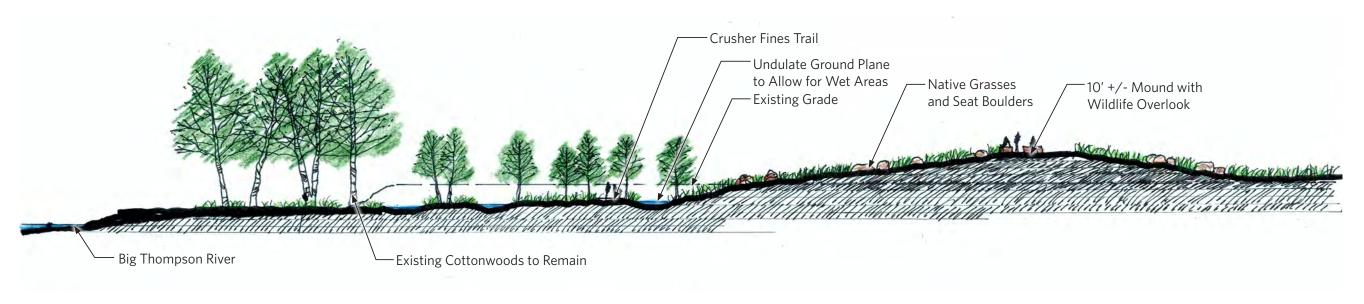


Proposed Wildlife Overlook



Figure 5-18-A. Boise Avenue Site

Note: Final configuration, including location of parking and structures may be adjusted in subsequent planning and design.



Scale: NTS

Figure 5-18-B. Section A: Boise Avenue Site- North to South Section



Scale: NTS

Figure 5-18-C. Section B: Boise Avenue Site- East to West Section

5.8.11.3 Land Use

Land within Reach 36 is primarily County zoned for Farming, Industry and Commercial. The Marisol Senior Living Center and adjacent neighborhood north of the river corridor is the only land located within the City boundary in Reach 36.

Potential commercial development is anticipated on County zoned property east of St. Louis Avenue. Additional development may occur north of the river directly west of Boise Avenue. Both new developments border the Old St. Louis Natural area and should establish connections to this natural amenity. South of Highway 402, potential development is anticipated as part of the new Highway 402 Corridor. Being in the County, all potential development in Reach 36 shall adhere to regulations of the Loveland GMA. Potential development bordering Highway 402 should adhere to the regulations of the Highway 402 Corridor.

5.8.12 Reach 37 - Boise Avenue to County Road 9E

5.8.12.1 Parks & Recreation

This reach is primarily private property, so there are no formal parks in the reach and the addition of recreational elements is limited.

Existing Features:

Willow Bend Park and Natural Area and the Simpson Ponds are included in Reach 37, so the recreational recommendations are specific to these two areas.

Simpson Ponds is the most eastern, publicly accessible land on the corridor. While it is owned by the State, this Master Plan developed the following recommendations to improve the accessibility to the Big Thompson River Corridor on the south end of Simpson Ponds.

The current trailhead consists of an upper and lower parking area. The upper parking area is accessed via a dirt road and borders the river, while the lower parking area is accessed off County Road 9E and borders the lower pond. No amenities currently exist at the upper parking area and those at the lower parking area have been poorly maintained.

The Master Plan recommends the upper parking area be restored to a natural condition and a new trailhead be constructed a few hundred feet to the west. A large flat area in this location, south of the dirt road, is perfect for adding additional parking. The natural topography in this location also allows for ADA access to the river. The new trailhead should include the following:

- Small soft surface parking lot made with road base or recycled asphalt,
- Restrooms raised out of the 100-year floodplain,
- Educational and wayfinding signage,
- Seating and shade elements,
- ADA trail connections for river access.

In this area, the riparian environment along the river is some of the most pristine along the corridor. Special considerations should be taken during the final design and construction of this trailhead and river access point to ensure minimal disturbance of this ecosystem.

The river access point should be informal in nature. Heavy use is not expected for this area so the river access point should be small and placed on the inner bend of the river so the natural point bar will create the access point. The access into the water may not be able to be ADA without significant impact but care should be taken to try to incorporate ADA access wherever it is feasible.



Example of an existing healthy riparian bench along the Big Thompson River Corridor near the south end of Simpson Ponds.



An informal river access point can be created on an existing point bar to minimize disturbance of the healthy riparian ecosystem.

5.8.12.2 Trails

In Reach 37, the City has secured an easement to extend the Recreational Trail east along the north side of the river. When on the Loveland Wastewater Treatment Plant property, care should be taken to route the trail in a way that limits the visual and olfactory impacts of the facility. Specific plant species may be planted to reduce smells and to screen the Wastewater Treatment Plant from trail users.

This Master Plan recommends that the Willow Bend Park and Natural Area include a series of crusher fines trails that will connect to ecologically desirable areas and the adjacent neighborhoods. A crusher fines trail is recommended on the north side of the Recreational Trail to connect to Torrent Duck Avenue and the adjacent neighborhood. A proposed trail underpass is recommended at County Road 9E. This trail underpass will provide a safe crossing for trail users and could be constructed when the existing bridge is replaced.

5.8.12.3 Land Use

The majority of the land along the river corridor in Reach 37 is privately owned and within the County. North of Highway 402 the land is zoned for Farming, Heavy Industrial and Industrial. Within this currently zoning, the City has acquired the Willow Bend Park and Natural Area for park and open space purposes. This land will be developed for passive recreation and include a system of trails that will connect to adjacent neighborhoods. Land within the City is located north of the river and is zoned for Planned Unit Development, Developing Resource and Low Density Residential.

Potential development may occur on County zoned land outside of the floodway on either side of the river but many of the property owners do not wish to develop it for high-density land use. Special care should be taken to respect the privacy of private property owners in this reach and connect any new developments to the river corridor. As with any land to be developed within the City's GMA, the land must be annexed into the City and development must adhere to all of the regulations for the GMA.

Potential development bordering Highway 402 should adhere to the guidelines for development in both the GMA and Highway 402 Corridor.

5.8.13 Reach 38 - County Road 9E to Future Boyd Lake Avenue

5.8.13.1 Parks & Recreation

There are no existing parks or Parks and Recreational recommendations for this reach.

5.8.13.2 Trails

The Loveland Recreational Trail is proposed to extend on the north side of the river east from existing County Road 9E to the future Boyd Lake Avenue. It is then proposed to continue east along the river and eventually connect with Johnstown's trail system.

5.8.13.3 Land Use

The majority of the land in Reach 38 is privately owned County land and is zoned for Farming and Industrial. City land within Reach 38 is zoned for Business and Planned Unit Development.

All of the potential development in this reach is south of the river. Potential development in this area should adhere to the requirements of the GMA and the Highway 402 Corridor.

5.9 Community Involvement Opportunities

The sections above outline many planning and engineering improvements along the corridor. This section is focused on community-based activities along the Big Thompson River through Loveland that are recommended to provide additional opportunities for members of the community to experience and become involved in stewardship activities. Most of these recommendations come directly from comments received during the public outreach

campaign over the summer of 2017.

5.9.1 River Cleanup

Many residents have expressed interest in participating in annual or more frequent river clean up activities. The City has an annual river clean up day, and there are often opportunities for volunteer stewardship projects in other natural areas. The annual clean up by the City should continue, as well as other existing volunteer programs. The BTWC could be a potential partner with the City in promoting and managing the adopt-a-river program.

5.9.2 Educational Programming

The Big Thompson River corridor presents excellent opportunities for educational programming. The Parks and Recreation Department has educational signage on a range of topics along the river corridor. Topics presented with existing signage include the 2013 flood, restoration activities, wildlife information, and others. At the Morey Wildlife Reserve, information on bird species observed on the site is provided at the entrance to the area, and citizens update observations.

Teachers at Bill Reed Middle School contacted the City and project team during the development of the Master Plan. These teachers are considering developing a yearlong curriculum for 6th grade middle school students focused on the master planning of the river. The curriculum would incorporate science, geography, maps, floodplains, river health, and recreation. The City and project team have been in contact with these teachers to determine how we can assist with this effort.

5.9.3 Community Events

Another important aspect of community involvement is the community events that occur along the river throughout the summer. In 2017, events at Fairgrounds Park included National Bike and Trails Day, the Farmers' Market, and the rubber duck race for the Corn Roast Festival. Of these events, the rubber duck race is the only one that is focused on the river, and it is possible to attend events in the picnic shelters at Fairgrounds Park without ever seeing the river due to screening by vegetation. The Rotary Club, which organizes the annual rubber duck race as a fundraiser for schools, reports that in past years, the Corn Roast Festival was held at Fairgrounds Park rather than the current downtown location.

Having an event such as the Corn Roast Festival or another community event near the river, where large crowds would be drawn to the river corridor, would be beneficial for raising community awareness of the river. Since the Master Plan proposes creation of additional river access areas from downstream of the Greeley-Loveland Canal to the King's Crossing Natural Area, a river-themed event could be created in the summer to celebrate the River Season with water-related activities, vendors, educational exhibits, etc. Examples from nearby communities include the Longmont Rhythm on the River Festival and the Boulder Creek Festival.

5.10 Reach-by-Reach Master Plan Sheets

This section presents the Master Plan improvements discussed above graphically on drawing sheets. Because there are nearly a dozen different categories of proposed project improvements, two sheets are provided for each reach. One sheet includes improvements related to flood hazard reduction, gravel pits, aquatic habitat, geomorphology, utilities, and water quality. The second sheet illustrates improvements proposed for natural areas, parks and recreation, trails, and land use. Accompanying each sheet is a table summarizing the proposed improvements. Figures 5-19 through 5-28 show recommended improvements for Reach 29 through Reach 38.

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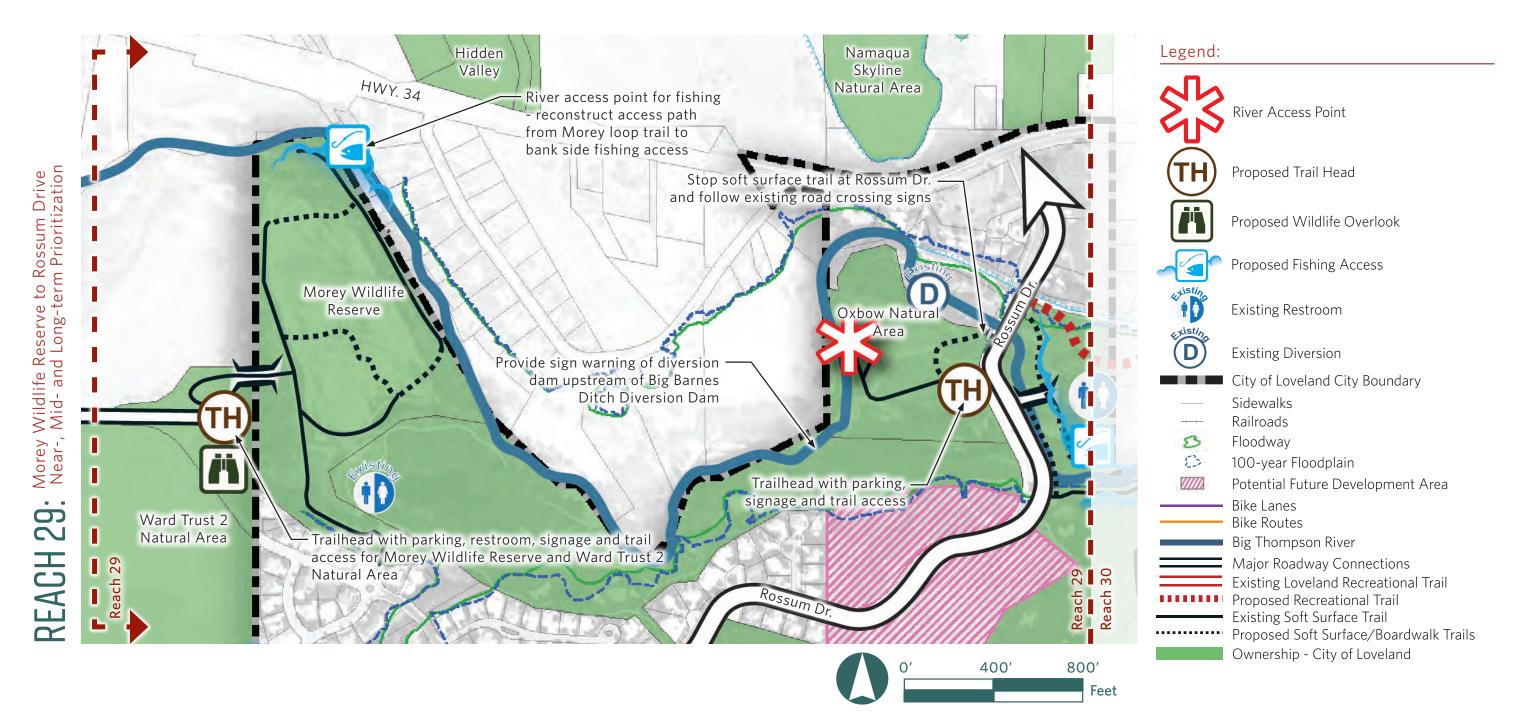




		Major Roadway Connections Big Thompson River Tributary of the Big Thompson River
T	- Deta	High Flow Path
	(D)	Existing Diversion Dam
7		City of Loveland City Boundary
		Sidewalks Railroads
	3	Floodway
100	8	100-year Floodplain
VC 15 ii	A A A	Ownership - City of Loveland Armored Overflow Protection See UDFCD Urban Storm Drainage Criteria Manual or USACE guidance for riprap sizing, use soil riprap in higher visibility area to soften appearance and provide vegetation Constructed Wetland Overflow Channel
		Sanitary Gravity Main
		Sanitary Pressurized Main
		Water Pressurized Main
		Stormwater Outfall
Reach 29 Reach 30	0'	400' 800' Feet

Legend:

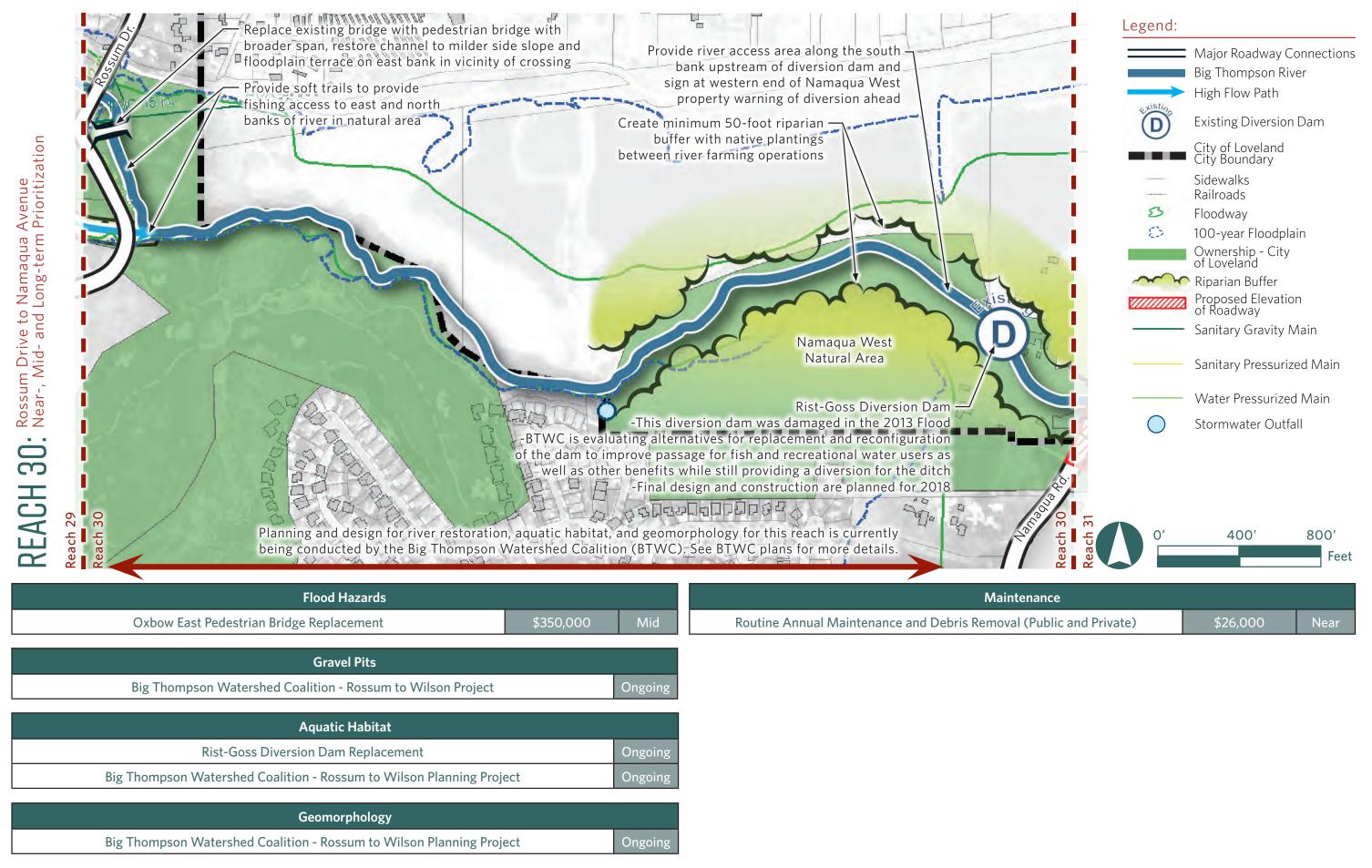
Flood Hazards		
Flood Hazards		
Morey Wildlife Reserve Constructed Wetland Overflow Channel	\$1,350,00	Mid
Overflow Weir upstream of Oxbow Natural Area	\$310,000	Mid
Aquatic Habitat		
Big Barnes Ditch Diversion Dam Fish and Boat Passage	\$1,810,000	Mid
Maintenance		
Routine Annual Maintenance and Debris Removal (Public and Private)	\$23,000	Near

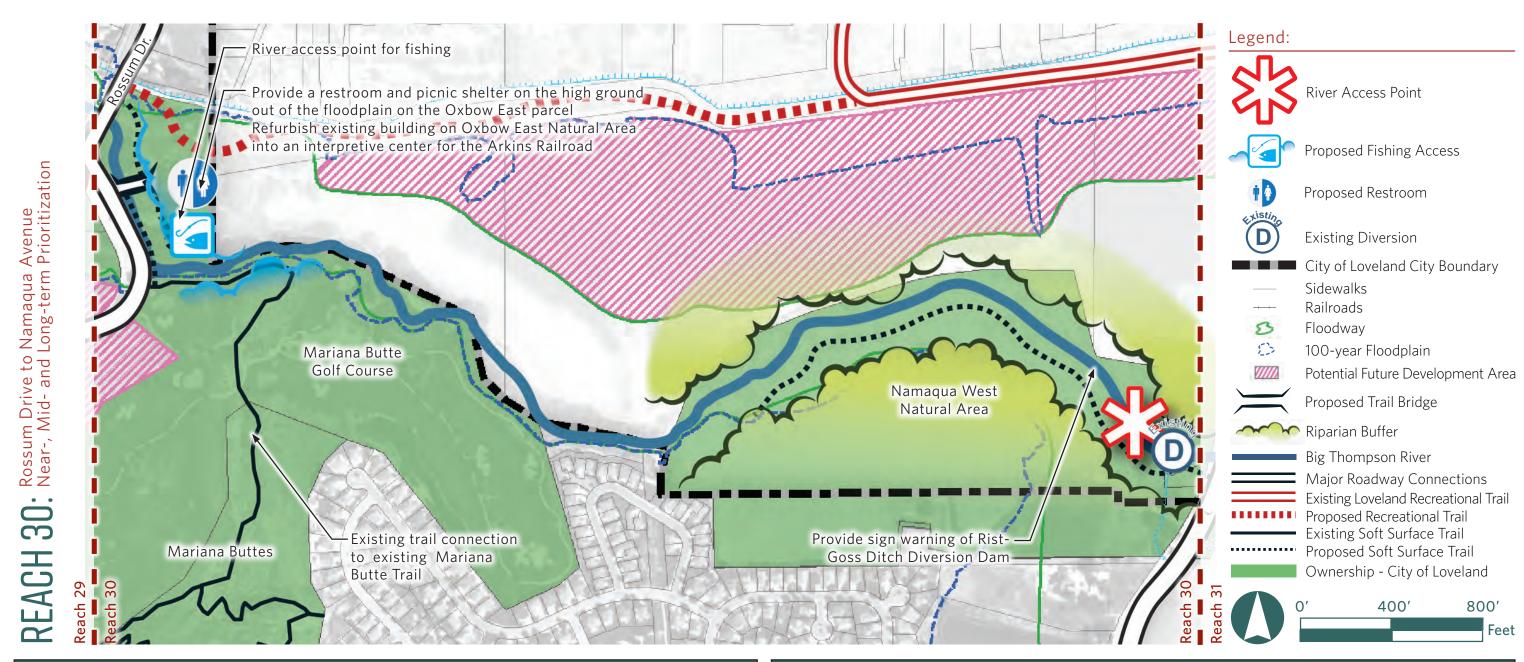


Natural Area/Open Space		
Morey Wildlife Reserve Revegetation and Weed Control	\$70,000	Near
Oxbow Natural Area Revegetation and Weed Control	\$30,000	Near

Parks & Recreation		
Oxbow Natural Area River Access	\$39,000	Mid
Morey Wildlife Reserve Fishing Access	\$6,000	Near
Morey Wildlife Reserve Trailhead	\$525,000	Mid
Oxbow Natural Area Trailhead	\$175,000	Mid

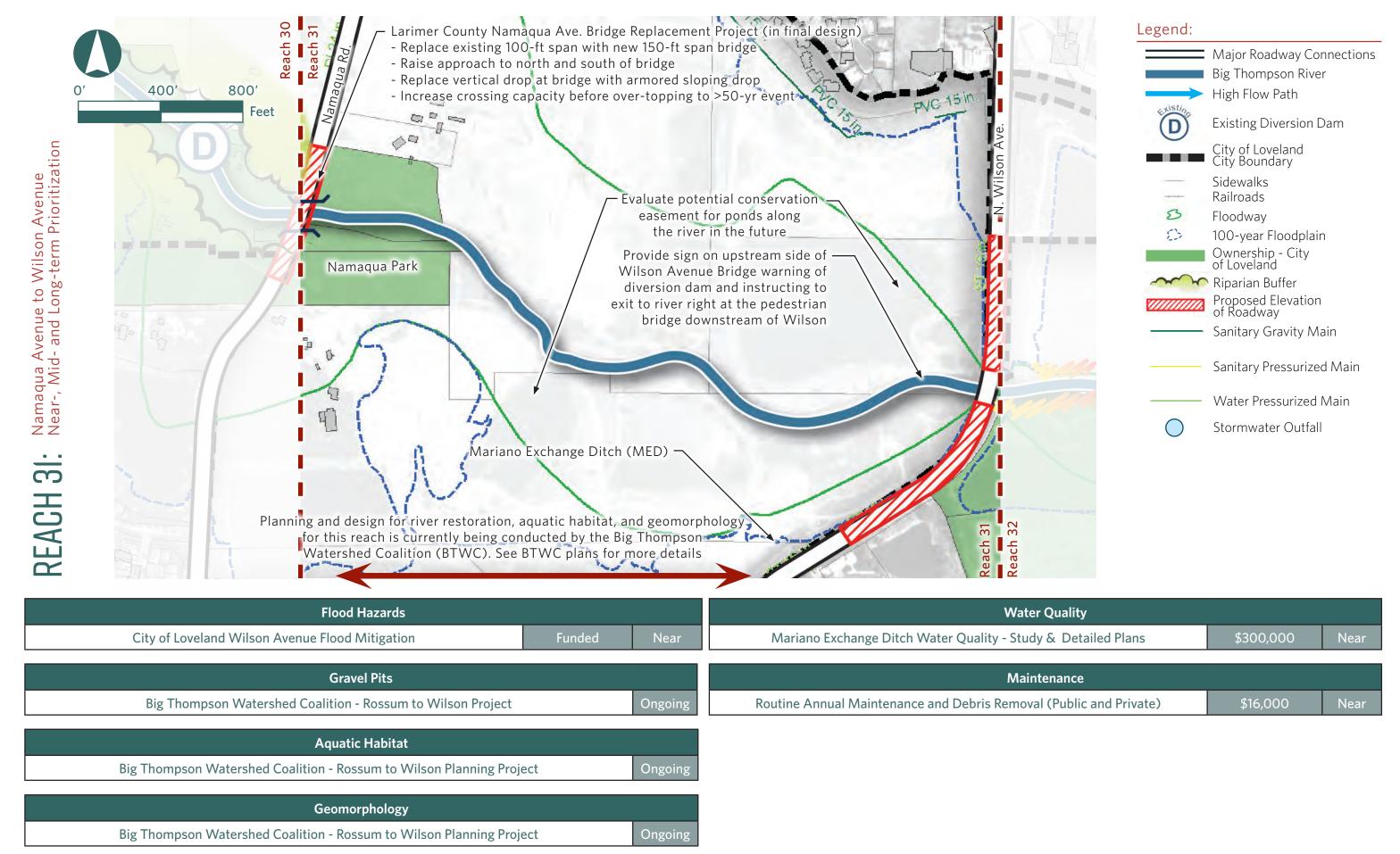
Trails		
Morey Wildlife Reserve Soft Surface Trails	\$320,00	Long
Trail Access to Morey Wildlife Reserve from New Trailhead	\$430,000	Long
Morey Wildlife Reserve Boardwalk Trails	\$360,000	Long

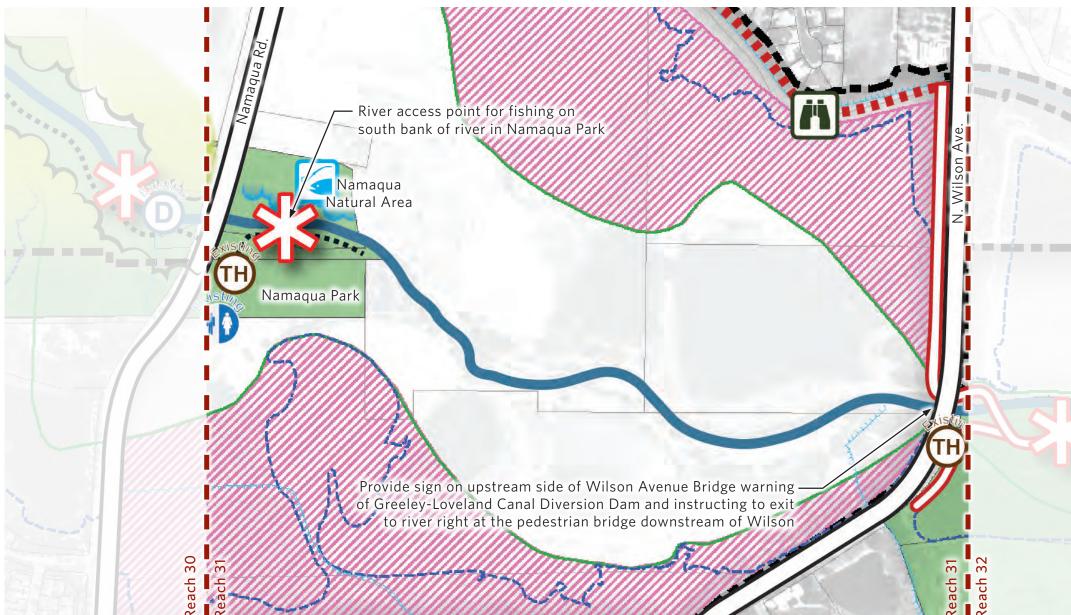




Natural Area/Open Space		
Oxbow East Natural Area Weed Control & Vegetation	\$20,000	Mid
Namaqua West Natural Area Weed Control & Vegetation	\$80,000	Mid
Parks & Recreation		
Oxbow East Parcel Picnic Shelter and Refurbished Building	\$440,000	Mid
Oxbow Natural Area Fishing Access	\$9,000	Mid
Rist-Goss Diversion Dam Warning	\$40,000	Near

Trails		
Rossum - Namaqua Recreational Trail Extension	\$368,000	Mid
Land Use		
Riparian Buffer	\$113,000	Mid
Buffer Area Livestock Exclusion	\$48,000	Mid
Loveland Ready Mix Coordination	\$13,000	Ongoing





Provide sign on upstream side of Wilson Avenue Bridge warning of Greeley-Loveland Canal Diversion Dam and instructing to exit			
to river right at th	ne pedestrian bridge do	wnstream of Wilson	
S <u>№</u>	Minney	MUMM	
ach each	*X/#///		
Res Res	<u> </u>		
Parks & Recreation			
Namaqua Park River Access	\$40,000	Near	
Greeley-Loveland Canal Diversion Dam Warning	\$3,000	Near	
Trails			
Namaqua - Wilson Recreational Trail Connection	\$368,000	Mid	
	•		
Landuse			

Legend:



River Access Point



Existing Trail Head



Proposed Wildlife Overlook



Proposed Fishing Access



Existing Restrooms



City of Loveland City Boundary



Railroads Floodway





■ Big Thompson River



Existing Loveland Recreational Trail Proposed Recreational Trail



Ownership - City of Loveland





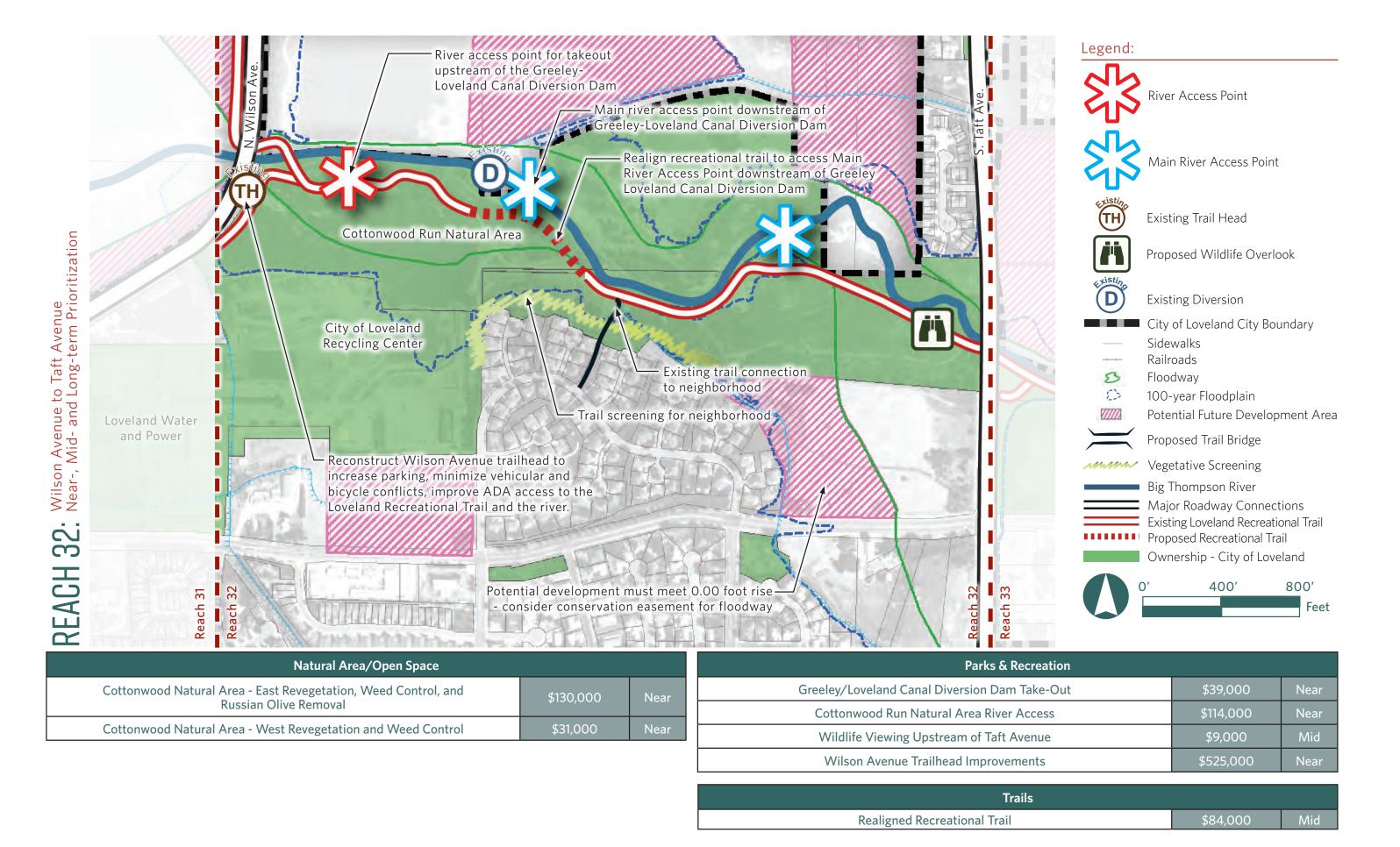
Legend:	
oleti.	Major Roadway Connections Big Thompson River High Flow Path
(D)	Existing Diversion Dam
	City of Loveland City Boundary
+	Sidewalks Railroads
3	Floodway
	100-year Floodplain Ownership - City of Loveland Proposed Elevation of Roadway Bank Stabilization
6.25 755 35	Sanitary Gravity Main
	Sanitary Pressurized Main
	Water Pressurized Main Stormwater Outfall

400'

800'

Feet

Geomorphology		
Bank Stabilization (~ 1800 feet)	\$1,430,000	Mid
Utilities		
Three 8-inch Sanitary Sewer Protection	\$111,000	Near
Maintenance		
Routine Annual Maintenance and Debris Removal (Public and Private)	\$19,000	Near



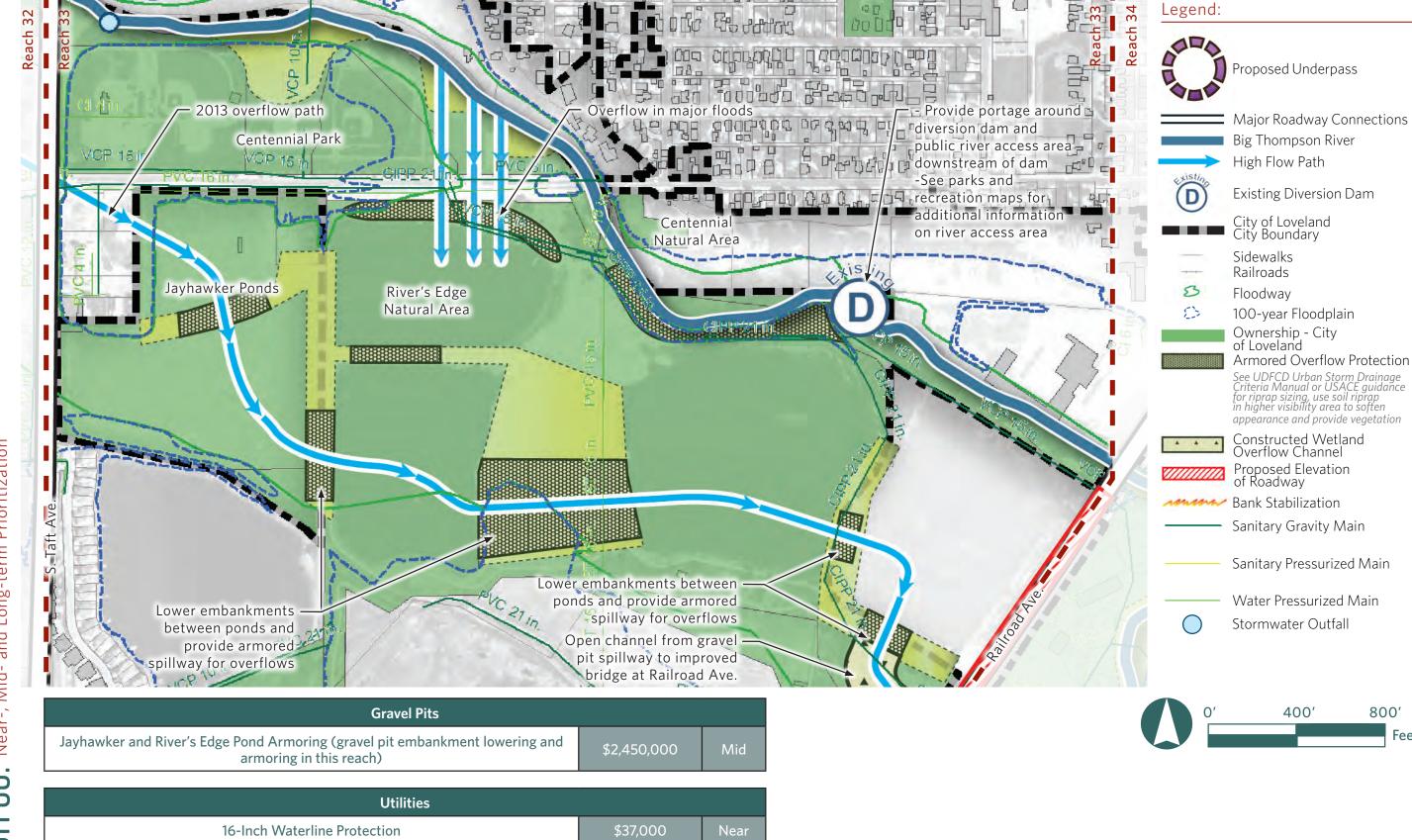


Figure 5-27-Reach 33 H & H Map

Near

\$24,000

Maintenance

Routine Annual Maintenance and Debris Removal (Public and Private)

800'

Feet

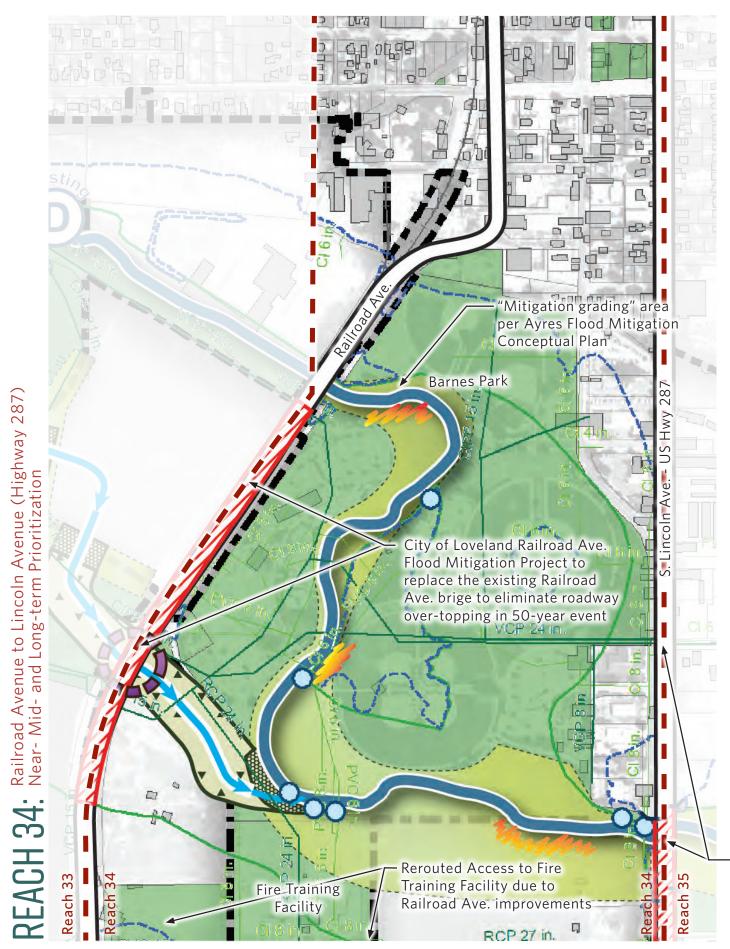
400'



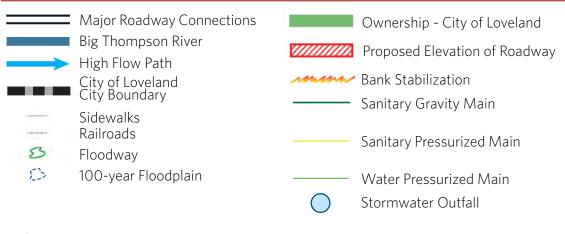




Parks & Recreation			
Centennial Park River Access	\$53,000	Mid	
Farmers Ditch Diversion Take-Out and Put-In	\$80,000	Near	
Trails			
Vegetative Screening	\$18,000	Near	



Legend:

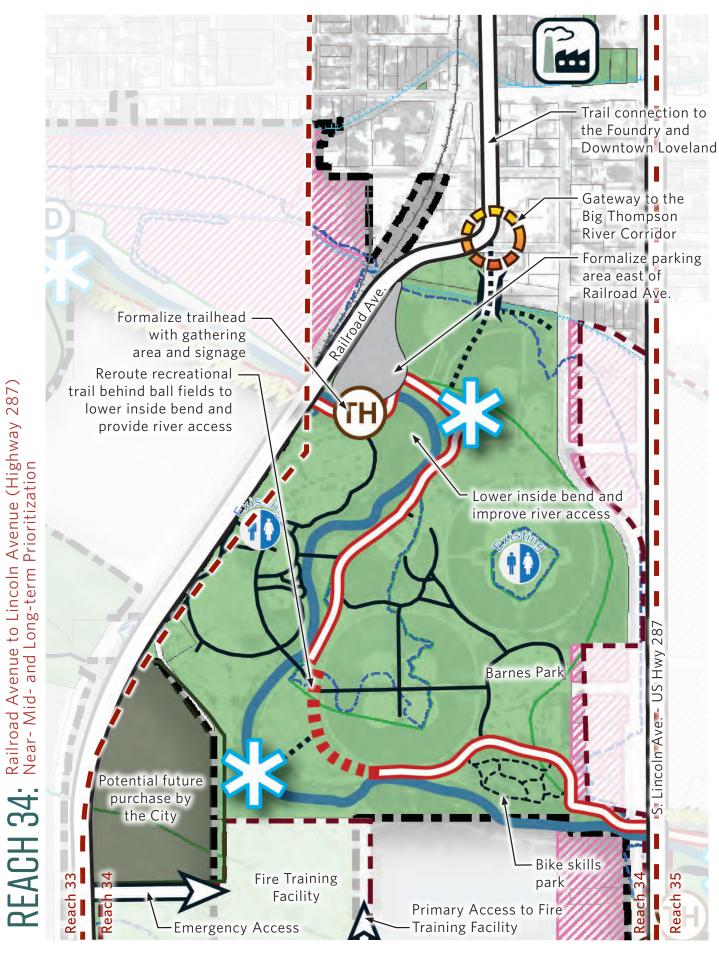




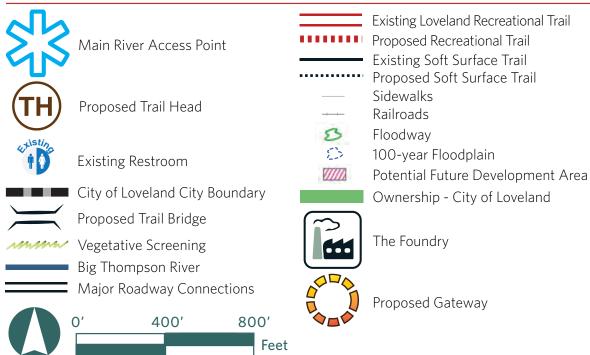
Flood Hazards		
City of Loveland Lincoln Avenue - US Highway 287 Flood Mitigation	\$16,900,000	Near
Geomorphology		
Bank Stabilization (~ 1200 feet)	\$945,000	Mid
Utilities		
24-Inch Sanitary Sewer Protection	\$37,000	Near
6-Inch Waterline Protection	\$37,000	Near
Maintenance Maintenance		
Routine Annual Maintenance and Debris Removal (Public and Private)	\$17,000	Near

City of Loveland Lincoln Ave. - US Hwy 287 Flood Mitigation Project

- Replace existing bridge with 240-ft span bridge
- Elevate roadway to eliminate 100-yr over-topping
- "Mitigation grading" upstream and downstream of crossing for additional floodplain storage
- See Ayres US Hwy 287 Bridge & Flood Mitigation Conceptual Plan



Legend:



Parks & Recreation			
Fairgrounds Park River Access	\$110,000	Mid	
Fairgrounds Park Bike Skills Park	\$132,000	Mid	
Gateway to the Big Thompson River Corridor Railroad Avenue Improvements	\$3,500,000	Long	
Redevelopment of Old Loveland Wastewater Treatment Plant Site	\$875,000	Mid	
Fairgrounds Park Trailhead	\$175,000	Mid	

Trails			
Bike Trail Connection from North End of Fairgrounds Park to 1st Street	\$158,000	Mid	
Realignment of Trail Near Fairgrounds Park River Access	\$109,000	Mid	

Armor overflow point - "Mitigation grading" area per Ayres Flood Mitigation Conceptual Plan - Armor return flow point to river When the St. Louis -Crossing Avenue Bridge is Natural Area replaced in the future, evaluate costs and benefits of increased conveyance capacity 弘 Lincoln Avenue (Highway 287) to St. Louis Avenue Near-, Mid- and Long-term Prioritization Hwy 402 Raise Hwy 402 through floodplain Provide culvert beneath Hwy 402 when roadway is elevated and provide flap gate if needed Potential area for future regional detention or water quality pond when area south of Hwy 402 develops -If flap gate is provided on culvert beneath Hwy 402, size based on retention standard - Sizing to be determined based on future proposed development in watershed - Future development in watershed to minimize directly connected impervious area to reduce runoff - Floodplain fill south of Hwy 402 35. and future detention/water quality pond not included in Master Plan costs (private development) Reach 34
Reach 35

Legend: Water Quality Pond ■ Major Roadway Connections Big Thompson River Potential Floodplain Fill Area High Flow Path Constructed Wetland Overflow Channel City of Loveland City Boundary Proposed Elevation of Roadway Sidewalks Bank Stabilization Railroads Sanitary Gravity Main 53 Floodway 100-year Floodplain Sanitary Pressurized Main Ownership - City of Loveland Ownership - Conservation Easement Water Pressurized Main Ownership - Larimer County Stormwater Outfall 400' 800' Feet



Figure 5-31-Reach 35 H & H Map

Consider acquiring easement within floodway for future trail connections and maintenance Natural Area Trail connection option along sidewalk to connect to Old St. Louis Natural Area Waterford Place -US Hwy Lincoln Avenue (Highway 287) to St. Louis Avenue Near-, Mid- and Long-term Prioritization Trailhead with parking, signage, restrooms and trail connections for river access Downtown Gateway Culvert with flapgate to manage backflow from river Potential area for future recreational detention or water quality pond when area south of Hwy 402 develops Potential floodplain fill area when area south of Hwy 402 develops REACH 35: Reach 34
Reach 35

Legend:



800'

Feet

400'

Natural Area/Open Space		
King's Crossing Natural Area Weed Control and Revegetation	\$24,000	Near
Parks & Recreation		
Parks & Recreation		
Gateway to Downtown Architectural Element Along Lincoln Avenue	\$132,000	Mid
King's Crossing Natural Area Trailhead	\$525,000	Mid
King's Crossing Natural Area River Access	\$276,000	Mid
Trails		
Vegetative Screening	\$5,000	Near
Lincoln Ave St. Louis Ave. Recreational Trail and Pedestrian Bridge	\$635,000	Mid
Lincoln Ave St. Louis Ave. Soft Trail	\$171,000	Mid

Figure 5-32-Reach 35 Rec Map

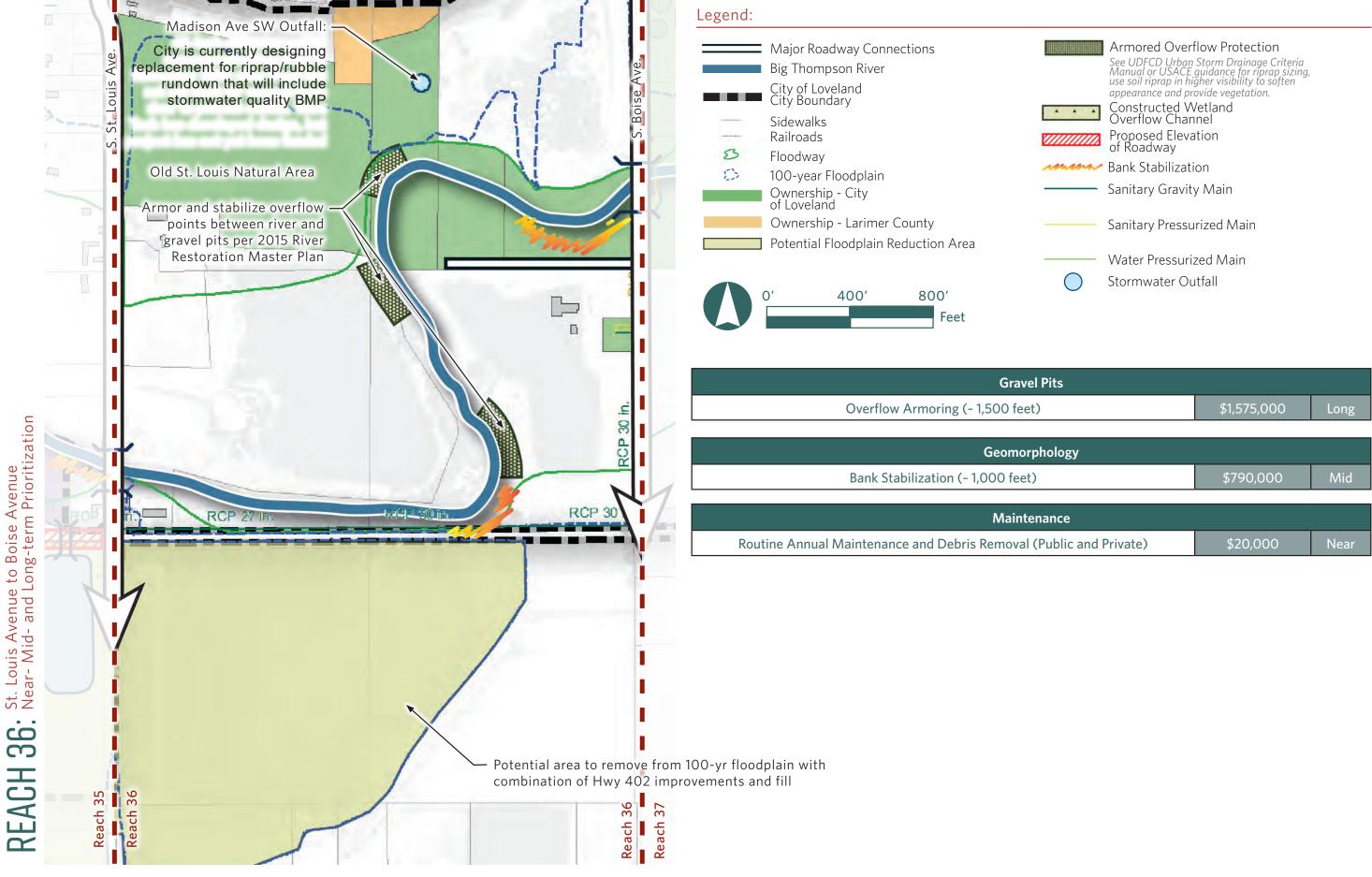
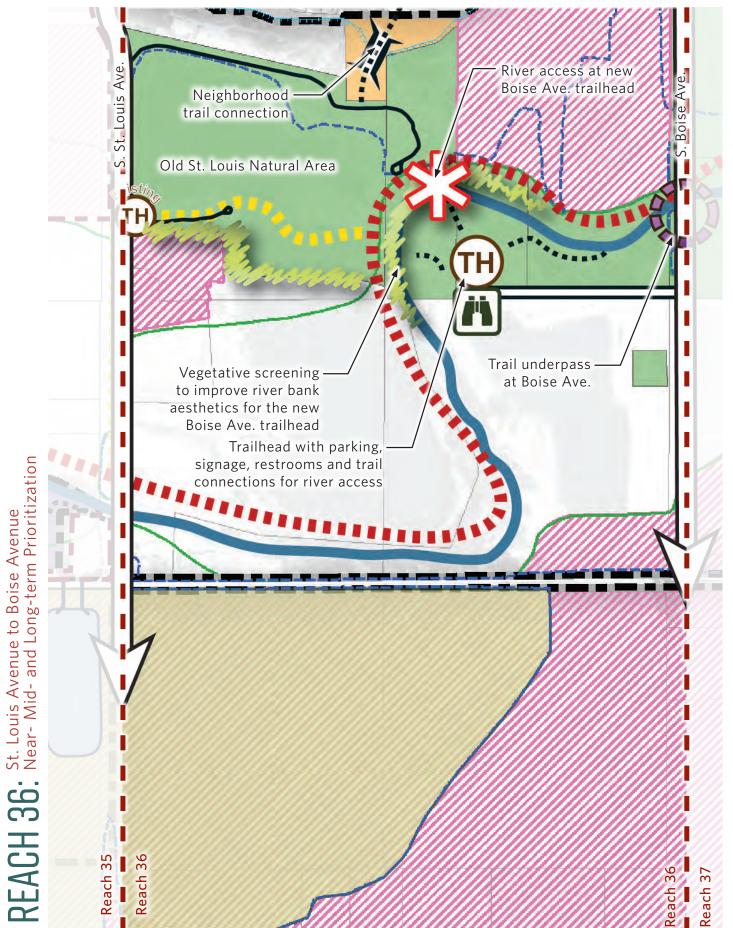
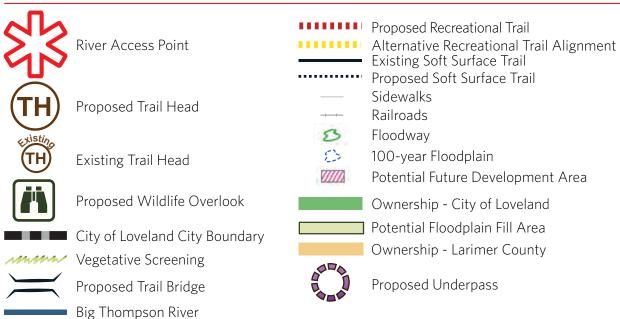


Figure 5-33-Reach 36 H & H Map



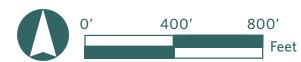
Legend:



Natural Area/Open Space		
Old St. Louis Natural Area Weed Control, Revegetation and Wetland Creation	\$100,000	Mid
Parks & Recreation		
Old St. Louis Natural Area Shelter	\$53,000	Near
Boise Ave. Site Trailhead	\$525,000	Mid
Parks & Recreation		
Vegetative Screening	\$12,000	Near
St. Louis Ave - Boise Ave Recreational Trail	\$530,000	Mid
Madison Avenue Neighborhood Trail Connection	\$130,000	Mid

Note: Proposed underpass costs not included in Master Plan because underpass will be constructed as part of road project.

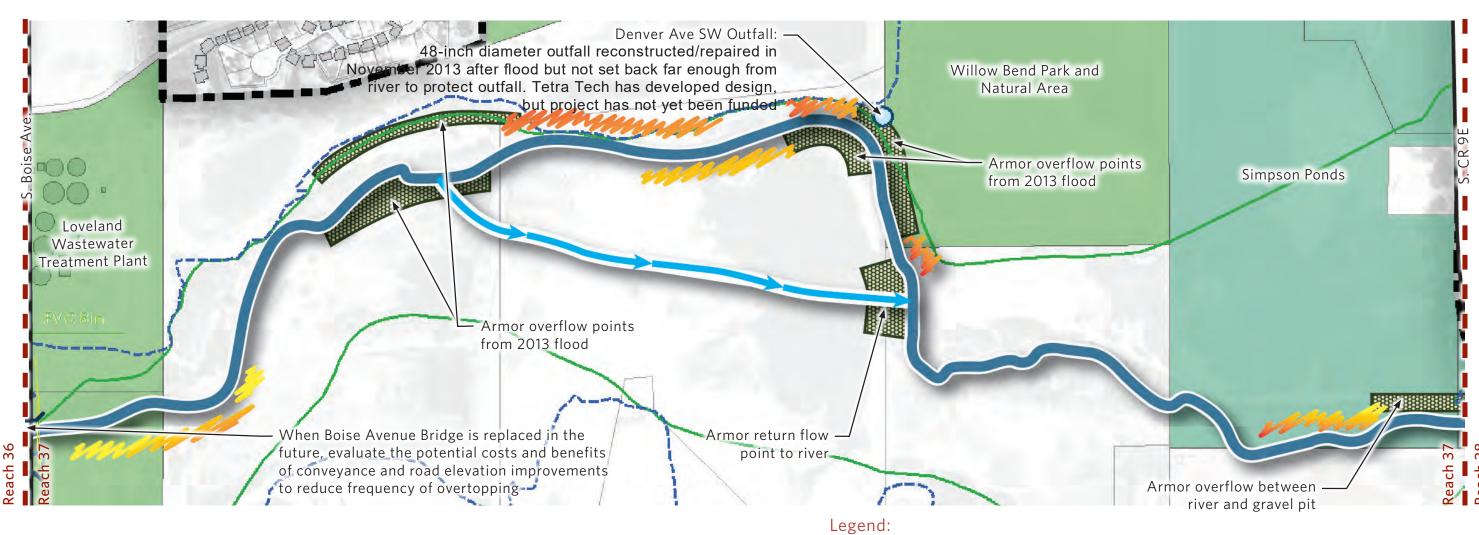
Old. St. Louis Natural Area Soft Trail



Major Roadway Connections

Figure 5-34-Reach 36 Rec Map

\$62,000

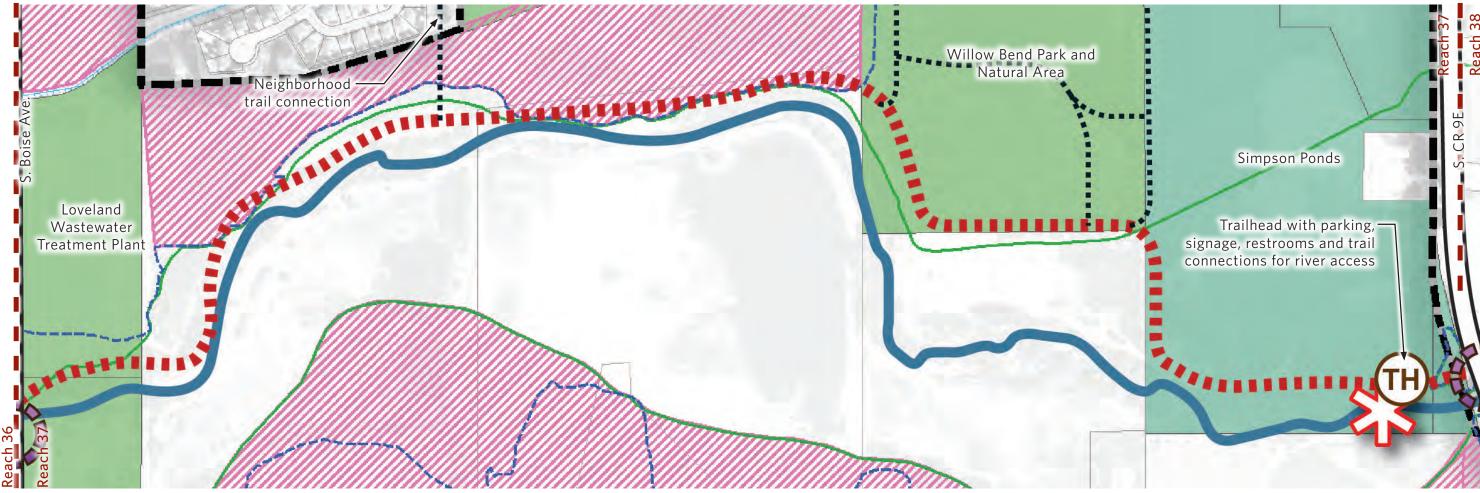




Boise Avenue to CR 9E Near-, Mid and Long-term Prioritization

800'

Feet

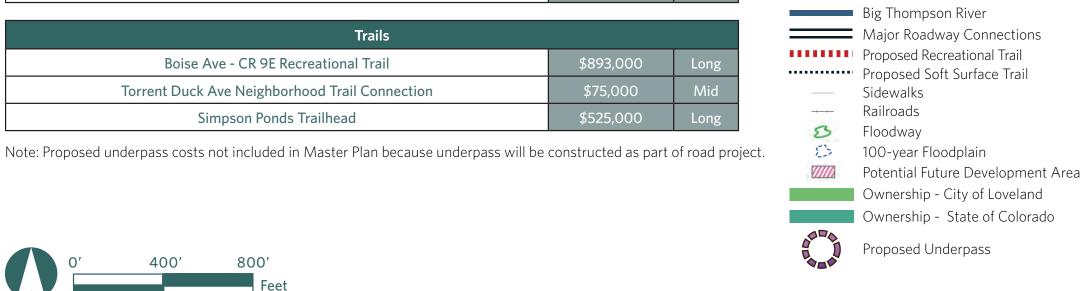


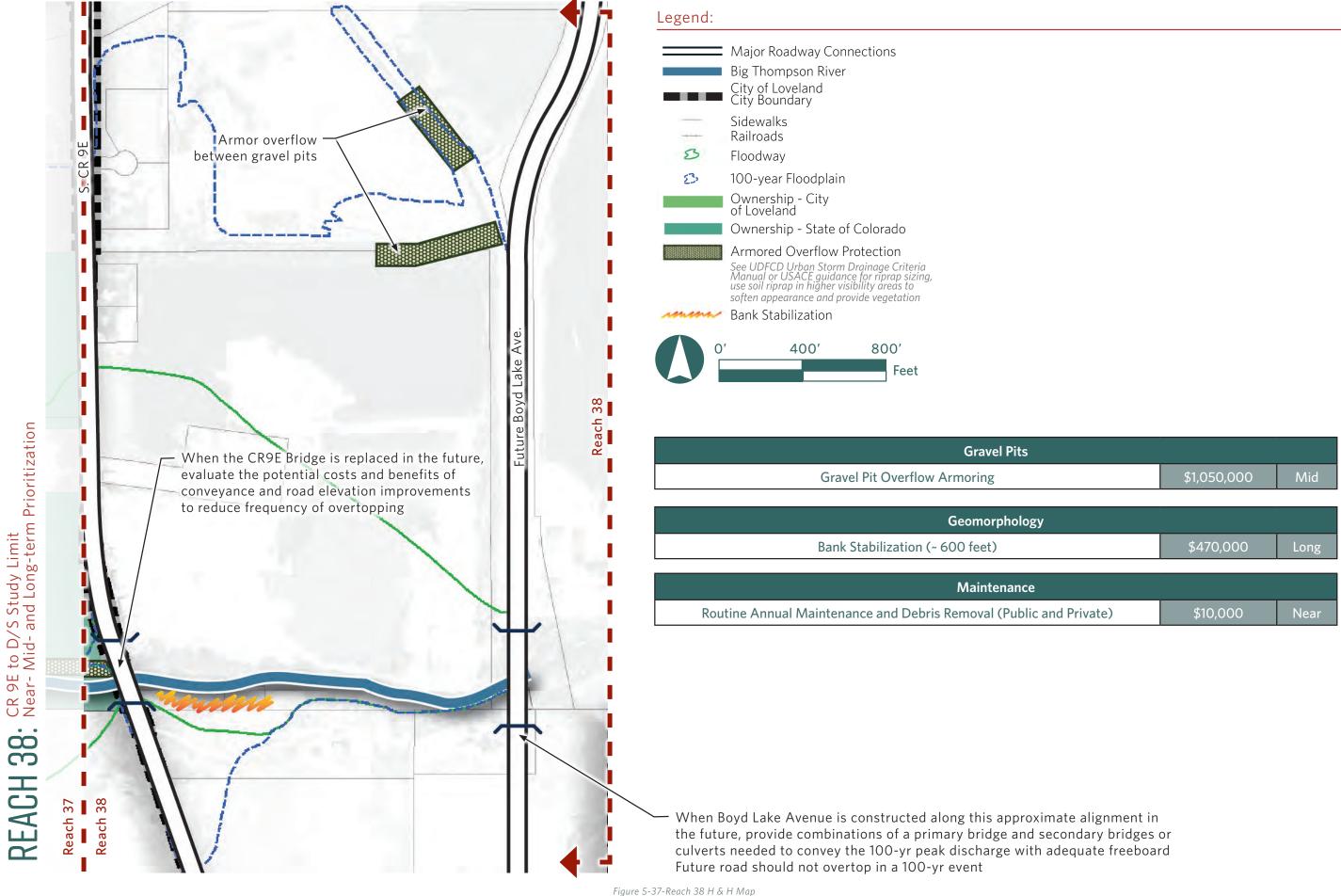
Legend:

River Access Point

City of Loveland City Boundary

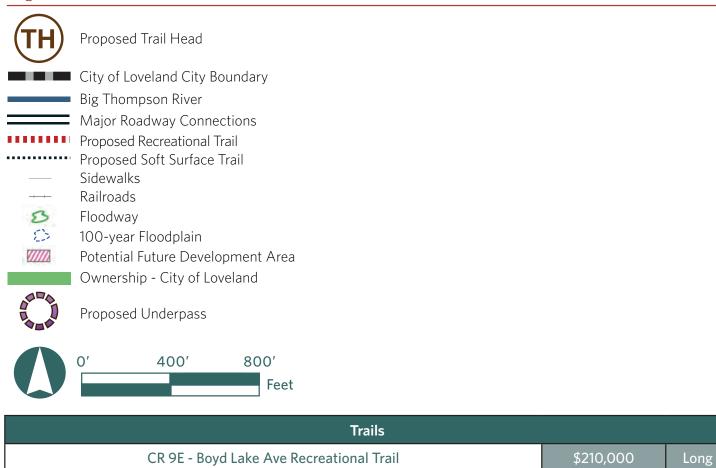
Natural Area/Open Space		
Willow Bend Park and Natural Area Weed Control and Revegetation	\$136,000	Near
Parks & Recreation		
Simpson Ponds River Access	\$35,000	Mid
Trails		
Boise Ave - CR 9E Recreational Trail	\$893,000	Long
Torrent Duck Ave Neighborhood Trail Connection	\$75,000	Mid
Simpson Ponds Trailhead	\$525,000	Long





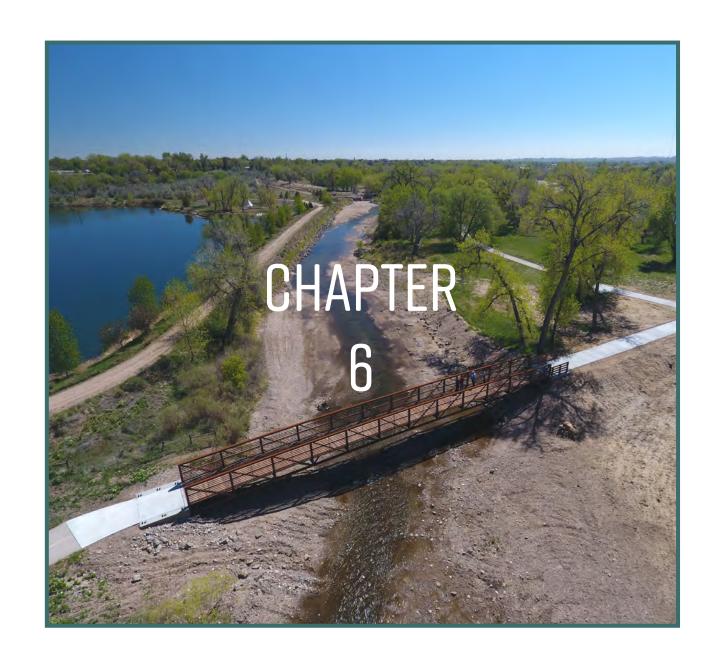
S. CR 9E Future trail connection along – Boyd Lake Ave will be part of the Boyd Lake Avenue road project Trail underpass at CR9E CR 9E to D/S Study Limit Near- Mid- and Long-term Prioritization REACH 38:

Legend:



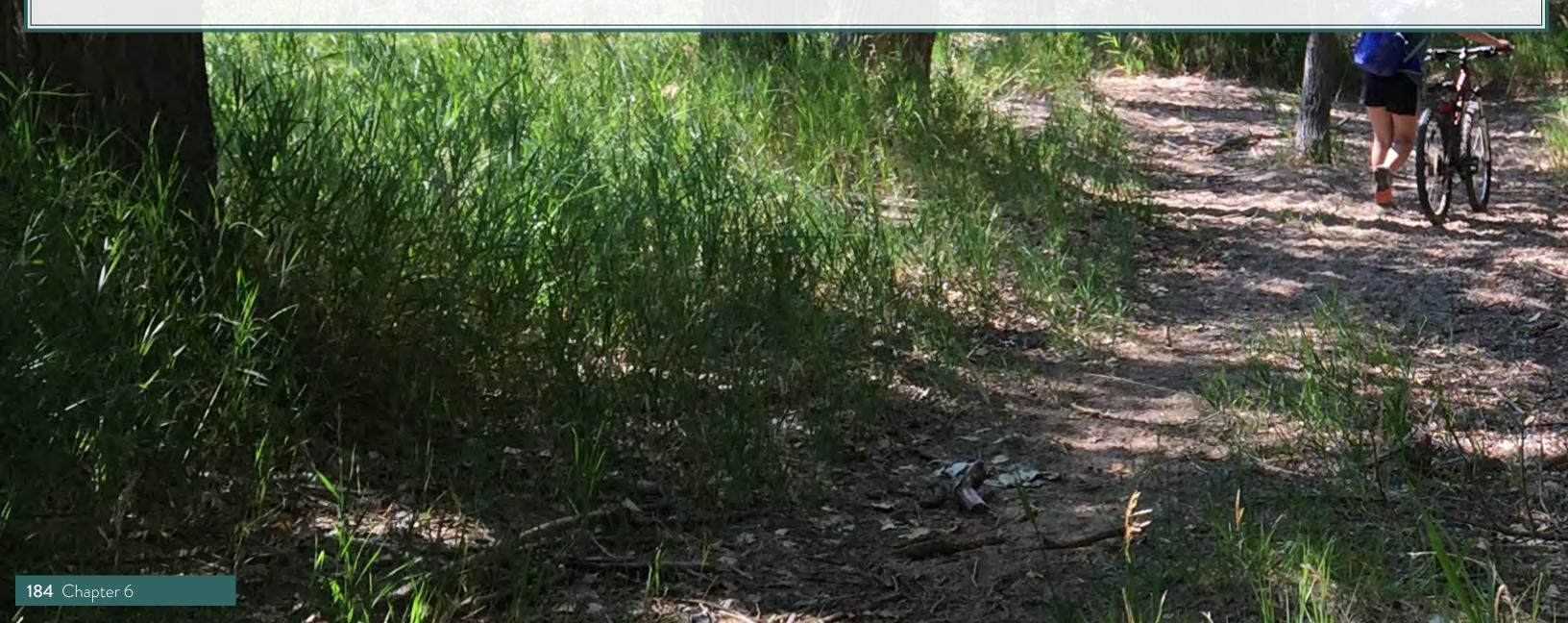
Note: Proposed underpass costs not included in Master Plan because underpass will be constructed as part of road project.

Figure 5-38-Reach 38 Rec Map



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6.0 COSTS AND PRIORITIZATION OF PROJECTS

Cost estimates for all of the proposed projects have been prepared at a conceptual level. As more detailed plans are developed, cost estimates may change based on site specific conditions and specific details of each project. To the extent feasible, proposed projects have also been categorized as Near-, Mid- or Long-term priorities. Many factors affect the prioritization and implementation of the proposed projects, so this Master Plan can be used as a general project implementation guideline with the flexibility of re-prioritizing projects as needed.

6.I PROJECT COSTS FOR IMPROVEMENTS

Cost estimates are often prepared at several points during project planning and design. The expected level of accuracy is directly proportional to the level of engineering effort applied and known details. Each category of estimate must be carefully prepared from the conceptual level to the study level, preliminary design and final engineers' estimate. The project team recommends four levels of accuracy for construction cost estimating categories as addressed below:

• Category 1: Conceptual Estimate

Category 3: Preliminary Estimate

Category 2: Study Estimate

• Category 4: Detailed Estimate

The accuracy of estimated costs should increase as the project moves from planning through design and to the final estimate prepared at the completion of design. It can be expected that conceptual estimates would have a relatively wide accuracy range relative to the construction contract amount because not all of the design features and details have been addressed during preliminary planning efforts. In comparison, the final detailed estimate should be more accurate due to the additional level of detail that is known when the design is completed.

The costs associated with this master plan are estimated at the conceptual level (Category 1). Therefore, an estimated cost may range from 50 percent higher than estimated to 30 percent less than estimated. Table 6-1 illustrates how the accuracy of the construction cost estimate categories change with respect to increasing levels of project detail.

Category	Project Level	Expected Accuracy Based on Estimated Cost
Conceptual	Pre-study estimates and screening of alternatives	+50% to -30%
Study Estimate	Refined master plans	+30% to -20%
Preliminary Estimate	Pre-design report	+20% to -10%
Detailed Estimate	Completed plans/specifications	+15% to -5%

Table 6-1. Categories of Estimated Costs

Similar to the cost estimates provided in the River Restoration Master Plan by Ayres in May 2015, there are several additional variables that will have an effect on the actual costs to implement the proposed projects including the actual length, height, width, and/or area of proposed projects, availability of material, construction methods, amount of material to import and/or export, amount of engineering design required, real estate needs, 404 and FEMA permitting requirements, among others.

Unit costs were developed based on values used from recent master plans, bid tabs from recent projects within the Big Thompson River corridor, and the project team's experiences with cost estimating on similar projects. Table 6-2 provides an overview of the unit costs that were used to develop the conceptual cost estimates for the proposed projects.

Project Element	Unit Cost	Unit Measure	
Hydraulics			
Roadway Reconstruction per Lane	\$725,000	MI	
Road Bridge	\$20,000	LF	
Pedestrian Bridge	\$200,000	EA	
Diversion Dam Retrofit for Recreation and Safety	\$50,000	VF	
Diversion Dam Fish Passage	\$50,000	VF	
Utility Protection	\$350	LF	
Wetland Creation/Open Water Feature	\$10,000	AC	
Mariano Exchange Ditch Water Quality Evaluation	\$250,000	LS	
Small Ditch Crossing Bridge	\$50,000	LS	
Channel			
Bank Stabilization	\$450	LF	
Stabilized Overflow	\$600	LF	
Wall or Elevated Roadway	\$2,500	LF	
Proposed Channel	\$300	LF	
Lower/Regrade	\$13,500	AC	
Floodplain Bench	\$10,000	AC	
Pedestrian Bridge	\$200,000	LS	
Trails			
Soft Trails (crusher fines)	\$35	LF	
Regional/Paved Trails	\$60	LF	
Boardwalk Trail	\$200	LF	
Trailhead - High Amenity	\$300,000	LS	
Trailhead - Low Amenity	\$100,000	LS	

Table 6-2. Unit Costs (MI = mile, LF = linear foot, EA = each, SY = square yard, AC = acre, LS = lump sum)

Project Element	Unit Cost	Unit Measure
Recreati	ion	
River Access (cobble area and path)	\$20,000	LS
River Access (stone stairs)	\$35,000	LS
River Access/Fishing Access	\$5,000	LS
Diversion Warning Signage and Buoy	\$2,000	LS
Trailhead High Amenity	\$300,000	LS
Trailhead Low Amenity	\$100,000	LS
Refurbish Existing Building as Simple Shelter	\$13,000	LS
Picnic Shelter	\$30,000	LS
Restroom Facility	\$210,000	LS
Natural Play Area	\$10,000	LS
Bike Skills Park	\$75,000	LS
Gateway Railroad Avenue Improvements	\$2,000,000	LS
Redevelopment of Wastewater Treatment Plant Site	\$500,000	LS
Gateway to Downtown Architectural Element	\$75,000	LS
Land U	se	
Riparian Buffer with Native Plantings	\$10,000	AC
Livestock Exclusion	\$30,000	LS
Property Owner Coordination for Future Land Uses	\$10,000	LS
Vegetative Screening	\$5,000	AC
Natural Area Weed Control	\$750	AC
Natural Area Full Seeding	\$3,500	AC
Natural Area Interseeding	\$1,500	AC
Natural Area Wetland Creation	\$40,000	AC
Natural Area Wetland Enhancement	\$30,000	AC

Table 6-2. Unit Costs (MI = mile, LF = linear foot, EA = each, SY = square yard, AC = acre, LS = lump sum)

Additional costs have also been included with each proposed project conceptual cost estimate to include items that will likely be required during the design and construction phase of a project. These additional costs are included as a percentage of the proposed improvement subtotal. Table 6-3 provides an overview of the additional costs and contingencies that are incorporated into the overall cost estimates.

Category	Percent of Proposed Project Subtotal*
Engineering	15%
Administrative/Legal	5%
Construction Management	15%
SWMP	5%
Mobilization	5%
Dewatering	5%
Traffic Control	5%
Contingency	25%
Total	80%

Table 6-3. Estimated Additional Costs & Contingency

Tables 6-4 through 6-13 provide an overview of the proposed project conceptual cost estimates for each resilience category. As discussed, the costs associated with this Master Plan are estimated at a conceptual level. Therefore, an estimated cost may range from 50 percent higher than estimated to 30 percent less than estimated.

^{*}Percentages are adjusted in some cases if activities/projects do not require as extensive or complicated planning, design, and construction techniques (e.g. weed control, revegetation, small projects)

Reach	Proposed Project	Conceptual Cost Estimate
	Flood Hazard Reduction	
29	Morey Wildlife Reserve Constructed Wetland Overflow Channel	\$1,350,000
29	Overflow Weir upstream of Oxbow Natural Area	\$310,000
30	Oxbow East Pedestrian Bridge Replacement	\$350,000
31	City of Loveland Wilson Avenue Flood Mitigation	Funded
34	City of Loveland Lincoln Avenue - US Highway 287 Flood Mitigation	\$16,900,000
35	Raise Highway 402	\$3,230,000

Table 6-4. Flood Hazard Reduction Proposed Project Conceptual Cost Estimates

Reach	Proposed Project	Conceptual Cost Estimate
	Gravel Pits	
30	Big Thompson Watershed Coalition - Rossum to Wilson Project	Ongoing
31	Big Thompson Watershed Coalition - Rossum to Wilson Project	Ongoing
33	Jayhawker and River's Edge Pond Armoring (all gravel pit embankment lowering and armoring in this reach)	\$2,450,000
35	Overflow Channel Armoring	\$675,000
36	Gravel Pit Armoring	\$1,575,000
37	Gravel Pit Armoring	\$2,625,000
38	Gravel Pit Armoring	\$1,050,000

Table 6-5. Gravel Pits Proposed Project Conceptual Cost Estimates

Reach	Proposed Project	Conceptual Cost Estimate
	Aquatic Habitat	
29	Big Barnes Ditch Diversion Dam Fish and Boat Passage (private dam - not included in Master Plan cost total)	\$1,810,000
30	Rist-Goss Diversion Dam Replacement	Ongoing
30	Big Thompson Watershed Coalition - Rossum to Wilson Project	Ongoing
31	Big Thompson Watershed Coalition - Rossum to Wilson Project	Ongoing

Table 6-6. Aquatic Habitat Proposed Project Conceptual Cost Estimates

Reach	Proposed Project	Conceptual Cost Estimate
	Geomorphology	
30	Big Thompson Watershed Coalition - Rossum to Wilson Project	Ongoing
31	Big Thompson Watershed Coalition - Rossum to Wilson Project	Ongoing
32	Bank Stabilization	\$1,430,000
34	Bank Stabilization	\$945,000
35	Bank Stabilization	\$945,000
36	Bank Stabilization	\$790,000
37	Bank Stabilization	\$2,363,000
38	Bank Stabilization	\$473,000

Table 6-7. Geomorphology Proposed Project Conceptual Cost Estimates (See maps in Appendix A and Figures in Section 5.10 for bank stabilization area)

Reach	Proposed Project	Conceptual Cost Estimate
	Natural Area/Open Space	
29	Morey Wildlife Reserve Revegetation and Weed Control	\$70,000
29	Oxbow Natural Area Revegetation and Weed Control	\$30,000
30	Oxbow East Natural Area Weed Control & Vegetation	\$20,000
30	Namaqua West Natural Area Weed Control & Vegetation	\$80,000
32	Cottonwood Natural Area – East Revegetation, Weed Control, and Russian Olive Removal	\$130,000
32	Cottonwood Natural Area – West Revegetation and Weed Control	\$31,000
35	King's Crossing Natural Area Weed Control and Revegetation	\$24,000
36	Old St. Louis Natural Area Weed Control, Revegetation, and Wetland Creation	\$100,000
37	Willow Bend Park and Natural Area Weed Control and Revegetation	\$136,000

Table 6-8. Natural Area/Open Space Proposed Project Conceptual Cost Estimates

Reach	Proposed Project	Conceptual Cost Estimate				
Parks & Recreation						
29	Oxbow Natural Area River Access	\$39,000				
29	Morey Wildlife Reserve Fishing Access	\$6,000				
29	Morey Wildlife Reserve Trailhead	\$525,000				
29	Oxbow Natural Area Trailhead	\$175,000				
30	Oxbow East Parcel Picnic Shelter and Refurbished Building	\$440,000				
30	Oxbow Natural Area Fishing Access	\$9,000				
30	Rist-Goss Diversion Dam Warning	\$40,000				
31	Namaqua Park River Access	\$40,000				
31	Greeley-Loveland Canal Diversion Dam Warning	\$3,000				
32	Greeley-Loveland Canal Diversion Dam Take-Out	\$39,000				
32	Cottonwood Run Natural Area River Access	\$114,000				
32	Wildlife Viewing Upstream of Taft Avenue	\$9,000				
32	Wilson Avenue Trailhead Improvements	\$525,000				
33	Centennial Park River Access	\$53,000				
33	Farmers Ditch Diversion Take-Out and Put-In	\$80,000				
34	Fairgrounds Park River Access	\$110,000				
34	Fairgrounds Park Bike Skills Park	\$132,000				
34	Gateway to the Big Thompson River Corridor Railroad Avenue Improvements	\$3,500,000				
34	Redevelopment of Old Loveland Wastewater Treatment Plant Site	\$875,000				
34	Fairgrounds Park Trailhead	\$175,000				
35	Gateway to Downtown Architectural Element Along Lincoln Avenue	\$132,000				
35	King's Crossing Natural Area Trailhead Improvements	\$525,000				
35	King's Crossing Natural Area River Access	\$276,000				
36	Old St. Louis Natural Area Shelter	\$53,000				
36	Boise Avenue Site Trailhead	\$525,000				
37	Simpson Ponds River Access and Take-Out	\$35,000				

Table 6-9. Parks and Recreation Proposed Project Conceptual Cost Estimates

Reach	Proposed Project	Conceptual Cost Estimate				
Trails						
29	Morey Open Space Soft Surface Trails	\$320,000				
29	Trail Access to Morey Wildlife Reserve from New Trailhead	\$403,000				
29	Morey Wildlife Reserve Boardwalk Trails	\$360,000				
30	Rossum - Namaqua Recreational Trail Extension	\$368,000				
31	Namaqua - Wilson Recreational Trail Connection	\$368,000				
32	Realigned Recreational Trail	\$84,000				
33	Vegetative Screening	\$18,000				
33	Realigned Recreational Trail	\$105,000				
34	Bike Trail Connection from North End of Fairgrounds Park to 1st Street	\$158,000				
34	Realignment of Trail near Fairgrounds Park River Access	\$109,000				
35	Vegetative Screening	\$5,000				
35	Lincoln Avenue – St. Louis Avenue Recreational Trail and Pedestrian Bridge	\$635,000				
35	Lincoln Avenue - St. Louis Avenue Soft Trail	\$171,000				
36	Vegetative Screening	\$12,000				
36	St. Louis Avenue - Boise Avenue Recreational Trail	\$530,000				
36	Madison Avenue Neighborhood Trail Connection	\$130,000				
36	Old St. Louis Natural Area Soft Trail	\$62,000				
37	Boise Avenue - CR 9E Recreational Trail	\$893,000				
37	Torrent Duck Avenue Neighborhood Trail Connection	\$75,000				
37	Simpson Ponds Trailhead	\$525,000				
38	CR 9E - Boyd Lake Avenue Recreational Trail	\$210,000				

Table 6-10. Trails Proposed Project Conceptual Cost Estimates

Reach	Proposed Project	Conceptual Cost Estimate
	Land Use	
30	Riparian Buffer	\$113,000
30	Buffer Area Livestock Exclusion	\$48,000
30	Loveland Ready Mix Coordination	\$13,000
31	Coordinate with Property Owners	\$14,000

Table 6-11. Land Use Proposed Project Conceptual Cost Estimates

Reach	Proposed Project	Conceptual Cost Estimate
	Utilities	
32	Three 8-inch Sanitary Sewers Protection	\$111,000
33	16-inch Waterline Protection	\$37,000
34	24-inch Sanitary Sewer Protection	\$37,000
34	6-inch Waterline Protection	\$37,000

Table 6-12. Utilities Proposed Project Conceptual Cost Estimates

Reach	Proposed Project	Conceptual Cost Estimate
	Water Quality	
31	Mariano Exchange Ditch Water Quality - Study & Development of Detailed Plans to Improve Water Quality	\$300,000
37	Denver Avenue Outfall Repairs and BMP	\$368,000

Table 6-13. Water Quality Proposed Project Conceptual Cost Estimates

Reach	Proposed Project	Conceptual Cost Estimate
29		\$23,000
30		\$26,000
31		\$16,000
32		\$19,000
33	Routine Annual Maintenance and Debris Removal (Public and Private)	\$24,000
34		\$17,000
35		\$14,000
36		\$20,000
37		\$34,000
38		\$10,000

Table 6-14. Maintenance Proposed Project Conceptual Cost Estimates

	Category & Cost											
Reach	Flood Hazard Reduction	Gravel Pits ²	Aquatic Habitat	Geomorphology ²	Natural Area/ Open Space	Parks & Recreation	Trails	Land Use	Utilities	Water Quality	Maintenance ⁴	Total
29	\$1,660,000		retrofit - not included i	Big Barnes diversion dam n overall cost estimate since vate dam	\$100,000	\$745,000	\$1,083,000				\$23,000	\$3,590,000
30	\$350,000¹	3	3	3	\$100,000	\$489,000	\$368,000	\$174,000			\$26,000	\$1,483,000
31	1	3	3	3		\$43,000	\$368,000	\$14,000		\$300,000	\$16,000	\$725,000
32				\$1,430,000	\$161,000	\$162,000	\$84,000		\$111,000		\$19,000	\$2,473,000
33	1	\$2,450,000				\$133,000	\$123,000		\$37,000		\$24,000	\$2,743,000
34	\$16,900,000			\$945,000		\$4,792,000	\$267,000		\$74,000		\$17,000	\$22,970,000
35	\$3,230,000	\$675,000		\$945,000	\$24,000	\$933,000	\$811,000				\$14,000	\$6,620,000
36		\$1,575,000		\$790,000	\$100,000	\$578,000	\$734,000				\$20,000	\$3,800,000
37		\$2,625,000		\$2,363,000	\$136,000	\$35,000	\$1,493,000			\$368,000	\$34,000	\$6,660,000
38	1	\$1,050,000		\$473,000			\$210,000				\$10,000	\$2,790,000
Totals	\$21,790,000	\$8,375,000	3	\$6,946,000	\$621,000	\$7,910,000	\$5,541,000	\$190,000	\$220,000	\$670,000	\$203,000	\$52,824,000

Table 6-15. Conceptual Costs by Reach and Category

Maintenance costs were estimated based on the total length of the river in each reach. A unit cost for routine maintenance of \$4/linear foot was applied. This cost was initially based on unit costs for maintenance used in typical UDFCD master planning studies but was adjusted upward for the Big Thompson River due to the fact that maintenance has been deferred for many years. Because the City can only access the river via publicly-owned river frontage, the City bears only a portion of the costs of maintaining the overall river corridor.

¹ Costs for road crossing improvements for Namaqua, Wilson and Railroad are not included because these projects are already funded; costs for future Boyd Lake Avenue bridge and conveyance improvements not included since funding for this will be from Transportation.

² Gravel pit and geomorphology improvements for reaches 35 - 38 involve public and private lands. More detailed planning should identify stakeholders and potential cost sharing opportunities.

³ BTWC working on improvements for Rossum to Wilson reach.

⁴ Maintenance cost estimates are for entire length of river through each reach, including public and private land. Maintenance costs are not included in total since they are estimated average annual costs.

6.2 PRIORITIZATION OF PROJECTS

The purpose of this section is to provide guidance for the implementation of the proposed improvements to the Big Thompson River corridor. The prioritization and phasing of the proposed projects is dependent upon a number of factors, including but not limited to:

- The availability of funding,
- Rate and areas of future development,
- Community desires or needs, and
- Land use changes.

Due to the current budgeting constraints faced by the City, the availability of funding is the limiting factor for the implementation of this Master Plan. Therefore, this Master Plan has not provided detailed prioritization of the proposed projects along the Big Thompson River Corridor. Instead, the top five action items and/or projects have been identified as the highest priorities in order to provide a catalyst for future proposed projects that can be implemented when funding becomes available. For other projects, this Master Plan is dynamic and provides the City of Loveland and Larimer County the flexibility to design and install projects based on available funding, applicable grants, upcoming adjacent development, and land use changes. To aid in prioritization of other projects, each project proposed has been assigned a Near-, Mid- or Long-term timescale for implementation. In general, Near-term projects are those recommended in the next 5 years; Mid-term projects have a horizon of 5 - 15 years; Long-term projects are expected to occur on the timescale of 15 to 30 years in the future. The following sections summarize the highest priority action items and/or projects identified in this Master Plan for implementation by the City of Loveland. The highest priority projects are all Near-term priorities and should be implemented as soon as funding is available. Mid-term and Long-term projects, as well as additional Near-term priority.

6.2.1 Priority #1 - Maintenance of River Corridor

Chapter 7 is dedicated to recommendations for the Big Thompson River Corridor management and maintenance and much more detailed information is provided. However, because there is no formal management and maintenance program for the Big Thompson River, portions of the river have been neglected which cause potential hazards and reduce the conveyance capacity of the Big Thompson River through the City. The highest priority from this Master Plan is to conduct maintenance along the river corridor. Maintaining the existing infrastructure and resources, in many cases, will increase the capacity of the Big Thompson River without the expense of capital improvement projects. The following summarizes some of the recommended high priority maintenance activities that should be conducted along the Big Thompson River (see Chapter 7 for additional information):

- Sediment and vegetation removal at bridge crossings, particularly the Taft Avenue bridge where the north bridge cell is blocked with sediment and vegetation.
- Removal of large woody material and other debris within the Big Thompson River that has the potential to become lodged at downstream bridge crossings during large flood events.
- Repair of eroding banks and bank stabilization at isolated areas along the Big Thompson River.
- Annual post-runoff inspections and post-flood inspections to identify areas in need of debris removal, bank stabilization, sediment removal or other maintenance activities.

As discussed in Chapter 7, an estimated incremental increase in annual maintenance expenditures on the order of \$100,000 per year would have a significant positive impact on the Big Thompson River corridor and its conveyance of flows through the City and reduce the City's liability. This annual maintenance cost is minimal compared to the estimated costs defined in Section 6.1 for the proposed projects identified in this Master Plan. To efficiently plan and execute maintenance activities, developing a detailed maintenance and management plan for the river is recommended. This plan would begin by itemizing reach-by-reach maintenance needs and cost projections and would include a map showing specific areas for maintenance activities (e.g. snags to remove, minor bank repair areas, bridge maintenance, etc.)

6.2.2 Priority #2 - River Corridor Coordinator

Because neither the City of Loveland nor Larimer County has a formal management and maintenance program for the Big Thompson River, responsibilities for the river corridor are shared between multiple City departments such as Parks and Recreation, Open Lands, and Public Works. However, none of these departments have funding dedicated to the maintenance of the actual river itself. Therefore, as discussed in further detail in Chapter 7, the Master Plan recommends that the City establish a new full-time position for a River Corridor Coordinator. This position would have many responsibilities but ultimately would coordinate between departments and programs in the City that have overlapping responsibilities for the river corridor to maximize the effectiveness of their combined efforts and to seek funding opportunities to conduct additional maintenance activities and implements recommendations from the Master Plan along the Big Thompson River Corridor. A River Corridor Coordinator would be an investment by the City that will pay dividends in terms of obtaining state and federal money to invest in the river corridor and in terms of reduced municipal liability due to improved management and maintenance of the river corridor.

BTWC could potentially perform many of the duties of a River Corridor Coordinator in the Near-term and already has well-established relationships with public and private entities along the river corridor. Until the City is able to establish a staff position for the River Corridor Coordinator, the city could consider contracting with BTWC to perform some or all of the positions functions.

6.2.3 Priority #3 - Lincoln Avenue - US Hwy 287 Improvements

Improving north-south travel capabilities during a major flood event is a high priority for public safety. Because Lincoln Avenue is a federal highway and major north-south route in Larimer County, implementing improvements to allow for safe crossing in a 100-year event is critical. Ayres has already developed plans for these improvements that include: (1) replacement of the existing bridge with a new 240-foot span bridge and raising the roadway south of the bridge by as much as four feet; (2) creating lowered and widened floodplain benches through Fairgrounds Park, with some minor top-of-bank berming; (3) reducing the size of the pond south of the channel and west of US Hwy 287 so that a low floodplain bench can be constructed on the south side of the channel; and (4) construction of a lowered and widened floodplain bench downstream of Hwy 287. The cost of this project is estimated at approximately \$17M, which makes it one of the most expensive projects included in the Master Plan; however, the importance of US Hwy 287 as a north-south major arterial route, the potential to reduce land included in the floodplain and floodway, and the overall improvements in resilience of the area helps justify these costs. The City should continue to pursue potential funding sources including FHWA, CDOT and/or FEMA.

6.2.4 Priority #4 - Wilson Avenue - Elevation of Roadway Approaches to Bridge

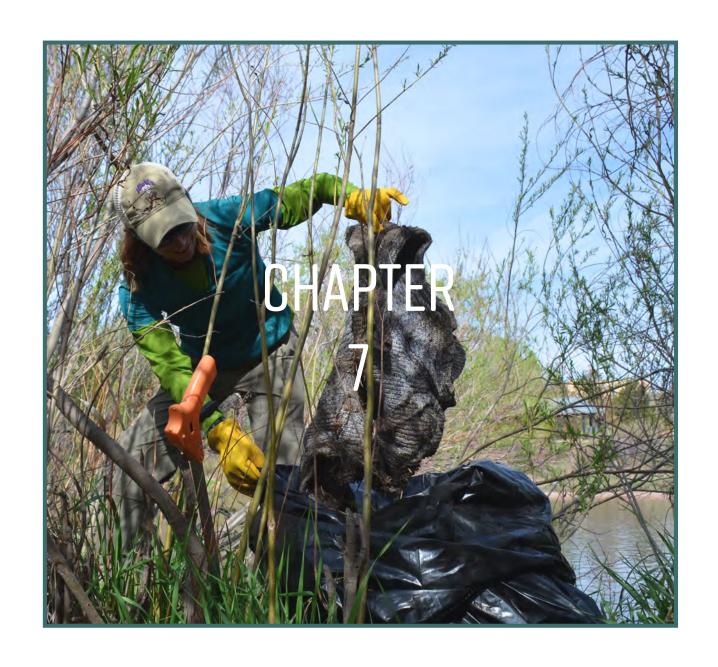
The project to elevate the approaches to the Wilson Avenue Bridge to upgrade crossing capacity before road overtopping to greater than a 100-year event is a high priority. This project is a high priority road crossing project in the Master Plan because it is the most economical way to establish a north south arterial with better than 100-year crossing capacity. During the 2013 flood, Wilson Avenue was the last to overtop and the first to reopen. This project is currently under design and it is anticipated that this project will be constructed in 2018. This project will increase the resilience of Reach 31, the lowest ranked reach in the baseline resilience assessment.

6.2.5 Priority #5 - Mariano Exchange Ditch Water Quality Evaluation

Based on water quality data, observations, and comments from the public, the single greatest water quality issue for the Big Thompson River through Loveland is the poor quality of water from Mariano Exchange Ditch. Where the Mariano Exchange Ditch enters the Big Thompson River upstream of Wilson Avenue, there is a visual spike in turbidity that can be seen at the confluence with the ditch and in the river downstream. Given public desires for greater river access and a healthy urban fishery, addressing the water quality of the Mariano Exchange Ditch return flows is a high priority. Finding a solution will require cooperation between the City, the Ditch and Reservoir Company and the State. Improving the water quality of the Big Thompson River through the City of Loveland would be a major step toward gaining public support for future Master Plan improvements. It will also benefit recreation and public safety for water users. The estimated cost of further study and conceptual design of improvements for reducing sediment discharges from Boedecker Reservoir is approximately \$300,000.

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7.0 CORRIDOR MANAGEMENT & MAINTENANCE RECOMMENDATIONS

Over the course of developing the Master Plan, the project team met with staff from multiple City departments including Public Works, Parks and Recreation, Open Lands, and the City Manager's office and Larimer County to discuss management and maintenance of the Big Thompson River Corridor through the City of Loveland. Based on these meetings, the following insights were gained into current management and maintenance practices for the river:

- 1. Neither the City nor Larimer County has a formal management or maintenance program for the Big Thompson River. Responsibilities for the river corridor are shared between multiple departments in the City including Parks and Recreation, Open Lands, and Public Works.
- 2. Areas in parks are generally well maintained by the Parks and Recreation department; however, maintenance is focused on park features and not on the river. In general, there is very little routine maintenance of the river.
- 3. Open Lands and Natural Areas conduct maintenance of the many natural and open space areas along the creek. This maintenance is mainly focused on mitigating invasive species. The level of this type of maintenance is increasing, and grant funding is available through the CWCB through the Invasive Phreatophyte Control Program (IPCP). This maintenance and management is mostly focused on the natural area adjacent to the river channel and are less focused on the river channel itself.
- 4. The Public Works department has a road and bridge maintenance program that addresses the crossings of the river that are maintained by the City. This maintenance is typically focused on the road surface and/or bridge structures and does not address the stream beneath the bridge or upstream or downstream conditions. If scour develops, it is generally addressed on a case-by-case basis if it presents a risk to the bridge. The City budget for bridge maintenance is approximately \$250,000 annually.
- 5. The County maintains some of the road crossings. In general, there is little coordination between the City and the County on the river corridor; however, the level of interaction/coordination is increasing. For example, the City and the County now coordinate on floodplain permits. As a part of the County bridge maintenance program, some maintenance of the channel is performed at road crossings, including removing accumulated debris and repairing erosion as needed.
- 6. In general, between road crossings, there is very little maintenance or monitoring of the river by either the City or the County. Many portions along the corridor are accessible via bike/pedestrian paths, but there are some reaches, mainly on the upper and lower ends of the 9-mile study reach, where the river is not easily accessible.

One of the greatest challenges in developing an effective management and maintenance program for the Big Thompson River Corridor is the availability of funding. Based on meetings with multiple City departments, the following information related to funding was identified:

- 1. As noted above, the City currently has funding for maintaining parks and for the bridge maintenance program. There is also funding for invasive species removal.
- 2. The City is expecting to have some discussion on stormwater utility rates in the not-too-distant future. Stormwater fees vary on land use and size. Residential rates are modest in comparison with comparable communities in Colorado. Stormwater utility fees generate about \$6M annually based on 2017 figures, but this revenue applies only to the stormwater collection and conveyance system (Municipal Separate Storm Sewer System [MS4]) and not the river corridor. An increase in rates could potentially be used to help fund a river corridor management and maintenance program, but



The City already performs many maintenance activities along the Big Thompson Rover Corridor. Parks, natural areas, picnic shelters, trails, restroom facilities, etc. are generally well maintained throughout the corridor. Despite the extensive maintenance of parks, natural areas, and road crossings, there is very little maintenance of the river channel itself that passes through these parks, natural areas, and bridges.

there would need to be good public and political support, and some modifications to how the fees are allocated.

- 3. Larimer County has a tax dedicated to purchasing and maintaining open lands. The County shares some of this funding with the City. The City has acquired substantial amounts of land along the river corridor, but it does not appear much of this funding has been applied to maintenance.
- 4. The City has a Capital Expansion Fee (CEF) for new residential development. This money is earmarked for acquisition of land for parks, recreation and open space. There is a potential that the CEF conditions could be modified to allow for some expenditures for restoration and/or maintenance of the river, since these needs are driven in part by development along the corridor.
- 5. There has been a lot of funding for flood recovery; however, many of these projects have been completed, and funding will soon expire. This is not funding for maintenance, instead it is related to recovery projects following the September 2013 flood. CWCB has some other grant programs including watershed restoration grants that are more likely sources for capital projects than for management and maintenance.

7.I STRATEGIES FOR IMPROVED MANAGEMENT

The two greatest needs for improved management and maintenance of the river corridor are (1) improved coordination between departments and programs in the City that have overlapping responsibilities for the river corridor to maximize the effectiveness of their combined efforts and (2) funding to conduct maintenance activities. Maintenance of the river is a long-term, ongoing need. While it may not be feasible to implement a comprehensive maintenance program immediately, beginning with maintenance activities that are feasible given currently available resources and then building the program incrementally as additional funding can be obtained through City or outside



Bridge and channel maintenance to clean out accumulated sediment and vegetation is one of the most cost effective ways to increase conveyance capacity. This will not eliminate the need for additional bridge and culvert capacity and some crossings; however, given constraints on funding, maintenance is a cost effective way to make incremental improvements and reduce municipal liability in a future large flood event.

sources can begin to make progress on this critical need for the river corridor.

To accomplish the first objective, the Master Plan recommends that the City establish a new position for a River Corridor Coordinator. This position is envisioned as a full time employee whose responsibilities would include the following at a minimum:

- 1. Identify and budget for needed river corridor maintenance activities including removal of large woody debris, trash, bank repair, erosion repair, maintenance of stream crossings, and similar activities needed to maintain a stable river channel. Beavers are active along some reaches of the river. In some areas with undeveloped floodplains, beaver dams may not cause adverse flooding effects; however, when beavers build dams in areas with urban development and structures, removal of dams may be needed to avoid increased flood risk.
- 2. Coordinate with different departments including Public Works, Parks and Recreation, Water and Power and others to implement maintenance activities.
- 3. Document all routine and restorative maintenance activities and track expenditures on an annual basis.
- 4. Document needs for additional capital projects.
- 5. Work to identify and apply for grants to fund restorative and routine maintenance and capital projects along the river corridor. Pursuing and managing grants takes a significant amount of time, and the City currently does not have adequate resources or capacity to manage multiple grants on an ongoing basis. This is an important role that the River Corridor Coordinator could fulfill.
- 6. Establish relationships with potential funding agencies including CWCB, CDOT, FHWA, CPW and

- others to obtain assistance with implementation of projects recommended by the Master Plan.
- 7. Work to develop partnerships with non-profits such as BTWC and BTWF and collaborative efforts between different City departments to fund and implement maintenance and capital improvement projects along the river.
- 8. Develop and maintain a public education and outreach program focused on the river to educate the public about the public safety, recreation and ecological benefits of the river corridor to help build public and political support for enhancements called for in the Master Plan.
- 9. Work as a liaison with parties interested in developing within or adjacent to the river corridor to educate them on master planned improvements and to facilitate integration of these improvements into development plans.
- 10. Work closely with Larimer County on maintenance and management issues. Many reaches of the river run through County-zoned land. One management issue identified by Larimer County during the Master Plan process is the disposition of a number of small parcels of County-zoned land that are surrounded by City land. The County would like to see these parcels annexed into the City. This is another task that the River Coordinator could work on to reduce the number of small isolated Countyzoned parcels along the corridor.

Section 404 Wetland Permitting for River Maintenance Activities

One recommendation of this Master Plan is for the City to work with the U.S. Army Corps of Engineers to develop a regional Section 404 permit covering various types of restorative maintenance. This has been a very successful strategy for the Urban Drainage and Flood Control District (UDFCD), which maintains many miles of stream within their jurisdiction.

Ideally such a permit would cover activities along the entire corridor. To accomplish this, UDFCD developed standard details that helped to simplify the process both for permitting and construction. While a regional Section 404 permit for these types of activities requires an investment in coordination and planning up-front, in the long-run, it will save a lot of time and money and simplifies the performance of maintenance and repair activities.

To further maintenance objectives, the Master Plan recommends that the City evaluate grant opportunities and other potential revenue sources to develop a river corridor maintenance and management plan that identifies specific areas that will be maintained, which department or program will perform maintenance, how maintenance activities will be documented and other aspects of managing the corridor.

Until the City can establish a formal River Corridor Coordinator position, the City could partner with the BTWC to have them assist with some of the above responsibilities. BTWC already has many relationships with public and private entities along the corridor and understands the river. The City currently has a "River Team" that is led by the Stormwater Engineering. The River Team could potentially be expanded to include BTWC and the County (if not already included) and also could play an important role in maintenance and management of the river. Given the role of Stormwater Engineering and the current River Team, it seems that the River Corridor Coordinator position could fit within the scope of Stormwater Engineering at the City.

7.2 MAINTENANCE RECOMMENDATIONS

The primary maintenance activities needed along the river include the following:

- Annual inspections of the corridor to identify areas in need of specific routine and restorative maintenance.
- Post-runoff inspections and post-flood inspections to identify areas in need of debris removal, bank stabilization, sediment removal or other maintenance activities.
- Sediment and vegetation removal at bridge crossings to restore flood conveyance capacities. The bridge at Taft Avenue is a good example of a crossing, where clearing sediment and vegetation from the north bridge cell could significantly increase flood conveyance.
- Removal of large woody material and other debris that has the potential to become lodged at downstream bridge crossings, exacerbating flooding problems. Woody debris in the stream channel and the overbank floodplains is desirable from a habitat perspective; however, in an urban area where obstructions to conveyance have the potential to cause greater flood damages, removal of debris is needed. There are currently many places along the river where trees that fell into the channel during the 2013 flood remain. Not only do these "snags" increase the potential for debris damming in future flood events, but they are also a hazard to recreational users of the river. Removal of large-diameter woody material could be conducted during low flow conditions, and some of the woody material could be reused for habitat enhancement if properly anchored.
- Repair of eroding areas along banks. Based on fieldwork conducted in the summer of 2017, the banks of the Big Thompson River are largely stable over most of the study area. There are, however, a number of locations where erosion remains from the 2013 flood and additional repairs are needed.



In some areas where sediment deposits from the flood persist in the river, vegetation is becoming established. As vegetation becomes established, the roots further stabilize and anchor deposited sediments leading to continued aggradation This is especially problematic at bridge crossings of the river where sediment accumulation reduces bridge and culvert capacity.



Some portions of banks through City-owned portions of the river corridor are in need of repair and/or improved stabilization methods. As a part of the Wilson to Taft Flood Recovery Project, material that had been dumped on banks and buried was removed, including numerous old cars and extensive concrete rubble. Similar types of cleanup and bank stabilization measures are needed in other areas.

To truly be effective, these maintenance activities should be implemented on public and private property along the study reaches. The City has the ability to maintain reaches of the river that can be accessed from public property, including a significant portion of the stream length from Wilson Avenue to Hwy 287. Reaches of the river that can be accessed from publicly owned lands are shown in yellow on Figure 7-1. The City should develop a plan to conduct maintenance along publicly owned reaches, incorporating the maintenance practices listed above. Overall, approximately 7 miles of river are accessible from either one or both banks from City-owned parks, natural areas, or open lands. The floodplain along these 7 miles of river is already actively maintained by existing City programs due to land uses including the Mariana Butte Golf Course; parks including Namaqua, Centennial, Fairgrounds, and Barnes Parks, and many natural areas.

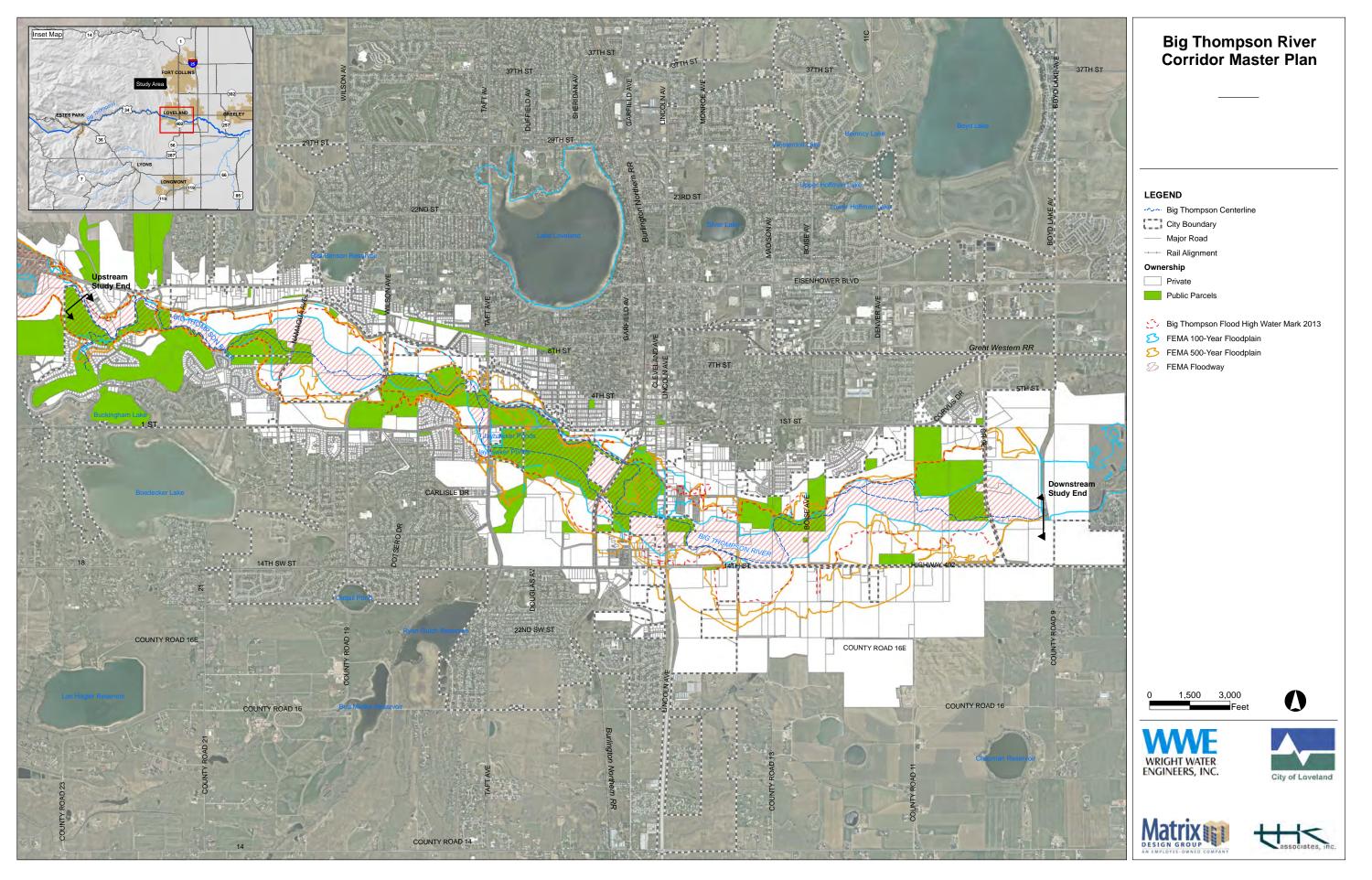


Figure 7-1. Maintenance Access

Table 7-1 lists reaches where river maintenance access is feasible and approximate distances (measured along the stream centerline). In some cases, the City only has maintenance access from one side of the river. In these instances, the City should maintain the floodplain and banks on the side of the river that is publicly owned and attempt to coordinate with private landowners on the opposite side of the river if any pressing maintenance needs are observed on private property. In calculating the stream distance for estimating maintenance costs, there is no differentiation of reaches where the City can maintain only one side of the river. While there may be some modest reductions in cost due to not maintaining the privately owned side of the stream, at this level of planning no adjustment to length or the unit cost is warranted.

Description	Unit Cost¹			
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	\$4			
Approximate Stream Maintenance Distances (measured along stream centerline)	Distance ²	Unit		
Morey, Golf Course & Oxbow Natural Area (access to only one side of river) =	1,000	LF		
Oxbow East and Golf Course (one side only for GC) =	1,000 LF			
Namaqua West and Namaqua Park (one side only for portions) =	4,200 LF			
Wilson to Taft =	4,600 LF			
Taft to RR via Rivers Edge =	7,700 LF			
Taft to RR via Big T =	5,800 LF			
RR to Lincoln - 287 =	4,400 LF			
Kings Crossing =	1,200 LF			
Old St. Louis =	800 LF			
Total Stream Maintenance Distance =	30,700 LF			
Total Estimated Cost =	\$120,000			

Table 7-1 Estimated Annual Maintenance Cost for City-accessible Portions of Big Thompson River through the City of Loveland

'Unit Cost Ref: Boulder Creek Restoration Master Plan, 2015 Icon Engineering for UDFCD, Boulder County, City of Boulder and City of Longmont. The Boulder Creek Plan uses a unit cost of \$2/LF. This is doubled in this table to account for the fact that the river has not been routinely maintained. Ongoing routine maintenance costs of \$2/LF are reasonable estimates for maintenance once a maintenance program is up and running, but for initial maintenance after many years of deferment, higher costs are appropriate.

 2 All distances approximate. Measured along stream centerline using Google Earth "path" tool.

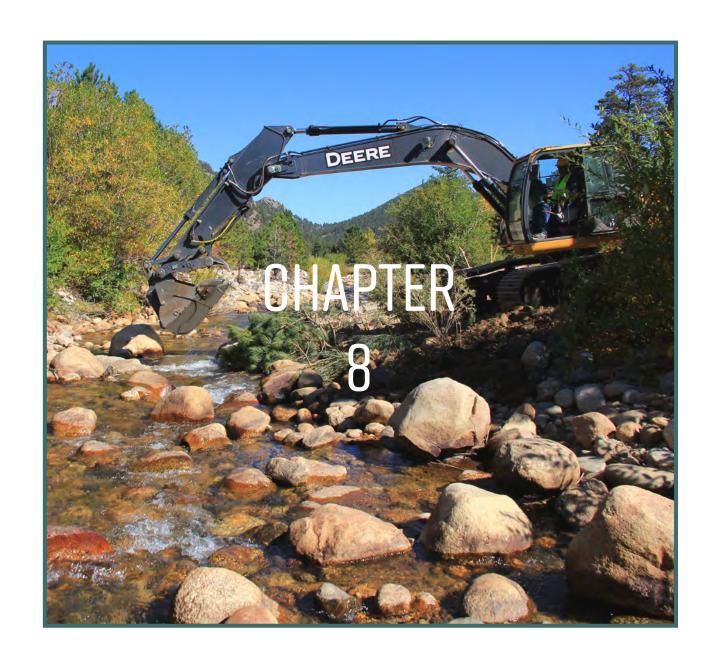
This Master Plan uses an estimated unit cost for river channel maintenance activities including sediment and debris removal, erosion, tree and weed removal, and other routine maintenance activities of \$4 per linear foot of river per year. Applying the unit cost to the total distance calculated in Table 7-1 results in an estimated annual maintenance cost of approximately \$120,000. This represents estimated annual costs in addition to existing maintenance activities along the corridor for parks, the golf course and natural areas. Since the City has not routinely maintained the river channel through the City, the costs of maintenance would likely be higher in the first year, due to the large amount of woody debris that remains. A unit cost of approximately \$2/LF could be used to estimate maintenance costs in the future once the river maintenance and management program is established.

While the City currently does not have a budget line item for river maintenance activities, this is a modest cost in the context of departmental budgets. It is also an extremely important item in terms of municipal liability. There are legal precedents for municipalities being sued for failing to maintain the flood carrying capacity of a waterway. While natural rivers require little to no maintenance, and trees and large woody debris in natural streams provide habitat and other benefits, in urban areas where a river has been channelized and constricted by bridges and other encroachments, maintenance cannot be ignored. Large woody debris in the channel has the potential to become lodged in bridge openings, causing elevated floodwaters upstream. It also can form debris dams in the river during a flood that can cause localized increases in peak flow rates when they breach. Developing a maintenance plan, as recommended above, is the first step in developing a river maintenance program.

The City should evaluate options for funding the River Corridor Coordinator and an annual maintenance program including the CEF or out of the stormwater utility fee. There would likely need to be some changes to the way the CEF and/or stormwater fees are administered for this to occur; however, there is no doubt that development necessitates maintenance of the river and that the MS4 affects the river at numerous outfall locations. As a first step in establishing a maintenance program, the City should evaluate grant funding to develop a maintenance plan and detailed cost estimate for various types of maintenance activities. There may be some locations where restorative maintenance projects could be eligible for grant funding for improving water quality by reducing bank erosion or by improving aquatic habitat.

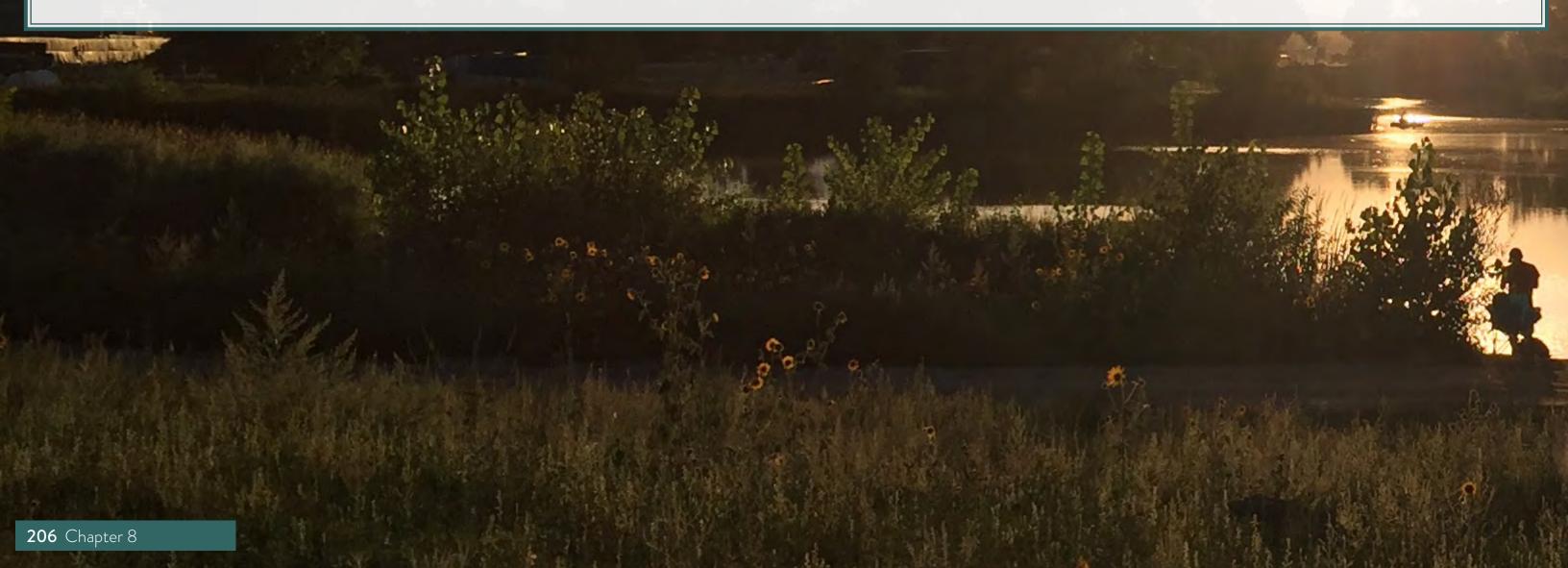
For privately owned reaches, the Master Plan recommends a public outreach campaign to inform property owners of their responsibility to maintain river frontage that they own. Owners of properties along the riverbanks should be identified, and information should be provided to them on types and frequencies of maintenance and repair activities that may be needed and potential adverse consequences of failing to do so. Such a public outreach effort should be coordinated with the County and the BTWC and would fall under the responsibilities of the River Corridor Coordinator position described above.

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8.0 FUNDING & IMPLEMENTATION

This is a comprehensive Master Plan, identifying more than 90 recommended projects in more than ten categories over nine miles of the Big Thompson River. Implementation of these improvements will require cooperation between multiple City departments and programs and Larimer County, investment by the community, and funding from other sources including grants from the federal and state government, public-private partnerships, and innovative financing mechanisms. Future Development should contribute to improvements along the corridor that mitigate impacts resulting from development and provide amenities to new neighborhoods.

Given current budgeting constraints faced by the City, there is no dedicated funding for implementing the recommendations of this Master Plan. There are several ongoing projects that are funded including the County's improvements to the Namaqua Avenue Bridge and removal of the low head dam downstream of the bridge, the BTWC's Rossum to Wilson Flood Recovery Project, and the Railroad Avenue improvements. As described in Chapter 6, the projects identified in the Master Plan are components of a long-term vision for the corridor. Because of current limitations on funding available to implement many of these projects, the Master Plan does not recommend a formal capital improvements program. Instead, the top five projects, based on public input, guidance from the City, and engineering and planning analysis are identified. Implementation of these projects will depend on the ability to obtain funding through the City budgeting process and other forms of support, such as the Community Development Block Grant (CDBG) funding that allowed for development of this Master Plan.

This chapter provides discussion of potential funding sources for improvements. Unlike some Master Plans that identify recommended improvements along with a detailed 5- or 10-year implementation and financing plan, this Master Plan should be viewed as a list of potential improvements that could be implemented in coming decades as funding is available and as projects are needed in response to community needs and future development as well as the behavior of the river during future flood events. Projects are categorized as Near-, Mid- and Long-term for purposes of general planning; however, these are not rigid classifications, and priorities may be adjusted as needs dictate.



In general, maintenance of the Big Thompson River through the City of Loveland is lacking. Several bridges, including the one pictured have aggradation and/or growth of vegetation that is impeding flow through one or more bridge cells. While major bridge projects are proposed at several crossings to increase conveyance capacity, the multimillion dollar price tag means that it may be years before these projects can be implemented. In the meantime, channel maintenance to keep bridge openings free and clear of excessive sediment and debris is the most cost effective way to increase conveyance capacity.

This Master Plan is intended to help to guide future land use decisions along the corridor, including a continued City policy of acquisition of land in the floodway and floodplain when there are willing sellers. As development occurs along the river corridor and as the need for improvements become more imminent due to public safety, protection or critical infrastructure, socioeconomic and political factors, this Master Plan should be consulted as a planning document to guide these future improvements so that they are designed and constructed in a way that is consistent with the long-term vision for the river corridor.

There is no "silver bullet" for funding the improvements recommended in this Master Plan. Implementation of the recommended improvements will require multiple sources of funding from a variety of sources.

8.I POTENTIAL SOURCES OF FUNDING FOR IMPROVEMENTS

While there are currently no dedicated sources of funding for improvements along the Big Thompson River Corridor, there are many potential opportunities for financing improvements ranging from dedicated municipal funding sources to public-private partnerships to grant opportunities. For any of these funding sources to be viable, strong public support is needed for this Master Plan, and multiple departments within the City and the administration must "buy in" to the vision of this Master Plan. This will be a long-term process and will require patience and resolve. By investing in this Master Plan, the City can transform the Big Thompson River from an underutilized resource into a resilient greenway that will provide safe conveyance of major floods while providing multiple recreational and environmental benefits to future generations of Loveland residents.

8.1.1 Potential Dedicated Sources of Municipal Funding

While the City has dedicated funding for a number of maintenance activities along the corridor related to roads and bridges, parks and natural areas, trails, and utilities, there is no dedicated funding source specifically for maintenance of the river, including the channel and overbank floodplains. Similarly, there is no existing fund specifically dedicated to hydraulic, habitat, or geomorphic improvements to the river.

Based on discussions with the City, there are several potential municipal sources of funding for improvements to the river corridor. Finding sources of municipal funding is critical for developing a maintenance program for the river and for implementing projects identified in this Master Plan. To be able to effectively pursue grants for improvements, municipal funding is essential since many grants require cost sharing.

8.1.1.1 Help Preserve Open Space Sales Tax

In 1995, the citizens of Larimer County approved the 1/4-cent Help Preserve Open Space sales tax to protect open space, natural areas, wildlife habitat, regional parks and trails. In 2014, voters overwhelmingly supported the extension of the tax until 2043. Although this is a Larimer County sales tax, a portion of the revenue generated by the sales tax is shared with the City of Loveland. Historically, this tax revenue has been used to acquire open lands and natural areas along the river corridor, which has been an extremely successful program for the City of Loveland, resulting in more than 1,300 acres of publicly owned land, protected from future development, along the river corridor. The extensive open space along the river corridor helps with the City's FEMA Community Rating System (CRS) score, and results in lower flood insurance premiums throughout the City and County.

Given the recommendations in this Master Plan for improved maintenance of the river corridor, the City should evaluate how this funding source is allocated between acquisition of new open lands and maintenance of existing assets. Increasing the focus on maintenance would enhance the river through existing City-owned natural areas, reducing flood hazards and public safety hazards from debris and unstable banks, and increasing the value of these assets to the community.

8.1.1.2 Capital Expansion Fee

In addition to the Larimer County Help Preserve Open Space sales tax, the City has an Open Lands Capital Expansion

Fee (CEF), for the acquisition, development and management of open space in and around Loveland. The CEF is a fee paid by developers to help to fund the infrastructure and governmental facilities and services that arise from new development in Loveland. As the name of the fee suggests, this source of funding is dedicated to capital improvements, and over the past several decades, this fees has helped to fund capital projects for roads, community and cultural services, as well as parks and open space that benefit the community and new development.

The CEF is a potential source of funding for improvements and restorative maintenance along the river corridor, although these funds are currently fully allocated for other purposes and projects. It is unclear whether the current restrictions on how CEF funds are used would allow these funds to be used for restorative maintenance of the corridor; however, the City should explore allocating a portion of funding from the CEF to maintenance activities since additional development along the river corridor increases the need to maintain the stream and floodplain.

Given the nature of project proposed along the river corridor, especially improvements planned to the east of Hwy 287, that will provide recreational and environmental benefits to future development, the CEF should be considered as a source of funding for some of the improvements identified in the Master Plan related to the impacts of new development on the river corridor.

8.1.1.3 Stormwater Utility Fee

A third potential source of dedicated funding that could aid in implementation of maintenance activities and capital projects along the river corridor is the City's stormwater utility fee. The City's stormwater utility is set up so that all residents of Loveland benefit equally from the services provided by the stormwater utility fee. Fee categories are divided into residential, commercial, industrial, and institutional properties. All fees collected are placed into one fund; the majority of the fund is utilized for capital improvement projects throughout the City, the balance is used to cover operation, maintenance and administration of the utility. Table 8-1 summarizes current fees as of 2017.

Type of Development	Monthly Fee
Residential:	
less than 4,000 sq. ft.	\$6.65
4000-5999 sq. ft.	\$8.30
6000-7999 sq. ft.	\$11.98
8000-9999 sq. ft.	\$14.99
10,000 sq. ft and over	\$16.64
Institutional (per acre)	\$35.78
Commercial (per acre)	\$90.86
Industrial (per acre)	\$75.98

Table 8-1 City of Loveland Stormwater Utility Fees

The stormwater utility fee funds maintenance and capital projects within the City's MS4, which includes the stormwater conveyances within the City, such as curbs, gutters, storm drains, water quality and detention ponds, stormwater outfalls, but not the Big Thompson River itself. There is precedence in Colorado for local governments using stormwater utility fees to fund major drainageway improvements such as many of the conveyance and geomorphic improvements recommended for the Big Thompson River. Because the current stormwater utility fee is dedicated to funding improvements within the MS4, the level of funding currently provided by the stormwater utility fees is fully allocated to existing MS4 needs. Using the stormwater utility fees to fund projects recommended in this Master Plan would require City Council approval to use funds for such purposes and potentially an increase in the



Stormwater utility fees are used to fund maintenance and capital projects within the City's MS4. The MS4 includes the curbs, gutters, inlets, storm drains and channels that convey stormwater runoff to the Big Thompson River, but not the river itself. Therefore, stormwater utility fees could be used for maintenance and repair of the stormwater outfall shown in the photo but not to clean out accumulated sediment and vegetation to the bridge cell shown to the left of the outfall. The City should investigate the potential to include some maintenance activities for the river within activities that can be funded using the stormwater utility fee such as removal of debris, sediment, trash, etc. immediately downstream of outfalls.

8.1.2 New Development

The CEF discussed above is one way that new development in and around the corridor can help to fund the improvements recommended in this Master Plan, and the stormwater utility fees from new impervious area are another source or revenue. In addition, the City has the ability to work with developers to achieve some of the objectives of the Master Plan through the development review and approval process. City floodplain and floodway regulations prevent or discourage development in hazardous areas, resulting in open space in the floodplain adjacent to developments that can either be acquired by the City from willing sellers or dedicated to the City as a part of subdivision platting.

When development or redevelopment projects are proposed along the river corridor, the City should carefully review the proposed development plans relative to this Master Plan to ensure consistency with Master Plan objectives. If there are elements of the Master Plan that are proposed on property that is being developed such as trails, stream buffers or bank stabilization, the City should negotiate with the developer to try to implement Master Plan recommendations as a part of the development to the extent feasible.

8.1.3 Grant Opportunities

The City of Loveland may be able to leverage a variety of grants or funding partners to support stream channel and

recreation improvements. Suggestions include:

Great Outdoors Colorado (GOCO): Multiple grants are available, including:

Local Park and Outdoor Recreation (LPOR) grants (up to \$350,000 per project) and mini grants (up to \$45,000 per project costing \$60,000 or less) fund new park development, enhancing existing park facilities, parkland acquisition and environmental education facilities. Applicants must provide at least 25% of the total project cost in matching funds, at least 10% of which must be a cash match.

Habitat Restoration grants are available for projects that improve and restore Colorado's rivers, streams, wetlands, and critical habitat. The program offers \$500,000 in available funding each grant cycle.

GOCO's Connect Initiative will invest \$30 million over the next five years to increase access to the outdoors in communities across the state. The grant will focus on connecting existing trail gaps, constructing new, highly demanded trail systems, and providing better walkable and bikeable access for youth and families to existing outdoor recreation opportunities. The maximum Connect Initiative grant request is \$2 million, with a minimum match of 25% of the total project cost, of which a minimum of 10% must be cash. It should be noted that GOCO grants are highly competitive.

Colorado Water Conservation Board (CWCB): Senate Bill 16-174, passed by the 2016 Colorado General Assembly, establishes funding for Watershed Restoration, which includes projects and plans designed to protect or restore watershed health and stream function. This may include projects and plans designed to stabilize perennial, ephemeral, and intermittent stream channels, provide habitat for aquatic and terrestrial species, re-vegetate riparian areas, reduce erosion in upland and riverine environments, improve recreational opportunities, provide fish passage, and improve channel/floodplain connectivity. CWCB funds from the Colorado Watershed Restoration Program shall not exceed 50% of the total cost of the individual plan or project.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS): The NRCS offers voluntary



The pedestrian bridge across the Big Thompson River upstream, of Wilson Avenue was replaced following the 2013 flood as a part of the Wilson to Taft Flood Recovery Project. This project for restoration of approximately 4,400 feet of the river included trail reconstruction, repair of erosion, and creation of floodplain benches in addition to the bridge replacement. This work was partially funded by FEMA grants in combination with City contributions.

programs to eligible landowners and agricultural producers to provide financial and technical assistance to help manage natural resources in a sustainable manner. Through these programs, the agency approves contracts to provide financial assistance to help plan and implement conservation practices that address natural resource concerns or opportunities to help save energy, improve soil, water, plant, air, animal and related resources on agricultural lands and non-industrial private forest land. Eligibility requirements for NRCS grants should be evaluated on a case-by-case basis since they primarily target agricultural producers.

Section 319 Grants through Colorado Department of Public Health and Environment: The Nonpoint Source Program (NPS Program) of the Colorado Department of Public Health and Environment, Water Quality Control Division (CDPHE, WQCD) funds nonpoint source projects to help achieve its two overarching objectives of restoring and protecting waterbodies from nonpoint source pollution impacts. Non-federal matching funds equal to at least 40% of the total project cost are required. The match can be cash and/or in-kind. Because 319 grants are federal funds, there can be year-to-year uncertainty regarding the amount and timing of available funds.

Colorado Parks and Wildlife: Colorado Parks and Wildlife has several grant programs ranging from Fishing is Fun to Habitat Partnership Programs. Other grant programs include the Non-Motorized Trails Grant Program, Outdoor Classroom Grants and Wetlands partnerships. All of these grant programs would be applicable to many of the projects recommended in this Master Plan.

Other sources of grants may include private foundations such as the Gates Family Foundation and organizations such as the Trust for Public Lands. There are also potential additional funding sources within the City including the City Council Special Project Reserve, the General Fund, the Tabor Excess Fund, the Trails CEF and the Streets Fund.

8.1.4 Public-Private Partnerships

A number of improvements recommended in this Master Plan are partially or fully on private property. These recommendations cannot be implemented without the cooperation and consent of landowners and have only been



The Rist-Goss diversion dam upstream of Namaqua Avenue is one of a half dozen along the Big Thompson River Corridor through Loveland. Funding through the Colorado Department of Local Affairs (CDBG-DR funds) is allowing the BTWC to evaluate options for improving fish passage and recreational safety at this location. Diversion dams such as this present opportunities for public-private partnerships to provide for fish passage and reduce hydraulic hazards and liability as the owners of the diversion dams implement repairs to dams in the future.

identified at a highly conceptual level in this plan. Many of these improvements are related to gravel pit embankment stability and the design and construction of spillways between the river and gravel pits and between adjoining gravel pits. Implementation of these improvements would provide benefits to the private landowners who own and operate the gravel pits and public safety benefits due to elimination of uncontrolled overtopping and reduction in the potential hazards of breaches of gravel pit embankments.

To the extent that new gravel mining activities are initiated or existing operations are modified, permitting through the Colorado Division of Reclamation Mining and Safety (DRMS) may require implementation of some of these improvements. In many cases, however, there are no regulatory drivers for requiring upgrades to embankment stability and/or spillways. The BTWC's Rossum to Wilson Flood Recovery Project is a good example of a non-profit organization obtaining grant funding and working with private property owners on design and implementation of these types of improvements, and this can serve as a model for improvements along other reaches through the City and east into Larimer County.

In addition to gravel pit improvements that will require cooperation between the City and private landowners for funding and implementation of improvements, the many diversion dams along the river are also opportunities for public private partnerships. Based on field reconnaissance in the summer of 2017, many of the diversion dams are in poor condition and will require significant repairs or replacement in the timeframe of 10 to 20 years, if not sooner. Many of these diversions are effected by debris and sediment in large flood events, and maintenance and hydraulic improvements along the river have the potential to help address some of these issues. For diversion dams upstream of the Greeley-Loveland Canal, retrofit for fish and boater passage is recommended. If this is done in conjunction with other repairs or improvements to diversion dams, there would be an opportunity for the City, ditch companies, and non-profits such as BTWC to work together to implement mutually beneficial improvements.

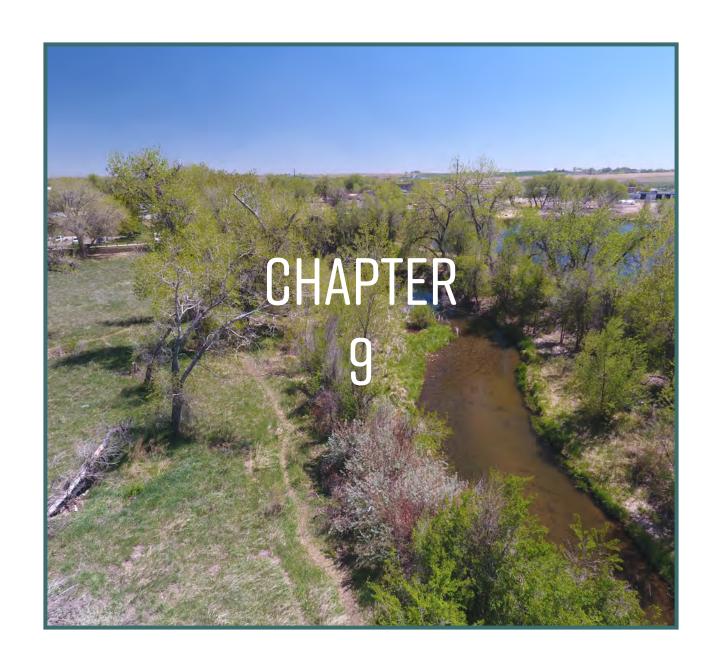
Another potential opportunity for a public-private partnership exists for the proposed Big Thompson River Gateway between the downtown, the Foundry redevelopment, and the river corridor. The concept for the Gateway includes streetscape improvements to Railroad Avenue between the downtown and the former wastewater treatment plant that is located immediately north of Fairgrounds Park and redevelopment of the City-owned wastewater treatment plant property. This concept has the potential to provide retail and/or restaurant opportunities along the revitalized street corridor and at the wastewater treatment plant site. This is an economic development opportunity in a blighted section of the City that could be eligible for federal grant funding and/or joint public-private investment.

Public-private partnerships should also be considered for maintenance of the river corridor since many sections of the river corridor are privately owned. In these areas, the City does not have access to the river to perform maintenance including debris removal, bank stabilization, and other maintenance and repair activities that are needed for a stable and resilient river corridor. As discussed in Chapter 7, the first step in improving maintenance of these privately-owned reaches is informing the property owners of maintenance responsibilities and potential liabilities that may arise from neglecting to perform maintenance that is needed. By encouraging stewardship of the river corridor, some degree of improved maintenance may occur on privately owned reaches; however, for more significant maintenance and repair activities involving heavy equipment, engineering design, and more expense, some public involvement will likely be needed. In these cases, the City should consider negotiating with landowners so that some public benefit in the form of an easement for a trail or improved access to the river could be exchanged for assistance with implementation of major maintenance or repair activities. Examples of these types of exchanges are provided by the UDFCD South Platte River Program in Adams County, where UDFCD assisted gravel pit owners with design, permitting and implementation of improvements to embankment stability in exchange for easements for maintenance and recreational access.

8.2 NEAR-TERM FUNDING STRATEGIES

The ongoing work by the BTWC on the Rossum to Wilson Flood Recovery Project is an excellent example of grant-funded improvements along the river corridor. BTWC obtained approximately \$5M in funding through the CWCB to implement aquatic habitat and stream stability improvements. Throughout the State of Colorado, communities have successfully obtained grant funding from sources identified above for improvements to aquatic habitat, stream stability, parks and open space, control of invasive species, and others. For transportation projects such as the Hwy 287 conveyance improvements, the City should explore ways to obtain partial or full funding from the Colorado Department of Transportation (CDOT) and/or the Federal Highway Administration (FHWA).

While federal and state cost sharing and grants present good opportunities for near-term funding, obtaining funding from these sources requires an investment by the City in terms of the time and effort required to prepare grant applications. Chapter 7 recommends that the City establish the position of a River Corridor Coordinator to oversee and facilitate management and maintenance of the Big Thompson River corridor and other major drainageways within the City. In addition to responsibilities for river corridor management and maintenance, the River Corridor Coordinator would also be responsible for identifying and pursuing funding opportunities to implement projects identified in the Master Plan. This Master Plan provides a strong foundation for preparing grant applications and for explaining the vision for the corridor with potential public and private partners. Between responsibilities for management, maintenance, grant applications and fostering partnerships, the River Corridor Coordinator would be a full time position. Although the costs to the City for a River Corridor Coordinator would be those of a full time employee plus costs to support the position's endeavors, this should be viewed as an investment by the City that will pay dividends in terms of obtaining state and federal money to invest in the river corridor and in terms of reduced municipal liability due to improved management and maintenance.



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