Sharktooth Bluffs Basin Storm Drainage Master Plan
September 2019

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September 4, 2019

Mr. Andrew Fisher, P.E., CFM
City of Greeley
Stormwater Division Project Manager
1001 9th Avenue
Greeley, CO 80631

RE: Sharktooth Bluffs Basin Storm Drainage Master Plan

Dear Mr. Fisher:

ICON Engineering, Inc. is pleased to submit the Final Conceptual Design Report for the Sharktooth Bluffs Storm Drainage Master Plan. This submittal includes revisions to the report based on comments received on the DRAFT Conceptual Design Report.

We believe this report will provide a solid framework to assist in prioritizing storm drainage improvements to ease flooding concerns and guide development in the watershed.

Once again, we would like to acknowledge the City's assistance in the preparation of this study. This report could not have been prepared without input from yourself, and other staff members at the City of Greeley.

We appreciate the opportunity to prepare this report and look forward to working with you on future projects.

Sincerely,

ICON ENGINEERING, Inc.

Craig D. Jacobson, P.E., CFM
Principal, Project Manager

Jaclyn Y. Michaelsen, P.E., CFM
Project Engineer

Jeremy K. Deischer, P.E.
Project Engineer

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ES EXECUTIVE SUMMARY

ES 1.0 PURPOSE AND OBJECTIVE

The purpose of this study is to develop a storm drainage master plan to be used by the City of Greeley as a guideline for future storm drainage infrastructure within the Sharktooth Bluffs Basin. This study developed design flows, analyzed the existing storm drainage systems, identified problem areas, developed alternatives to mitigate flooding hazards, and provides a preliminary design for future improvements.

ES 2.0 PLANNING PROCESS

The planning process began by reviewing previous studies within the basin and holding a kickoff meeting with City staff to discuss project goals and objectives. Aside from site specific development reports, most of the basin had not been studied previously. Eastern portions of the basin had previously been included in the 2006 Sheep Draw Comprehensive Drainage Plan. The original Sheep Draw Basin boundary can be seen on Figure ES.1.

Several progress meetings were held throughout the duration of the project. Meeting minutes for each progress meeting can be found in Appendix A. On February 13th, 2019 a public meeting was held at the Greeley Family FunPlex to gather community input regarding the baseline hydrology, problem areas, and initial alternatives developed to mitigate flooding hazards throughout the basin.

The team members who were involved within this study are listed in the table below:

Table ES 1: Project Participants

Participant	Representing	Title
Andrew Fisher, P.E., CFM	City of Greeley	Stormwater Capital Projects Engineer
Joel Hemesath	City of Greeley	Public Works Director
Craig Jacobson, P.E., CFM	ICON Engineering, Inc.	Project Manager
Jaclyn Michaelsen, P.E., CFM	ICON Engineering, Inc.	Project Engineer
Jeremy Deischer, P.E.	ICON Engineering, Inc.	Project Engineer
Monica Ramirez, EI	ICON Engineering, Inc.	Project Engineer

ES 3.0 PROJECT AREA DESCRIPTION

The Sharktooth Bluffs Basin, named after fossilized shark teeth found in the area, has a rich history dating back to World War II. The basin was home to a 320 acre World War II Prisoner of War Camp that housed Germans and Austrians from 1944 – 1946. Several years later, in 1961, one of four Atlas E nuclear missile silos constructed in Weld County was built in the basin. The missile site was deactivated in 1965, but still serves as an amenity to the basin, providing tours of the site and is home to a campground. Sharktooth Ski Area, referred to as the world's smallest ski resort, was in operation from 1971-1986. During the construction of the ski area, the fossilized shark teeth, in which the area was named after, were found.

Located within the City of Greeley, Town of Windsor, and unincorporated Weld County, the Sharktooth Bluffs Basin covers an area of approximately 7.8 square miles. Previously known as West Poudre Basin, Sharktooth Bluffs Basin generally slopes from the southwest near 10th Street to the northeast where stormwater runoff discharges into the Cache La Poudre River. The basin is generally bounded by US Highway 257 to the west, the Cache La Poudre to the north, N 71st Avenue to the east and 10th Street to the south. Of the total basin area, 3.7 square miles are currently within the City of Greeley, with 6.8 square miles located in the City's Long Range Growth boundary.

The current study area encompasses the West Poudre Basin and areas previously studied as part of the *Comprehensive Drainage Plan for Sheep Draw Basin* in 2006. Four watersheds, Wiedeman Creek, Poudre River Ranch, Fairway Tributary, and Northridge Draw, located in the eastern portion of Sharktooth Bluffs are not directly tributary to Sheep Draw and were incorporated into the Sharktooth Bluffs Basin.

Currently the basin is approximately ten percent built-out with various residential developments in addition to notable landmarks; Missile Site Park, Sharktooth Bluff, Boomerang Links Golf Course, Northridge High School, and Winograd K-8 School. Some commercial properties exist along the eastern edge of the watershed south of Canberra Commons.

Sharktooth Bluffs Basin is made up of numerous drainageways which outfall into the Cache La Poudre River. These drainageways include; Spur Draw, Hertzke Draw, Orr Gulch, Sharktooth Draw, Poudre Learning Center Tributary, Wiedeman Creek, Fairway Tributary, and Northridge Draw.

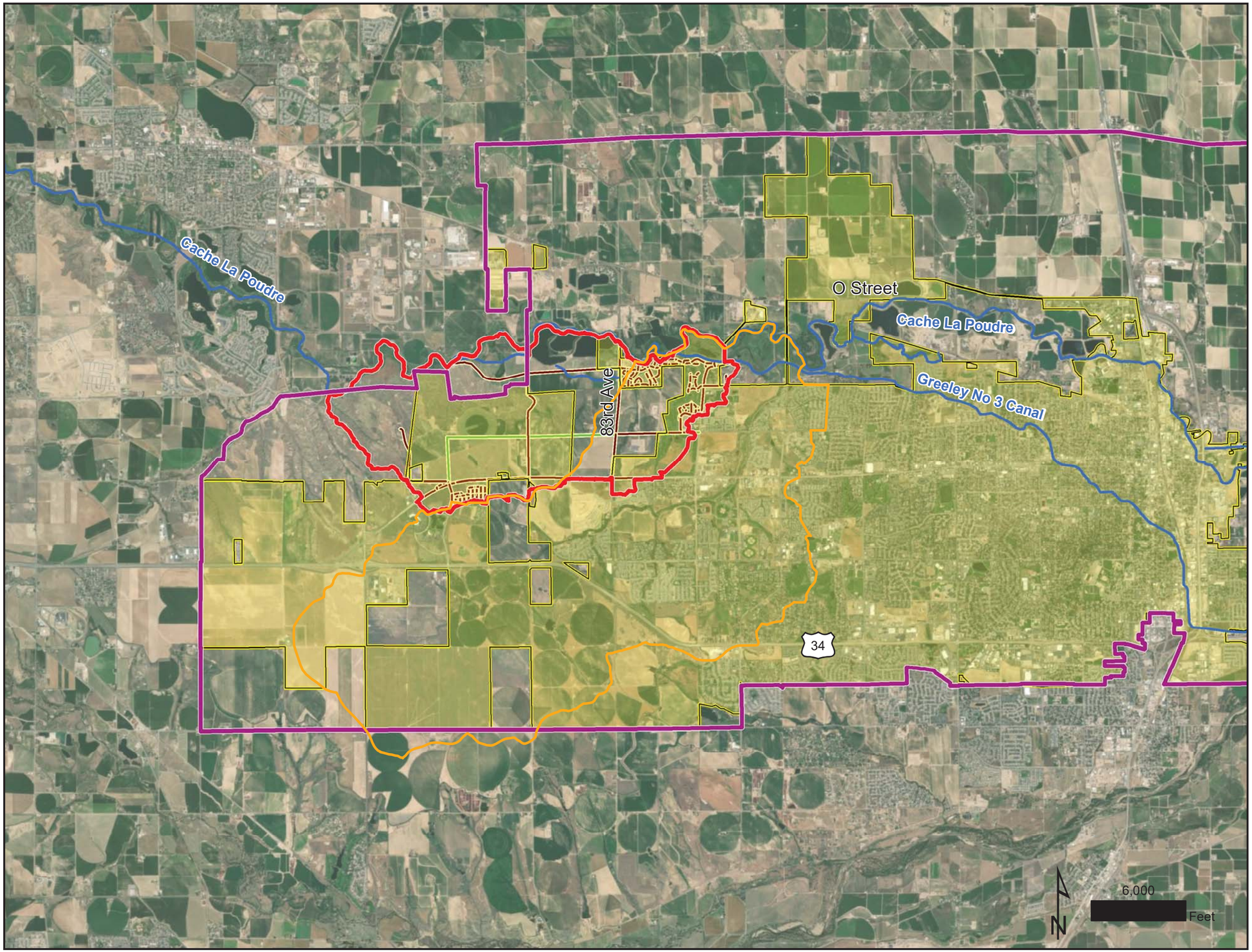
Two irrigation canals are found within the watershed. The Greeley No. 3 Canal, a 13-mile long canal conveying flow east through downtown Greeley, originates in the eastern portion of the basin. The William R. Jones Ditch conveys flow from the Cache La Poudre River just east of the bluffs to Siebring Reservoir. Siebring Reservoir, a series of ponds located between N 95th Avenue and N 83rd Avenue, is a raw water storage facility owned by Central Colorado Water Conservancy District. On the eastern edge of Siebring Reservoir is the Poudre Learning Center, a 65 acre area donated to the local community after the gravel mining operations ceased.

Bisecting the watershed are water transmission lines from the Bellevue Water Treatment Plant.

In the next twenty years, Greeley's population is expected to grow by up to fifty percent, per Greeley's *2035 Comprehensive Transportation Plan*. Much of this growth will push development west of the downtown area, into the Sharktooth Bluffs Basin. Roadway improvements to 83rd Avenue and 4th Street are planned in the *2035 Comprehensive Transportation Plan* to accommodate the increase in population, connecting Windsor, Greeley, Milliken and Platteville. Much of the area is currently located within unincorporated Weld County but lies within the City of Greeley Long Term Growth Area.

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure ES.1 - Vicinity Map



- Sheep Draw Basin
- Long Range Expected Growth Boundary
- Sharktooth Bluffs Boundary
- City of Greeley Boundary
- Existing Roads
- Future Roads

City of Greeley Colorado

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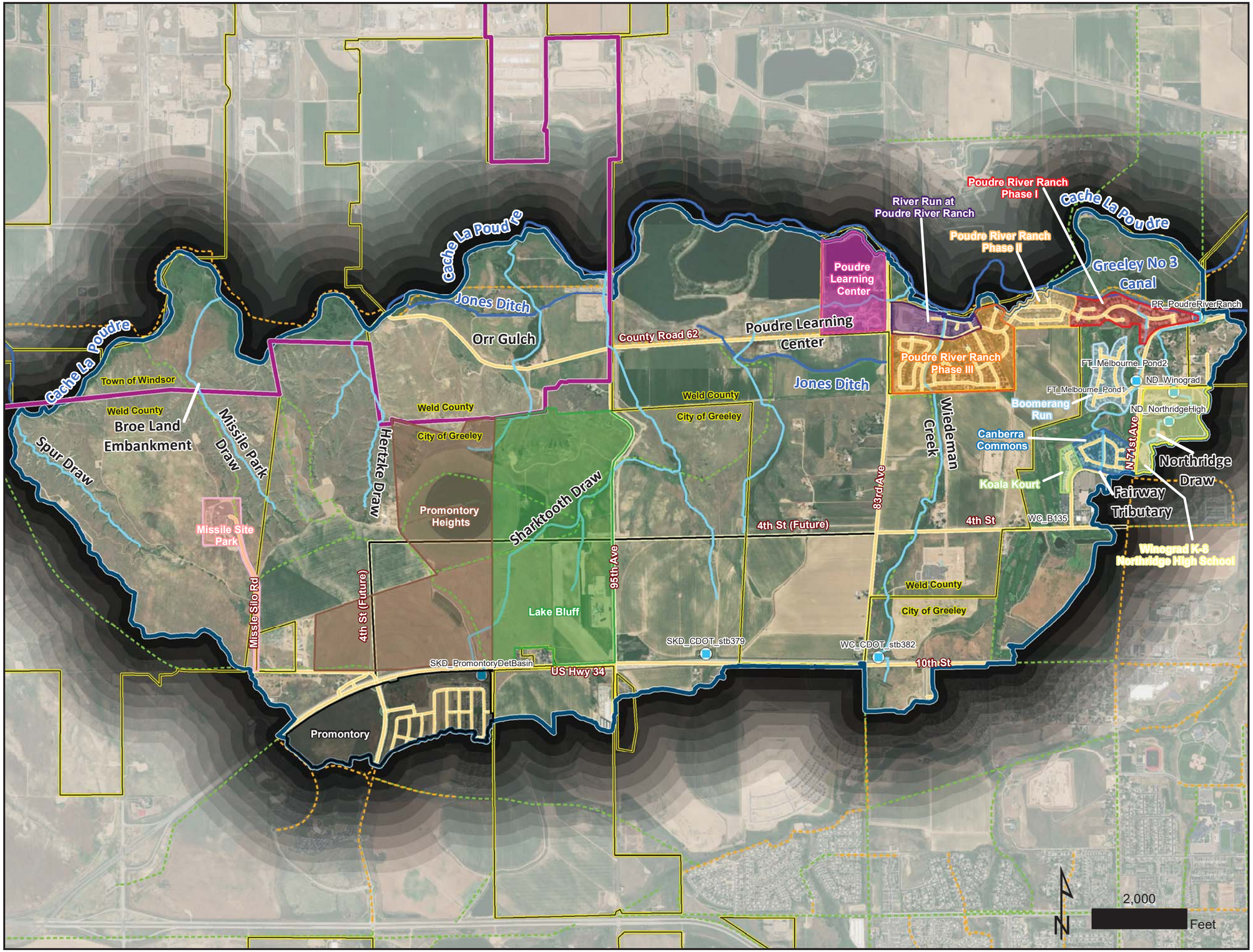
Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure ES.2 - Study Area Map



Neighborhoods

- Boomerang Run
- Canberra Commons
- Koala Kourt
- Lake Bluff
- Missile Site Park
- Poudre Learning Center
- Poudre River Ranch Phase I
- Poudre River Ranch Phase II
- Poudre River Ranch Phase III
- Promontory
- Promontory Heights
- River Run at Poudre River Ranch
- Winograd K-8 Northridge High School
- Existing Detention Basin
- Drainageway
- Long Range Expected Growth Boundary
- Basin Boundary
- Jurisdictional Boundary
- Existing Trails
- Future Trails

City of Greeley Colorado

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ES 3.1 PROJECT AREA HYDROLOGY

A new hydrologic model was prepared for the Sharktooth Bluffs Basin. The model establishes hydrology for the 2-, 5-, 10-, 50-, and 100-year storm frequencies for both existing and future land use conditions. The Colorado Urban Hydrograph Procedure 2005 version 2.0.0 (CUHP) was used to develop runoff hydrographs for each subwatershed. Subwatershed hydrographs were then routed using the EPA Stormwater Management Model version 5.1.012 (SWMM) to determine discharges at each design point.

FLO-2D, a two-dimensional hydrodynamic model, was used to develop diversion curves for two separate areas where flow splits were observed to occur.

During the existing conditions evaluations, agricultural irrigation was accounted for by adjusting soil infiltration parameters within the hydrologic model.

City of Greeley stormwater criteria requires any future development to detain to historic 5-year discharges. To evaluate the impact development will have on design flows, a future conditions hydrologic model was developed to simulate the change in land use and estimate the required detention.

ES 3.2 PROJECT AREA HYDRAULICS

No previous hydraulic analysis had been completed for the watershed. Site specific drainage reports existed independently for each development. For this study, flooding hazards were identified using hydraulic models for the 10-, and 100-year events. Areas of high hazard, representing flood hazards more likely to affect the safety of people and property was also identified for the basin by routing the baseline hydrology through the drainages using FLO-2D. Hydraulic analysis in this study was also completed to evaluate roadway crossings and existing storm drainage systems to determine whether they met current City drainage criteria.

ES 4.0 ALTERNATIVE ANALYSIS

Alternatives were developed to improve the conveyance of roadway crossings, mitigate existing flooding hazards observed in the hydraulic analysis, and separate stormwater runoff from entering the irrigation canals.

For each roadway crossing, alternatives were developed to increase the conveyance of the crossing to meet current City criteria, allowing overtopping during the 100-year event. An additional alternative to convey the entire 100-year discharge without any overtopping was also developed. Flood control and flood hazard mitigation alternatives were also developed to best manage the major split flows occurring, or to alleviate flooding on homes and buildings through drainageway improvements, storm drain systems, or detention.

Finally, guidance regarding the future management of the stream and riparian corridors has also been provided such that natural function of the stream corridors can continue to thrive as development becomes more prevalent in the basin.

ES 5.0 MASTER PLAN

The Selected Plan identifies the alternatives selected by the project team to include in the Conceptual Design phase of the project. The Selected Plan generally follows the recommended plan alternatives, with the modification to the proposed improvements in Sharktooth Draw. A memo, dated June 11, 2019, summarizes new alternatives for the basin and explains why the previously proposed alternatives were revised. This memo can be found in Appendix A. In summary, a detention pond and storm drain outfall are now being proposed near 95th Avenue and County Road 62, in lieu of extensive channel improvements to the outfall to the Cache La Poudre River. An additional alternative was developed at the Bellevue Pipeline crossing of Sharktooth Draw to provide further protection against future stream erosion.

The master plan improvements are intended to mitigate existing flooding hazards, ensure current and future roadway crossings are compliant with City criteria, to address any channel stability issues and concerns, separate base flows from irrigation ditches, enhance water quality, and provide general guidance for preservation and improvement to the drainageways throughout the Sharktooth Bluffs Basin. Finally, the master plan improvements identify and incorporate trail connections to the regional networks, where applicable.

Culverts were sized for existing conditions land use scenario. Prior to construction and final design, any development that has occurred upstream of the roadway crossing should be added into the existing conditions model to update the design discharge.

Cost estimates can be found in Table ES 4. A schematic of the master plan improvements can be found in Figure ES.4 and Figure ES.5.

ES 5.1 SPUR DRAW

Spur Draw, the western most watershed in the Sharktooth Basin, is located just east of US Highway 257. Stormwater runoff from the basin sheet flows to the Sharktooth Bluffs where the narrow gullies convey water northwest to the Cache La Poudre River. All flow is confined to the bluff areas. The watershed is currently undeveloped and future land use projects the watershed to remain open space. No roadway crossings, or other infrastructure is currently proposed in the watershed. Beyond monitoring runoff and potential sediment transport from the bluffs areas, no improvements are currently proposed for this watershed.

ES 5.2 MISSILE PARK DRAW

This 275 acre watershed is bounded by Spur Draw to the west, Hertzke Draw to the east, Sharktooth Draw to the south and Cache La Poudre River to the north. The watershed spans three jurisdictions: Town of Windsor at the downstream end of the watershed, unincorporated Weld County, and the City of Greeley. Similar to Spur Draw, stormwater runoff is conveyed in narrow gullies which converge into a drainageway that bisects the watershed. Near the downstream end of the watershed, in the Town of Windsor and Weld County, there is an approximately 10-foot high embankment which detains flows from continuing north to the Cache La Poudre River. No records were found regarding this being a regulated detention basin or registered state dam.

With exception to ponding that could occur behind this embankment, no other significant drainage problems were identified for this watershed, particularly within the limits of the City of Greeley. Beyond monitoring runoff and potential sediment transport from the bluffs areas, and monitoring the effects of the embankment for water collection, repair, or need to breach, no improvements are currently proposed for this watershed.

ES 5.3 HERTZKE DRAW

Hertzke Draw, located to the east of Missile Park Draw and west of Sharktooth Draw watersheds, primarily consists of steep gullies conveying stormwater runoff to the north. Upstream of the outfall into the Cache La Poudre River, the watershed transitions from the confined gully drainageway to an alluvial fan. The watershed lies within Town of Windsor, unincorporated Weld County, and City of Greeley. The bluffs in the southeastern portion of the watershed, within the City of Greeley, lie on property proposed to be developed as part of the Promontory Heights Development.

Flooding potential within the watershed is minimal with more flooding potential located in the alluvial zones near the Poudre River. No buildings or structures are shown to be inundated and flooding potential will be lessened with future development in the watershed. Beyond monitoring runoff and potential sediment transport from the bluffs areas, no improvements are currently proposed for this watershed.

ES 5.4 ORR GULCH

Orr Gulch is bounded by Hertzke Draw to the west and Sharktooth Draw to the south and east. The northern portion of the watershed falls within unincorporated Weld County, while the southern portion is located within the City of Greeley. The portion within the City of Greeley is proposed to remain open space as part of the proposed Lake Bluff Development. The narrow bluff gullies collect stormwater runoff in the headwater of the basin before the flow is spread into an alluvial fan south of County Road 62. North of County Road 62, the William R. Jones Ditch bisects the lower watershed, conveying irrigation flows from the Cache La Poudre River to Siebring Reservoir.

Flooding problems within the watershed are primarily related to ponding south of the William R. Jones Ditch, where flow depths approach 3-feet in what appears to be a historic oxbow from the Cache La Poudre River and potential overtopping of County Road 62. Since this area is located outside of the City of Greeley with no current plans for expansion of this roadway system, no alternatives were evaluated in this watershed.

ES 5.5 SHARKTOOTH DRAW

Sharktooth Draw extends from south of 10th Street to the Cache La Poudre River. The watershed lies within the City of Greeley and unincorporated Weld County. The headwaters of Sharktooth Draw begin south of 10th Street, east of Promontory Circle near the State Farm property. Stormwater runoff then continues in a northeast direction to the river.

Flooding within the watershed is generally confined near 10th Street, then transitions between overland and confined flow through 95th Avenue when entering the bluffs region. Downstream, flood flows again become unconfined when Sharktooth Draw splits to the north and the east, in an alluvial pattern, near County Road 62, where nearly half of the 100-year discharge diverts to the Poudre Learning Center watershed.

Problems areas within the watershed focus around overtopping of existing roadway crossings, including: 95th Avenue, both north of 10th Street and closer to the Poudre River near County Road 62; and County Road 62, which currently has no defined drainage system and is located within Greeley's anticipated expansion area. These areas experience overtopping in both the 10- and 100-year events. In addition to the roadway crossings, the split flow near 95th Avenue and County Road 62 has the potential to impact roadway improvements and future development during the larger storm events (above the 10-year level). Finally, the future expansion of 4th Street will require planning as it crosses drainages within the Sharktooh Draw watershed. Currently, the proposed 4th Street alignment is proposed to cross three local drainages.

ES 5.5.1 SHARKTOOTH DRAW – FUTURE 4TH STREET CROSSING WEST

The western most future 4th Street crossing is located approximately 1600 ft. west of 95th Avenue. A 10 ft. wide by 4.5 ft. high RCBC is proposed to convey the 10-year design discharge, while limiting overtopping during the 100-year design storm to a depth less than 6 inches.

ES 5.5.2 SHARKTOOTH DRAW – FUTURE 4TH STREET CROSSING CENTRAL

The central future 4th Street crossing is located approximately 700 ft. west of 95th Avenue. A 48-inch RCP is proposed to convey flow underneath the road and limit overtopping in accordance with City criteria.

ES 5.5.3 SHARKTOOTH DRAW – FUTURE 4TH STREET CROSSING EAST

The third of the 4th Street future crossings of Sharktooth Draw is located approximately 2,000 ft. east of 95th Avenue. A 48-inch RCP is proposed such that the future crossing meets City overtopping criteria.

ES 5.5.4 SHARKTOOTH DRAW – 95TH AVENUE CULVERT CROSSING

Approximately 4,200 ft. north of 10th Street, Sharktooth Draw crosses 95th Street. The existing crossing is undersized to convey flow within City criteria. Flow overtops the roadway to the north of the current culvert crossing, with one to two feet of flooding inundating the roadway during the 100-year event.

Proposed improvements at 95th Street to meet City criteria include a dual cell 8 ft. wide by 4.5 ft. high RCBC. Although the roadway will still overtop during the existing conditions 100-year event, overtopping depths are limited to within City criteria.

ES 5.5.5 SHARKTOOTH DRAW – BELLEVUE PIPELINE STABILITY

Three water mains from the Bellevue Water Treatment Plant cross Sharktooth Bluffs downstream of 95th Avenue. Runoff within the drainageway has the potential to erode the channel, exposing the water mains. Cutoff walls are proposed upstream and downstream of the crossing location to stabilize the drainageway at this location.

Prior to installation, further investigation into the actual depths of the pipelines should be done to further confirm the risk and stabilization needs at this location. Depths are unknown at this time.

ES 5.5.6 SHARKTOOTH DRAW – COUNTY ROAD 62

As part of the alternatives review process, the Central Colorado Water Conservancy District (CCWCD), the owners of Siebring Reservoir, were engaged to discuss the possibility of discharging stormwater into the reservoir. After discussions with CCWCD, concerns regarding costs to manage the system and water rights of any stormwater discharged in the reservoir determined that the outfall as proposed in one of the alternatives was not feasible. The alternate alignment proposed, channel downstream of County Road 62 parallel to 95th Avenue, was also determined to be infeasible due to the recent development of a gas extraction site spanning west from 95th Avenue.

A supplemental alternative analysis developed four additional alternatives for this area. After discussion with City staff, the chosen improvements in this location include: a regional detention basin to manage existing runoff to the area; a drainage channel paralleling 95th Avenue; and a 38 inch by 60 inch horizontal elliptical reinforced concrete pipe (HERCP) storm drain system in 95th Avenue, downstream of County Road 62 to the Cache La Poudre River.

The detention basin as proposed will provide a multi-objective function for the local natural area in Sharktooth Draw, providing flood management, but also improving the ecological function, wildlife habitat, and public access within the site. Future trails currently proposed along Sharktooth could be incorporated into the facility located through the bottom and along the top of the facility. The detention facility area would also help promote wildlife through preservation of native vegetation and habitat areas, as well as be designed to provide regional water quality benefits. Natural hydrologic function could continue to exit by conveying bankfull, base, flows undetained through the pond area, up to the capacity of the proposed downstream infrastructure and acceptable roadway overtopping. Pond landscaping could include seeding with drought-tolerant native seed mixes, infrequent or no-mow areas. Any needed mowing practices could occur outside of ground-nesting bird seasons in the spring.

The proposed detention basin layout for the conceptual design is such that it does not exceed the requirements of a jurisdictional dam in the State of Colorado. However, given the changing dam safety requirements, it is still recommended that the City consult the State for current guidance prior to purchasing land or designing the detention facility.

Similar to other improvements mentioned above, the pond has been sized for existing conditions discharges to reduce overtopping at 95th Avenue and County Road 62 to meet City Criteria, as if no changes in hydrology occur upstream. Prior to implementation, the pond site should be reevaluated to determine if upstream development has reduced flows and volume into the pond. The downstream channel and pipe system at 95th Avenue and County Road 62 has been sized for future discharges as if all proposed development is in place. Once development is in place, the pond may be significantly reduced, or not needed altogether. This scenario would be indicative of Alternative D, as presented in the supplemental alternatives analysis found in Appendix A. Regardless of the proposed detention facility, all developments in the Sharktooth Draw Basin are to adhere to current City of Greeley detention standards, detaining to the 5-yr historic discharge.

Similarly, it should be noted that under existing conditions, these alternatives, as proposed, will still result in overtopping of County Road 62, following the existing flow path, north to the Cache La Poudre River. As the basin develops further, this overtopping will eventually be eliminated.

ES 5.6 POUDRE LEARNING CENTER

The Poudre Learning Center watershed extends from the Cache La Poudre River south to 10th Street, between N 83rd Avenue to the east and N 95th Avenue to the west. Flow in the upper portion of the watershed primarily consists of sheet flow down into the bluffs. The stormwater runoff spreads from the confined flow in the bluffs into an alluvial fan south of County Road 62. Flow crosses the William R. Jones Ditch and County Road 62 into Siebring Reservoir. An outlet channel from the most eastern portion of Siebring Reservoir conveys flow east to 83rd Avenue before the outfall location into the Cache La Poudre River.

Future development near the Poudre Learning Center Basin is zoned to occur in the areas where potential flooding is shown in the models. For these future developments to be protected, careful consideration should be taken in site layout and future storm drainage infrastructure.

An out-building is potentially inundated from flooding, north of the Jones Ditch near the westernmost sump location. Even after improvements are made to the western spill flows in the Sharktooth Draw basin, this building may remain in a potential inundation area due to its proximity with the canal. No other buildings are identified to be inundated during the existing conditions 100-year event; however, it should be noted that an oil and gas well site does exist within the headwaters channel of the draw, near the future 4th Street alignment.

Discharges at the future 4th Street alignment remain less than 100-cfs at this location; therefore, improvement alternatives were not developed within the Poudre Learning Center watershed for the roadway system.

ES 5.6.1 POUDRE LEARNING CENTER – COUNTY ROAD 62 (WEST) CROSSING

The westernmost crossing of the Poudre Learning Center is located approximately 3,000 ft. east of 95th Avenue. Dual 10 ft. wide by 4 ft. high RCBCs are proposed to limit overtopping to City criteria. The culvert is proposed to be installed in a sump condition discharging towards the quarry area located in the center of the western flow path.

ES 5.6.2 POUDRE LEARNING CENTER – COUNTY ROAD 62 (CENTRAL) CROSSING

The central crossing of Poudre Learning Center at County Road 62 is located approximately 2,300 ft. west of North 83rd Avenue. A 36 inch RCP culvert is proposed to provide adequate conveyance underneath the roadway and Poudre River trail for the localized sump. The proposed culvert will discharge into the swale in the Poudre Learning Center property.

ES 5.6.3 POUDRE LEARNING CENTER – COUNTY ROAD 62 (EAST) CROSSING

The easternmost crossing of County Road 62 is located approximately 150 ft. west of North 83rd Avenue. A 6 ft. wide by 4 ft. tall RCBC is proposed to convey flow through the roadway crossing, limiting overtopping to City criteria. Downstream of the culvert, channel grading is proposed to convey the flow to the main stem of the Poudre Learning Center channel just west of 83rd Avenue.

ES 5.6.4 POUDRE LEARNING CENTER – NORTH 83RD AVENUE CROSSING

Approximately 650 ft. north of County Road 62, a dual cell 13 foot wide by 6 foot tall RCBC is proposed to convey flow underneath 83rd Avenue to the Cache La Poudre River. 83rd Avenue is a major arterial, requiring 100-year conveyance capacity of the culvert with no overtopping.

ES 5.6.5 POUDRE LEARNING CENTER – WILLIAM R. JONES CANAL BASEFLOW SEPARATION

In the Poudre Learning Center Basin, flow crosses an old remnant of the William R. Jones Ditch and County Road 62 into Siebring Reservoir. The Jones Ditch downstream of Siebring Reservoir is no longer used for irrigation purposes. During storm events, the Jones Ditch has the potential to intercept runoff from flow exiting the Poudre Learning Center main draw, and from backwater behind County Road 62. Formalizing a spill location just upstream of 83rd Avenue is proposed to help mitigate flooding hazards on downstream property created from uncontrolled spill flows.

ES 5.7 WIEDEMAN CREEK

The Wiedeman Creek watershed extends from the Cache La Poudre River south beyond 10th Street. The watershed lies within the City of Greeley and unincorporated Weld County. Runoff generally drains from south of 10th Street, north to the Cache La Poudre River. Poudre River Ranch Phase III and the River Run at Poudre River Ranch Phases I and II developments are present within this watershed. Two main drainage patterns convey flow through Poudre River Ranch. Street flooding along Poudre River Road and North 81st Avenue pose flooding hazards with flooding depths exceeding City maximum flow depth criteria. Additional flood hazards were identified south of the 4th Street roadway crossing, east of Wiedeman Creek in a localized sump area.

ES 5.7.1 WIEDEMAN CREEK – 4TH STREET CROSSING

Wiedeman Creek crosses 4th Street approximately 900 ft. east of 83rd Avenue. A proposed 6 ft. wide by 4 ft. high RCBC will convey flows such that overtopping during the 100-year event is within City overtopping criteria.

ES 5.7.2 WIEDEMAN CREEK – 81ST AVENUE

Primary problems within the Wiedeman Creek watershed focus on drainage within the Poudre River Ranch Phase III development. Infrastructure within the development is undersized for existing conditions design flows. As flow enters the development, the undersized 7 ft. wide by 4 ft. tall RCBC leads to flow overtopping Skyview Street in excess of City criteria. Downstream of Skyview Street, the drainage system continues in an open channel parallel 81st Avenue before the system is intercepted in a 5 foot wide by 4 foot tall RCBC. Flows in excess of the storm drain system spill onto 81st Avenue, resulting in flood depths exceeding City criteria. Two homes are inundated west of the 5 foot by 4 foot box culvert entrance where flow spills onto 81st Avenue.

Upstream of the development, a 22.7 Ac-ft. regional detention basin is proposed to mitigate the flooding hazards. A 72 inch RCP is proposed as the outlet structure to the facility, limiting the peak release such that the downstream infrastructure meets City criteria at Skyview Street and 81st Avenue.

Construction of a detention basin could provide the City can opportunity to work with the surrounding land owners to minimize costs of the pond while maximizing the potential benefit of the pond. Future development in the area could use the detention pond footprint to help minimize the remaining on-site detention requirements, thus promoting a working relationship between the City and development groups.

The proposed detention pond has been designed such that it does not exceed the requirements of a jurisdictional dam in the State of Colorado. However, given the changing dam safety requirements, it is still recommended that the City consult the State for current guidance prior to purchasing land or designing the detention facility.

Prior to implementation of the detention pond, the pond would need to be re-evaluated based upon upstream development and possible reduction in volume. Regardless of the proposed detention facility, all developments in the Wiedeman Creek Basin are to adhere to current City of Greeley detention standards, detaining to the 5-yr historic discharge.

Similarly to in Sharktooth Draw, the proposed detention pond in could provide a multi-objective function for a natural area. A future trail is currently proposed to extend along Wiedeman Creek through the proposed detention basin. The detention facility would also promote wildlife activities by maintaining adequate flows to preserve native vegetation and habitat, as well to improve water quality. It should be noted that the conceptual design cost estimate for the pond assumes minimal facility enhancements since the pond itself may no longer be needed as the upstream property develops.

ES 5.7.3 WIEDEMAN CREEK – 78TH AVENUE

At the upstream end of Poudre River Ranch Phase III at 78th Avenue, offsite flow inundates one structure along the west side of 78th Avenue. A swale is proposed south of the Poudre River Ranch Phase III development to capture flows from the south east to 78th Avenue. A combination of storm drain and surface flow conveyance will carry the flow north, meeting City of Greeley depth criteria without inundating structures.

ES 5.7.4 WIEDEMAN CREEK – AMOUR HILL DRIVE

An existing 30 inch storm drain intercepts stormwater runoff from the agricultural land east of Amour Hill Drive. The shallow unconfined flow from the Wiedeman Family Farm runoff potentially inundates two structures as the stormwater continues west to Amour Hill Drive. The storm drain flow is conveyed west between two residential properties where the flow is discharged into an open channel between N 78th Avenue and Amour Hill Drive. The open channel is conveyed underneath Poudre River Road in a 36-inch storm drain which outfalls in the same open channel as the storm drain in N 78th Avenue. The capacity in the existing storm drain is greatly reduced by the slope of the system.

Improving the slope of the system at Armor Hill Drive will greatly increase the capacity of the system. Relaying the 30 inch storm drain as it crosses Amour Hill Drive will collect the majority of the flow. The flow that is not collected in the proposed system will travel overland through a defined channel to Amour Hill Drive.

The improvements also consist of replacing two inlets on Amour Hill Drive, one manhole and relaying 55ft of 30-inch pipe. Since this project improves the drainage on the existing system, any changes to future hydrology are not anticipated to impact this proposed improvement.

ES 5.8 FAIRWAY TRIBUTARY

The Fairway Tributary Watershed extends from the Greeley No. 3 Canal south past Dundee Court. The watershed lies within the City of Greeley and unincorporated Weld County. Stormwater runoff is conveyed from the south through Boomerang Links Golf Course north to Poudre River Road in the Poudre River Ranch Phase I development. Runoff is ultimately discharged into the Greeley No. 3 Canal.

Flows near the upstream end of the watershed meander through the golf course converging at the corner of C Street and Melbourne Street. Baseline hydrologic modeling does not account for the unformalized and inadvertent detention on the golf course and indicates overtopping of Melbourne Street at a depth less than 6 inches. Overtopping flows not intercepted by the storm drain inlet at the C Street and Melbourne Street intersection continue north along 71st Avenue into the Northridge Draw Watershed.

Runoff from the Wiedeman Family Farm property on the northwest edge of the watershed is conveyed in a northeast direction, crossing Vallevue Drive to the east where flows enter a storm drain crossing Poudre River Road. The storm drain continues north and is flumed in the 36 inch storm drain over the Greeley No. 3 Canal.

ES 5.8.1 FAIRWAY TRIBUTARY – MELBOURNE STREET

The proposed storm drain system improvements at Melbourne Street include intercepting flow from Boomerang Links Golf Course south of Melbourne Street. A proposed 42 inch RCP storm drain will convey the discharge into the existing Northridge Draw channel north of C Street.

The improvement requires removal of a portion of the existing storm drain system, resetting the existing inlet laterals at West C Street and 71st Avenue, and CDOT Type D inlets to collect water from the fairway.

Minor channel improvements to the drainageway will be required upstream and downstream of the storm drain system in order to promote drainage.

The culvert was sized for existing conditions land use scenario. Prior to construction and final design, any development that has occurred upstream of the roadway crossing should be added into the existing conditions model to update the design discharge.

ES 5.8.2 FAIRWAY TRIBUTARY – CACHE COURT CANAL BASEFLOW SEPARATION

To separate stormwater flow from the Greeley No. 3 Canal, a flume is proposed just west of Cache Court. Conveying the flows over the canal and discharging the stormwater into the open space north of the canal will reduce flows in excess of the decreed flow entering the canal that pose flooding hazarding downstream. Improvements to the open space north of the canal include a low flow crossing such that the open space trail is not inundated by nuisance runoff.

ES 5.9 NORTHRIDGE DRAW

On the eastern edge of the basin, Northridge Draw is home to Northridge High School, Winograd K-8, and Northridge Estates. Runoff drains from south to north, passing through the school property to C Street where the existing drainageway continues north onto private property. No formal conveyance is provided north of C Street with flows overtopping 71st Avenue to the north, at a depth less than six inches, into the Foothills Tributary Watershed. At the downstream end of the watershed stormwater runoff is discharged into the Greeley No. 3 Canal.

ES 5.10 NORTHRIDGE DRAW – C STREET AND 71ST AVENUE

The proposed storm drain system proposed in the Fairway Tributary discharges into an existing swale north of C Street. The Winograd detention basin also contributes to the existing swale, conveying flow from south of C Street to the north through the 18 inch RCP outlet. The existing drainage swale is proposed to convey flow north to an existing retention pond. A 42 inch RCP outlet is proposed to intercept any runoff in excess of the normal water pool elevation and discharge to the northwest. A CDOT Type D inlet will intercept flow near 71st Avenue in a 42 inch RCP storm drain system. The culvert will discharge into an existing drainage swale that will convey flow north to 71st Street.

Approximately 5 acres of easement acquisition is proposed. Property acquisition costs were estimated based from a unit cost per acre. Property acquisition may or may not be needed should the City take on management of the drainage swale and retention pond.

At 71st Avenue, a proposed inlet will collect the 100-year flow of 71 cfs and convey it into a proposed 42 inch storm drain system that will discharge into a drainage swale along the south side of 71st Avenue. The swale will be conveyed under 71st Avenue into an existing detention pond in the Poudre River Ranch Phase I development. Slight regrading of the existing detention basin from Poudre River Drive downstream is proposed to encourage better drainage in the area.

A 7 foot wide by 3 foot deep flume is proposed to be installed at the existing spillway elevation of the pond. The flume will convey flows to the north side of the Greeley No. 3 ditch, separating stormwater runoff from the Greeley No. 3 Canal. On the north side of the canal, flow will travel to 71st Avenue where a proposed 24 inch culvert will increase the drainage capacity of the two existing RCP crossing. East of 71st Avenue, the flow is conveyed along the historic drainage path in a wetland channel continuing into the Sheep Draw Basin. The wetland channel, within the 100-year Cache La Poudre River floodplain, outfalls into the Poudre River approximately 200 feet upstream of the main stem of Sheep Draw.

CDOT Type D inlets were estimated as the pond outlet to maintain the existing pool elevation in the pond such that the facility is used for stormwater detention beyond the current storage elevations. The official water right requirements associated with the existing retention pond should be investigated prior to implementation.

ES 5.11 STREAM BUFFER WIDTH

In order to ensure the long-term stability of a stream system, a buffer is recommended to be preserved between the stream and anthropogenic influences. In natural streams, the stream belt width or floodplain width often serves as the buffer. The stream belt width is diagrammatically shown in Figure ES 3. Belt width is the lateral distance from the outside edge of one meander to the outside edge of the next meander. Channel meanders shift through time, generally moving in a downstream direction. By preserving the land within the belt width of a stream, one can allow the channel to continue to evolve and change its planform without coming into conflict with human infrastructure.

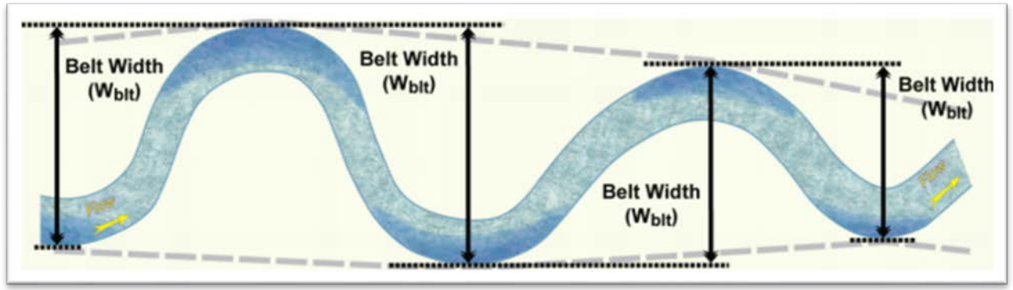


Figure ES 3: Stream Belt Width (Wildland Hydrology, 2013)

Two methods were used to estimate stream belt widths for major drainageways within the Sharktooth Basin. The Stream Belt Width method is an empirical procedure based on a relationship of the meander belt width to channel bankfull width through a power equation. The second method utilizes the ideal stream belt width based on shear stress. If the shear stress applied on a floodplain by flowing water exceeds the carrying capacity of the floodplain vegetation, the vegetation will be destroyed, and subsequent erosion, scour, and channel avulsions could occur. In

order to prevent this, the critical shear stress at which the vegetation will begin to fail was reviewed. The two methods were compared for each scenario for existing and future hydrology with the most conservative values shown in the table below.

Table ES 2: Stream Buffer Width

Drainageway	Channel Buffer Width	
	Ex. Conditions	Fut. Conditions
Sharktooth Draw	186	73
Poudre Learning Center	130 [1]	56
Wiedeman Creek	119	64

1- Value adjusted based on Rosgen classification

As shown by the table, the required belt or floodplain width has the potential to change over time with projected hydrology changes from new development. It is recommended that at a minimum, the existing stream belt widths be preserved within the basin to maintain stream health and maximize drainageway resiliency. Further evaluations may be required as the basin develops over time. The approximate buffer width for both existing and future hydrologic scenarios can be found in Figure 7.4.

As development occurs in each watershed, City detention criteria will reduce peak flows along the drainageways. As such, channel buffer widths may reduce accordingly to the future condition widths shown above. It is recommended that this transition be considered after the upstream watershed has reached approximately 80 percent development density. At this time it is also recommended that a more detailed geomorphic study be completed to best determine the appropriate thresholds for the bankfull channel and floodplain areas within the buffer width. Additional design considerations are discussed below.

ES 5.12 STREAM MANAGEMENT CORRIDOR

Given an adequate floodplain corridor, natural streams adjust to changing hydrologic and sediment supply regimes have well-established, healthy riparian corridors that provide bank stabilization, and have increased resiliency to higher flow rates. A healthy stream corridor is generally comprised of a multi-stage channel, promoting riparian vegetation during smaller flows while providing flood terraces, activating the overbanks to relieve pressure on the system during periodic higher flow events. The multi-stage channel allows for energy to dissipate as flow spreads on the floodplain terraces, naturally transports and deposits sediment, and promotes a healthy biodiversity of vegetation.

As urbanization occurs within a basin, buildings, roadways, and infrastructure often encroach on a stream corridor. Allowable widths and depths of floodplains are often restricted, increasing the velocities and erosive power of flood flows. With development anticipated throughout the Sharktooth Basin in coming years, existing stream corridors should be protected in order to maintain or establish High-Functioning, Low Maintenance (HFLM) stream systems and promote the overall health of the drainageway.

Channel parameters for the stream management corridor were developed using Rosgen stream classifications. Bankfull areas were estimated using regional regression equations developed for the Front Range based on tributary area to each design reach. General geomorphic bankfull channel parameters can be found in Table ES 3.

Guidance for other stream parameters such as pool to pool spacing, entrenchment ratio, meander width, and sinuosity for each reach are summarized in Table 7-22. These values were developed as guidance for planning purposes but further analysis would be required during design. The complete geomorphic analysis for each reach can be found in Appendix D.

Several recent stream restoration projects completed by ICON were used to approximate a stream restoration cost per linear foot of drainageway along the major drainageway corridors in the Sharktooth Basin: Sharktooth Draw, Poudre Learning Center Tributary, and Wiedeman Creek. The unit cost per linear foot reflects: earthwork; installation stream restoration items such as riffle structures, bank protection, riprap, and other stabilization measures; reseeding and native vegetation that might be beneficial. An average cost per linear foot of $750 was used. It is recommended that through a City budget, or property reimbursement fees, the costs presented in Table ES 3 be used to plan for future stream restoration needs which may develop as the hydrology changes overtime.

Table ES 3: Geomorphic Analysis

Watershed	Design Pt	Reach Length (ft.)	Bankfull Channel Approx. Width (ft.)	Bankfull Channel Approx. Depth (ft.)	Cost Estimate
Sharktooth Draw	95th Ave	4050	9.6	0.9	$3,037,500
Sharktooth Draw	Sharktooth Bluffs to CR 62	2660	10.4	1.0	$1,995,000
Poudre Learning Center	CR 62 to Poudre	3900	9.3	0.5	$2,925,000
Poudre Learning Center	DS of Bluffs to CR 62	2140	5.9	0.5	$1,605,000
Wiedeman Creek	4th St. to 81st Ave	2860	9.3	0.8	$2,145,000
Wiedeman Creek	10th St to 4th St	3240	7.3	0.7	$2,430,000

ES 5.13 PRIORITIZATION AND PHASING

In general, drainage improvements should be constructed from downstream to upstream within each watershed, with exception to improvements which may reduce downstream discharges, such as detention basin projects. Proposed improvements were ranked based on: effectiveness in mitigating flood hazards, feasibility of construction, and performance of existing storm drainage infrastructure in the vicinity of each project.

High priority should be given to any project that mitigates flooding hazards and increases public health and safety. This includes the proposed improvements in Wiedeman Creek at 81st Avenue and Amour Hill Drive that removes structures from being inundated during the 100-year design storm and improvements in Northridge Draw which protect structures near the drainageway in Northridge Estates.

Medium priority was assigned to projects where existing flooding hazards were not imminent but proposed improvements provided protection against future flooding hazards. These projects include separating stormwater runoff from the irrigation canals within the basin that were not designed to convey runoff and the improvements along Sharktooth Draw at County Road 62 that provides a drainageway downstream of the bluffs.

Low priority was given to roadway crossing improvements to bring them up to current City criteria. The roadway crossing improvements should be completed in conjunction as planned roadway improvement and expansion occur.

The following projects have phasing impacts that need to be considered prior to final design and construction:

- The County Road 62 (east) roadway crossing in the Poudre Learning Center watershed needs to be constructed prior to, or in conjunction with, the Jones ditch canal baseflow separation.
- The flood mitigation project at Melbourne Street, in the Fairway Tributary watershed, cannot be installed until the flood mitigation projects in the Northridge Draw watershed have been completed.

A benefit cost analysis was completed for the proposed improvements along 81st Avenue. The proposed improvements mitigate $175,656 total expected damages over the project life of 50 years. The project cost estimate including maintenance of $4,996,304 resulted in a benefit to cost ratio of 0.04.

Although the benefit from mitigating flood damages does not solely justify the project, the proposed improvements accomplish several other project goals such as removing overtopping of roadways and flooding depths in streets in excess of City criteria. More information on the benefit cost analysis can be found in Section 7.3 . No other proposed improvements mitigated significant damage on insurable structures warranting a benefit cost analysis.

Prioritization and costs of each improvement can be found in Table ES 4.

Table ES 4: Master Plan Cost Estimate Summary

Watershed	Location	Priority	Capital	Easement / ROW	Engineering	Legal / Admin	Contract Admin / CM	Contingency	Total Capital Cost	Annual O&M	50-year O&M
Sharktooth Draw	Future 4th Street (West) Roadway Crossing	Low	$ 125,408	$ -	$ 18,811	$ 6,270	$ 12,541	$ 31,352	$ 194,382	$ 50	$ 1,571
	Future 4th Street (Central) Roadway Crossing	Low	$ 45,134	$ -	$ 6,770	$ 2,257	$ 4,513	$ 11,284	$ 69,958	$ 50	$ 1,571
	Future 4th Street (East) Roadway Crossing	Low	$ 45,134	$ -	$ 6,770	$ 2,257	$ 4,513	$ 11,284	$ 69,958	$ 50	$ 1,571
	95th Avenue Roadway Crossing	Low	$ 214,015	$ -	$ 32,102	$ 10,701	$ 21,402	$ 53,504	$ 331,724	$ 120	$ 3,771
	County Road 62 Improvements & Upstream Detention Pond	Medium	$ 7,626,086	$ 2,114,000	$ 1,143,913	$ 381,304	$ 762,609	$ 1,906,522	$ 13,934,434	$ 90,019	$ 2,828,722
	Bellevue Pipeline Stabilitization	Medium	$ 79,900	$ -	$ 11,985	$ 3,995	$ 7,990	$ 19,975	$ 123,845	$ 670	$ 21,054
	Total		$ 8,135,677	$ 2,114,000	$ 1,220,351	$ 406,784	$ 813,568	$ 2,033,921	$ 14,724,301	$ 90,959	$ 2,858,260
Poudre Learning Center	County Road 62 (West) Roadway Crossing	Low	$ 311,206	$ -	$ 46,681	$ 15,560	$ 31,121	$ 77,802	$ 482,370	$ 100	$ 3,142
	County Road 62 (Central) Roadway Crossing	Low	$ 38,892	$ -	$ 5,834	$ 1,945	$ 3,889	$ 9,723	$ 60,283	$ 50	$ 1,571
	County Road 62 (East) Roadway Crossing	Low	$ 401,548	$ 96,800	$ 60,232	$ 20,077	$ 40,155	$ 100,387	$ 719,199	$ 2,125	$ 66,775
	83rd Avenue Roadway Crossing	Low	$ 420,038	$ -	$ 63,006	$ 21,002	$ 42,004	$ 105,010	$ 651,060	$ 160	$ 5,028
	Jones Ditch at 83rd Avenue Canal Baseflow Seperation	Medium	$ 100,193	$ 96,800	$ 15,029	$ 5,010	$ 10,019	$ 25,048	$ 252,099	$ 1,034	$ 32,492
	Total		$ 1,271,877	$ 193,600	$ 190,782	$ 63,594	$ 127,188	$ 317,970	$ 2,165,011	$ 3,469	$ 109,008

Watershed	Location	Priority	Capital	Easement / ROW	Engineering	Legal / Admin	Contract Admin / CM	Contingency	Total Capital Cost	Annual O&M	50-year O&M
Wiedeman Creek	4th Street Roadway Crossing	Low	$ 90,415	$ -	$ 13,562	$ 4,521	$ 9,042	$ 22,604	$ 140,144	$ 100	$ 3,142
	Skyview Street	---	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,502	$ 47,198
	81st Avenue Detention Basin	High	$ 1,799,261	$ 998,000	$ 269,889	$ 89,963	$ 179,926	$ 449,815	$ 3,786,854	$ 23,589	$ 1,179,450
	78th Avenue	High	$ 100,152	$ 59,000	$ 15,023	$ 5,008	$ 10,015	$ 25,038	$ 214,236	$ 1,224	$ 61,200
	Amour Hill Drive	High	$ 110,013	$ 22,000	$ 16,502	$ 5,501	$ 11,001	$ 27,503	$ 192,520	$ 1,073	$ 53,650
	Total		$ 2,099,841	$ 1,079,000	$ 314,976	$ 104,993	$ 209,984	$ 524,960	$ 4,333,754	$ 27,488	$ 1,344,640
Poudre River Ranch Phase I and II	Poudre River Road	---	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 818	$ 25,705
	Total		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 818	$ 25,705
Fairway Tributary	Cache Court Canal Baseflow Seperation	Medium	$ 86,021	$ -	$ 12,903	$ 4,301	$ 8,602	$ 21,505	$ 133,332	$ 434	$ 13,638
	Melbourne Street	High	$ 93,050	$ 8,800	$ 13,958	$ 4,653	$ 9,305	$ 23,263	$ 153,029	$ 301	$ 9,459
	Detention North of Melbourne Street	---	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 702	$ 22,059
	Total		$ 179,071	$ 8,800	$ 26,861	$ 8,954	$ 17,907	$ 44,768	$ 286,361	$ 1,437	$ 45,156
Northridge Draw	C Street and 71st Avenue	High	$ 942,378	$ 470,000	$ 141,357	$ 47,119	$ 94,238	$ 235,595	$ 1,930,687	$ 4,739	$ 148,916
	Total		$ 942,378	$ 470,000	$ 141,357	$ 47,119	$ 94,238	$ 235,595	$ 1,930,687	$ 4,739	$ 148,916

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure ES.4 - Master Plan Schematic - Sharktooth Draw and Poudre Learning Center

Downstream of Country Road 62
Proposed Improvements:
Channel Improvements
38" x 60" HERCP

83rd Avenue
Proposed Improvement:
(2) 13 ft. x 6 ft. RCBC

County Road 62 (West)
Proposed Improvement:
(2) 10 ft. x 4 ft. RCBC

County Road 62 (East)
Proposed Improvement:
6 ft. x 4 ft. RCBC
Channel Improvements

Roadway Crossing
County Road 62
Proposed Improvement:
88 Ac-ft. Detention
Downstream Channel

County Road 62 (Central)
Proposed Improvement:
36 in. RCP

95th Avenue
Proposed Improvement:
(2) 8 ft. x 4.5 ft. RCBC

Jones Ditch at 83rd Avenue
Proposed Improvement:
Spillway and Channel Improvements

Bellvue Watermain Crossing
Proposed Improvements:
Stability Improvements

4th Street (West)
Proposed Improvement:
10 ft. x 4.5 ft. RCBC

4th Street (Central)
Proposed Improvement:
48 in. RCP

4th Street (East)
Proposed Improvement:
48 in. RCP

Cache La Poudre
Jones Ditch
County Road 62
Poudre Learning Center
Weld County
City of Greeley
Hertzke Draw
Missile Park Draw
Sharktooth Bluffs
4th St (Future)
Spur Draw
Wiedeman Creek
N 95th Ave
N 81st Ave
83rd Ave
95th Ave
Missle Silo Rd
State Hwy 257 Spur
US Hwy 34 Bus
12th St
103rd Avenue Ct
103rd Ave
102nd Ave
101st Ave
10th St
11th St

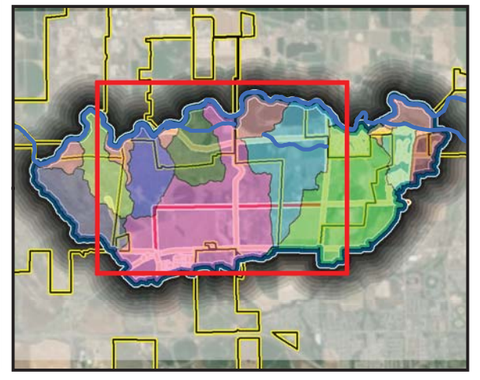
N

1,200 Feet

- Detention Basin
- Canal Crossing Improvement
- Roadway Crossing Improvement
- Proposed Grading
- Channel Improvement
- Storm Drain Improvements
- Drainageway
- Jurisdictional Boundary
- Existing Trails
- Future Trails

City of Greeley Colorado

ICON ENGINEERING, INC.



Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure ES.5 - Master Plan Schematic - Wiedeman Creek, Fairway Tributary, and Northridge Draw

Cache Court
Proposed Improvement:
Greeley No. 3 Canal Flume

71st Avenue
Proposed Improvement:
24 in. RCP

Poudre River Ranch Phase I
Proposed Improvement:
Easement Acquistion
Greeley No. 3 Canal Flume

71st Avenue
Proposed Improvement:
(2) 6 ft. x 2 ft. RCBC

C Street
Proposed Improvement:
Drainage Easement
Formalize Retention
Drainage Channel

Melbourne Street
Proposed Improvement:
42 in. RCP

Amour Hill Dr
Proposed Improvement:
30 in. RCP

81st Avenue
Proposed Improvement:
Detention 22 Ac-ft.

78th Avenue
Proposed Improvement:
Channel Improvements

Roadway Crossing
4th Street Crossing
Proposed Improvement:
6 ft. x 4 ft. RCBC

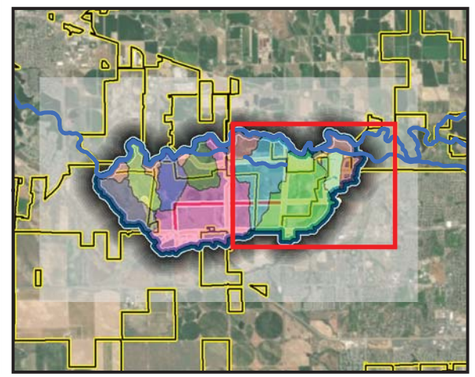
Cache La Poudre
Greeley No. 3 Ditch
Jones Ditch
Fairway Tributary
Northridge Draw
Wiedeman Creek
Poudre River Ranch
Poudre Learning C
Sharktooth Bluffs
Plateau Rd
F St
C St
4th St
4th St (Future)
10th St
11th St
US Hwy-34-Bus
W Canberra St
Skyview St
Surrey St
Sage Ave
Deville Dr
Riverside Ct
County Road 62
County Road 27
N 81st Ave
N 78th Ave
N 83rd Ave
83rd Ave
71st Ave
N 71st Ave
N 67th Ave
Dundee Ave
Weld County
City of Greeley

1,000 Feet

- Detention Basin Improvement
- Storm Drain Improvements
- Roadway Crossing Improvement
- Canal Crossing Improvement
- Proposed Grading
- Drainageway
- Jurisdictional Boundary
- Approximate Easement
- Existing Trails
- Future Trails

City of Greeley Colorado

ICON ENGINEERING, INC.



1.0 INTRODUCTION

1.1 AUTHORIZATION

This study was authorized by the City of Greeley on May 1st 2018 under project #FA18-03-022.

1.2 PURPOSE AND SCOPE

The focus of the study is to produce a comprehensive storm drainage master plan to assist the City, guide development, prioritize capital improvement projects, and improve water quality throughout the Sharktooth Bluffs Basin.

The following is a summary of the scope of work for this study.

- Review of Existing Information and Field Reconnaissance
- Evaluate and update baseline hydrology and hydraulics
    - Define individual subwatershed boundaries
    - Develop hydrologic models for the 2-, 5-, 10-, 50-, and 100-year return period storms subject to the following guidelines:
        - Use the Colorado Urban Hydrograph Procedure (CUHP) to generate basin runoff hydrographs.
        - Use the Environment Protection Agency Storm Water Management Model (EPA SWMM) to route the individual hydrographs.
        - Evaluate the performance of existing storm drain infrastructure 30 inches or greater in size.
        - Identify existing and potential future areas prone to flooding.
- Alternatives Analysis
    - Identify and analyze feasible alternative storm drain and water quality solutions.
        - Develop set of rating criteria to evaluate alternative solutions to drainage problems.
- Conceptual Design
    - Refine the selected plan to a conceptual design level.
    - Prepare updated cost estimates and phasing of improvements for selected plan.

1.3 PLANNING PROCESS

Progress Meetings were held on a bi-weekly basis throughout the project. Minutes from progress meetings can be found in Appendix A.

1.4 MAPPING AND SURVEY

Base map Geographic Information System (GIS) layers received from the City of Greeley included:

- Building Footprints
- Land Use (Asphalt/Concrete, Gravel/Hard packed Earth)
- Utilities
    - Non-potable Water: Lift Stations, Lines, Valves
    - North Weld: Water Lines, Water Meters
    - Sanitary Sewer: Line, Manhole
    - Stormwater: Culvert, Inlet, Main, Manhole,
    - Water Hydrants: Line, Valves
- Parcel information
- Roads, Street Centerlines
- Zoning

One foot interval contours were generated from LiDAR project mapping. Project mapping was based on Federal Emergency Management Agency (FEMA) 2013 Post-flood LiDAR mapping with the following attributes and is equivalent to 1-foot contour interval topographic mapping:

Name: 2013 South Platte River Flood Area 1
Collection Date: Fall 2013 – Spring 2014
Vertical Accuracy: 9.25 cm RMSE
Point Spacing: 0.7 m
Vertical Datum: NAVD88
Horizontal Datum: NAD83

Following the collection of the 2013 LiDAR data, the River Run at Poudre River Ranch development was constructed. The proposed grading plan from this development has been incorporated into the existing conditions surface.

As part of this study, ICON Engineering and King Surveyors also collected survey information for the hydrologic detention facilities considered in the analysis, as well as additional storm drain manholes that were not surveyed previously. All survey information was collected on the NAD83 horizontal datum and the NAVD88 vertical datum.

1.5 DATA COLLECTION

Various drainage reports and planning documents were reviewed as part of this study. A summary of the reports can be found below:

Table 1-1: Data Collected

Document Title	Date	Author
Final Drainage Report for Boomerang Ranch Subdivision First Filing	Jul-2001	Pickett Engineering Company
Drainage Report for Poudre River Ranch Phase I	Dec-1998	Pickett Engineering Company
Final Drainage Report for Poudre River Ranch Second Filing	Aug-1999	Pickett Engineering Company
Addendum to Drainage Report for Boomerang Ranch First Filing	Jul-2001	Futura Engineering, Inc.
Drainage and Erosion Control Study for Poudre River Ranch Third Filing	Jul-2002	North Star Design, Inc.
Lake Bluff Preliminary Planned Unit Development Plan	Nov-2008	Westside Investment Partners, Inc.
2035 Comprehensive Transportation Plan	May-2011	City of Greeley
River Run at Poudre River Ranch, First Filing	Mar-2014	King Surveyors
Final Drainage and Erosion Control Study for River Run at Poudre River Ranch, Second Filing	Apr-2016	North Star Design, Inc.
City of Greeley Parks, Trails and Open Lands	May-2016	Design Workshop, Inc.
Final Utility Plans River Run at Poudre River Ranch, Second Filing	Jan-2017	North Star Design, Inc.
Imagine Greeley Comprehensive Plan	Jan-2018	City of Greeley
Lake Bluff Preliminary Planned Unit Development Plan	Aug-2018	Westside Investment Partners, Inc.
Promontory Heights Preliminary Planned Unit Development Plan	Jun-2019	Planscapes

1.6 ACKNOWLEDGEMENTS

The team members who were involved with this study are listed in the table below:

Table 1-2: Project Participants

Participant	Representing	Title
Andrew Fisher, P.E., CFM	City of Greeley	Stormwater Capital Projects Engineer
Joel Hemesath	City of Greeley	Public Works Director
Craig Jacobson, P.E., CFM	ICON Engineering, Inc.	Project Manager
Jaclyn Michaelsen, P.E., CFM	ICON Engineering, Inc.	Project Engineer
Jeremy Deischer, P.E.	ICON Engineering, Inc.	Project Engineer
Monica Ramirez, EI	ICON Engineering, Inc.	Project Engineer

2.0 STUDY AREA DESCRIPTION

2.1 PROJECT AREA

The Sharktooth Bluffs Basin, named after fossilized shark teeth found in the area has a rich history dating back to World War II. The basin was home to a 320 acre World War II Prisoner of War Camp that housed Germans and Austrians from 1944 – 1946. Several years later in 1961, one of four Atlas E nuclear missile silos constructed in Weld County was built in the basin. The missile site was deactivated in 1965, but still serves as an amenity to the basin, providing tours of the site and is home to a campground. Sharktooth Ski Area, referred to as the world's smallest ski resort, was in operation from 1971-1986. During the construction of the ski area, the fossilized shark teeth in which the area was named after were found.

Located within the City of Greeley, Town of Windsor, and unincorporated Weld County, the Sharktooth Bluffs Basin covers an area of approximately 7.8 square miles. Previously known as West Poudre Basin, Sharktooth Bluff Basin generally slopes from the southwest near 10th Street to the northeast where stormwater runoff discharges into the Cache La Poudre River. The basin is generally bounded by US Highway 257 to the west, the Cache La Poudre to the north, N 71st Avenue to the east and 10th Street to the south. Of the total basin area, 3.7 square miles are currently within the City of Greeley with 6.8 square miles are in the Long Range Growth boundary.

The current study area encompasses the West Poudre Basin and areas previously studied as part of the *Comprehensive Drainage Plan for Sheep Draw Basin* in 2006. Four watersheds, Wiedeman Creek, Poudre River Ranch, Fairway Tributary, and Northridge Draw, located in the eastern portion of Sharktooth Bluffs are not directly tributary to Sheep Draw and were incorporated into the Sharktooth Bluffs Basin.

Currently the basin is approximately ten percent built-out with various residential developments in addition to notable landmarks; Missile Site Park, Sharktooth Bluff, Boomerang Links Golf Course, Northridge High School, and Winograd K-8 School. Some commercial properties exist along the eastern edge of the watershed south of Canberra Commons.

Sharktooth Bluffs Basin is made up of numerous drainageways which outfall into the Cache La Poudre River. These drainageways include; Spur Draw, Hertzke Draw, Orr Gulch, Sharktooth Draw, Poudre Learning Center Tributary, Wiedeman Creek, Fairway Tributary, and Northridge Draw.

Two irrigation canals are found within the watershed. The Greeley No. 3 Canal, a 13-mile long canal conveying flow east through downtown Greeley, originates in the eastern portion of the basin. The William R. Jones Ditch conveys flow from the Cache La Poudre River just east of the bluffs to Siebring Reservoir. Siebring Reservoir, a series of ponds located between N 95th Avenue and N 83rd Avenue, is a raw water storage facility owned by Central Colorado Water Conservancy District. On the eastern edge of Siebring Reservoir is the Poudre Learning Center, a 65 acre area donated to the local community after the gravel mining operations ceased.

Bisecting the watershed are water transmission lines from the Bellevue Water Treatment Plant.

In the next twenty years, Greeley's population is expected to grow by up to fifty percent, per Greeley's *2035 Comprehensive Transportation Plan*. Much of this growth will push development west of the downtown area, into Sharktooth Bluffs Basin. Roadway improvements to 83rd Avenue and 4th Street are planned in the *2035 Comprehensive Transportation Plan* to accommodate the increase in population, connecting Windsor, Greeley, Milliken and Platteville. Much of the area is currently located within unincorporated Weld County but lies within the City of Greeley Long Term Growth Area.

A watershed map highlighting features throughout the watershed can be found in Figure 2.1.

2.2 LAND USE

Sharktooth Bluffs Basin is comprised of Type A, B, C, and D soils as defined by the Natural Resources Conservation Service (NRCS). The western half of the basin is predominately Type A and D soil with the eastern primarily consisting of Type A and Type B soils. To account for increased runoff caused by irrigation flows and irrigation-induced saturated soils on agricultural lands, Type A and B soils were assigned soil infiltration properties of Type C and D soils in the existing conditions analysis. More information on the soil parameters can be found in Section 3.4.5 . A soil map of the watershed can be found in Appendix B.

Existing land use parameters were obtained using GIS shapefiles provided by the City of Greeley. Impervious values for each land use designation (gravel, paved parking, sidewalk, etc.) were selected using Table 6-3 of the Urban Storm Drainage Criteria Manual (USDCM) and can be seen in Table 2-1. In several areas in Poudre River Ranch and River Run at Poudre River Ranch the existing land use GIS shapefiles did not reflect the extent of current development. Representative sections were developed to determine typical percent impervious for these areas and applied to the neighborhoods lacking data.

Future land use parameters were developed using GIS zoning shapefiles provided by the City. Projected land use in the *Imagine Greeley* planning document was used to supplement areas outside of the City. The impervious values chosen for each zoning classification can be found in Table 2-2. Open space areas were assigned a 7% imperviousness in the future conditions model to account for paved surfaces within open space areas.

Imperviousness for each subwatershed was computed using the area weighted average of each land use type through GIS. The entire study area is approximately 13 percent impervious for existing conditions land use. Future land use projects the entire study area to be approximately 42 percent impervious. Impervious values are shown for the watershed on the impervious map in Appendix B.

Table 2-1: Existing Land Use Classification

Land Use	Percent Impervious (%)
Pervious	5
Road- Unpaved	40
Trail	40
Building	90
Driveway	90
Sidewalk	90
Road- Paved	100
Parking	100
Water	100

Table 2-2: Future Land Use Classification

Zoning Classification	DU / Ac.	Percent Impervious (%)
Open Space	--	7
Residential Estate	1 - 3	30
Residential - Low Density	3 - 5	50
Residential - Medium Density	5 - 10	60
Residential - High Density	10 - 20	70
Planned Urban Development (PUD)	--	70
Industrial - Low Density	--	80
Industrial - Medium Density	--	85
Commercial High Intensity	--	95

2.3 OUTFALL DESCRIPTIONS

Outfalls were categorized based on their location spatially within the basin and which major drainage watersheds to which they are tributary. An inventory of all major storm drainage structures can be found in Table 4-1. An outfall map can be found in Figure 2.3. The amount of area for each watershed within the current City limits and within the Long Term Growth Area can be found in Table 2-3.

2.3.1 SPUR DRAW

Spur Draw, the western most watershed, is located just east of US Highway 257. The watershed, approximately 330 acres of the basin, lies entirely within unincorporated Weld County. Stormwater runoff from the basin sheet flows to the Sharktooth Bluffs where the narrow gullies convey water northwest to the Cache La Poudre River. The drainageway in the central portion of the watershed is approximately 4,600 feet in length, with an average slope of 2.9 percent. The watershed is currently undeveloped and future land use projects the watershed to remain open space.

Looking west from Missile Site Park into Spur Draw Watershed

2.3.2 MISSILE PARK DRAW

Narrow gullies in the bluffs convey stormwater runoff in Missile Park Draw

This 275 acre watershed is bounded by Spur Draw to the west, Hertzke Draw to the east, Sharktooth Draw to the south and Cache La Poudre River to the north. The watershed spans three jurisdictions: Town of Windsor at the downstream end of the watershed, unincorporated Weld County, and the City of Greeley. Similar to Spur Draw, stormwater runoff is conveyed in narrow gullies which converge into a drainageway that bisects the watershed. Near the downstream end of the watershed, in the Town of Windsor and Weld County, the Broe Land Embankment is an approximately 10-foot high embankment detaining flows from continuing north to the Cache La Poudre River. Research into this property found no record it was a regulated detention basin or registered state dam. Therefore, no detention was accounted for behind the embankment. The Missile Park Draw basin is not expected to develop in the future due to the open space zoning it is assigned.

The watersheds namesake, Missile Site Park, is located near the headwaters of the watershed on the southwest side. In 1961, Missile Site Park was constructed and the location of one of the four Atlas E nuclear missile silo constructed in Weld County. Deactivated in 1961, the site still serves as an amenity, providing tours of the site and home to a campground.

2.3.3 HERTZKE DRAW

Hertzke Draw, located to the east of Missile Park Draw and west of Sharktooth Draw watersheds, primarily consists of steep gullies conveying stormwater runoff to the north. Upstream of the outfall into the Cache La Poudre River, the 270 acre watershed transitions from the confined gully drainageway to an alluvial fan. The main drainageway in the watershed is approximately 4,200 feet long, at an approximate 2 percent slope. The watershed lies within Town of Windsor, unincorporated Weld County, and City of Greeley. The bluffs in the southeastern portion of the watershed, within the City of Greeley, lie on property proposed to be developed as part of the Lake Bluff Development.

2.3.4 ORR GULCH

William R Jones Ditch conveys irrigation flow in the lower portion of Orr Gulch

Orr Gulch, bounded by Hertzke Draw to the west and Sharktooth Draw to the south and east, is a 270 acre watershed. Sharktooth Bluff, home of the ski resort from 1971 – 1986, separates Orr Gulch from the Sharktooth Draw watershed along the southeastern boundary. The northern portion of the watershed falls within unincorporated Weld County. The southern portion is within the City of Greeley. The portion within the City of Greeley is proposed to remain open space as part of the proposed Lake Bluff Development. The narrow bluff gullies collect stormwater runoff in the headwater of the basin before the flow is spread into an alluvial fan south of County Road 62. North of County Road 62, the William R. Jones

Ditch bisects the lower watershed, conveying irrigation flows from the Cache La Poudre River to Siebring Reservoir.

2.3.5 SHARKTOOTH DRAW

Sharktooth Bluff was the home for the ski resort from 1971 - 1986

Sharktooth Draw extends from south of 10th Street to the Cache La Poudre River, covering 1,235 acres. The watershed lies within the City of Greeley and unincorporated Weld County. The headwaters of Sharktooth Draw begin south of 10th Street, east of Promontory Circle near the State Farm property. Stormwater runoff continues in a northeast direction to the Promontory subdivision detention basin. Flow is conveyed under 10th Street to the north at numerous locations, including west of 101st Avenue at the Promontory development, and east and west of 95th Avenue. North of 10th Street, west of 95th Avenue, sheet flow conveys the runoff through existing farm fields before reaching the bluffs and a better defined drainageway. The future proposed roadway expansion of 4th Street to the west will cross Sharktooth Draw before the runoff reaches the bluffs. North of the future 4th Street expansion, the flow is conveyed in a northeast direction to the roadway crossing at 95th Avenue where dual 36-inch pipes convey flow underneath the roadway. East of 95th Avenue, the drainageway sharply turns to the north, exiting the bluffs into an alluvial fan, south of County Road 62. Sharktooth Bluff, the home of the ski resort in operation from 1971 – 1986, is located west of N 95th Avenue as the flow exits the bluffs. Flow overtops County Road 62 to the northwest and crosses the William R. Jones Ditch before the outfall location into the Cache La Poudre River, west of Siebring Reservoir.

2.3.6 POUDRE LEARNING CENTER TRIBUTARY

The 610 acre Poudre Learning Center watershed extends from the Cache La Poudre River south to 10th Street, between N 83rd Avenue to the east and N 95th Avenue to the west. The Poudre Learning Center is located northwest of the County Road 62 and N 83rd Avenue intersection. Flow in the upper portion of the watershed primarily consists of sheet flow down into the bluffs. The stormwater runoff spreads from the confined flow in the bluffs into an alluvial fan south of County Road 62. Flow crosses the William R. Jones Ditch and County Road 62 into Siebring Reservoir. An outlet channel from the most eastern portion of Siebring Reservoir conveys flow east to 83rd Avenue before the outfall location into the Cache La Poudre River.

2.3.7 WIEDEMAN CREEK

The Wiedeman Creek watershed extends from the Cache La Poudre River south beyond 10th Street. The 875 acre watershed is generally bounded by N 83rd Avenue to the west and the Fairway Tributary watershed to the east. The watershed lies within the City of Greeley and unincorporated Weld County. Runoff south of 10th Street is conveyed underneath 10th Street into a water quality basin constructed as part of the 10th Street improvements in 2005, which also forced CDOT to relocate the P.O.W. Camp 202 pillars. Flow from the detention basin is released into Wiedeman Creek, continuing north past 4th Street to Poudre River Ranch. Roadway crossings at N 83rd Avenue and 4th Street convey flow from the existing farmland west of N 83rd Avenue to Wiedeman Creek south of 4th Street. North of 4th Street Wiedeman Creek intercepts the 12-inch corrugated metal pipe that drains the area on Boomerang Links Golf Course south of 4th Street and Dundee Avenue.

River Run at Poudre River Ranch is located at the downstream end of Wiedeman Creek

Wiedeman Creek enters Poudre River Ranch Phase III, crossing Skyview Street through a 7 foot wide by 4 foot tall box culvert. An open channel along N 81st Avenue conveys discharge through Poudre River Ranch Phase III. Flows are then intercepted by a 5 foot wide by 4 foot tall box culvert south of Poudre River Road. This box culvert discharges flow north of River Run at Poudre River Ranch into a water quality basin before discharging into the Cache La Poudre River.

Local runoff west of N 81st Avenue in Poudre River Ranch Phase II is conveyed through two primary flow paths. A grass swale conveys flow to three elliptical concrete pipes crossing Poudre River Road just east of N 83rd Avenue. Street flow is conveyed north on Double Tree Drive turning east at Poudre River Road. Stormwater at this location is intercepted in a storm drain that conveys and intercepts additional stormwater runoff through River Run at Poudre River Ranch.

Runoff from the existing farm land and Boomerang Links concentrates in two additional locations before being conveyed through Poudre River Ranch Phase III. First, stormwater is intercepted along N 78th Avenue in a storm drain system that increases in size from 18-inches at Skyview Street to 36-inches at Poudre River Road. The storm drain discharges west of Riverside Court into an open channel that conveys flow into a water quality basin and subsequently the Cache La Poudre River.

Second, a 30-inch storm drain intercepts stormwater runoff from the existing farm land east of Amour Hill Drive. The flow is conveyed west where the flow is discharged into an open channel between N 78th Avenue and Amour Hill Drive. The open channel is conveyed underneath Poudre River Road in a 36-inch storm drain which outfalls in the same open channel as the storm drain in N 78th Avenue.

The Wiedeman Creek watershed was previously considered to be in the Sheep Draw Basin, and was studied in a report from 2006 by Anderson.

2.3.8 POUDRE RIVER RANCH TRIBUTARY

Poudre River Ranch Subdivision

The Poudre River Ranch watershed consists of the 25 acre Poudre River Ranch Phase II development. The watershed is bounded by Wiedeman Creek to the west, and Fairway Tributary to the south and east. Flow is conveyed off the existing farmland onto the street at N 77th Avenue then west on Plateau Road before being directed northeast on Poudre River Road to an existing water quality basin. Flow from the water quality basin discharges into Cache La Poudre River just upstream of the Greeley No. 3 Canal diversion.

The Poudre River Ranch watershed was previously considered to be in the Sheep Draw Basin, and was studied in a report from 2006 by Anderson.

2.3.9 FAIRWAY TRIBUTARY

Runoff is conveyed north through Boomerang Links Golf Course

The 144 acre Fairway Tributary originates north of 4th Street and west of N 71st Avenue. Stormwater runoff from Canberra Commons, located north of Dundee Avenue and west of N 71st Avenue, is conveyed to the Boomerang Links Golf Course. The runoff is then conveyed northeast through the golf course to the intersection of W Melbourne Street and N 71st Avenue. Flow continues north into the two existing detention basins along the west side of N 71st Avenue. Stormwater from the detention basins are conveyed into the Northridge Draw watershed through an 18-inch storm drain. Flows exceeding the capacity of the detention basin continue north in an open channel to the roadway crossing at Poudre River Road. A 30-inch storm drain conveys flow under the roadway, discharging into the Greeley No. 3 Canal.

The western portion of Boomerang Links Golf Course is conveyed along the golf course to the retention pond on the northern side of the golf course. The retention pond does not outlet and retains stormwater runoff for irrigation use. Flows north of the golf course enter a 42-inch storm drain, near the intersection of Vallevue Drive and Poudre River Road, which convey flow across the Greeley No. 3 Canal into the Poudre River Ranch Natural Area.

The Fairway Tributary watershed was previously considered to be in the Sheep Draw Basin, and was studied in a report from 2006 by Anderson.

2.3.10 NORTHRIDGE DRAW

Detention is provided at both Winograd K-8 and Northridge HS

Northridge Draw, located east of N 71st Avenue, is the easternmost watershed in the basin, covering an area of 98 acres. The watershed originates near the intersection of N 71st Avenue and Dundee Avenue. Stormwater runoff from the parking lot of Northridge High School is conveyed in a storm drain underneath the baseball fields to the detention basin in the northeast corner of the high school property. Runoff from the school property east of the parking lot is collected in a storm drain system and conveyed out of the basin to the east. Flow from the detention basin north of Northridge High School is conveyed north past Winograd K-8 school to the detention basin south of C Street. The detention basin discharges flow north under C Street to a drainageway on private property. The drainageway conveys flow north through a retention pond to a small roadside swale along N 71st Avenue. Flows in excess of the 18 inch storm drain underneath N 71st Avenue continue north east discharging into the Greeley No. 3 Canal.

The Northridge Draw watershed was previously considered to be in the Sheep Draw Basin, and was studied in a report from 2006 by Anderson.

2.3.11 POUDRE RIVER WATERSHEDS

Several subwatersheds drain directly to the Cache La Poudre River

Several subwatersheds are direct flow areas to the Cache La Poudre River or Greeley No. 3 Canal. These watersheds span from adjacent to Spur Draw to the west and Northridge Draw to the east. Combined these watersheds account for 410 acres of the basin.

The Poudre River direct flow area to the north of Greeley No 3 Canal was previously considered part of the Sheep Draw Basin, and was studied in a 2006 Anderson report.

2.4 CITY OF GREELEY LONG TERM GROWTH AREA

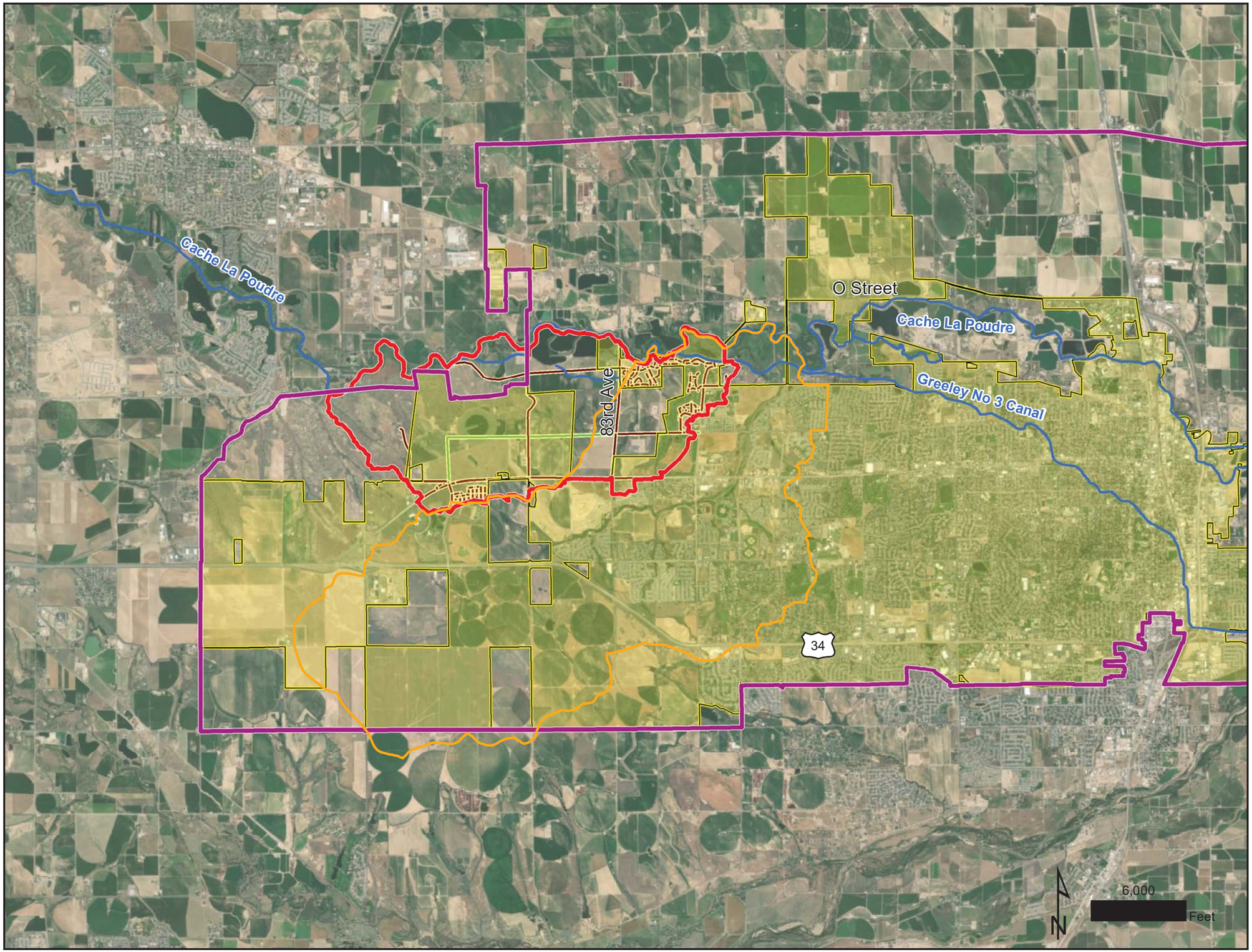
In the next twenty years, Greeley's population is expected to grow by up to fifty percent, per Greeley's *2035 Comprehensive Transportation Plan*. Much of this growth will push development west of the downtown area, into Sharktooth Bluffs Basin. Roadway improvements to 83rd Avenue and 4th Street are planned in the *2035 Comprehensive Transportation Plan* to accommodate the increase in population, connecting Windsor, Greeley, Milliken and Platteville. Much of the area is currently located within unincorporated Weld County but lies within the City of Greeley Long Term Growth Area. A comparison of the percentage of each watershed currently within City boundaries and the amount in the projected City of Greeley Long Term Growth Area can be found in the table below.

Table 2-3: Long Term Growth Area

Watershed	Existing Greeley		Future Greeley	
	Area (Ac)	% of Basin	Area (Ac)	% of Basin
Fairway Tributary	125	87	144	100
Hertzke Draw	215	80	215	80
Missile Park Draw	44	16	186	68
Northridge Draw	70	72	98	100
Orr Gulch	84	31	84	31
Poudre Learning Center	168	28	607	100
Poudre River	130	32	321	79
Poudre River Ranch	17	70	25	100
Sharktooth Bluffs	1123	91	1152	93
Spur Draw	23	7	332	100
Wiedeman Creek	383	44	876	100

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 2.1 - Vicinity Map



Sheep Draw Basin
Long Range Expected Growth Boundary
Sharktooth Bluffs Boundary
City of Greeley Boundary
Existing Roads
Future Roads

City of Greeley Colorado

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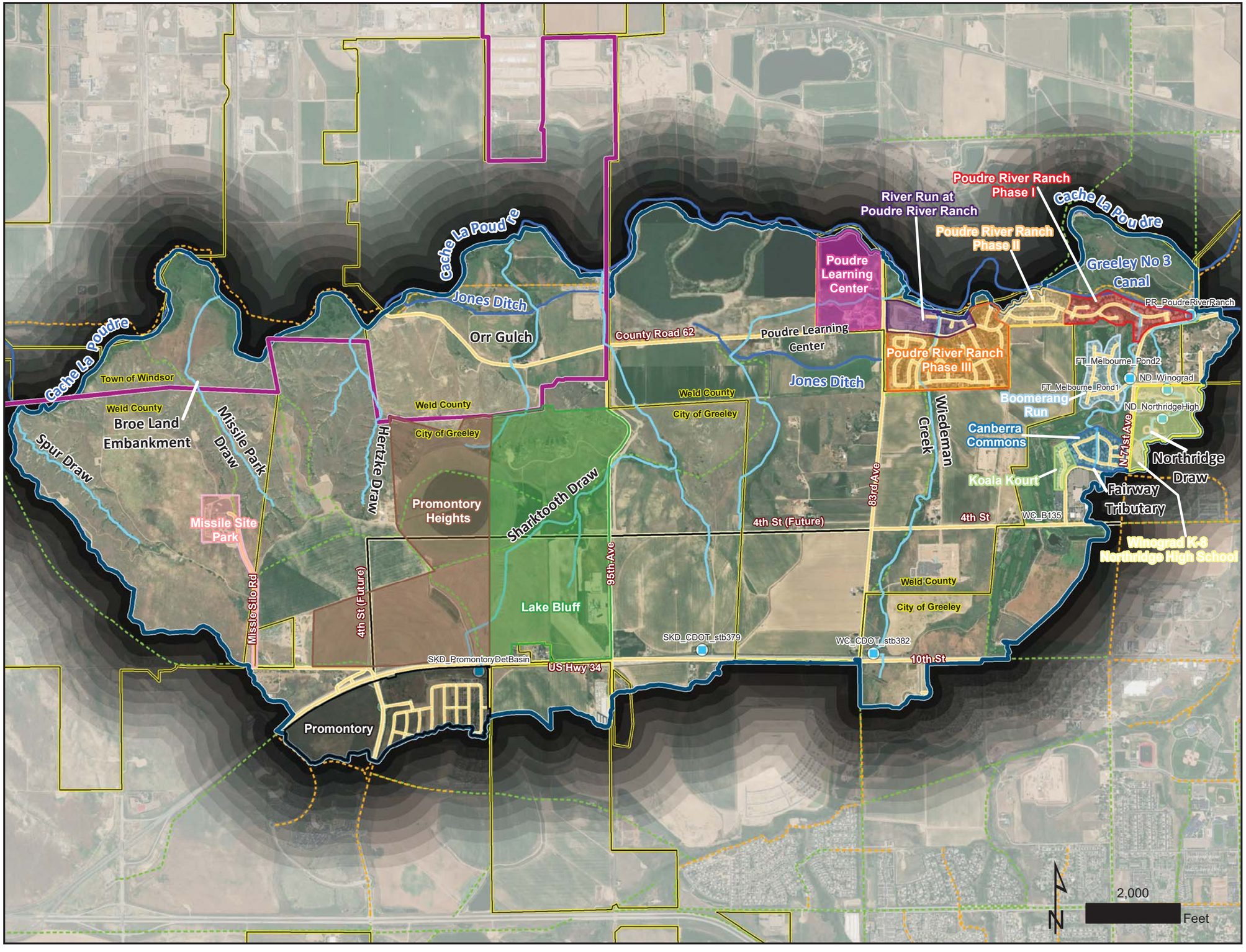
Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 2.2 - Study Area Map



Neighborhoods

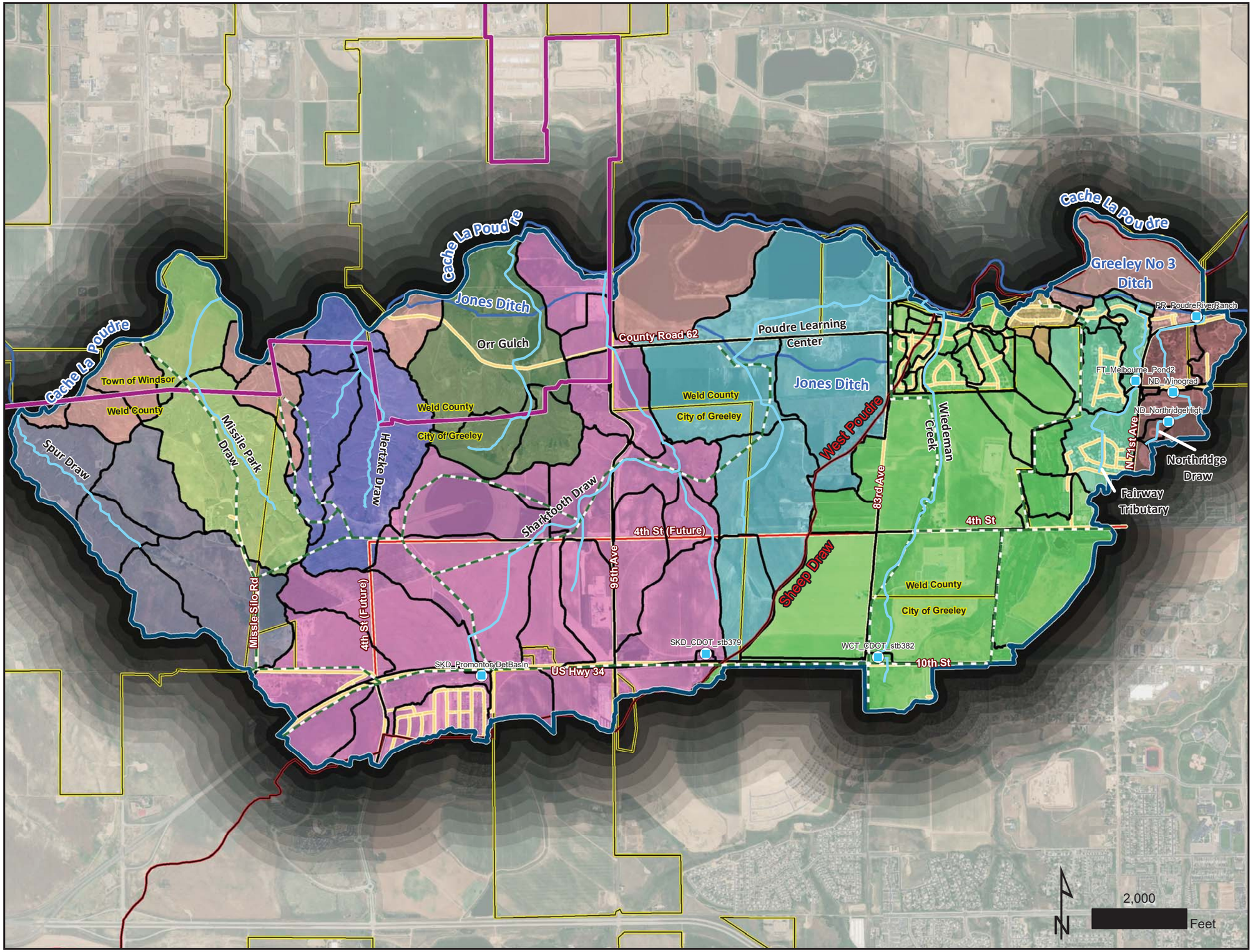
- Boomerang Run
- Canberra Commons
- Koala Kourt
- Lake Bluff
- Missile Site Park
- Poudre Learning Center
- Poudre River Ranch Phase I
- Poudre River Ranch Phase II
- Poudre River Ranch Phase III
- Promontory
- Promontory Heights
- River Run at Poudre River Ranch
- Winograd K-8 Northridge High School
- Existing Detention Basin
- Drainageway
- Long Range Expected Growth Boundary
- Basin Boundary
- Jurisdictional Boundary
- Existing Trails
- Future Trails

City of Greeley Colorado

ICON ENGINEERING, INC.

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 2.3 - Watershed Map



- Existing Detention Basin
- Drainageway
- Proposed Trails (City Trails MP)
- Long Range Expected Growth Boundary
- Basin Boundary
- Sheep Draw Boundary
- Subwatershed Boundary
- Jurisdictional Boundary

Watershed

- Fairway Tributary
- Hertzke Draw
- Missile Park Draw
- Northridge Draw
- Orr Gulch
- Poudre Learning Center
- Poudre River
- Poudre River Ranch
- Sharktooth Bluffs
- Spur Draw
- Wiedeman Creek

City of Greeley Colorado

ICON ENGINEERING, INC.

3.0 HYDROLOGIC ANALYSIS

3.1 OVERVIEW

A new hydrologic model was prepared for the Sharktooth Bluffs Basin. The model establishes hydrology for the 2-, 5-, 10-, 50-, and 100-year storm frequencies for both existing and future land use conditions. The Colorado Urban Hydrograph Procedure 2005 version 2.0.0 (CUHP) was used to develop runoff hydrographs for each subwatershed. Subwatershed hydrographs were then routed using the EPA Stormwater Management Model version 5.1.012 (SWMM) to determine discharges at each design point.

Due to the level of subwatershed discretization, one minute time step between computations was used in CUHP.

In general, the hydrologic model included storm drain pipes 30 inches or greater; however sixteen exceptions for pipes smaller than 30 inches were made when the storm drain systems diverted flow in a different direction than the topographic conveyance.

During the existing conditions evaluations, soil infiltration parameters were adjusted to account for saturated soil from agricultural irrigation. The adjustment to the soil infiltration parameters are further described in Section 3.4.5 .

Two areas in the basin were identified where flow splits changed routing direction. These areas were refined to include tabular flow diversions within the SWMM model. The tabular curves were based on a comparison of inflow and outflow using FLO-2D software. FLO-2D is a two-dimensional hydrodynamic model particularly well suited to simulating complex surface water flow. These diversions are further explained in Section 3.5.3 .

City of Greeley stormwater criteria requires any future development to detain to historic 5-year discharges. To simulate these effects from the future land use, conceptual ponds were modeled in each subwatershed where zoning or future land use projections indicated future development would occur. The conceptual detention basins estimated the storage required for each subwatershed to detain to 5-year historic release rates. The future conditions SWMM model is further described in Section 3.5.4 .

3.2 COLORADO URBAN HYDROGRAPH PROCEDURE

The Colorado Urban Hydrograph Procedure translates a watershed's response from rainfall into a runoff hydrograph that reflects peak runoff rates, volumes, and timing. CUHP is an evolution of the Snyder unit hydrograph calibrated to the Colorado Front Range using data collected by the U.S. Geological Survey beginning in 1969 (Reference 2). The 1982 version of CUHP was developed using data collected at seven sites along the Front Range. The current version of CUHP developed empirical relationship between the input hyetograph and observed output flow using data from 30 sites, representing a full range of land uses (Reference 2). Urban Drainage and Flood Control District (UDFCD), now operating as the Mile High Flood District, commissioned a calibration effort after experiencing higher than anticipated peak flows in their planning studies. The recalibration study recommended updating CUHP to better match gage data and update rainfall values from NOAA Atlas 2 to NOAA Atlas 14. Version CUHP v.2.0.0 was released in September of 2016 and was found to have less error than CUHP v.1.4.4 when compared to recorded rainfall and corresponding runoff (Reference 2).

3.3 DESIGN RAINFALL

One- and six-hour rainfall depths were obtained from NOAA Atlas 14 Point Precipitation Frequency Data Server for various points throughout the basin. Spatially varying the rainfall throughout the watershed was not deemed necessary after examining the distribution of point precipitation values. The one- and six-hour rainfall point precipitation value can be found in Table 3-1.

Table 3-1: 1- and 6-hr Rainfall Depth

Return Period	1-Hr Rainfall Depth (in)	6-Hr Rainfall Depth (in)
2-yr	0.85	1.28
5-yr	1.12	1.68
10-yr	1.41	2.08
50-yr	2.29	3.38
100-yr	2.77	4.07

Areal adjustments were not applied due to the lack of a contiguous basin exceeding the thresholds of two square miles for the 2-, 5-, 10-year design storms and fifteen square miles for the 50-, and 100-year storms. Two hour rainfall distributions were generated in the CUHP software from the one - and six-hour rainfall depths.

Complete rainfall distributions are provided in Appendix B.

3.4 SUBWATERSHED CHARACTERISTICS

Subwatershed characteristics for each basin are further described below and can be found in Appendix B.

3.4.1 SUBWATERSHED DELINEATION

The 7.8 square mile Sharktooth Bluffs Basin was delineated into 105 subwatersheds. Subwatersheds were named based on their tributary outfall. The outfalls from west to east are: Spur Draw, Missile Park Draw, Hertzke Draw, Orr Gulch, Sharktooth Draw, Poudre Learning Center Tributary, Wiedeman Creek, Poudre River Ranch Tributary, Fairway Tributary, and Northridge Draw. All irrigation facilities were assumed to be flowing full at the start of the design storm and were not taken into consideration for subwatershed delineation.

Subwatersheds ranged from 0.4 acres to 200 acres in size, with the average subwatershed size of 43 acres.

3.4.2 WATERSHED IMPERVIOUSNESS

Characterizations of existing and future watershed imperviousness were determined using various sources of information provided by the City. Existing imperviousness was predominately developed using the City of Greeley land use GIS shapefiles. Future imperviousness was developed from City of Greeley Zoning GIS Shapefiles. Modifications to the base data for both existing and future land use are further described below.

Imperviousness for each subwatershed was computed with GIS software using the area weighted average of each land use type. Subwatershed imperviousness during existing conditions range from 5 percent to 69 percent. Future land use projects subwatershed imperviousness to range from 5 percent to 85 percent.

Impervious values are shown for the watershed on the impervious map in Appendix B.

The impervious values chosen for each land use type and zoning classification can be found in Table 2-1 and Table 2-2.

3.4.2.1 EXISTING CONDITIONS WATERSHED IMPERVIOUSNESS

Impervious values for each land use designation were selected using Table 6-3 of the Urban Storm Drainage Criteria Manual (USDCM) and can be seen in Table 2-1. In Poudre River Ranch Phase III and River Run at Poudre River Ranch, the existing land use GIS shapefiles did not reflect the extent of current development. Representative sections for each land use density were developed to determine typical percent impervious for these areas and applied to the neighborhoods.

3.4.2.2 FUTURE CONDITIONS WATERSHED IMPERVIOUSNESS

Impervious values for future land use were derived from Greeley's land use zoning map along with the City's *Imagine Greeley Land Use Guidance Map*, Adopted in January 2018 to determine the densities of each designated land use area. The imperviousness of each of these areas can be seen in Table 2-2. Specific development plans were also used to determine future imperviousness in the Lake Bluff subdivision. Instead of using specific land use assignment the Lake Bluff subdivision was assigned an overall imperviousness due to the uncertainty in placement of specific development components (i.e. schools, shopping, and housing). A composite imperviousness value was derived from an area weighted average of the plan and found to be 51.2 percent; this imperviousness was applied to the extents of the Lake Bluff Development.

3.4.3 LENGTH, CENTROID DISTANCE, SLOPE

CUHP parameters such as subwatershed length, distance to centroid, and slopes were derived for each subwatershed using topographic data generated from FEMA 2013 Post-flood LiDAR mapping. Slopes were computed using the length-weighted, corrected average slope from Equation 6-7 and Figure 6-4 of the USDCM.

3.4.4 DEPRESSION LOSSES

Depression storage loss was determined based on Table 6-6 from the USDCM. Aerial imagery was used to examine each subwatershed to determine depression loss characteristics. Developed areas were assigned pervious depression loss values of 0.35 inches with undeveloped areas assigned a depression loss value more typical of wooded areas and open fields, 0.40 inches. During future conditions modeling, areas with projected future development were adjusted to a pervious depression loss value of 0.35 inches. A value of 0.1 inches was selected for the impervious depression storage loss for all subwatersheds.

3.4.5 SOIL INFILTRATION PARAMETERS

Soil data for the watershed was obtained from Natural Resources Conservation Service (NRCS) web soil survey. Each soil classification assigned a map unit symbol based on the soil characteristics. Map unit symbols categorization was then summarized into one of the four major soil types ranging from Type A representing well-draining soils, to Type D representing poorly-draining soils. These soil types were each assigned parameters for use in Horton's infiltration equation. Horton's infiltration equation initially infiltrates a high amount of runoff early in the storm, eventually decaying to a steady state constant value. Horton's infiltration method was found to provide a balance between simplicity and a reasonable physical description of the infiltration process for CUHP (Reference 1).

Soil types throughout the watershed are spatially varied, consisting predominantly of Type A soils on the eastern side, Type A and B soils in the southern portion of the basin, and a mix of Type A, B, and D soils in the northern and western portions of the basin. Soil parameters were averaged on an area weighted basis for subwatersheds that contained multiple soil types.

During existing conditions analysis, soil infiltration parameters were adjusted to account for the possibility of saturated soils during the design storm. Type A and Type B soils in areas determined to be actively irrigated agricultural land, as identified by historic photographs, were adjusted to reflect the soil infiltration parameters more typical with a Type C or D soils to account for the soil to be saturated during the design storm. This adjustment addressed the decreased imperviousness from saturated soils in actively irrigated areas, as well as additional irrigation runoff.

No changes were made to the NRCS web soil survey soil infiltration parameters for future land use conditions.

Soil types for existing and future land use conditions can be found in Appendix B.

3.5 HYDROGRAPH ROUTING

Subwatershed runoff hydrographs were routed using EPA SWMM 5.1.012 to determine design discharges at each design point. Naming conventions for each junction and routing element were spatially assigned based on the watershed they were within. Watersheds were abbreviated within the SWMM modeling and can be found in Table 3-2, below.

Table 3-2: Watershed SWMM Modeling Abbreviations

Watershed	SWMM Model Abbreviation
Spur Draw	SD
Missile Park Draw	MPD
Hertzke Draw	HD
Orr Gulch	OG
Sharktooth Draw	SKD
Poudre Learning Center	PLC
Wiedeman Creek	WC
Poudre River Ranch	PRR
Fairway	FT
Northridge Draw	ND
Poudre River Direct Flow Areas	PR

3.5.1 ROUGHNESS COEFFICIENT

Roughness coefficients (Manning's n) for SWMM routing were selected using Table MD-1 from USDCM. Following UDFCD guidance, the n-values for pipes were then increased by 25% to better represent modeling conditions when using EPA SWMM.

3.5.2 CONVEYANCE ELEMENTS

Several conduit types were utilized to convey individual subwatershed hydrographs to design points. Trapezoidal channel sections were used for open channel conveyance in Spur Draw, Missile Park Draw, Sharktooth Draw, and Wiedeman Creek based on existing contour data. Closed circular conduits were assigned to storm drain infrastructure, based on City of Greeley's GIS information, and supplemented by field data. Irregular cross sections were developed to represent typical street cross sections of varying widths, to convey surface flow. Generalized street cross sections were defined as transects in the SWMM model representing street widths of thirty and forty feet. Irrigation canals were assumed to be flowing full at the beginning of the design storm and were not accounted for in routing of any stormwater runoff.

A SWMM routing schematic can be found on the interactive map, located in Appendix B.

3.5.3 EXISTING CONDITIONS DETENTION FACILITIES

Several existing detention facilities were accounted for in the baseline hydrology SWMM model. These included the Promontory detention basin, two CDOT detention basins north of 10th Street, two detention basins northwest of West Melbourne Street and N 71st Avenue, Northridge High School detention basin, Winograd K-8 School detention basin, and the Poudre River Ranch Phase I detention basin. Storage volumes for each facility were estimated from the topographic mapping. Release rates were estimated from orifice and weir calculations reflecting existing outlet structure configurations. Survey information gathered by ICON Engineering was used for invert elevations of outlet pipes, as well as spillway overtopping elevations to define outlet release rates. Storage and discharge curves for all the detention basins included in the hydrologic model are provided in Appendix B.

Inadvertent storage behind roadways and other embankments were not included in the hydrologic models, as detention since the City cannot adequately ensure that the current detention volumes or characteristics will remain. Any future development on these privately owned parcels would likely disrupt the detention volume relationship, altering the hydrologic modeling. These areas include the embankment in Missile Park Draw and south of 10th Street and 83rd Avenue.

3.5.4 FUTURE CONDITIONS DETENTION FACILITIES

As mentioned previously, City of Greeley criteria requires any future development to detain the developed 100-year design discharge to the 5-year historic design discharge. Conceptual detention basins were placed in the future conditions SWMM model to approximate the detention required in each subwatershed with future development. The volume required to detain each subwatershed to 5-year historic discharges can be found in Table 3-3 with locations shown in Figure 3.2. Although each subwatershed is detained to the 5-year historic release rate, due to hydrograph and routing timing, slight increases in total flow are observed at some design points.

It should be noted the existing 5-year flow rates were developed with reduced soil infiltration parameters on irrigated agricultural land, further described in Section 3.4.5 . Reducing the existing soil infiltration parameters to account for saturated soils increases the peak flow for these subwatersheds during existing conditions analysis. This approach would lead to detaining flows to an increased flow rate compared to future soil infiltration parameters.

3.5.5 FLOW DIVERSIONS

Tabular diversion curves were developed using FLO-2D to more accurately represent diversions in the Sharktooth Draw and Poudre Learning Center Watersheds. A range of steady state discharges were applied to the FLO-2D surface to generate the tabular rating curves used in the SWMM models. Exhibits for each of these diversion curves, including the flow diversion rating tables can be found in Appendix B.

3.6 RESULTS OF ANALYSIS

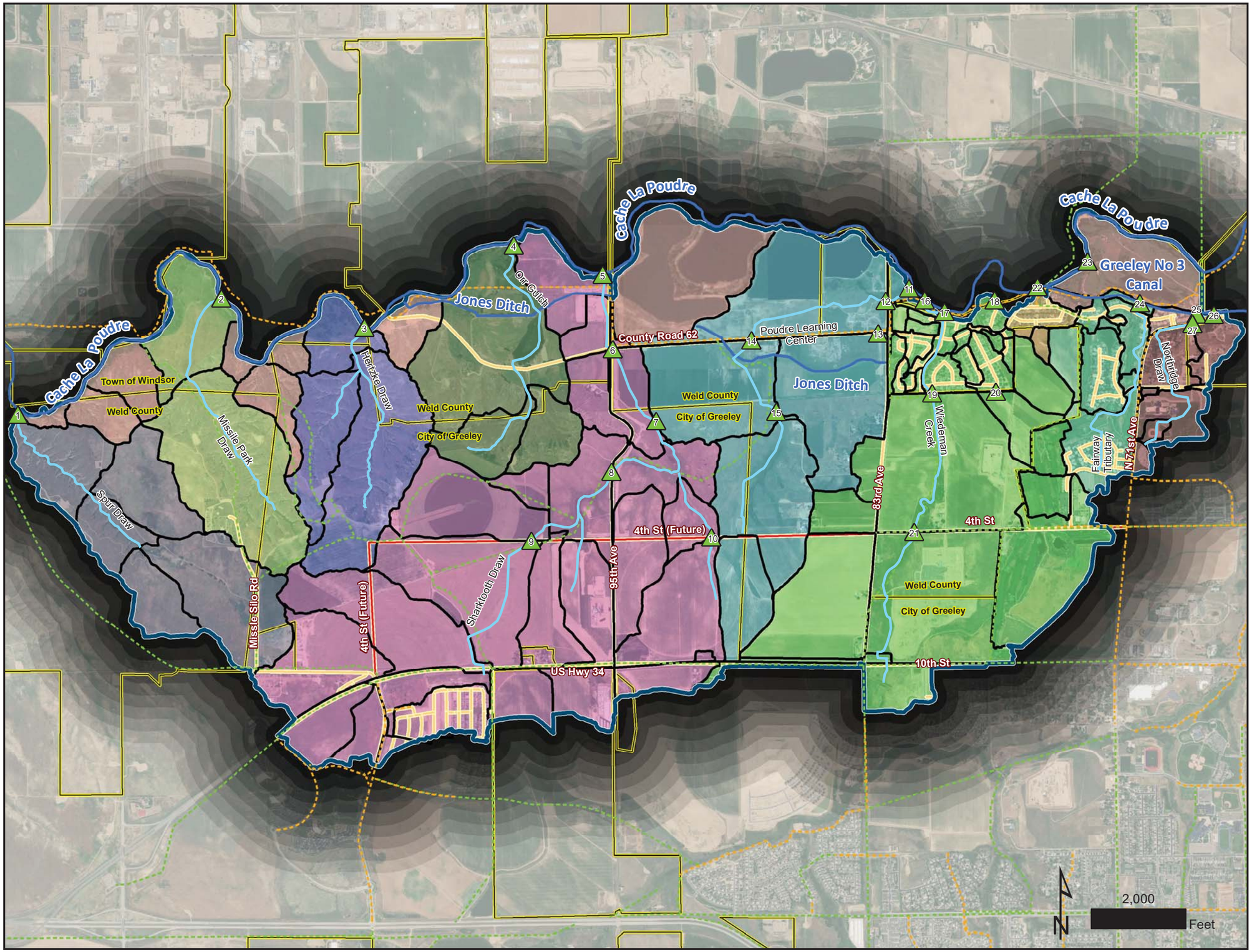
Peak discharges and inflow volumes for the 2-, 5-, 10-, 50-, and 100-year storm event for all design points can be found in Appendix B. A summary of peak flows at key design points throughout the watershed are shown in Table 3-4 with the design points labeled in Figure 3.1. Detention volumes required to meet City criteria to detain future 100-year discharges to historic 5-year discharges can be found in Table 3-3 with the locations labeled in Figure 3.2.

Table 3-3: Future Land Use Proposed Detention Basin Sizing

Basin	Historic 5 yr (cfs)	Future 100 yr (cfs)	Approximate Detention (Ac-ft.)
FT_100	0.2	6.5	0.8
FT_101	0.2	47.8	3.3
FT_105	0.1	25.2	1.5
FT_110	0.1	5.0	0.3
FT_115	0.4	8.3	0.4
FT_120	0.2	66.4	5.0
FT_125	0.1	54.1	3.3
FT_130	0.6	106.0	8.9
HD_100	1.5	56.7	5.4
HD_105	1.6	91.4	9.4
HD_110	4.8	209.7	23.1
MPD_100	2.9	117.6	9.4
MPD_105	1.6	264.0	26.5
ND_100	0.3	67.4	3.6
ND_105	0.2	72.5	4.8
ND_110	0.1	2.9	0.2
ND_115	0.1	3.9	0.2
ND_120	0.1	1.2	0.1
ND_130	0.2	96.2	6.0
ND_135	0.1	14.8	1.0
ND_140	0.1	21.0	1.1
OG_100	4.1	191.3	21.1
OG_105	1.3	101.6	7.8
OG_110	1.6	115.3	7.3
PLC_100	0.4	12.8	1.4
PLC_105	3.9	245.1	29.3
PLC_110	4.4	254.9	20.2
PLC_115	2.8	219.3	18.4
PLC_120	4.0	240.0	21.2
PLC_121	1.6	181.3	11.0
PRR_100	0.9	53.7	3.4
PRR_105	1.0	16.9	0.9
SD_100	2.2	87.6	8.5
SD_105	1.9	88.6	7.1
SD_110	1.3	52.1	4.4
SD_115	1.3	50.4	5.2
SD_120	3.2	150.7	15.1
SKD_100	1.5	58.9	6.9
SKD_105	0.5	24.7	3.1
SKD_110	0.1	66.2	5.4
SKD_115	1.0	56.2	4.7
SKD_120	2.0	131.8	9.5
SKD_125	1.5	80.9	5.2
SKD_126	2.9	243.6	16.5
SKD_130	1.6	143.3	11.8
SKD_135	2.8	213.6	11.7
SKD_136	1.8	158.9	10.5
SKD_137	1.1	116.9	9.7
SKD_140	2.2	243.0	15.4
SKD_141	0.5	51.0	2.8
SKD_145	2.6	361.0	23.4
SKD_150	0.8	173.3	16.0
SKD_155	1.3	222.8	16.4
SKD_165	2.3	31.3	3.4
SKD_170	3.9	46.6	3.9
SKD_175	2.1	32.8	3.9
SKD_190	0.1	77.0	5.3
SKD_195	0.6	121.3	8.0
WC_100	0.1	7.5	0.6
WC_101	0.1	26.5	1.4
WC_102	0.2	18.4	1.3
WC_103	0.1	12.4	0.8
WC_105	0.2	32.2	2.2
WC_105.1	0.1	8.2	0.4
WC_106	0.3	40.3	3.0
WC_107	0.4	32.9	1.6
WC_109	0.1	8.2	0.5
WC_110	0.3	55.0	3.4
WC_111	0.5	23.4	1.4
WC_112	0.1	7.5	0.5
WC_112.5	0.1	11.5	0.6
WC_113	0.4	96.1	5.7
WC_114	0.2	87.2	5.1
WC_115	0.3	42.6	2.7
WC_120	3.2	706.0	39.1
WC_130	0.3	38.2	3.5
WC_135	1.6	300.4	19.0
WC_140	4.5	567.1	34.8
WC_146	0.9	80.6	4.7
WC_150	3.4	371.4	24.1
WC_160	1.4	149.1	7.7
WC_170	0.3	7.7	0.7
WC_171	0.1	10.9	0.5
WC_172	0.2	16.6	0.8
WC_173	0.1	11.2	0.8

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 3.1 - SWMM Peak Flow Discharge



- Design Point
- Drainageway
- Existing Trails
- Future Trails
- Basin Boundary
- Subwatershed Boundary
- Jurisdictional Boundary

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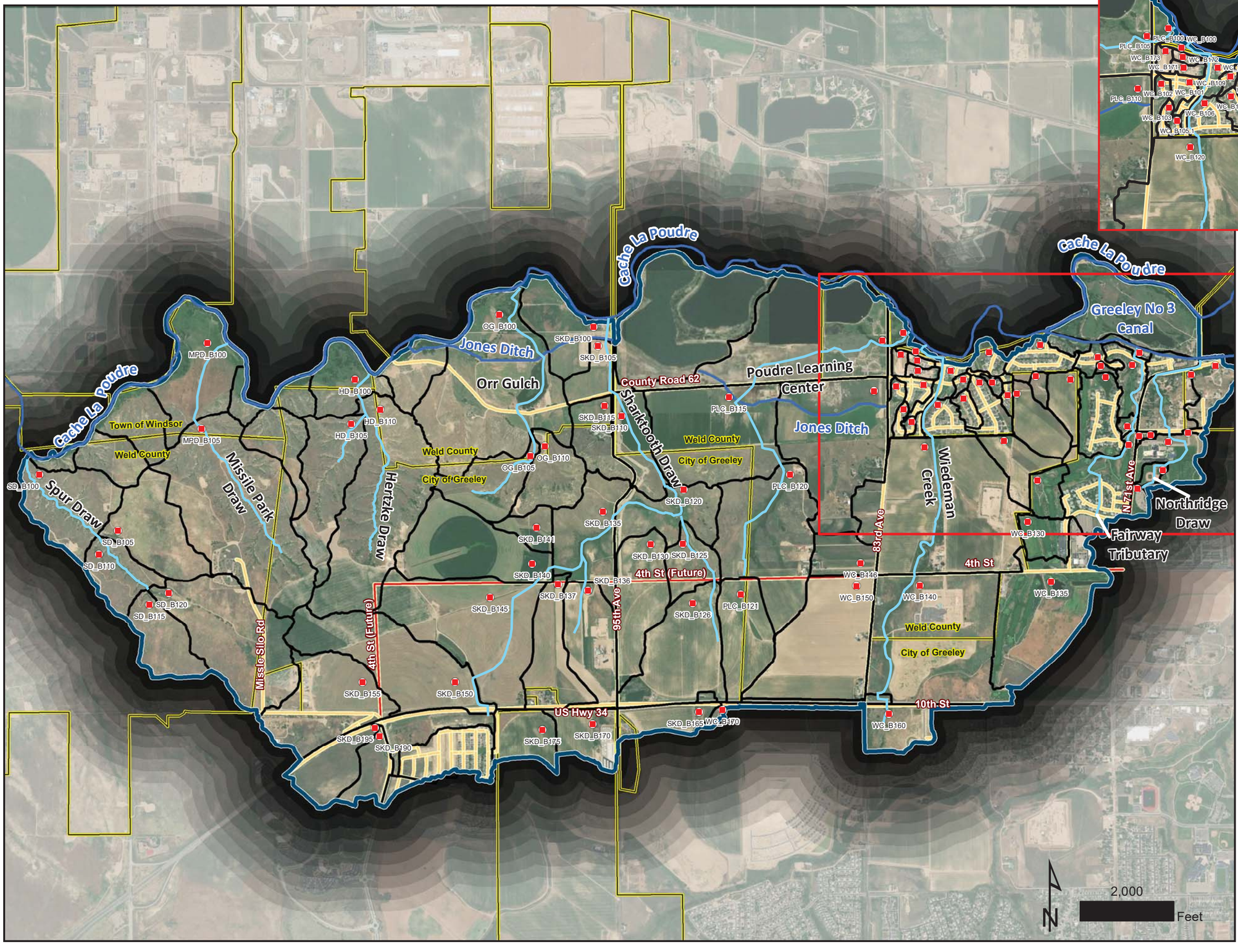
Table 3-4: Peak Flow Comparison

Figure 3-1 / Figure 3-2 ID	Location	Existing Peak Flow Rate (cfs)					Future Peak Flow Rate (cfs)				
		2-yr	5-yr	10-yr	50-yr	100-yr	2-yr	5-yr	10-yr	50-yr	100-yr
1	Spur Draw Outfall	4	10	31	275	412	4	7	10	10	10
2	Missile Park Draw Outfall	5	10	38	246	365	1	2	4	4	4
3	Hertzke Draw Outfall	5	11	48	232	335	5	6	8	8	8
4	Orr Gulch Outfall	2	5	18	154	254	3	4	7	7	7
5	Sharktooth Draw Outfall	13	35	122	450	636	24	26	31	40	47
6	Sharktooth Draw at CR 62	12	33	115	391	542	22	24	28	37	44
7	Sharktooth Draw at Diversion	14	37	142	710	1063	25	26	31	40	48
8	Sharktooth Draw at 95th Ave	11	29	104	528	793	16	18	23	32	40
9	Sharktooth Draw at Future 4th St (West)	5	14	48	250	374	6	6	8	13	13
10	Sharktooth Draw at Future 4th St (East)	3	6	22	88	124	3	3	3	4	4
11	Poudre Learning Center Outfall	31	49	98	136	139	19	19	19	20	21
12	Poudre Learning Center at 83rd Ave	31	48	96	686	1110	19	19	19	20	20
13	Poudre Learning Center at CR 62 and 83rd Ave	3	7	21	163	251	4	4	4	4	4
14	Poudre Learning Center at CR 62	2	5	37	440	732	10	10	11	11	12
15	Poudre Learning Center at Diversion	2	5	24	135	198	8	5	5	5	5
16	Wiedeman Creek Outlet 1	19	39	104	199	219	16	16	16	17	17
17	Wiedeman Creek Outlet 2	5	7	10	370	608	1	2	3	5	6
18	Wiedeman Creek Outlet 3	10	16	32	121	174	3	4	4	6	8
19	Wiedeman Creek at Poudre River Ranch	12	27	84	475	698	15	15	15	15	15
20	Wiedeman Creek at N 78th Ave	1	2	7	37	55	1	1	1	1	1
21	Wiedeman Creek at Future 4th St	8	18	48	195	264	9	9	9	10	10
22	Poudre River Ranch Outfall	6	8	12	32	44	1	1	1	2	2
23	Fairway Tributary Outfall	8	11	18	25	25	1	1	1	1	1
24	Fairway Tributary Outfall 2	2	4	5	18	50	0	0	0	0	0
25	Poudre River Outfall	6	10	14	26	31	5	7	10	21	27
26	Northridge Draw Outfall	0	1	5	66	114	0	0	0	0	0
27	Northridge Draw at 71st Ave	6	9	15	67	104	1	1	2	2	2

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 3.2 - Future Development Detention Basins



- Future Detention Basin
- Drainageway
- Basin Boundary
- Subwatershed Boundary
- Jurisdictional Boundary

City of Greeley Colorado

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4.0 HYDRAULIC ANALYSIS

Existing capacity for each storm drain system, comprised of inlets and subsurface pipes, was estimated from normal depth pipe calculations. The approximate design storm capacity of existing storm drain infrastructure can be found in Table 4-1 and is further discussed in Section 4.2 . Design storm capacity was determined from the normal depth pipe capacity in the baseline SWMM model.

FLO-2D was used to evaluate the residual flooding and hazard potential throughout the watershed for the 10- and 100-year design storms. FLO-2D software is a two-dimensional flood routing model that was used to identify residual flood potential with the watershed. FLO-2D simulates channel flow, unconfined overland flow and street flow over complex topology. The model uses the full dynamic wave momentum equation and a central finite difference routing scheme with eight potential flow directions to predict the progression of a floodwave over a system of square grid elements. The development of the FLO-2D model is further discussed in Section 4.2.1 . Identifying areas of high hazard potential is further discussed in Section 4.3 .

4.1 PREVIOUS ANALYSIS

No previous analysis has studied the western portion of the Sharktooth Bluffs Basin. On the eastern side of the basin, Weidman Creek, Poudre River Ranch, Fairway Tributary, and Northridge Draw have been previously studied in the Sheep Draw Basin study. These areas were included in subwatershed delineation when developing peak flows along the main stem of Sheep Draw but were not studied in detail. Drainage reports developed as part of each proposed developed site only studied site specific locations.

4.2 EVALUATION OF EXISTING FACILITIES

The existing storm drain infrastructure and roadway crossings were evaluated to determine the approximate design storm conveyance capacity. A summary of existing infrastructure and the approximate design storm capacity can be found in Table 4-1. In general, roadway crossing capacities exceeded the 10-year levels, but were found to be less than 50-year capacity. When considering the additional detention required through development of the basin, the roadway crossing capacity increased to convey the 100-year design storm in most locations. The approximate capacity of existing detention basins can be found in Table 4-2.

4.2.1 FLO-2D MODEL DEVELOPMENT

Three FLO-2D models were created to encompass the Sharktooth Bluffs Basin. Separate models were created for the west portion (Spur Draw, Missile Park Draw, and Hertzke Draw), central portion (Orr Gulch, Sharktooth Draw), and eastern portion (Poudre Learning Center, Wiedeman Creek, Fairway Tributary, and Northridge Draw) of the basin. The three discrete models allowed the grid cell size to be refined to 10-foot by 10-foot in order to maximize the precision in identifying flooding potential throughout the watershed. Elevations for each grid cell were computed through FLO-2D by interpolating the project LiDAR data, outlined in Section 1.4 . Building obstructions were incorporated into the FLO-2D model as blockages based on the building footprints GIS information provided by the City of Greeley.

The existing storm drain system for pipes 30 inches and greater in diameter were accounted for in the hydraulic analysis by integrating a dynamic SWMM model within the FLO-2D models.

Two different approaches were taken for the residual FLO-2D modeling of the basin. The first FLO-2D approach utilized individual subwatershed hydrographs from the baseline hydrology model (CUHP) and applied these hydrographs directly to the FLO-2D surface. Each hydrograph was applied at a single FLO-2D grid cell where the majority of discharges were expected to converge for each subwatershed. This approach more accurately correlates the hydrology CUHP runoff with the FLO-2D modeling; however, this approach also leaves gaps in the inundated area upstream of the location where the individual hydrograph is applied.

The second approach used was a rain-on-grid, this approach models the general inundation limits basin-wide. FLO-2D uniformly applies the rainfall hyetograph across the entire basin. The rainfall hyetograph was determined from CUHP using the point precipitation rainfall values. Infiltration was spatially varied throughout the basin using the Horton's infiltration method. Although this method would produce different results from CUHP, it provides an estimate of residual inundated areas within each individual sub-watershed, information which is also valuable to the City.

FLO-2D rain-on-grid is typically modeled to provide general flow paths throughout the basin, identify key design points, and provide preliminary problems area. The baseline hydrology model, utilizing the subwatershed runoff hydrographs from CUHP, is used to help refine problem area identification and provide flooding depths throughout the basin using project hydrology.

4.3 FLOOD HAZARDS

The result of the baseline hydrology FLO-2D residual flooding for the 10-, and 100-year design storms can be found in Figure 4.1 and Figure 4.2, respectively.

The result of the rain-on-grid analysis for the 10- and 100-year design storm can be found in Figure 4.3 and Figure 4.4, respectively.

High hazard zone mapping was completed for the basin using the baseline hydrology FLO-2D. Areas of high hazard indicate locations where an unacceptably high hazard to human safety exists. High hazard was defined as areas where the product of velocity (feet per second) and depth (feet) equals or exceeds four, or where flow depths equal or exceed four feet.

Areas of high hazard for the 10-, and 100-year design storm can be found in Figure 4.5 and Figure 4.6, respectively.

The flood hazards of each watershed are discussed below:

4.3.1 SPUR DRAW

The FLO-2D analysis indicated the major runoffs are confined within Spur Draw during both the 10- and 100-year design storms. There were also inundation areas during the 100-year design storm to the east of the bluffs but west of the Missile Site Park. These inundated areas do not pose any flooding hazards to insurable structures and no future development is expected in Spur Draw according to future City of Greeley Zoning.

4.3.2 MISSILE PARK DRAW

Flows in the upper portions of Missile Park Draw are mainly concentrated in defined drainageways. Discharge is conveyed downstream, ponding behind the Broe Land embankment, with maximum depths nearing nine feet during

the 100-year design storm. Shallow flow overtops the embankment, spreading out, as it flows to the north, northeast to the Cache La Poudre River. Additional ponding areas northwest of Missile Site Park were also observed. Maximum depths of up to ten inches pond in these areas before flow is conveyed northeast into the defined drainageway through the bluffs.

4.3.3 HERTZKE DRAW

Runoff in the Hertzke Draw is characterized by centralized flow paths through the drainages in the bluffs with a major alluvial fan as the flows exit the bluffs and continue to the Cache La Poudre River. In the bluffs, sub-drainageways converge into a main south to north drainage channel, which has depths ranging from six to twelve inches during the 100-year event. With no current development in the watershed and future zoning indicating the area remain open space, no flooding hazards to structures are expected in Hertzke Draw.

4.3.4 ORR GULCH

Sheet flooding is typical in the lower Orr Gulch basins as the flows leave the defined drainages and, then spread to the alluvial fan as the flows continue north to the Cache La Poudre River. Some of these flows in the lower basins of the watershed split and continue into the Sharktooth Draw outfall. Additional areas of inundation in the western portion of Orr Gulch were also identified. Flow of less than six inches in depth is conveyed north where the runoff ponds against the embankment of the William R. Jones Ditch. North of the Jones Ditch, the flow outfalls into the Cache La Poudre River in multiple locations.

The *Imagine Greeley Land Use Guidance Map* indicates the watershed to remain as open space. If the area were to develop, consideration should be taken to formalize the drainage paths within the watershed.

4.3.5 SHARKTOOTH DRAW

Major inundation is confined to the major drainage ways with depths up to 2.5 feet in areas. There are flooding concerns around the intersection of North 95th Avenue and County Road 62. The majority of areas showing inundation are where future land development is designated as open space or nature areas. A significant area of ponding was identified in the area of the proposed Lake Bluff Development, currently irrigated farmland located in the western portion of the watershed. Grading and onsite drainage associated with the Lake Bluff Development would be expected to remove the sump area and convey the discharge downstream. Near the downstream end of the watershed, overtopping of County Road 62 and N 95th Avenue pose significant flooding hazards as the basin develops.

4.3.6 POUDRE LEARNING CENTER

The baseline hydrologic scenario show the flows confined to the major drainageways in the southern portions of the watershed before opening up and spreading out as the flows approach the outfalls into the Cache La Poudre River. Flows are ponded to the west of North 83rd Avenue as they move from west to east to the river. Several areas of inundation were observed in the Poudre Learning Center subwatershed. West of North 83rd Avenue, flow sumps in three locations before continuing north to County Road 62. These three locations have maximum ponding depths of approximately four feet south of County Road 62. As development occurs, flows overtopping County Road 62 pose increased flooding hazards in the primary east-west corridor in the basin.

Future development in the Poudre Learning Center Basin is zoned to occur in the areas where potential flooding is shown in the models. For these future developments to be protected, careful consideration should be taken in site layout and future storm drainage infrastructure.

4.3.7 WIEDEMAN CREEK

The lower portions of Wiedeman Creek, near Poudre River Ranch and River Run at Poudre River Ranch, are fully developed. Two main drainage patterns convey flow through Poudre River Ranch. During the 100-year design storm, depths exceed five feet near the entrance to both culverts along the North 81st Avenue drainageway. Street flooding along Poudre River Road and North 81st Avenue pose flooding hazards to the watershed with flooding depths exceeding City maximum flow depth criteria of 18-inches. Additional flood hazards were identified south of the future 4th Street expansion east of Wiedeman Creek. During the 100-year design storm, flows overtop 4th Street in a secondary location east of the roadway culvert crossing. As this area develops, onsite drainage should provide a secondary crossing of 4th Street or convey this flow safely to the existing roadway crossing.

As the upper portions of the basin develop and possible 4th Street expansion occur, consideration should be taken to ensure no additional flow is conveyed that pose hazards to downstream properties.

4.3.8 POUDRE RIVER RANCH

Poudre River Ranch has one major drainage way through the development from the existing farmland to the south. These flows enter the site on North 77th Avenue and follow Plateau Road to the west and Poudre River Road to the northeast and east before flows outfall north to the Cache La Poudre River. The FLO-2D modeling shows flows are generally contained within the roadway and don't pose significant flooding hazards to structures.

Future development in the farmlands in the central portion of the Weidman Creek basin south of the Poudre River Ranch Development could potentially direct flows from this area into Poudre River Ranch, creating the potential for hazards.

4.3.9 FAIRWAY TRIBUTARY

On the northern edge of the watershed, flows are generally conveyed in Poudre River Road to the east. Depths approach thirty inches on the south side of the road near the storm drain culvert crossing with depths in the roadway near one foot in this location. Flooding hazards associated with the overtopping of W Melbourne Street and N 71st Avenue exists along the eastern edge of the watershed. Flows overtopping N 71st Avenue to the east are conveyed into Northridge Draw watershed, adding additional flooding hazards to what local runoff in Northridge Draw would indicate.

Further analysis in the Fairway Tributary watershed identified several areas of inundation, in the upper portions of the watershed, not shown in the baseline conditions model. Discharge is conveyed in the street in Canberra Commons and along Dundee Avenue south of Boomerang Links Golf Course. In general, the models indicate flow is contained within the right-of-way with some flow ponding on private property during the 100-year design storm.

Throughout the golf course, local depressions and the retention ponds north of Canberra Commons were shown to pond in excess of two and half feet during the 100-year design storm. In Boomerang Run, local runoff is conveyed north on Brisbane Avenue discharging into the retention pond located on the north end of the subdivision.

4.3.10 NORTHRIDGE DRAW

Throughout Northridge Draw, similar flow patterns were observed between the baseline conditions and rain-on-grid analysis. The 100-year design storm indicates flooding hazards to properties north of C Street and east of N 71st Avenue, discharge overtops the private pond to the south of this area, inundating structures to the north. The model also indicates flooding to the south of North 71st Ave with depths nearing twelve inches.

4.3.11 POUDRE RIVER WATERSHEDS

The Poudre River Watersheds tend to be in the more remote western portion of the study area, or downstream of any development where they do not pose a hazard. The models identified a flow path from North 71st Ave northeast to Greeley No. 3 Canal, this flow path does not currently inundate any structures but structures to the south of North 71st Street in the Northridge Draw drainage are inundated. Although additional flow paths were observed, no additional flooding hazards were identified in the rain-on-grid analysis for those areas directly tributary to the Cache La Poudre River or the Greeley No. 3 Canal.

Table 4-1: Existing Facilities Inventory

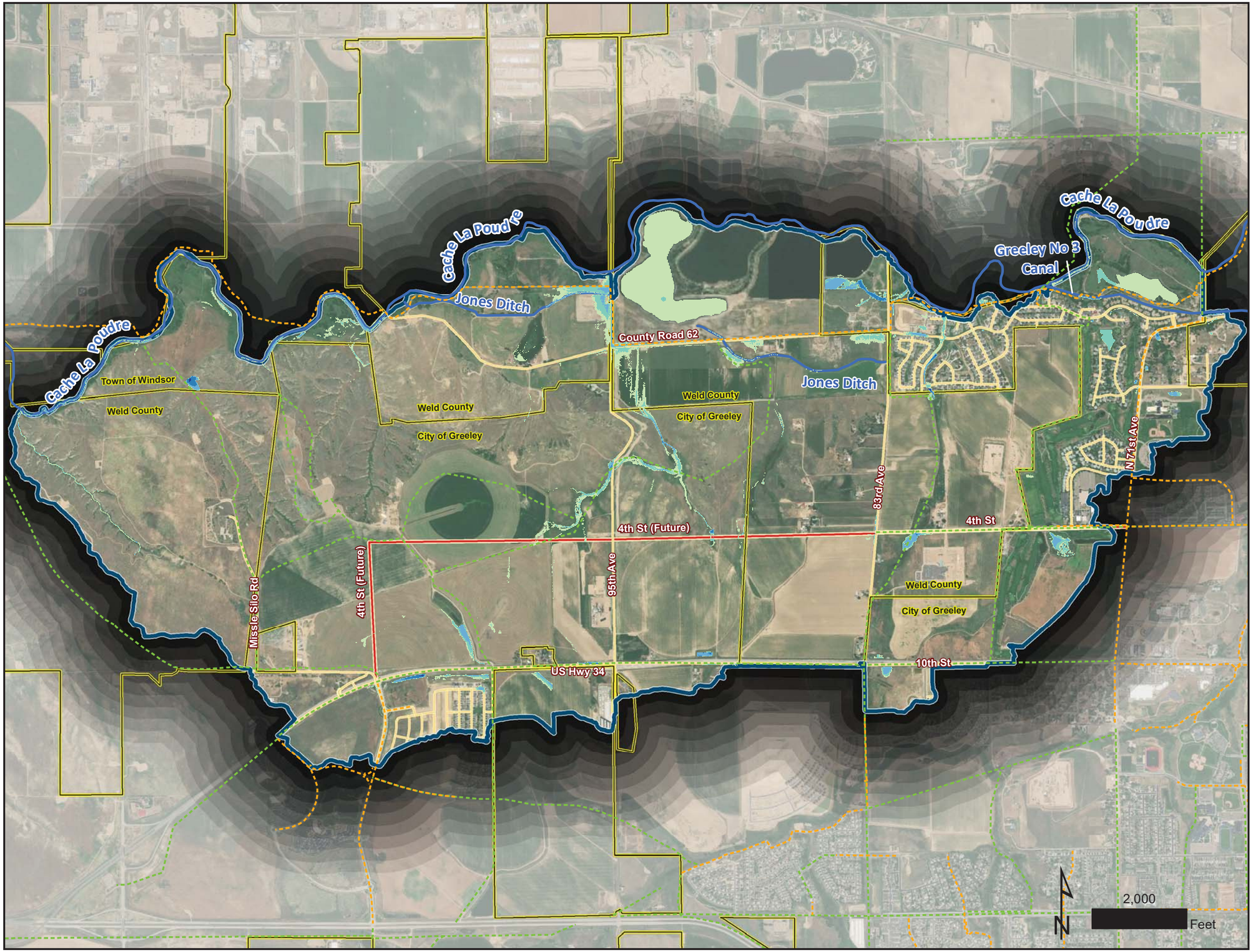
Watershed	Location	Pipe Characteristics		Design Storm Capacity		Ex. Peak Discharge (cfs)					Fut. Peak Discharge (cfs)				
		Size	Capacity (cfs)	Existing	Future	2	5	10	50	100	2	5	10	50	100
Fairway Tributary	Poudre River Road crossing west of Cache Ct.	30" RCP	11	< 50-yr	> 100-yr	1.6	2.8	7.2	53.2	85.3	0.2	0.2	0.2	0.2	0.2
	Poudre River Rd. crossing east of Vallevue Dr.	42" RCP	69	> 100-yr	> 100-yr	2.7	4.0	8.2	30.2	43.4	0.5	0.5	0.5	0.5	0.5
Wiedeman Creek	Poudre River Rd. crossing west of Riverside Ct.	36" RCP	111	> 100-yr	> 100-yr	1.4	3.3	9.2	35.3	50.4	0.6	0.6	0.6	0.6	0.6
	78th Ave	30" RCP	38	< 100-yr	> 100-yr	0.7	1.7	7.1	36.5	55.0	0.5	0.5	0.5	0.5	0.5
	78th Ave & Poudre River Rd	48" RCP	115	> 100-yr	> 100-yr	7.3	11.5	20.5	74.6	107.6	2.3	2.8	3.3	5.7	7.1
	Skyview St	7' x 4' RCBC	309	< 50-yr	> 100-yr	11.9	27.7	84.6	476.8	699.7	14.9	15.0	15.1	15.3	15.5
	81st Ave	5' x 4' RCBC	150	< 50-yr	> 100-yr	14.0	31.0	90.2	494.8	725.5	15.2	15.4	15.5	15.7	15.9
	River Run at Poudre River Ranch	42" RCP	58	> 100-yr	> 100-yr	5.2	6.8	9.0	21.9	29.9	0.1	0.1	0.1	0.1	0.1
	Poudre River Road east of N 83rd Ave	(3) 19" x 30" HERCP	36	> 100-yr	> 100-yr	3.4	4.9	6.7	12.6	15.7	0.3	0.3	0.3	0.3	0.3
	N 83rd Ave south of 4th St	36" RCP	47	< 50-yr	> 100-yr	3.0	7.7	26.9	108.2	153.1	3.4	3.4	3.4	3.4	3.4
	10th St	36" RCP	32	< 50-yr	> 100-yr	3.8	6.0	12.5	46.4	64.7	3.5	4.3	5.1	8.7	10.6
Poudre Learning Center	PLC Crossing of 83rd Ave	48" RCP	128	< 50-yr	> 100-yr	30.7	47.2	97.7	690.0	1094.3	18.5	18.6	18.9	19.7	20.2
Sharktooth Bluffs	95th Ave	(2) 36" RCP	132	< 50-yr	> 100-yr	10.9	28.8	104.3	528.3	793.3	16.2	18.3	22.6	32.1	40.0
	10th Street at Promontory	24" RCP	8	< 50-yr	< 50-yr	0.5	0.6	0.9	9.7	22.6	1.3	1.7	3.6	13.4	21.2
	10th Street west of 95th	54" CMP	188	> 100-yr	> 100-yr	3.2	5.5	13.6	55.9	79.4	2.4	4.5	6.0	11.4	19.2

Table 4-2: Existing Detention Basin Capacity

Detention Basin	Watershed	100-yr Peak Inflow (cfs)	100-yr Peak Release (cfs)	Maximum Available Storage (Ac-ft.)	Approximate Capacity (yr)
Melbourne Pond 1	Foothills Tributary	70.6	70.4	0.4	< 2-yr
Melbourne Pond 2	Foothills Tributary	70.4	70.4	0.5	< 10-yr
Northridge High School	Northridge Draw	19.0	8.5	1.2	> 100-yr
Winograd K-8 School	Northridge Draw	36.6	8.7	5.2	> 100-yr
Poudre River Ranch	Poudre River	31.2	31.2	0.02	> 100-yr
CDOT stb 379	Sharktooth Draw	32.4	18.9	3.6	> 100-yr
Promontory	Sharktooth Draw	147.1	22.6	23.4	> 100-yr
CDOT stb 382	Wiedeman Creek	77.5	39.6	4.8	< 50-yr

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 4.1 - FLO-2D Residual Flooding - Baseline Hydrology - 10-Year



- Existing Trails
- Future Trails
- Basin Boundary
- Jurisdictional Boundary

Residual Flooding Depth

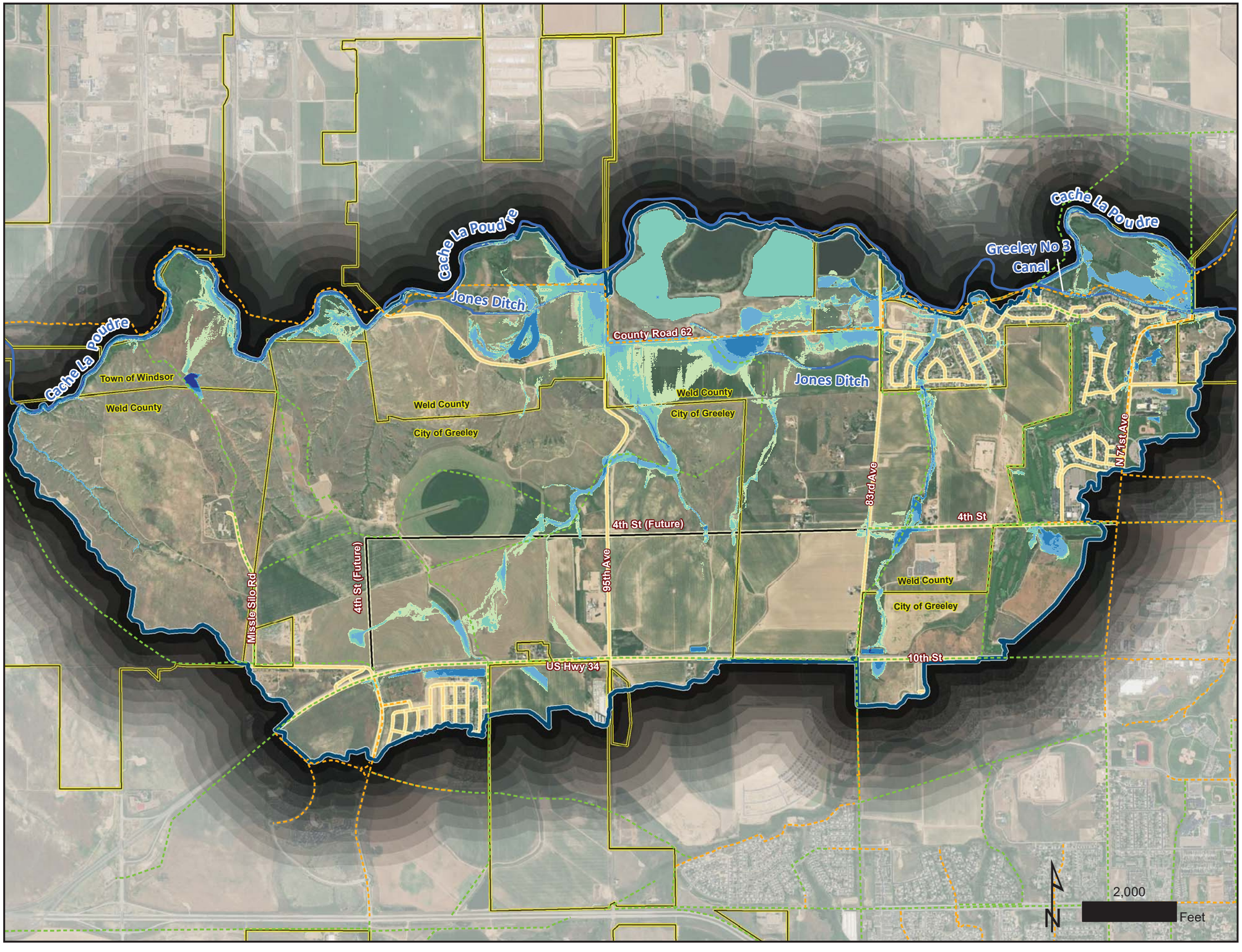
- 3 - 6"
- 6 - 12"
- 1 - 2.5'
- 2.5 - 5'
- > 5'

City of Greeley Colorado

ICON ENGINEERING, INC.

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 4.2 - FLO-2D Residual Flooding - Baseline Hydrology - 100-Year



Existing Trails

Future Trails

Residual Flooding Depth

- 3 - 6"
- 6 - 12"
- 1 - 2.5'
- 2.5 - 5'
- > 5'

Basin Boundary

Jurisdictional Boundary

City of Greeley Colorado

ICON ENGINEERING, INC.

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 4.3 - FLO-2D Residual Flooding - Rain-on-grid - 10-Year

Cache La Poudre
Cache La Poudre
Cache La Poudre
Greeley No 3 Canal
Jones Ditch
Jones Ditch
County Road 62
Town of Windsor
Weld County
Weld County
City of Greeley
Weld County
City of Greeley
City of Greeley
83rd Ave
N 71st Ave
4th St
4th St (Future)
4th St (Future)
95th Ave
Missie Silo Rd
Weld County
City of Greeley
10th St
US Hwy 34
N
2,000
Feet

- Existing Trails
- Future Trails
- Basin Boundary
- Jurisdictional Boundary

Residual Flooding Depth

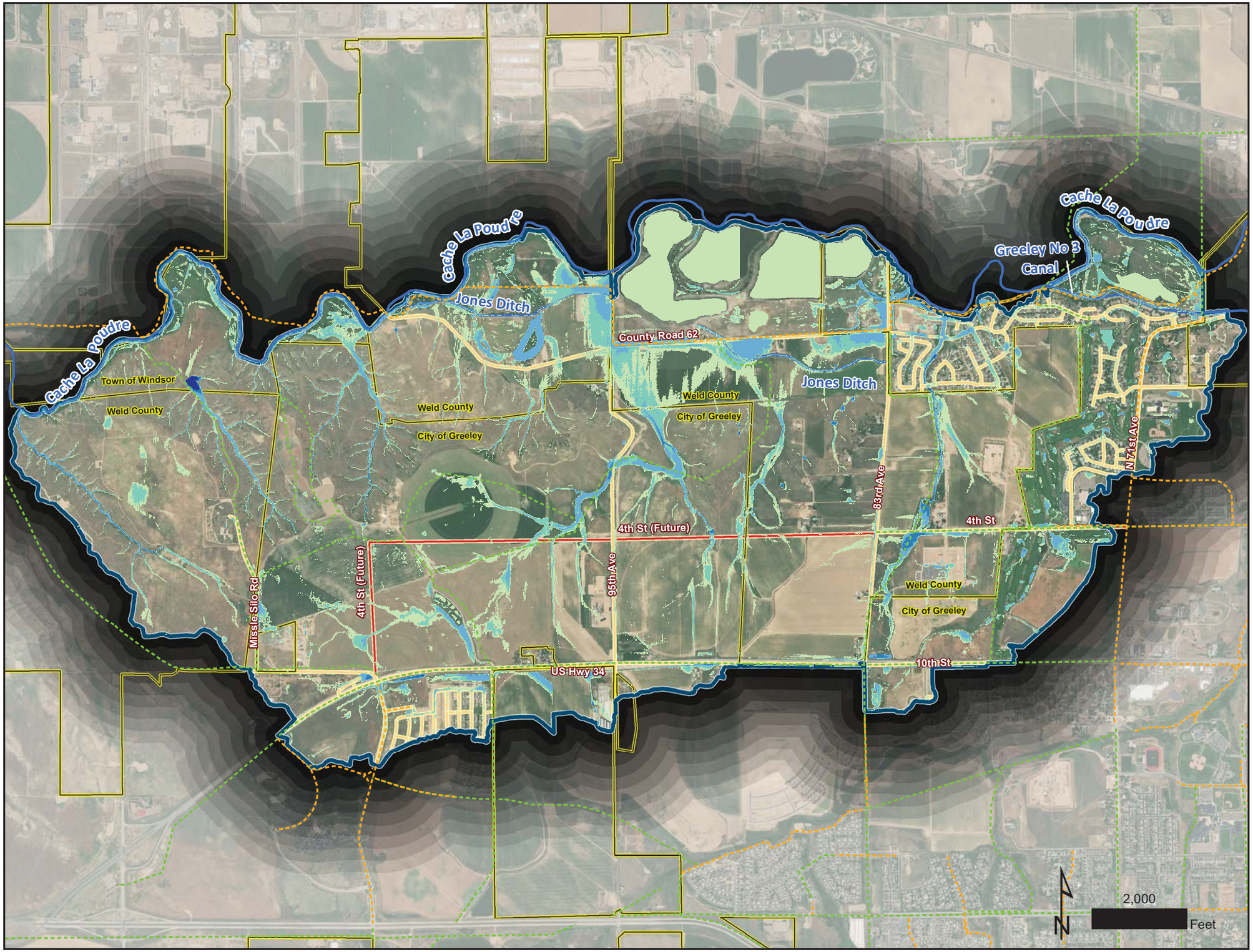
- 3 - 6"
- 6 - 12"
- 1 - 2.5'
- 2.5 - 5'
- > 5'

City of Greeley Colorado

ICON ENGINEERING, INC.

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 4.4 - FLO-2D Residual Flooding - Rain-on-grid - 100-Year



- Existing Trails
- Future Trails
- Basin Boundary
- Jurisdictional Boundary

Residual Flooding Depth

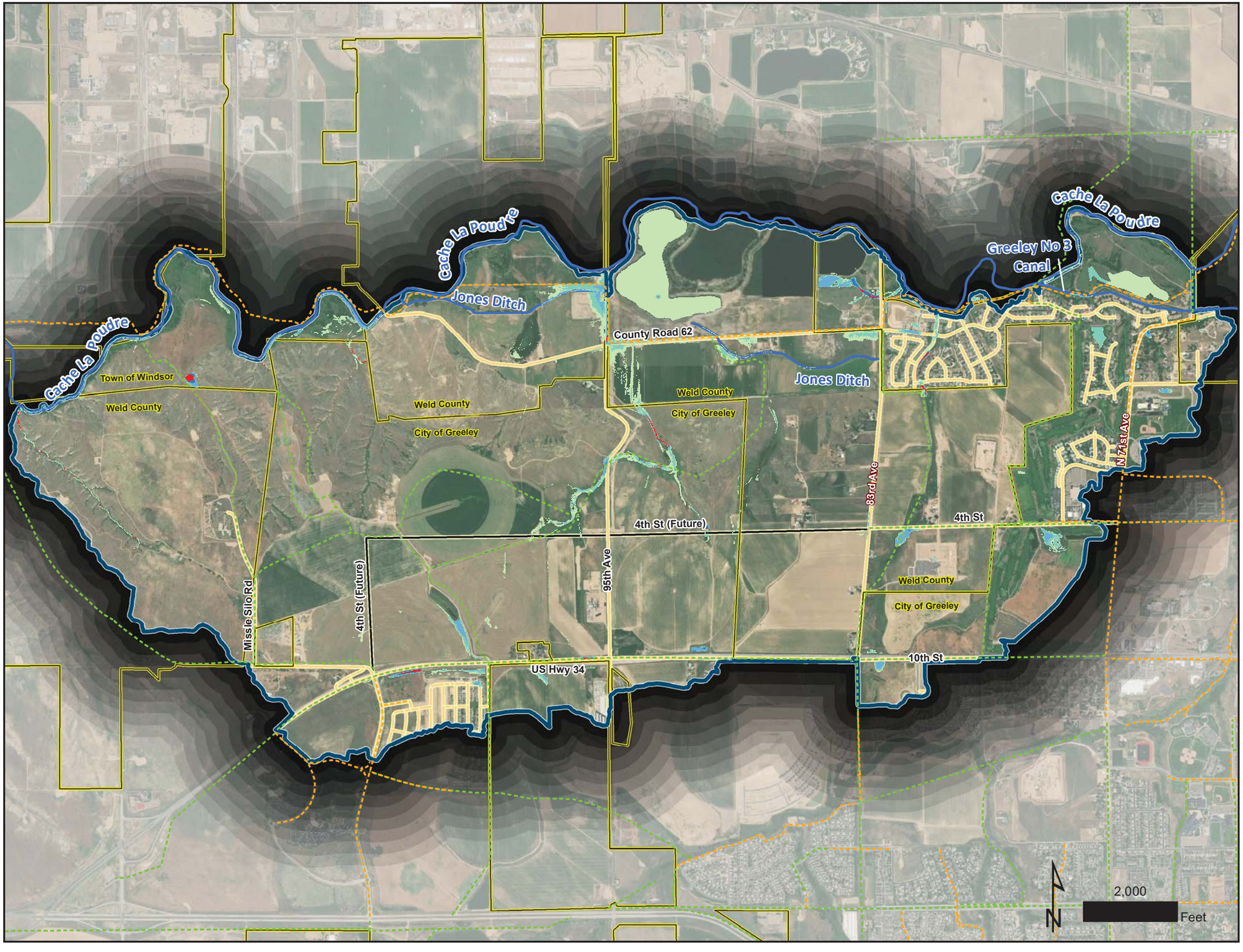
- 3 - 6"
- 6 - 12"
- 1 - 2.5'
- 2.5 - 5'
- > 5'

City of Greeley Colorado

ICON ENGINEERING, INC.

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 4.5 - FLO-2D Hazard ID - Baseline - 10-Year



Residual Flooding Depth

- High Hazard Area
- Existing Trails
- Future Trails
- 3 - 6"
- 6 - 12"
- 1 - 2.5'
- 2.5 - 5'
- > 5'
- Basin Boundary
- Jurisdictional Boundary

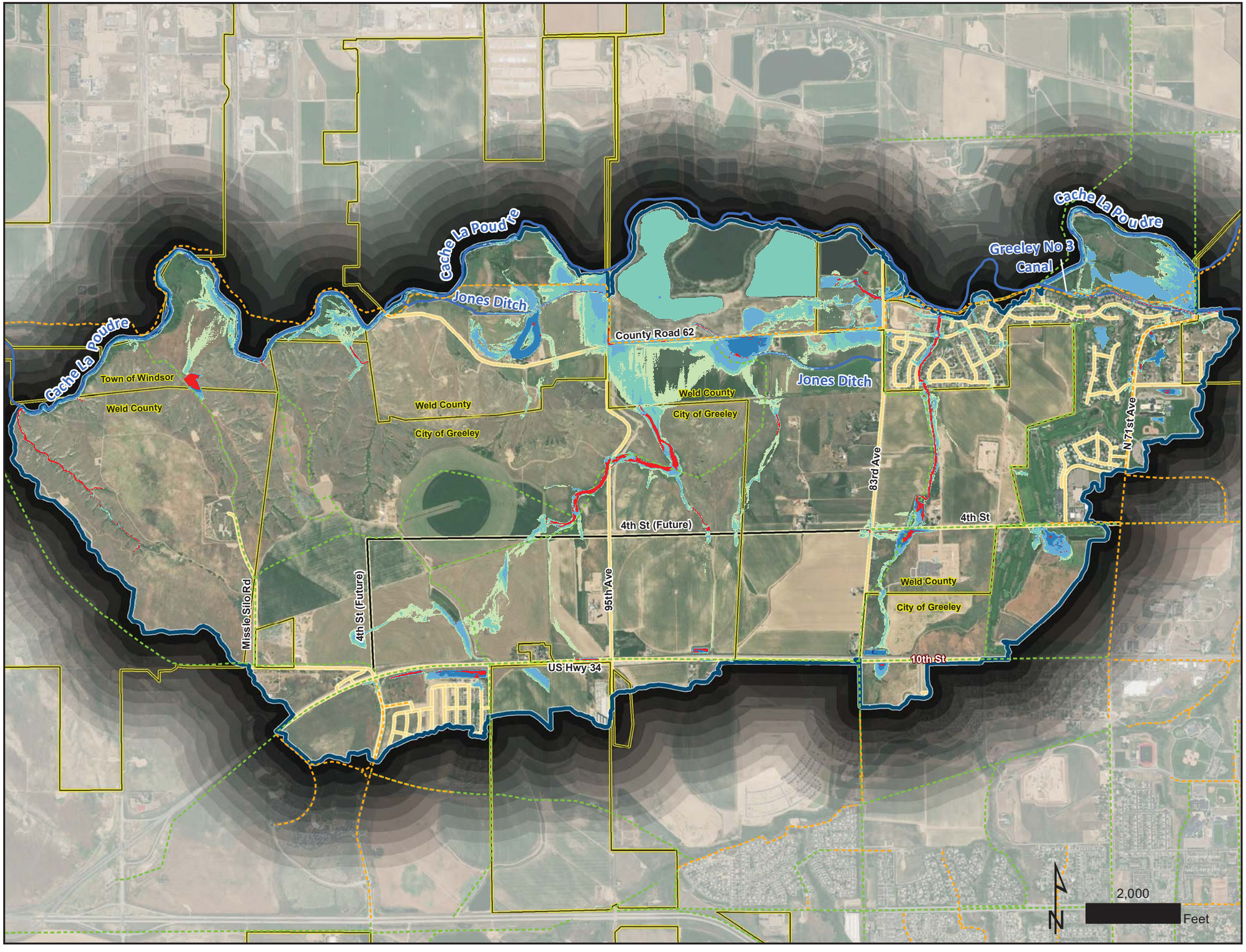
*High hazard area was defined as areas where the product of velocity (feet per second) and depth (feet) equals or exceeds four, or where flow depth equals or exceeds four feet

City of Greeley Colorado

ICON ENGINEERING, INC.

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 4.6 - FLO-2D Hazard ID - Baseline - 100-Year



Residual Flooding Depth

- High Hazard Area
- Existing Trails
- Future Trails
- 3 - 6"
- 6 - 12"
- 1 - 2.5'
- 2.5 - 5'
- > 5'
- Basin Boundary
- Jurisdictional Boundary

*High hazard area was defined as areas where the product of velocity (feet per second) and depth (feet) equals or exceeds four, or where flow depth equals or exceeds four feet

City of Greeley Colorado

ICON ENGINEERING, INC.

5.0 ALTERNATIVE ANALYSIS

5.1 ALTERNATIVE DEVELOPMENT PROCESS

The primary goals of this phase of the project is to develop alternatives which: mitigate existing flooding hazards, ensure current and future roadway crossings are compliant with City criteria, assess channel stability and possible sediment transport from the bluff areas, separate base flows from irrigation ditches, enhance water quality, and provide general guidance for preservation and improvement to the Sharktooth Bluffs drainageways throughout the basin as development begins to occur.

Design criteria and alternative category selection was reviewed at periodic progress meetings with City of Greeley Staff. Further discussion of each alternative plan is provided below, along with the review of project benefits and costs for applicable options. The alternatives can be found in Figure 5.2 through Figure 5.5.

5.2 CRITERIA AND CONSTRAINTS

All alternatives were designed to meet criteria set forth in the *City of Greeley Design Criteria and Construction Specifications Storm Drainage Volume II* (Reference 3).

5.2.1 FLOOD HAZARD MITIGATION CRITERIA

Detention basins were designed in accordance to Section 11a of City criteria. Maximum slopes on earthen embankments were designed to be no steeper than 4 horizontal to 1 vertical. Trickle channels were designed with a minimum longitudinal slope of 0.4 percent. A minimum of one foot freeboard was provided above the 100-year water surface elevation. In addition to City criteria, detention basins were limited to a maximum depth of five feet during the 100-year for safety concerns.

Storm drainage alternatives were designed to maintain a minimum of 18-inches of cover.

5.2.2 ROADWAY CROSSING CRITERIA

Culvert sizing for proposed roadway crossings were designed to meet criteria set forth in Section 8a and 9a of City criteria. This criteria states that: no overtopping shall occur for any street classification during the 10-year design storm; for local roads with a roadside ditch, collector, and minor arterial roadways, overtopping during the 100-year design storm shall not exceed 6-inches at the street crown; and no overtopping is allowed for roadways classified at major arterials. Roadway crossings were designed such that outlet velocities would not exceed twelve feet per second with a maximum headwater depth of one and one-half times the culvert diameter, or culvert height for non-round shapes.

5.3 ALTERNATIVE CATEGORIES

Across the basin several types of alternative categories were considered to meet project goals within each watershed.

5.3.1 NO ACTION ALTERNATIVE

The baseline alternative, or no action alternative, represents no improvements in the basin. The existing flood hazards and roadway overtopping would remain, or potentially worsen over time. Maintenance costs are included in this alternative for existing infrastructure.

5.3.1 MINIMUM DRAINAGE CRITERIA:

Improvements to meet the minimum criteria for existing and future roadway crossings, along with drainage through development areas, are recommended under this category. Roadway crossings were designed for locations in which the 100-year existing conditions design flow exceeded 100 cfs.

5.3.2 FLOOD CONTROL AND FLOOD HAZARD MITIGATION:

Flood control and flood hazard mitigation alternatives are proposed in areas of the basin when damage to buildings occur and where site specific mitigation measures could be considered to best manage spilt or unconfined flow. In addition, flood control alternatives are proposed in locations with the potential to improve drainage or flooding beyond the City's minimum standards, such as providing conveyance for the 100-year storm event. Alternatives ranged from: confinement of split flows to a central flow path, increasing storm drain capacity to 100-year levels, and detention alternatives to attenuate flows such that existing storm infrastructure could provide a higher level of service.

5.3.3 CANAL BASE FLOW SEPARATION IMPROVEMENTS:

In order to help mitigate flooding hazards on downstream property from flows exceeding the capacity of the William R. Jones Ditch and Greeley No. 3 Canal, alternatives were developed in Poudre River Ranch Phase I and II to separate stormwater from entering the canal, continuing the flow paths to the Cache La Poudre River.

5.4 ALTERNATIVE HYDRAULICS

Alternatives were developed using a variety of hydraulic software. Roadway crossings were designed using the U.S. Department of Transportation's, Federal Highway Administration's, HY-8 Culvert Analysis Program (HY-8). Storm drainage and detention alternatives were modeled using SWMM to determine appropriate pond and pipe size. The reduction in flooding was also reviewed using FLO-2D.

5.5 ALTERNATIVE COSTS

Alternative cost estimates were developed using UDFCD's master planning cost estimating spreadsheet UD-MP COST, version 2.2. 2012 unit cost values were adjusted to present value using the Colorado Construction Cost Index, 2018 Third Quarter Report. The average value of the last four quarters (1.34) of the Fisher Ideal Index was used to adjust unit costs. A summary of unit costs can be found in Appendix C.

Operation and Maintenance was also included within the UD-MP Cost worksheet. A minimum level-of-service for manhole and inlet maintenance was assumed to occur once per year. The minimum level-of-service for maintenance on detention basins and water quality facilities was assumed to occur once a year. Structural maintenance on canal spillways were assumed to be performed once every five years.

Costs for detention basins were estimated using the Complete-in-Place detention facility unit costs based on the necessary acre-feet of detention.

More naturalized stream systems are recommended for the Sharktooth Basin. Given many unknown factors, costs developed during alternative analysis also included riprap for undefined bank stabilization (i.e. Type L riprap over an estimated one half of the channel length); planting costs for disturbed areas assumed to be 85 percent reclamation and seeding (native grasses) and the remaining 15 percent wetland plantings; and as applicable riffle grade control at 200 ft. intervals along the channel length.

Right-of way, easement costs, and property values were calculated from current Weld County Assessor's information. Easement / ROW acquisition amounts were calculated as a percentage of the total actual land value. For undeveloped parcels, an average value of $88,000 / Acre was estimated from properties throughout the basin.

Asphalt was included as a special item within the UD-Cost spreadsheet at $250 lb. / ton for each roadway crossing.

No alterations were made to default values calculated as a percent of Capital Improvement Costs, such as Engineering, Legal/Administrative, Contract Administration/Construction Management, and Contingency. Dewatering, Traffic Control and Utility Coordination / Relocation were assigned based on the following percentages of capital costs: Dewatering (1%), Traffic Control (5%), Utility Coordination / Relocation (5%).

5.6 ALTERNATIVE PLANS

5.6.1 SPUR DRAW

Spur Draw, the western most watershed in the Sharktooth Basin, is located just east of US Highway 257. Stormwater runoff from the basin sheet flows to the Sharktooth Bluffs where the narrow gullies convey water northwest to the Cache La Poudre River. All flow is confined to the bluff areas. The watershed is currently undeveloped and future land use projects the watershed to remain open space. No roadway crossings, or other infrastructure is currently proposed in the watershed. Beyond monitoring runoff and potential sediment transport from the bluffs areas, no improvements are currently proposed for this watershed.

5.6.2 MISSILE PARK DRAW

This 275 acre watershed is bounded by Spur Draw to the west, Hertzke Draw to the east, Sharktooth Draw to the south and Cache La Poudre River to the north. The watershed spans three jurisdictions: Town of Windsor at the downstream end of the watershed, unincorporated Weld County, and the City of Greeley. Similar to Spur Draw, stormwater runoff is conveyed in narrow gullies which converge into a drainageway that bisects the watershed. Near the downstream end of the watershed, in the Town of Windsor and Weld County, there is an approximately 10-foot high embankment which detains flows from continuing north to the Cache La Poudre River. As discussed prior, no records were found regarding this being a regulated detention basin or registered state dam.

With exception to ponding that could occur behind this embankment, no other significant drainage problems were identified for this watershed, particularly within the limits of the City of Greeley. Beyond monitoring runoff and potential sediment transport from the bluffs areas, and monitoring the effects of the embankment for water collection, repair, or need to breach, no improvements are currently proposed for this watershed.

5.6.3 HERTZKE DRAW

Hertzke Draw, located to the east of Missile Park Draw and west of Sharktooth Draw watersheds, primarily consists of steep gullies conveying stormwater runoff to the north. Upstream of the outfall into the Cache La Poudre River, the watershed transitions from the confined gully drainageway to an alluvial fan. The watershed lies within Town of Windsor, unincorporated Weld County, and City of Greeley. The bluffs in the southeastern portion of the watershed, within the City of Greeley, lie on property proposed to be developed as part of the Lake Bluff Development.

Flooding potential within the watershed is minimal with more flooding potential located in the alluvial zones near the Poudre River. No buildings or structures are shown to be inundated and flooding potential will be lessened with future development in the watershed. Beyond monitoring runoff and potential sediment transport from the bluffs areas, no improvements are currently proposed for this watershed.

5.6.4 ORR GULCH

Orr Gulch is bounded by Hertzke Draw to the west and Sharktooth Draw to the south and east. The northern portion of the watershed falls within unincorporated Weld County, while the southern portion is located within the City of Greeley. The portion within the City of Greeley is proposed to remain open space as part of the proposed Lake Bluff Development. The narrow bluff gullies collect stormwater runoff in the headwater of the basin before the flow is spread into an alluvial fan south of County Road 62. North of County Road 62, the William R. Jones Ditch bisects the lower watershed, conveying irrigation flows from the Cache La Poudre River to Siebring Reservoir.

Flooding problems within the watershed are primarily related to ponding south of the William R. Jones Ditch, where flow depths approach 3-feet in what appears to be a historic oxbow from the Cache La Poudre River and potential overtopping of County Road 62. Since this area is located outside of the City of Greeley with no current plans for expansion of this roadway system, no alternatives were evaluated in this watershed.

5.6.5 SHARKTOOTH DRAW

Sharktooth Draw extends from south of 10th Street to the Cache La Poudre River, covering 1,235 acres. The watershed lies within the City of Greeley and unincorporated Weld County. The headwaters of Sharktooth Draw begin south of 10th Street, east of Promontory Circle near the State Farm property. Stormwater runoff then continues in a northeast direction to the river.

Flooding within the watershed is generally confined near 10th Street, then transitions between overland and confined flow through 95th Avenue when entering the bluffs region. Downstream, flood flows again become unconfined when Sharktooth Draw splits to the north and the east, in an alluvial pattern, near County Road 62, diverting up to 541 cfs of the total 100-year discharge of 1063 cfs to the Poudre Learning Center watershed.

Problems areas within the watershed focus around overtopping of existing roadway crossings, including: 95th Avenue, both north of 10th Street and closer to the Poudre River near County Road 62; and County Road 62, which currently has no defined drainage system and is located within Greeley's anticipated expansion area. These areas experience overtopping in both the 10- and 100-year events. In addition to the roadway crossings, the split flow near 95th Avenue and County Road 62 has the potential to impact roadway improvements and future development

during the larger storm events (above the 10-year level). Finally, the future expansion of 4th Street will require planning as it crosses drainages within the Sharktooh Draw watershed. Currently, the proposed 4th Street alignment is proposed to cross three local drainages.

5.6.5.1 NO ACTION ALTERNATIVE

The No Action Alternative for the Sharktooth Draw watershed consists of maintaining the existing roadway culvert crossings at 95th Avenue, north of 10th Street. This work is required to ensure that the existing culvert is functional during a storm event. No other action is required within the watershed.

5.6.5.2 MINIMUM CRITERIA ALTERNATIVE

The Minimum Criteria Alternative addresses overtopping for 95th Avenue near 10th Street and overtopping of 95th Avenue near County Road 62. In addition, this alternative proposes culverts sized for the three drainageway crossings along the 4th Street Alignment.

95th Avenue, north of 10th Street. As shown by the hydraulic study, drainage in this area overtops the roadway to the north of the current crossing. 0.5 foot to 1 foot of overtopping occurs during the 10-year event and 1 foot to 2 foot of overtopping occurs during the 100-year event. The Minimum Criteria Alternative proposes to improve the 95th Avenue crossing from two 36-inch RCP's to a two cell 8 foot by 4.5 foot RCBC. The improved crossing structure will convey 764 cfs, with approximately 29 cfs overtopping the roadway during existing conditions 100-year event.

95th Avenue and County Road 62. No significant culvert crossings currently exist for either 95th Avenue or County Road 62 at this location. Only an 18" CMP currently crosses 95th Avenue, east to west. As shown by the hydraulic study, drainage in this area overtops each roadway splitting flow between the Sharktooth Draw and Poudre Learning Center Watersheds. 10-year overtopping depths are approximately 3 to 6 inches, whereas 100-year depths exceed a foot. The Minimum Criteria Alternative proposes to add a double 10 foot by 6 foot RCBC culvert at the 95th Avenue/ County Road 62 intersection to reduce overtopping depths to meet criteria. Approximately 1,063 cfs will be conveyed in the box culvert with 45 cfs overtopping the roadways during the 100-year event. The improved crossing structure will convey 935 cfs, with approximately 45 cfs overtopping the roadway during existing conditions 100-year event. To effectively collect the Sharktooth Draw flows for the culvert conveyance, channel grading would be anticipated up to 3,000 feet upstream and 1,500 feet downstream of the proposed culvert crossing, along private property to the east of 95th Avenue. Alternative outfall channels were developed to convey the flow downstream of County Road 62 on both the east and west side. The east side alternative proposes to discharge the outfall to Siebring Reservoir; however it may be preferred to outfall to the Cache La Poudre River, in which case a separation crossing with the Jones Ditch may be required. Both construction costs and easement costs for the 90 foot wide channel have been included in the alternative cost estimates, although this work could also be completed through redevelopment. With this improvement, the split flow to the Poudre Learning Center Basin will be eliminated for flows up to the 100-year event.

Future 4th Street Culvert Crossings: The future expansion of 4th Street will require planning as it crosses drainages within the Sharktooth Draw watershed. Currently, the proposed 4th Street alignment is proposed to cross three local drainages, referred to as 4th Street West, Central, and East, for comparison. The Minimum Criteria Alternative proposes to add new culvert crossings meeting city criteria. These culverts are identified below:

Table 5-1: Sharktooth Draw - Minimum Criteria Alternatives

Location	Ex. 100-year Discharge (cfs)	Improvement	Culvert Flow (cfs)	Overtopping Flow (cfs)
Future 4th Street Crossing (West)	391	10 ft. x 4.5 ft RCBC	338	53
Future 4th Street Crossing (Central)	151	48 in. RCP	122	29
Future 4th Street Crossing (East)	124	48 in. RCP	111	13
95th Avenue	793	(2) 8 ft. x 4.5 ft. RCBC	764	29
95th Avenue / County Road 62	1,063	(2) 10 ft. x 6 ft. RCBC	1020	43

FLO-2D modeling in the area of 4th Street identified depths surrounding the future roadway ranging from one to six inches in the 10-year design storm to over 1 foot during the 100-year event. More importantly, the flow width during the 100-year even can exceed two hundred feet, where special consideration should be taken in the culvert design and construction. It may be more practical to construct more than one culvert in each area.

5.6.5.3 FLOOD CONTROL AND FLOOD HAZARD MITIGATION ALTERNATIVES

No buildings or structures are inundated by flood flows within the Sharktooth Draw Basin. Flood control improvements consist of upsizing the proposed roadway crossings to 100-year facilities. A listing of the proposed facilities meeting 100-year capacity is shown below.

Table 5-2: Sharktooth Draw - Flood Control and Flood Hazard Mitigation Alternatives

Location	Ex. 100-year Discharge (cfs)	Improvement Size
Future 4th Street Crossing (West)	391	12' x 4' RCBC
Future 4th Street Crossing (Central)	151	6 ft. x 3 ft. RCBC
Future 4th Street Crossing (East)	124	6 ft. x 3 ft. RCBC
95th Avenue	793	(2) 10 ft. x 5 ft. RCBC
95th Avenue / County Road 62	1,063	(2) 10 ft. x 7 ft. RCBC

5.6.5.4 CANAL BASE FLOW SEPARATION IMPROVEMENTS

No specific canal base flow separation alternatives have been proposed for the Sharktooth Draw watershed. As discussed previously, depending on the selected outfall for the watershed (i.e. the Cache La Poudre River or the Siebring Reservoir, an improvement to bypass the Jones Ditch may be required. If selected, this will be addressed during the conceptual design phase.

5.6.5.1 SUMMARY

A summary of alternatives and costs based on each alternative plan are presented below. The total costs include property acquisition, City project management, and engineering costs broken out in further sections of this report.

Table 5-3: Sharktooth Draw Alternative Costs

Location	Alternative Plan	Improvement	Total Capital Cost	50-YR O&M
Future 4th Street Crossing (West)	Minimum Criteria	10 ft. x 4.5 ft. RCBC	$ 188,188	$ 3,142
	Flood Control	12 ft. x 4 ft. RCBC	$ 210,434	$ 3,142
Future 4th Street Crossing (Central)	Minimum Criteria	48 in. RCP	$ 51,379	$ 3,142
	Flood Control	6 ft. x 3 ft. RCBC	$ 116,330	$ 3,142
Future 4th Street Crossing (East)	Minimum Criteria	48 in. RCP	$ 51,379	$ 1,571
	Flood Control	6 ft. x 3 ft. RCBC	$ 127,482	$ 1,571
95th Avenue	Minimum Criteria	(2) 8 ft. x 4.5 ft. RCBC	$ 326,674	$ 3,771
	Flood Control	(2) 10 ft. x 5 ft. RCBC	$ 384,338	$ 3,771
County Road 62 & Upstream Channel	Minimum Criteria	(2) 10 ft. x 6 ft. RCBC Channel Improv.	$ 4,482,851	$ 331,519
	Flood Control	(2) 10 ft. x 7 ft. RCBC Channel Improv.	$ 4,584,145	$ 331,519
Downstream of County Road 62	Option 1	Channel Improv West of CR 62	$ 2,387,740	$ 169,687
	Option 2	Channel Improv East of CR 62	$ 1,374,785	$ 94,271

5.6.6 POUDRE LEARNING CENTER

The Poudre Learning Center watershed extends from the Cache La Poudre River south to 10th Street, between N 83rd Avenue to the east and N 95th Avenue to the west. Flow in the upper portion of the watershed primarily consists of sheet flow down into the bluffs. The stormwater runoff spreads from the confined flow in the bluffs into an alluvial fan south of County Road 62. Flow crosses the William R. Jones Ditch and County Road 62 into Siebring Reservoir. An outlet channel from the most eastern portion of Siebring Reservoir conveys flow east to 83rd Avenue before the outfall location into the Cache La Poudre River.

Hydraulic analysis demonstrates that flows within the watershed are generally confined to the major drainageways in the southern portions of the watershed before fanning overland as the flows approach the outfalls into the Cache La Poudre River. Flow ponds south of County Road 62 and west of North 83rd Avenue, including open areas of the Poudre Learning Center property. South of County Road 62, three locations have maximum ponding depths of approximately four feet.

Future development near the Poudre Learning Center Basin is zoned to occur in the areas where potential flooding is shown in the models. For these future developments to be protected, careful consideration should be taken in site layout and future storm drainage infrastructure.

County Road 62 bisects the watershed at the north end of the basin. Similar to the Sharktooth Draw watershed, County Road 62 is mostly outside of the City of Greeley; however it is located within Greeley's anticipated expansion area. Just west of 83rd Avenue, adjacent to the Poudre Learning Center, County Road 62 is located within the City boundaries.

An out-building is potentially inundated from flooding, north of the Jones Ditch near the westernmost sump location. Even after improvements are made to the western spill flows in the Sharktooth Draw basin, this building may remain in a potential inundation area due to its proximity with the canal. No other buildings are identified to be inundated during the existing conditions 100-year event; however, it should be noted that an oil and gas well site does exist within the headwaters channel of the draw, near the future 4th Street alignment.

Discharges at the future 4th Street alignment remain less than 100-cfs at this location; therefore, improvement alternatives were not developed within the Poudre Learning Center watershed for the roadway system.

5.6.6.1 NO ACTION ALTERNATIVE

The No Action Alternative for the Poudre Learning Center watershed consists of maintaining the existing roadway culvert crossings at County Road 62, an existing 24" CMP, and the existing crossing at 83rd Avenue, a 48" RCP. This work is required to ensure that the existing culvert is functional during a storm event. No other action is required within the watershed.

5.6.6.2 MINIMUM CRITERIA ALTERNATIVE

The Minimum Criteria Alternative proposes to install, or improve, culvert crossings along County Road 62 and 83rd Avenue. At 83rd Avenue, the existing 48" RCP is proposed to be replaced with a two cell 13 foot by 6 foot RCBC. 83rd Avenue is a major arterial, requiring 100-year conveyance capacity with no overtopping. The RCBC will convey the 100-year design flow of 1,094 cfs through the crossing.

Along County Road 62, new culverts are proposed at the three sump locations located between the Jones Ditch and the roadway. These three culverts are fed by the 790 cfs runoff exiting the draw. The alluvial topography generally splits flow evenly between east and west flow paths, roughly 400-cfs each way. 12 foot by 4 foot RCBC's are proposed at the western most and easternmost sump locations to convey 400-cfs each, with less than six inches of water overtopping the roadway. The western culvert is proposed to be installed in a sump condition discharging towards the quarry area located in the center of the western flow path. The eastern culvert will replace the existing 24" CMP and discharge west of 83rd Avenue on the Poudre Learning Center property. Due to the culvert depth at this location channel and bank grading between the learning center and roadway will be needed to the 83rd Avenue Culvert. The primary purpose of the central culvert is to drain the localized sump from crossing the roadway. A 36" RCP culvert is proposed to cross County Road 62 and bike path, discharging into a localized swale in the Poudre Learning Center property.

All of these improvements assume that the split flow from Sharktooth Draw is able to be discharged north with flow removed from the Poudre Learning Center basin. If improvements within the Poudre Learning Center Watershed occur first, the culvert sizes may need to be enlarged for additional discharges.

Table 5-4: Poudre Learning Center Minimum Criteria Alternatives

Location	Ex. 100-year Discharge (cfs)	Improvement	Culvert Flow (cfs)	Overtopping Flow (cfs)
County Road 62 (West)	400	12 ft. x 4 ft. RCBC	351	49
County Road 62 (Central)	--	36 in RCP	--	--
County Road 62 (East)	400	12 ft. x 4 ft. RCBC	351	49
83rd Avenue	1,094	(2) 13 ft. x 6 ft. RCBC	1,094	--

5.6.6.3 FLOOD MITIGATION ALTERNATIVE

Flood control improvements consist of upsizing the proposed roadway crossings to 100-year facilities. Street classification dictated 83rd Avenue as a 100-year crossing in the Minimum Criteria Alternative and no additional Flood Mitigation Alternative was developed. A listing of the proposed facilities meeting 100-year capacity is shown below.

Table 5-5: Poudre Learning Center Flood Mitigation Alternatives

Location	Ex. 100-year Discharge (cfs)	Improvement Size
County Road 62 (West)	400	12 ft. x 5 ft. RCBC
County Road 62 (East)	400	12 ft. x 5 ft. RCBC
83rd Avenue	--	--

5.6.6.4 CANAL BASE FLOW SEPARATION IMPROVEMENTS:

The Jones Ditch has the potential to intercept runoff from flow exiting the Poudre Learning Center main draw, and from backwater behind County Road 62. Due to the alignment differences between the ditch, roadway, and draw exit location, separation of the inflows did not appear practical. As an option, a designated spill location has been proposed upstream of 83rd Avenue to spill flows above the canal decree to the County Road 62 east culvert and subsequently through 83rd Avenue and to the Cache La Poudre River.

Table 5-6: Poudre Learning Center Canal Seperation Alternatives

Location	Improvement Size
Jones Ditch at 83rd Avenue	50 ft. spillway and DS Channel

5.6.6.5 SUMMARY

A summary of alternatives and costs based on each alternative plan are presented below. The total costs include property acquisition, City project management, and engineering costs broken out in further sections of this report.

Table 5-7: Poudre Learning Center Alternatives Cost

Location	Alternative Plan	Improvement	Total Capital Cost	50-YR O&M
County Road 62 (West)	Minimum Criteria	12 ft. x 4 ft. RCBC	$ 303,689	$ 3,142
	Flood Mitigation	12 ft. x 5 ft. RCBC	$ 346,173	$ 3,142
County Road 62 (Central)	Minimum Criteria	36 in. RCP	$ 40,735	$ 1,571
County Road 62 (East)	Minimum Criteria	12 ft. x 4 ft. RCBC & DS Channel	$ 586,032	$ 66,775
	Flood Mitigation	12 ft. x 5 ft. RCBC & DS Channel	$ 619,772	$ 66,775
Jones Ditch at 83rd Ave	Canal Baseflow Separation	Spillway & DS Channel	$ 130,249	$ 32,492
83rd Avenue	Minimum Criteria	(2) 13 ft. x 6 ft. RCBC	$ 562,723	$ 5,028

5.6.7 WIEDEMAN CREEK

The Wiedeman Creek watershed extends from the Cache La Poudre River south beyond 10th Street. The watershed lies within the City of Greeley and unincorporated Weld County. Runoff generally drains south of 10th Street, north to the Cache La Poudre River. Poudre River Ranch Phase III and the River Run at Poudre River Ranch Phases I and II developments are present within this watershed. Two main drainage patterns convey flow through Poudre River Ranch. During the 100-year design storm, depths exceed five feet near the entrance to both culverts along the North 81st Avenue drainageway. Street flooding along Poudre River Road and North 81st Avenue pose flooding hazards with flooding depths exceeding City maximum flow depth criteria of 18-inches. Additional flood hazards were identified south of the future 4th Street roadway expansion, east of Wiedeman Creek in a localized sump area.

Primary problems within the Wiedeman Creek watershed focus on drainage within the Poudre River Ranch Phase III development area. The more prominent area of concern is at the southern boundary of the property, where the drainage infrastructure is undersized. First, the 700 cfs discharge from the south exceeds the capacity of the existing 7 foot wide by 4 foot tall RCBC. This results in overtopping of Skyview Street in excess of City criteria. Downstream, the system downsizes to a 5 foot wide by 4 foot tall RCBC, resulting in spill flows to 81st Avenue with flow depths in excess of the City's 18 inch criteria. Two homes are inundated west of the 5 foot by 4 foot box culvert entrance where flow spills onto 81st Avenue. A reduced slope on the culvert section limits the storm drain capacity to less than an estimated 185 cfs. The combined lack of drainage in this area exceeds City criteria regarding flow depth, with also the potential to inundate recently constructed homes. Baseline hydraulic modeling indicates one home in the River Run at Poudre River Ranch Phase I is inundated at the northeast corner of Poudre River Road and 81st Avenue. Surface flow continues north in 81st Avenue spilling over River Run Drive to the north into the Cache La Poudre River.

Local runoff west of 81st Avenue in Poudre River Ranch Phase III is conveyed through two primary flow paths. A grass swale conveys flow to three elliptical concrete pipes crossing Poudre River Road just east of N 83rd Avenue. Street flow is conveyed north on Double Tree Drive turning east at Poudre River Road. Stormwater at this location is intercepted in a storm drain that conveys and intercepts additional stormwater runoff through River Run at Poudre River Ranch Phase II. Flow sumps in two locations along Redwing Avenue within River Run at Poudre River Ranch Phase II but flooding is confined within the right-of-way and does not exceed City depth criteria of 18 inches.

Runoff from the existing farm land and Boomerang Links concentrates in two additional locations before being conveyed through Poudre River Ranch Phase III. First, stormwater is intercepted along N 78th Avenue in a storm drain system that increases in size from 18-inches at Skyview Street to 36-inches at Poudre River Road. The flow is unconfined upstream of the neighborhood inundating one structure south of Skyview Street and west of 78th Avenue. Flows exceeding the capacity of the 18 inch lateral along Sage Avenue spill to the east inundating three homes during the 100-year storm. Surface runoff sumps just west of 78th Avenue, exceeding City criteria of 18 inches in depth. The storm drain discharges west of Riverside Court into an open channel that conveys flow into a water quality basin and subsequently the Cache La Poudre River. Second, a 30-inch storm drain intercepts stormwater runoff from the existing farm land east of Amour Hill Drive. The shallow unconfined flow from the Wiedeman Family Farm is intercepted within the 30-inch storm drain, inundating two structures as the stormwater continues west to Amour Hill Drive. The storm drain flow is conveyed west where the flow is discharged into an open channel between N 78th Avenue and Amour Hill Drive. The open channel is conveyed underneath Poudre River Road in a 36-inch storm drain which outfalls in the same open channel as the storm drain in N 78th Avenue.

5.6.7.1 NO ACTION ALTERNATIVE

The No Action Alternative Plan proposes no improvements to the drainage systems within the Wiedeman Creek watershed. This alternative consists of maintaining the existing roadway culvert crossings at 10th Street, N 83rd Avenue, Poudre River Road (east of 83rd Avenue), River Run at Poudre River Ranch, 81st Avenue, 78th Avenue, and the Poudre River Road crossing west of Riverside Court.

With the No Action Alternative, drainage concerns will not be improved through the Poudre River Ranch Phase II and the River Run at Poudre River Phase I and II neighborhoods, but will rely on future development upstream to alleviate the problems over time through established development criteria.

5.6.7.1 MINIMUM CRITERIA ALTERNATIVE

For Poudre River Ranch Phase III, meeting the minimum City criteria requires that the roadways not overtop beyond a 6 inch depth during the 100-year event and that an 18 inch depth is not exceeded along the roadways. This predominately requires improvement to the Skyview Street culvert and 81st Avenue storm drain system. At Skyway Street, a 12 foot by 5 foot RCBC is proposed to convey the 700 cfs, with 607 cfs passing the culvert and 93 cfs overtopping the roadway at a depth less than 6 inches. Along North 81st Avenue, utility conflicts north of Poudre River Road restrict storm drain infrastructure height to four feet. The Minimum Criteria Alternative proposes a 9 foot by 4 foot box culvert to convey approximately 380 cfs in the storm drain allowing the excess 320 cfs to overtop onto North 81st Avenue. Existing street capacity in 81st Avenue is approximately 380 cfs before the flooding depth criteria of 18-inches is exceeded.

As an alternative, detention upstream of Skyview Drive on the vacant Wiedeman Family Farm parcel was considered to reduce flood depths downstream. Approximately 7.5 Ac-ft. of detention is required to detain the existing conditions 100-yr flow to 500 cfs. The detained 100-year peak flow rate of 500 cfs can be safely conveyed in the existing storm drain at North 81st Avenue and overflow in the street at a depth of less than 18-inches. The proposed detention improvements would alleviate the existing flooding issues in Poudre River Ranch Phase II and could be incorporated into the future detention required at upstream properties develop. Alternative costs include purchase of property for this detention pond. However, the City may be able to request payback for this property should it be incorporated into the future development needs.

Proposed improvements to the 78th Avenue storm drain system from Poudre River Road east alleviate depth in excess of 18-inches during the 100-year design storm just west of 78th Avenue. Increasing the existing 48 inch storm drain to a 60 inch provides the additional conveyance capacity to reduce street flooding to meet City depth criteria.

For the current conditions and future 4th Street alignment, to meet current City criteria, the 4th Street roadway crossing near 83rd Avenue is proposed to be improved to a 6 foot by 4 foot RCBC, reflecting 238 cfs culvert capacity and 36 cfs overtopping. Similar to the Sharktooth Draw watershed, the top width of flow in this area is significant, close to 1,500 feet. The expanse of flow will need to be considered in the design of a culvert for 4th Street. Improvements at this location will also reduce inundation on 83rd Avenue which has the potential to occur.

Table 5-8: Wiedeman Creek Minimum Criteria Alternatives

Location	Ex. 100-year Discharge (cfs)	Improvement	Culvert Flow (cfs)	Overtoping Flow (cfs)
4th Street	264	6 ft. x 4 ft. RCBC	238	36
Skyview Street	700	12 ft. x 5 ft. RCBC	607	93
81st Avenue (Storm Drain)	700	9 ft. x 4 ft. RCBC	380	320
81st Avenue (Detention)	Inflow 700 Outflow 500	Detention Basin (7.5 Ac-ft.)	180	320
78th Avenue	108	60" RCP	108	--

5.6.7.2 FLOOD MITIGATION ALTERNATIVES

Similar to the minimum criteria alternatives, flood mitigation alternatives are proposed in Poudre River Ranch Phase III to eliminate flooding from the streets and development areas. Along the southern flowpath, from Skyview Street through Poudre River Road, double cell 8 foot by 4 foot RCBCs, transitioning to a double cell 11 foot by 4 foot RCBC are proposed to eliminate overtopping.

Similarly, as an alternative, multiple detention alternatives upstream of Skyview Drive on the vacant Wiedeman Family Farm parcel were also considered. To detain existing conditions peak flows to the existing storm drain capacity of 140 cfs, a detention facility with a maximum storage of approximately 44 Ac-ft. is required. The proposed detention would mitigate any flooding and overtopping of both Skyview Street and North 81st Avenue during the existing conditions, 100-year design storm, and could be incorporated to include on-site detention when upstream properties develop. An additional detention alternative was evaluated to detain existing conditions peak

flows to a level of service that the existing Skyview Street crossing would meet minimum criteria and flooding in 81st Avenue would be reduced below 18-inches in depth. Providing an approximate maximum storage of 22 Ac-ft., detains the peak discharge to 325 cfs, reducing the overtopping of Skyview Street to less than six inches and flooding in 81st Avenue to less than 18 inches. Alternative costs include purchase of property for these detention pond options. However, the City may be able to request payback for this property should it be incorporated into the future development needs.

At Amour Hill Drive formalized conveyance of offsite flows and proposed improvements to the storm drain system will mitigate two structures inundated in the baseline hydrologic modeling east of Amour Hill Drive. Maintaining a 0.5 percent slope through the entire system provides the adequate capacity to collect flows off the fields east of the neighborhood and flows within the street without inundating structures. Detention upstream of the storm drain system would detain flows in excess of the existing storm drain capacity. Approximately 4.4 Ac-ft. of detention is required to detain flows to existing storm drain capacity.

At the upstream end of Poudre River Ranch Phase III at 78th Avenue, offsite flow inundates one structure along the west side of 78th Avenue. The Flood Hazard Mitigation Alternative proposes to convey this flow to the east upstream of the neighborhood where the flow can convey on the street with City depth criteria and does not inundate structures.

Other flood control improvements consisted of upsizing the proposed roadway crossings to 100-year facilities, specifically at 4th Street and Skyview Street. The 4th Street culvert is proposed to be upsized to a 7 foot by 3 foot RCBC to convey the existing conditions 100-year discharge of 264 cfs. At Skyview Street, a 14 foot by 5 foot RCBC will convey the 700 cfs 100-year discharge without overtopping.

Table 5-9: Wiedeman Creek Flood Mitigation Alternatives

Location	Ex. 100-year Discharge (cfs)	Improvement
4th Street	264	7 ft. x 4 ft. RCBC
Skyview Street	700	14 ft. x 6 ft. RCBC
81st Avenue (Storm Drain)	700	(2) 8 ft. x 4 ft. RCBC (2) 11 ft. x 4 ft. RCBC
81st Avenue (Detention)	Inflow 700 Outflow 325	Detention Basin (22 Ac-ft.)
81st Avenue (Detention)	Inflow 700 Outflow 150	Detention Basin (44 Ac-ft.)
Amour Hill Drive	15	30" RCP
Amour Hill Drive	Inflow 43 Outflow 15	Detention Basin (4.4 Ac-ft)
78th Avenue	55	Channel Improv.

5.6.7.3 CANAL BASE FLOW SEPARATION IMPROVEMENTS

No canal separation alternatives are proposed for this watershed.

5.6.7.4 SUMMARY

A summary of alternatives and costs based on each alternative plan are presented below. The total costs include property acquisition, City project management, and engineering costs broken out in further sections of this report.

Table 5-10: Wiedeman Creek Alternative Costs

Location	Alternative Plan	Improvement	Total Capital Cost	50-YR O&M
4th Street	No Action	--		
	Minimum Criteria	6 ft. x 4 ft. RCBC	$ 128,584	$ 3,142
	Flood Mitigation	7 ft. x 4 ft. RCBC	$ 138,001	$ 3,142
Skyview Street	No Action	--	--	$ 17,849
	Minimum Criteria	12 ft. x 5 ft. RCBC	$ 551,087	$ 9,427
	Flood Mitigation	14 ft. x 6 ft. RCBC	$ 710,363	$ 17,849
81st Avenue	No Action	--	$ -	$ 47,198
	Minimum Criteria (Storm Drain)	9 ft. x 4 ft. RCBC	$ 1,591,481	$ 47,198
	Minimum Criteria (Detention)	Detention Basin (7.5 Ac-ft.)	$ 1,483,853	$ 426,167
	Flood Mitigation (Storm Drain)	(2) 8 ft. x 4 ft. RCBC (2) 11 ft. x 4 ft. RCBC	$ 4,872,927	$ 81,764
	Flood Mitigation (Detention)	Detention Basin (22 Ac-ft.)	$ 3,369,232	$ 678,813
	Flood Mitigation (Detention)	Detention Basin (44 Ac-ft.)	$ 6,676,439	$ 1,089,362
Amour Hill Drive	No Action	Easement	$ 39,785	$ 47,450
	Flood Mitigation	30" RCP	$ 260,792	$ 47,450
	Flood Mitigation	Detention Basin (4.4 Ac-ft.)	$ 504,245	$ 277,910
78th Avenue	No Action	--	$ -	$ 9,019
	Minimum Criteria	60" RCP	$ 689,284	$ 15,335
	Flood Mitigation	Channel Improv.	$ 64,028	$ 23,568

5.6.8 POUDRE RIVER RANCH

The Poudre River Ranch Watershed, located in the northeast corner of the basin, lies completely within the City boundary. Runoff in the watershed is conveyed through two major flow paths both originating south of the neighborhood on the undeveloped Wiedeman Family Farm parcel. Runoff from the field collects at 77th Avenue and the north east corner of the parcel. At 77th Avenue, runoff is conveyed in the street as the flow travels west on Plateau Road before turning east on Poudre River Road. Flow is intercepted by a storm drain system and outfalls into the water quality pond just south of the Cache La Poudre River. Runoff from the Wiedeman Family Farm parcel is also conveyed between private property and the Boomerang Links Golf Course where several storm drains convey

flow to Vallevue Drive. Flows exceeding the capacity of the storm drain near Vallevue Drive continue east in the roadway into the Foothills Tributary watershed.

Conveyance within the western portion of the watershed is entirely dependent on stormwater in the street. The baseline FLO-2D indicates the street has capacity to convey the 100-year design storm without inundating structures or exceeding City depth criteria. In the eastern portion of the watershed, flow bypassing the existing 36 inch storm drain south of the neighborhood nearly inundates one structure, with flows splitting to the north and east around the property as flow is conveyed towards Vallevue Drive.

5.6.8.1 NO ACTION ALTERNATIVE

The No Action Alternative for Poudre River Ranch provides maintenance costs for the existing storm drains in Poudre River Road and behind the property near Vallevue Drive. Providing maintenance on these systems will ensure they function as intended and keep runoff from inundating structures in the watershed.

Table 5-11: Poudre River Ranch Alternative Cost

Location	Alternative Plan	Improvement	Total Capital Cost	50-YR O&M
Poudre River Road	No Action	--	$ -	$ 25,705

5.6.9 FAIRWAY TRIBUTARY

The Fairway Tributary Watershed extends from the Greeley No. 3 Canal south past Dundee Court. The watershed lies within the City of Greeley and unincorporated Weld County. Stormwater runoff is conveyed from the south through Boomerang Links Golf Course north to Poudre River Road in the Poudre River Ranch Phase I development. Runoff is ultimately discharged into the Greeley No. 3 Canal.

Flows near the upstream end of the watershed meander through the golf course converging at the corner of C Street and Melbourne Street. Baseline hydrologic modeling does not account for the unformalized and inadvertent detention on the golf course and indicates overtopping of Melbourne Street at a depth less than 6 inches. Overtopping flows not intercepted by the storm drain inlet at the C Street and Melbourne Street intersection continue north along 71st Avenue into the Northridge Draw Watershed.

Runoff from the Wiedeman Family Farm property on the northwest edge of the watershed is conveyed in a northeast direction, crossing Vallevue Drive to the east where flows enter a storm drain crossing Poudre River Road. The storm drain continues north and is flumed in the 36 inch storm drain over the Greeley No. 3 Canal.

Areas identified as possible flooding concerns include two roadway crossings and stormwater discharging into the Greeley No. 3 Canal. On the eastern edge of the watershed, two small existing detention basins just north of C Street west of 71st Avenue are undersized. Flows exceeding the 18 inch RCP outlet pipe spill north along the golf course and east over 71st Avenue. During the 100-year design storm flows overtopping 71st Avenue do not exceed 6 inches in depth.

Flows contained in Poudre River Road are conveyed in an easterly direction towards a sump location just west of Cache Court. As stormwater is conveyed within the street and in the sump location, flows do not exceed the City's 18 inch criteria.

Unformalized detention and areas of retention on the golf course were not accounted for in the hydrologic analysis since adequate assurances of maintenance could not be obtained. Future zoning information identifies the golf course as an area of possible future development which could have impact on the runoff patterns in the watershed.

5.6.9.1 NO ACTION ALTERNATIVE

The No Action Alternative proposes no improvements to existing stormwater infrastructure. Maintenance costs are provided for the existing 18 inch storm drain underneath 71st Avenue to ensure depths are limited to less than six inches in the 100-year design storm.

5.6.9.2 MINIMUM CRITERIA ALTERNATIVE

Stormwater infrastructure within Fairway Tributary meets current City criteria and therefore no Minimum Criteria Alternatives are proposed.

5.6.9.3 FLOOD MITIGATION ALTERNATIVES

The Flood Mitigation Alternative proposes to mitigate all flow overtopping 71st Avenue. The proposed improvements include intercepting 59 cfs from Boomerang Links Golf Course south of Melbourne Street. Option 1 proposes a 42 inch RCP to convey the discharge into the storm drain Flood Hazard Mitigation Alternative proposed in Northridge Draw Watershed at 71st Avenue and Melbourne Street. In addition to inflows from the golf course, the proposed storm drain in the Northridge Draw Watershed will intercept discharge from the two existing detention basins north of Melbourne Street. Option 2 conveys the flow east to the open channel north of Winograd K-8 detention basin. This alternative requires the Minimum Criteria Alternative for Northridge to be in place prior to implementation

Table 5-12: Fairway Tributary Flood Hazard Mitigation Alternatives

Location	Ex. 100-year Discharge (cfs)	Improvement Size
Melbourne Street	59	42" RCP
Detention North of Melbourne Street	5	18" RCP

5.6.9.4 CANAL BASE FLOW SEPARATION IMPROVEMENTS

The Canal Base Flow Separation Alternative proposes to flume the stormwater just west of Cache Court over the Greeley No. 3 Canal. Discharging the stormwater into the open space north of the canal will reduce flows in excess of the decreed flow entering the canal that pose flooding hazards downstream of uncontrolled spill flows from the canal. Improvements to the open space north of the canal include a low flow crossing such that the open space trail is not inundated by nuisance runoff.

Table 5-13: Fairway Tributary Canal Seperation Alternatives

Location	Design Flow (cfs)	Improvement Size
Cache Ct.	45	Flume and Low flow trail crossing

5.6.9.5 SUMMARY

A summary of alternatives and costs based on each alternative plan are presented below. The total costs include property acquisition, City project management, and engineering costs broken out in further sections of this report.

Table 5-14: Fairway Tributary Alternatives Cost

Location	Alternative Plan	Improvement	Total Capital Cost	50-YR O&M
Cache Court	No Action	--	--	--
	Canal Baseflow Separation	36" Flume & DS Channel	$ 65,299	$ 13,638
Melbourne Street	Flood Mitigation (Option 1)	42" RCP	$ 79,719	$ 7,887
	Flood Mitigation[1] (Option 2)	42" RCP	$ 552,061	$ 37,300
Detention North of Melbourne Street	No Action	--	$ -	$ 22,059
	Flood Mitigation[1]	18" RCP	$ 24,862	$ 15,775

1 - Alternative relies on Northridge Draw Flood Mitigation Alternative being in place

5.6.10 NORTHRIDGE DRAW

On the eastern edge of the basin, Northridge Draw is home to Northridge High School, Winograd K-8, and Northridge Estates. Runoff drains from south to north, passing through the school property to C Street where the existing drainageway continues north onto private property. No formal conveyance is provided north of C Street with flows overtopping 71st Avenue to the north at a depth less than six inches into the Foothills Tributary Watershed. At the downstream end of the watershed stormwater runoff is discharged into the Greeley No. 3 Canal.

5.6.10.1 MINIMUM CRITERIA ALTERNATIVE

For Northridge Draw, easement acquisition, formalizing the existing retention pond, and channel conveyance improvements are proposed north of C Street. Channel improvements will provide conveyance for runoff from Winograd K-8 detention basin and flows from Melbourne Street proposed to be conveyed in the Fairway Tributary Flood Mitigation Alternative Option 1. The existing retention pond is proposed to be formalized to ensure flows continue north in the channel and do not divert east out of the retention pond inundating homes.

Table 5-15: Northridge Draw Minimum Criteria Alternatives

Location	Improvement
C Street	Easement Acquisition / Channel Improvements / Outlet works

5.6.10.2 FLOOD MITIGATION ALTERNATIVE

Flood Mitigation Alternatives are proposed in the watershed to intercept runoff currently discharged onto private property and safely convey the flow within the right-of-way. Flows from the Winograd K-8 detention basin are intercepted at C Street and conveyed west in a 24 inch RCP. The pipe increases in size at 71st Avenue to 42 inches where the Melbourne Street Option 2 and Detention North of Melbourne improvements in the Fairway Tributary Watershed outfall into the proposed system. Fifteen hundred feet north of C Street the proposed storm drain discharges into a 250 foot roadside swale on the south east side of the road. A 7 by 3 RCBC conveys the stormwater underneath the road into the existing Poudre River Ranch Phase I development detention basin. A flume, proposed in the Canal Base Flow Separation Alternative, will convey flow exceeding the capacity of the detention basin over the canal into the open space.

Table 5-16: Northridge Draw Flood Mitigation Alternative

Location	Ex. 100-year Discharge (cfs)	Improvement Size
C Street	9	24" RCP
	66	42" RCP
71st Avenue	102	7 ft. x 3 ft. RCBC

5.6.10.3 CANAL BASE FLOW SEPARATION ALTERNATIVE

The existing Poudre River Ranch Phase I detention basin intercepts flow on the west side of 71st Avenue south of the Greeley No. 3 Canal. The detention basin discharges all runoff into the canal through the combination of an outlet pipe and spillway. Several alternatives were evaluated to disconnect the outfall completely from the canal but were determined to be infeasible without creating a siphon system underneath the canal. A flume is proposed to cross the canal at the existing spillway elevation to convey flows into the open space north of the Greeley No. 3 Canal. The 7 foot by 3 foot RCBC flume will convey 116 cfs from the storm drain and roadside swale proposed in the Flood Mitigation Alternative. Construction of the flume over the canal will also require reconfiguration of the existing maintenance road in the open space north of the canal.

Table 5-17: Northridge Draw Canal Baseflow Seperation Alternative

Location	Improvement Size
Poudre River Ranch Phase I	Spillway and DS Improvements

5.6.10.4 SUMMARY

A summary of alternatives and costs based on each alternative plan are presented below. The total costs include property acquisition, City project management, and engineering costs broken out in further sections of this report.

Table 5-18: Northridge Draw Alternative Cost Estimates

Location	Alternative Plan	Improvement	Total Capital Cost	50-YR O&M
C Street	Minimum Criteria	Easement / Channel / Retention Pond	$ 791,893	$ 213,995
	Flood Mitigation	Storm Drain	$ 1,360,601	$ 102,724
71st Avenue	Flood Mitigation	Roadway Crossing	$ 142,575	$ 2,043
PRR Phase I	Canal Baseflow Seperation	Greeley No. 3 Canal Flume	$ 253,128	$ 33,937

5.7 BENEFIT COST ANALYSIS

A benefit cost analysis was performed to determine the potential benefits of implementing flood mitigation alternatives along North 81st Avenue. For the purposes of this analysis, all residential structures were assumed to have finished basements with window openings at ground level.

Structure values were obtained from the Weld County Assessor's website. Contents value was assumed to be 50 percent of the structure value. A standard FEMA discount rate of seven percent was used along with the project useful lifetime of 50 years when computing present value of damages.

An Excel spreadsheet was developed to simulate FEMA's calculations of benefit-cost ratio. All flood return intervals (2-, 5-, 10-, 50-, and 100-yr) were accounted for when computing expected annual damages before mitigation for each structure. All proposed alternatives along 81st Avenue mitigated flooding from all structures and therefore an expected annual damage after mitigation of zero was used. Expected annual benefits were converted to total project benefits to include damages incurred over the entire lifetime of the project.

As seen below, the benefit-cost ratio for the 81st Avenue improvement is 0.04. Although the benefit from mitigating flood damages does not solely justify the project, the proposed improvements at 81st accomplish several other project goals such as removing overtopping of roadways in excess of six inches and flooding depths in streets of greater than 18 inches.

Table 5-19: Benefit-Cost Analysis

81st Avenue Benefit Cost Analysis		
Expected Annual Damages Before Mitigation	$	12,728
Expected Annual Damages After Mitigation	$	-
Expected Annual Benefit	$	12,728
Total Project Benefits Over Project Useful Life	$	175,656
Total Project Cost Including Maintenance	$	4,048,045
Benefit - Cost Ratio		0.04

5.8 OTHER CONSIDERATIONS

5.8.1 WATER QUALITY:

No specific water quality improvements have been evaluated for the Sharktooth Bluffs Basin. Site-specific water quality control measures will be incorporated as the basin develops and the City's development criteria is met. Land buffers for major drainageways will also help preserve the natural water quality features that exist today.

5.8.2 BANK EROSION AND SEDIMENT TRANSPORT FROM SHARKTOOTH BLUFFS

The Sharktooth Bluffs represent a unique erosional land feature located in the western portion of the basin. The bluffs consist of a number of dendritic gullies eroded into sandy loam soils. The narrow gullies are often 10-40 feet deep. Soils in the area primarily consist as Type 61, tassel fine sandy loam, as defined by the NRCS. The tassel fine sandy loam soils have a very slow infiltration rate, which results in a high runoff potential when thoroughly saturated.

Historic imagery showed the extent of the bluffs have not changed significantly in recent years (Google Earth)

A desktop review of this area was performed to evaluate continued erosion potential as an active source of sediment to the Poudre River. Historic aerial imagery dating back to 1999 was compared to current imagery. This review revealed that the extent of the gullies has not changed significantly over the last 20 years. Headcuts appear to be either migrating very slowly or not at all. The change in depth of the gullies is unknown. However, the bottom of the gullies appear well vegetated and not believed to be actively deepening. For these reasons it is believed the bluffs are largely stabilized and may not be an active source of sediment to the Cache La Poudre River. Further on-site investigation may be necessary to confirm this conclusion should aggradation be identified in areas of the Poudre River near these locations. After discussion with City staff, and due to limited site access, an onsite analysis was not deemed necessary for this study.

5.8.3 STREAM BUFFER WIDTH

In order to ensure the long-term stability of a stream system, a buffer is recommended to be preserved between the stream and anthropogenic influences. In natural streams, the stream belt width or floodplain width often serves as the buffer. The stream belt width is diagrammatically shown in Figure 5-1. Belt width is the lateral distance from the outside edge of one meander to the outside edge of the next meander (Figure 1). Channel meanders shift through time, generally moving in a downstream direction. By preserving the land within the belt width of a stream, one can allow the channel to continue to evolve and change its planform without coming into conflict with human infrastructure.

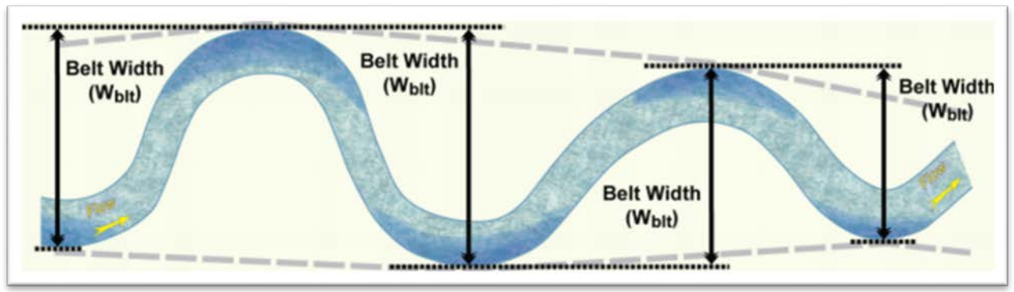


Figure 5.1: Stream Belt Width (Wildland Hydrology, 2013)

Two methods were used to estimate stream belt widths for major drainages within the Sharktooth Basin. The Stream Belt Width method is an empirical procedure based on a relationship of data from stream systems across many physiographical regions, developed by Williams in 1986, this procedure related the meander belt width to channel bankfull width through a power equation. The expression Williams developed is shown below (Equation 1).

Equation 1 : $W_{blt} = 3.7 * W_{bankfull}^{1.12}$

Many of the streams within the Sharktooth Basin, including for Sharktooth Draw, Poudre Learning Center, and Wiedeman Creek, have had their planform changed or influenced by humans in the past. Because a field geomorphic survey of the subject streams was not possible, estimates of bankfull width had to be utilized for the Williams equation to work. Therefore, a regional relationship developed for urban Front Range streams was utilized. The equation which was developed by ICON and subconsultants from field data, relates bankfull area (square feet) to drainage area (square miles) (Equation 2). Utilizing Equation 2 along with an average bankfull width-to-depth ratio of 18, allowed the bankfull widths to be estimated, along with the estimates for the ideal channel belt width for the Sharktooth Basin drainageways.

Equation 2: $A_{bankfull} = 7.4051 * A_{Drainage}^{0.6582}$

The second method utilized to calculate the ideal stream belt width was based on shear stress. If the shear stress applied on a floodplain by flowing water exceeds the carrying capacity of the floodplain vegetation, the vegetation will be destroyed, and subsequent erosion, scour, and channel avulsions could occur. In order to prevent this, the critical shear stress at which the vegetation will begin to fail was reviewed.

For vegetation types such those found on the floodplains of Sharktooth Draw, Poudre Learning Center Creek, and Wiedeman Creek (short grass prairie without bushes and trees), a critical shear stress of 1.5 lbs. per square foot was used. Using this critical shear stress threshold, the average stream slope, the 100-year discharge, and the average stream velocity, the minimum floodplain width can be calculated (Equation 3).

Equation 3: $W_{Floodplain} = \frac{Q_{100}}{V * \left(\frac{\tau_c}{\gamma * S}\right)}$

Where τ_c=Critical Shear Stress (lb/ft^2), γ = Unit Weight of Water (lb/ft^3), Q_{100} = 100-year Discharge (cfs), V = Average Velocity of Flow (ft/s), $W_{floodplain}$ = Width of Floodplain (ft), S = Stream Slope (ft/ft)

Results from both the belt width method and floodplain width method are shown in table 5-6 below.

Table 5-20: Stream Buffer Width

Drainageway	Channel Buffer Width	
	Ex. Conditions	Fut. Conditions
Sharktooth Draw	186	73
Poudre Learning Center	130 [1]	56
Wiedeman Creek	119	64

1- Value adjusted based on Rosgen classification

As shown by the table, the required belt or floodplain width has the potential to change over time with projected hydrology changes from new development. It is recommended that at a minimum, the existing stream belt widths be preserved within the basin to maintain stream health and maximize drainageway resiliency. Further evaluations may be required as the basin develops over time.

As development occurs in each watershed, City detention criteria will reduce peak flows along the drainageways. As such, channel buffer widths may reduce accordingly to the future condition widths shown above. It is recommended that this transition be considered after the upstream watershed has reached approximately 80 percent development density. At this time it is also recommended that a more detailed geomorphic study be completed to best determine the appropriate thresholds for the bankfull channel and floodplain areas within the buffer width. Additional design considerations are discussed below.

5.8.4 GEOMORPHIC ROADWAY CROSSINGS

Roadway crossings sized to compliment high functioning streams are safer, more resilient to large flood events, better convey sediment and debris, require less maintenance over time, and also provide better conditions for aquatic passage than traditionally designed crossings. The Urban Drainage and Flood Control District, now operating as the Mile High Flood District, supports this concept but understands that in some cases, site conditions will limit the design.

For new stream crossings within developing areas, and also for the replacement of old structures at already established crossings, geomorphic crossing design should be considered. It is recognized that geomorphic design is not possible for all stream crossing situations. Economically, Geomorphically Sized Crossing (GSCs) are more expensive initially than traditional designs. Additionally, GSCs generally require more space than traditional crossings. Sometimes these or other constraints may limit geomorphic design. In these instances, the reasons why a geomorphic design is not feasible at a particular site, should be clearly demonstrated prior to undertaking a different design approach.

The key principle of GSCs is that rather than being sized primarily on a hydraulic basis where the primary goal is to pass a design discharge, the crossing is sized based on the dimensions and characteristics of the upstream and downstream channel and floodplain. Further information regarding the design of GSCs is available from the UDFCD.

Alongside the GSCs, auxiliary floodplain culverts should be considered as a means of minimizing contraction and expansion of high flows at the crossing, where practical. Many small floodplain culverts function more efficiently than just one large floodplain culvert. Floodplain relief culverts should be sized large enough to allow for maintenance as needed.

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 5.2 - Alternative Map - Sharktooth Draw

Channel Improvements
Downstream of County Road 62
Option 2

Roadway Crossing
County Road 62 & Upstream Channel
Minimum Criteria:
(2) 10 ft. x 6 ft. RCBC & Channel Improvements
100-yr:
(2) 10 ft. x 7 ft. RCBC & Channel Improvements

Channel Improvements
Downstream of County Road 62
Option 1

Roadway Crossing
95th Avenue
Minimum Criteria: (2) 8 ft. x 4.5 ft RCBC
100-yr: (2) 10 ft. x 5 ft. RCBC

Roadway Crossing
Future 4th Street Crossing (West)
Minimum Criteria: 10 ft. x 4.5 ft. RCBC
100-yr: 12 ft. x 4 ft. RCBC

Roadway Crossing
Future 4th Street Crossing (Central)
Minimum Criteria: 48 in. RCP
100-yr: 6ft. x 3 ft. RCBC

Roadway Crossing
Future 4th Street Crossing (East)
Minimum Criteria: 48 in. RCP
100-yr: 6 ft. x 3 ft. RCBC

Cache La Poudre
Jones Ditch
Orr Gulch
Hertzke Draw
Missile Park Draw
Spur Draw
Sharktooth Bluffs
Wiedeman Creek
Poudre Learning Center
Weld County
City of Greeley
County Road 25
County Road 27
County Road 62
N 95th Ave
N 81st Ave
N 83rd Ave
95th Ave
4th St (Future)
Missle Silo Rd
State Hwy 257 Spur
US Hwy 34 Bus
10th
11th
12th St
106th Ave
103rd Avenue Ct
103rd Ave
102nd Ave
101st Avenue Ct
101st Ave
Poudre River

N

1,200
Feet

- Channel Improvement
- Roadway Crossing Improvement
- Inundated Structure
- Drainageway
- Existing Trails
- Future Trails
- Jurisdictional Boundary

City of Greeley Colorado

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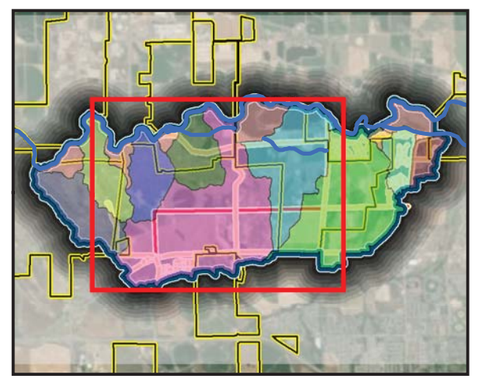

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 5.3 - Alternative Map - Poudre Learning Center Watershed

- Channel Improvement
- Canal Crossing Improvement
- Roadway Crossing Improvement
- Inundated Structure
- Drainageway
- Existing Trails
- Future Trails
- Jurisdictional Boundary

City of Greeley Colorado

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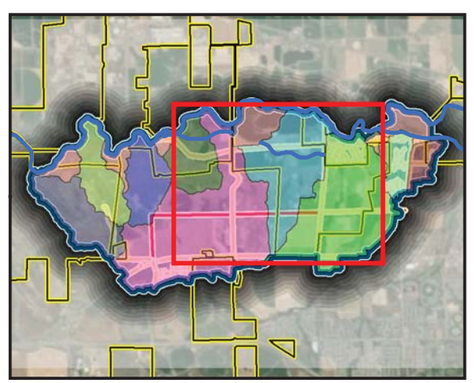

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 5.4 - Alternative Map - Wiedeman Creek

Flood Hazard Mitigation
81st Avenue
Minimum Criteria:
9 ft. x 4 ft. RCBC
Flood Mitigation:
(2) 9 ft. x 4 ft. RCBC
(2) 11 ft. x 4 ft. RCBC

Flood Hazard Mitigation
78th Avenue
Minimum Criteria:
60 in. RCP

Flood Hazard Mitigation
Armour Hill Dr
Flood Mitigation (Option 1):
30 in. RCP
Flood Mitigation (Option 2):
2.4 Ac-ft. Detention &
Sediment Basin

Flood Hazard Mitigation
78th Avenue
Improvement:
Channel Improvement

Roadway Crossing
Skyview Street
Minimum Criteria: 12 ft. x 5 ft RCBC
100-yr: 14 ft. x 6 ft. RCBC

Flood Hazard Mitigation
Upstream of Poudre River Ranch Phase III
Minimum Criteria: 7.5 Ac-ft.
Flood Mitigation (Option 1): 22 Ac-ft.
Flood Mitigation (Option 2): 44 Ac-ft.

Roadway Crossing
4th Street Crossing
Minimum Criteria: 6 ft. x 4 ft. RCBC
100-yr: 7 ft. x 4 ft. RCBC

Cache La Poudre
Greeley No 3 Ditch
County Road 27
County Road 62
Jones Ditch
River Run Dr
Riverside Ct
Poudre River Ranch
Plateau Rd
Vallevue Dr
Poudre River Rd
Surrey St
N 81st Ave
N 78th Ave
Amour Hill Rd
Double Tree Dr
Deville Dr
Horizon Cr
Sage Ave
Skyview St
N Wyndham Ave
airway Tributary
W Melbourne St
Northridge Draw
Poudre Learning Center
W Canberra St
W Canberra Street Dr
N 71st Ave
Dundee Ave
N 83rd Ave
Wiedeman Creek
4th St (Future)
4th St
83rd Ave
Weld County

N
700
Feet

- Storm Drain Improvement
- Channel Improvement
- Inundated Structure
- Detention Basin Improvement
- Roadway Crossing Improvement
- Drainageway
- Jurisdictional Boundary
- Existing Trails
- Future Trails

City of Greeley Colorado

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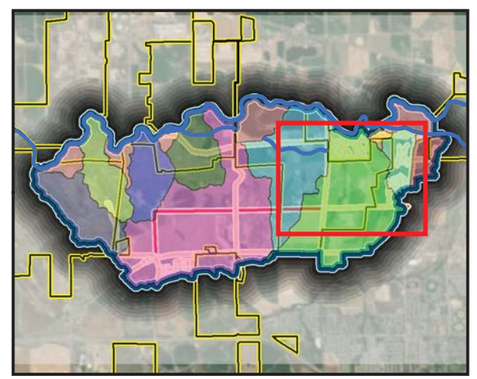
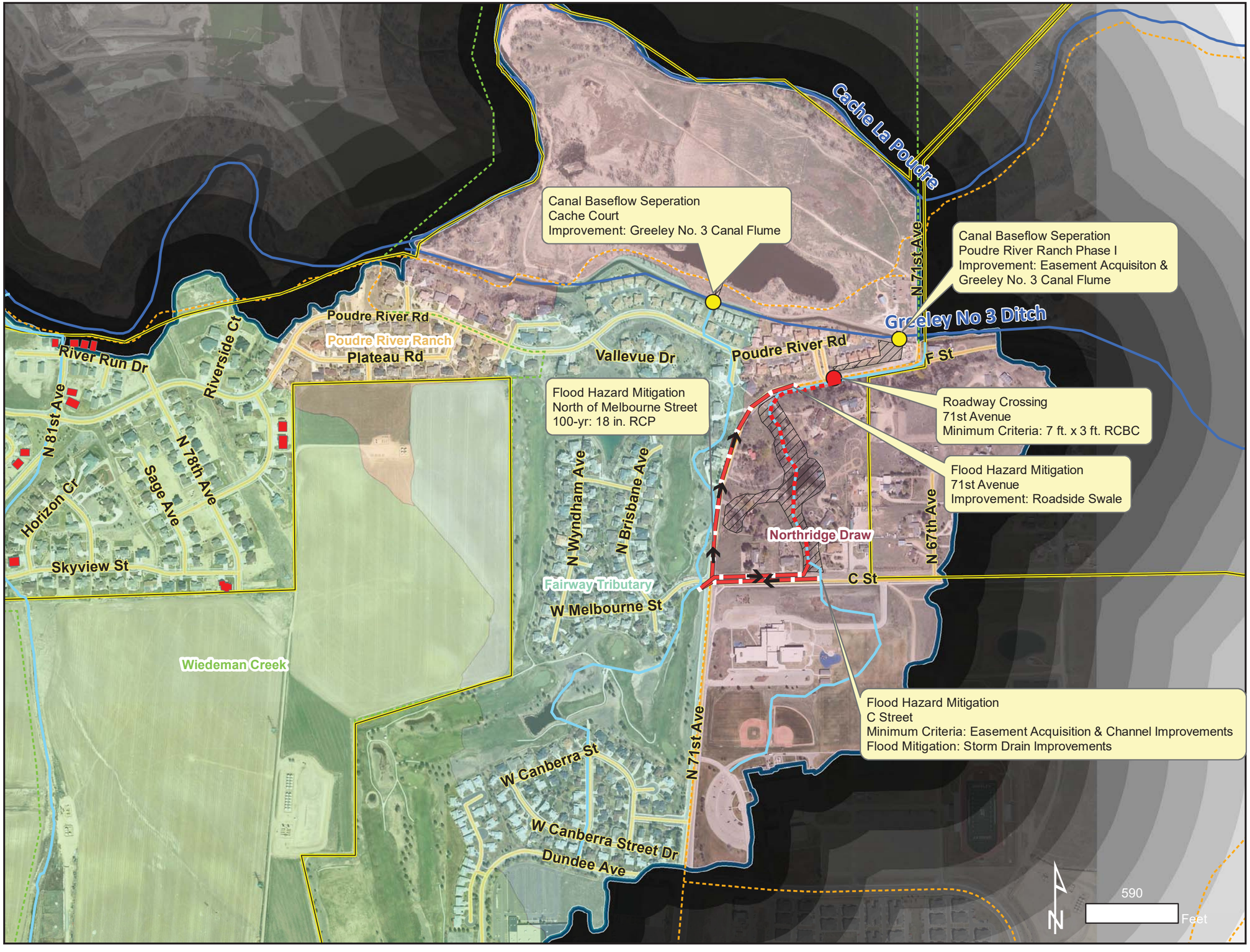


Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 5.5 - Alternative Map - Fairway Tributary & Northridge Draw



- Storm Drain Improvements
- Channel Improvements
- Canal Crossing Improvement
- Roadway Crossing Improvement
- Inundated Structure
- Approximate Easement
- Drainageway
- Existing Trails
- Future Trails
- Jurisdictional Boundary

City of Greeley Colorado

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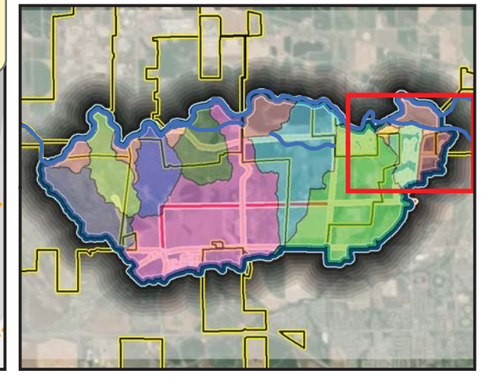

6.0 RECOMMENDED PLAN

The recommended plan is a combination of alternative plans for each watershed. Improvements proposed in the recommended plan for each watershed are shown in Figure 6.1, Table 6-1 and discussed in further detail below. Cost estimates for all proposed improvements can be found in Table 6-2 and Table 6-3.

6.1 PLAN DESCRIPTION

All roadway crossings that do not currently meet City criteria are proposed to be improved to the Minimum Criteria Crossing Alternative sizing with the exception of Skyview Street in the Wiedeman Creek Watershed. While overtopping will still occur during the existing condition 100-year storm, future detention as the basin develops will reduce the peak discharge and eliminate overtopping. When the basin is fully developed, all roadway crossing infrastructure proposed in the recommended plan will exceed the 100-year discharges.

For the purpose of alternative analysis, all roadway crossings were sized as a single crossing structure. Each roadway crossing should be further evaluated to implement a high functioning, low maintenance stream crossing, where practical. Further guidance on geomorphic roadway crossings can be found in Section 5.8.4 .

All components of the Canal Base Flow Separation plan are included in the recommended plan. Separating stormwater from the canal will protect downstream users by responsibly managing the spill of the canal and help reduce uncontrolled spills from canal further downstream.

The recommended plan includes several components of the Flood Hazard Mitigation Alternative Plan. At 81st Avenue in Wiedeman Creek, the proposed detention of 22 Ac-ft. upstream of Poudre River Ranch Phase III will reduce flows overtopping Skyview Street to less than six inches and reduce the depth in the street from flow overtopping the storm drain system into 81st Avenue to less than 18 inches. Although this alternative is more expensive than the combination of Minimum Criteria Alternatives for Skyview Street and 81st Avenue, the cost of the proposed detention could be offset by incorporating the facility into future development and would not drastically oversize Skyview Street when considering future detained flows. The recommended plan will remove all structures along 81st Avenue currently inundated in the baseline modeling. On the eastern edge of Wiedeman Creek, formalizing runoff from the farm field and replacing the Amour Hill Drive storm drain system will remove structures on the east side of the road from flooding.

At 78th Avenue and Poudre River Road, the No Action Plan is recommended. No structures are currently inundated at the intersection and future detention upstream of the development will reduce flows such that street flooding depths do not exceed 18 inches. At the southern end of 78th Avenue channel improvements proposed in the Flood Hazard Mitigation Alternative will alleviate the flooding on the house on the west side of 78th Avenue by conveying flows to 78th Avenue where the flow can be conveyed on the street.

In Northridge Draw, the Minimum Criteria Alternative is recommended. Easement acquisition, channel improvements and formalizing the outlet structure ensure the City access to perform maintenance and maintain the integrity of the drainageway from north of C Street to the 71st Avenue roadway crossing. Once this alternative is in place, the Option 2 Alternative for Foothills Tributary can be implemented conveying additional runoff to the open channel.

The recommended plan for the stream buffer width on each drainageway is Method 2, Floodplain Width, as described in Section 5.8.3 . Method 2, the larger of the stream buffer widths, was chosen as the recommended plan in order to encourage a health stream system by providing room for the channel to meander and an adequate corridor for a stable floodplain.

6.2 WATER QUALITY IMPACTS

No regional water quality improvements are proposed for the Sharktooth Bluffs Basin. Water quality will be provided on a site specific basis throughout the basin as development occurs.

Eroding channel banks also can lead to degradation in water quality throughout a basin. By monitoring the bluffs for erosion and sediment transport and providing adequate channel buffer widths less erosion and sediment transport will occur, increasing the water quality for the basin and the Cache La Poudre River.

6.3 OPERATION AND MAINTENANCE

The recommended plan includes the installation of storm drain infrastructure, requiring maintenance for culverts, inlets and manholes. Proposed detention basins will also require additional maintenance. This increase in maintenance cost will be offset by the reduction in damages to roads and infrastructure caused by nuisance level flooding.

6.4 ENVIRONMENTAL AND SAFETY ASSESSMENT

The recommended plan positively affects the Sharktooth Bluffs Basin by increasing the public safety from flood hazards throughout the watershed and enhancing the environmental impacts of the watershed through the responsible management of the drainageways in the watershed.

Table 6-1: Recommended Plan

Watershed	Location	No Action	Minimum Criteria	Flood Hazard Mitigation	Canal Baseflow Separation
Sharktooth Draw	Future 4th Street (West)		X		
	Future 4th Street (Central)		X		
	Future 4th Street (East)		X		
	95th Avenue		X		
	County Road 62 & Upstream Channel		X		
	Downstream of County Road 62			X	
Poudre Learning Center	County Road 62 (West)		X		
	County Road 62 (Central)		X		
	County Road 62 (East)		X		
	83rd Avenue		X		
	Jones Ditch at 83rd Avenue				X
Wiedeman Creek	4th Street		X		
	Skyview Street	X			
	81st Avenue			X	
	78th Avenue - Poudre River Road	X			
	78th Avenue - Upstream of Development		X		
	Armour Hill Drive			X	
Poudre River Ranch	Poudre River Road	X			
Fairway Tributary	Cache Court				X
	Melbourne Street			X	
	Detention North of Melbourne Street	X			
Northridge Draw	C Street				
	71st Avenue			X	
	PRR Phase 1				

Table 6-2: Recommended Plan Cost Estimates - Sharktooth Draw and Poudre Learning Center Watersheds

Watershed	Location	Alternative Type	Capital	Easement / ROW	Engineering	Legal / Administrative	Contract Admin / CM	Contingency	Total Capital Cost	Annual O&M	50-year O&M
Sharktooth Draw	Future 4th Street (West)	Minimum Criteria	$ 121,411	$ -	$ 18,212	$ 6,071	$ 12,141	$ 30,353	$ 188,188	$ 100	$ 3,142
	Future 4th Street (Central)	Minimum Criteria	$ 33,148	$ -	$ 4,972	$ 1,657	$ 3,315	$ 8,287	$ 51,379	$ 100	$ 3,142
	Future 4th Street (East)	Minimum Criteria	$ 33,148	$ -	$ 4,972	$ 1,657	$ 3,315	$ 8,287	$ 51,379	$ 50	$ 1,571
	95th Avenue	Minimum Criteria	$ 210,757	$ -	$ 31,614	$ 10,538	$ 21,076	$ 52,689	$ 326,674	$ 120	$ 3,771
	County Road 62 & Upstream Channel	Minimum Criteria	$ 2,277,297	$ 953,040	$ 341,595	$ 113,865	$ 227,730	$ 569,324	$4,482,851	$ 10,550	$ 331,519
	Downstream of County Road 62	Channel Improv East of CR 62	$ 745,023	$ 220,000	$ 111,753	$ 37,251	$ 74,502	$ 186,256	$1,374,785	$ 3,000	$ 94,271
	Total		$ 2,675,761	$ 953,040	$ 401,365	$ 133,788	$ 267,577	$ 668,940	$5,100,471	$ 10,920	$ 343,145
Poudre Learning Center	County Road 62 (West)	Minimum Criteria	$ 195,929	$ -	$ 29,389	$ 9,796	$ 19,593	$ 48,982	$ 303,689	$ 100	$ 3,142
	County Road 62 (Central)	Minimum Criteria	$ 26,281	$ -	$ 3,942	$ 1,314	$ 2,628	$ 6,570	$ 40,735	$ 50	$ 1,571
	County Road 62 (East)	Minimum Criteria	$ 378,085	$ -	$ 56,713	$ 18,904	$ 37,809	$ 94,521	$ 586,032	$ 2,125	$ 66,775
	83rd Avenue	Minimum Criteria	$ 363,047	$ -	$ 54,457	$ 18,152	$ 36,305	$ 90,762	$ 562,723	$ 160	$ 5,028
	Jones Ditch at 83rd Avenue	Canal Base flow Separation	$ 84,031	$ -	$ 12,605	$ 4,202	$ 8,403	$ 21,008	$ 130,249	$ 1,034	$ 32,492
	Total		$ 1,047,373	$ -	$ 157,106	$ 52,368	$ 104,738	$ 261,843	$1,623,428	$ 3,469	$ 109,008

Table 6-3: Recommended Plan Cost Estimates - Wiedeman Creek, Fairway Tributary, Northridge Draw Watersheds

Watershed	Location	Alternative Type	Capital	Easement / ROW	Engineering	Legal / Administrative	Contract Admin / CM	Contingency	Total Capital Cost	Annual O&M	50-year O&M
Wiedeman Creek	4th Street	Minimum Criteria	$ 82,957	$ -	$ 12,444	$ 4,148	$ 8,296	$ 20,739	$ 128,584	$ 100	$ 3,142
	Skyview Street	No Action	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,502	$ 47,198
	81st Avenue	Flood Mitigation (22 Ac-ft. Detention)	$ 616,679	$ 528,000	$ 92,502	$ 30,834	$ 61,668	$ 154,170	$1,483,853	$ 13,562	$ 426,167
	78th Avenue	No Action	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 287	$ 9,019
		Flood Mitigation	$ 41,309	$ -	$ 6,196	$ 2,065	$ 4,131	$ 10,327	$ 64,028	$ 750	$ 23,568
	Amour Hill Drive	Flood Mitigation	$ 142,585	$ 39,785	$ 21,388	$ 7,129	$ 14,259	$ 35,646	$ 260,792	$ 1,510	$ 47,450
	Total		$ 883,530	$ 567,785	$ 132,530	$ 44,176	$ 88,354	$ 220,882	$1,937,257	$ 17,711	$ 556,544
Poudre River Ranch Phase I and II	Poudre River Road	No Action	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 818	$ 25,705
	Total		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 818	$ 25,705
Fairway Tributary	Cache Court	Canal Base flow Separation	$ 42,129	$ -	$ 6,319	$ 2,106	$ 4,213	$ 10,532	$ 65,299	$ 434	$ 13,638
	Melbourne Street	Flood Mitigation1 (Option 1)	$ 51,431	$ -	$ 7,715	$ 2,572	$ 5,143	$ 12,858	$ 79,719	$ 251	$ 7,887
	Detention North of Melbourne Street	No Action	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 702	$ 22,059
	Total		$ 93,560	$ -	$ 14,034	$ 4,678	$ 9,356	$ 23,390	$ 145,018	$ 1,387	$ 43,584
Northridge Draw	C Street	Minimum Criteria	$ 371,099	$ 216,689	$ 55,665	$ 18,555	$ 37,110	$ 92,775	$ 791,893	$ 6,810	$ 213,995
	71st Avenue	Flood Mitigation	$ 91,984	$ -	$ 13,798	$ 4,599	$ 9,198	$ 22,996	$ 142,575	$ 65	$ 2,043
	PRR Phase 1	Canal Baseflow Seperation	$ 159,483	$ 159,483	$ 159,483	$ 159,483	$ 159,483	$ 159,483	$ 159,483	$ 159,483	$ 159,483
	Total		$ 463,083	$ 216,689	$ 69,463	$ 23,154	$ 46,308	$ 115,771	$ 934,468	$ 6,875	$ 216,038

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 6.1 - Recommended Plan - Sharktooth Draw and Poudre Learning Center

Recommend Plan was modified following the Recommended Plan. Reference Section 7 and memo in Appendix A for proposed improvements

Roadway Crossing
County Road 62 (West)
Minimum Criteria:
12 ft. x 4 ft. RCBC

Roadway Crossing
County Road 62 (East)
Minimum Criteria:
12 ft. x 4 ft. RCBC
Channel Improvements

Roadway Crossing
83rd Avenue
Minimum Criteria:
(2) 13 ft. x 6 ft. RCBC

Roadway Crossing
County Road 62
Minimum Criteria:
(2) 10 ft. x 6 ft. RCBC
Upstream Channel Improvements

Channel Improvements
Downstream of Country Road 62
Option 2 Channel

Roadway Crossing
95th Avenue
Minimum Criteria:
(2) 8 ft. x 4.5 ft. RCBC

Roadway Crossing
County Road 62 (Central)
Minimum Criteria:
36 in. RCP

Roadway Crossing
4th Street (West)
Minimum Criteria:
10 ft. x 4.5 ft. RCBC

Canal Baseflow Separation
Jones Ditch at 83rd Avenue
Improvement:
Spillway and Channel Improvements

Roadway Crossing
4th Street (East)
Minimum Criteria:
48 in. RCP

Roadway Crossing
4th Street (Central)
Minimum Criteria:
48 in. RCP

Cache La Poudre
Jones Ditch
County Road 25
N 95th Ave
County Road 62
Poudre River Rd
County Road 27
N 81st Ave
Weld County
City of Greeley
Poudre Learning Center
Hertzke Draw
Missile Park Draw
4th St (Future)
Sharktooth Bluffs
95th Ave
Wiedeman Creek
83rd Ave
Spur Draw
Missile Silo Rd
State Hwy 257 Spur
US Hwy 34 Bus
10th St
11th St
12th St
103rd Avenue Ct
103rd Ave
102nd Ave
101st Ave

1,200 Feet

- Channel Improvement
- Canal Crossing Improvement
- Roadway Crossing Improvement
- Drainageway
- Existing Trails
- Future Trails
- Jurisdictional Boundary

City of Greeley Colorado

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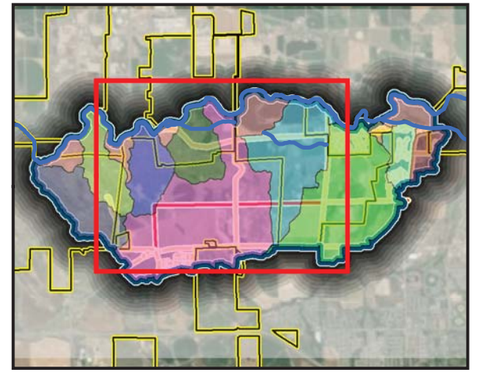

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 6.2 - Recommended Plan - Wiedeman Creek, Fairway Tributary, and Northridge Draw

Canal Baseflow Seperation
Cache Court
Improvement:
Greeley No. 3 Canal Flume

Canal Baseflow Seperation
Poudre River Ranch Phase I
Improvement:
Easement Acquistion
Greeley No. 3 Canal Flume

Flood Hazard Mitigation
71st Avenue
Improvement:7 ft. x 3 ft. RCBC

Flood Hazard Mitigation
C Street
Improvement:
Easement & Channel Improvements

Flood Hazard Mitigation
Melbourne Street
Improvement: Storm Drain

Flood Hazard Mitigation
Amour Hill Dr
Flood Mitigation:
30 in. RCP

Flood Hazard Mitigation
81st Avenue
Flood Mitigation:
Detention 22 Ac-ft.

Flood Hazard Mitigation
78th Avenue
Flood Mitigation:
Channel Improvements

Roadway Crossing
4th Street Crossing
Minimum Criteria:
6 ft. x 4 ft. RCBC

Cache La Poudre
Greeley No. 3 Ditch
Jones Ditch
Fairway Tributary
Northridge Draw
Wiedeman Creek
Poudre River Ranch
Poudre Learning Ce
Sharktooth Bluffs
4th St (Future)
County Road 27
County Road 62
N 71st Ave
F St
Plateau Rd
Riverside Cir
N 81st Ave
Surrey St
Deville Dr
Sage Ave
N 78th Ave
Skyview St
N Wyndham Ave
N 67th Ave
C St
71st Ave
W Canberra St
Dundee Ave
4th St
N 83rd Ave
83rd Ave
10th St
11th St
US Hwy-34-Bus
Weld County
City of Greeley

1,000 Feet

- Storm Drain Improvements
- Channel Improvement
- Detention Basin Improvement
- Canal Crossing Improvement
- Roadway Crossing Improvement
- Approximate Easement
- Drainageway
- Existing Trails
- Future Trails
- Jurisdictional Boundary

City of Greeley Colorado

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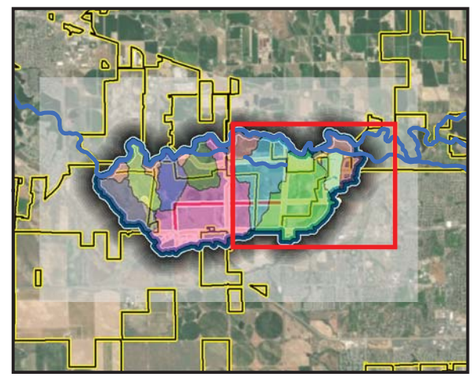

7.0 CONCEPTUAL DESIGN

7.1 PLAN DEVELOPMENT OVERVIEW

The Selected Plan identifies the alternatives selected by the project team to proceed to the Conceptual Design phase of the project. The Selected Plan generally follows the recommended plan alternatives, with the modification to the proposed improvements in Sharktooth Draw. A memo, dated June 11, 2019 found in Appendix A, summarizes new alternatives for the basin and explains why the previously proposed alternative was revised. In summary, a detention pond and storm drain outfall are now being proposed instead of the channel improvements at the north end of the watershed. An additional alternative was also proposed at the Sharktooth Draw crossing of the Bellevue Pipeline to provide additional protection again stream erosion beyond that discussed with the future stream restoration needs.

The master plan improvements are intended to mitigate existing flooding hazards, ensure current and future roadway crossings are compliant with City criteria, to address any channel stability issues and concerns, separate base flows from irrigation ditches, enhance water quality, and provide general guidance for preservation and improvement to the drainageways throughout the Sharktooth Bluffs Basin. Finally, the master plan improvements identify and incorporate trail connections to the regional networks, where applicable.

7.1.1 GENERAL RECOMMENDATIONS

Land-use changes to contributing watersheds affect the flood hazard nature (i.e., runoff rates, volumes and depths), the transport of sediment, and the water quality of the receiving natural waterways. To encourage implementation of this master plan, it is recommended that:

- As the basin urbanizes, the City shall take steps to ensure that the major waterways are stabilized, that any existing degraded reaches of the waterways, and their tributaries, are rehabilitated, and erosion and sediment transport during construction activities is controlled.
- That new land development activities, significant redevelopment activities, and publicly funded projects, provide, to the maximum extent practicable, runoff volume control practices (i.e., minimize directly connected impervious areas and employ infiltrating BMPs) whenever site conditions permit.
- Require that all BMPs for all new development, redevelopment, and publicly funded projects provide to the maximum extent practicable a Water Quality Capture Volume (WQCV) and Excess Urban Runoff Volume (EURV) as recommended in the Urban Storm Drainage Criteria Manual – Volume 3, after accounting for volume reductions achieved using volume control practices.
- The City of Greeley should adopt a policy of preserving a stream corridor as open spaces to the maximum extent possible as development occurs. Approximate Stream Buffer Widths were developed for Sharktooth Draw, Poudre Learning Center, and can be found in Section 5.8.3 .
- Geomorphic Roadway Crossings, as described in Section 5.8.4 , should be considered during final design to compliment high functioning streams, be more resilient to large flood events, better convey sediment and debris, require less maintenance over time, and also provide better conditions for aquatic passage than traditionally designed crossings.
- The City of Greeley Natural Resources Department strongly supports a naturalized stormwater management strategy that not only provides stormwater management for the benefit of the life, safety and property of the citizens of Greeley, but also considers and supports sustainable natural systems in the installation and maintenance of stormwater management facilities. Small creeks and drainages only encompass approximately one percent of the land mass in Colorado but supports nearly 85 percent of the state's wildlife species, making these areas critical for wildlife. These areas are also important movement corridors for wildlife between larger habitat areas.
- Wherever possible, provide public use and access and/or trails within the corridors of identified waterways in order to provide maintenance access that will also provide for active and passive recreation of the public.

7.1.2 COST ESTIMATES

Cost estimates for the Conceptual Design were developed using UDFCD's master planning cost estimating spreadsheet UD-MP COST, version 2.2. 2012 unit cost values were adjusted to present value using the Colorado Construction Cost Index, 2018 Third Quarter Report. The average value of the last four quarters (1.34) of the Fisher Ideal Index was used to adjust unit costs. A summary of unit costs can be found in Appendix C.

Operation and Maintenance costs were also included within the UD-MP Cost worksheet. A minimum level-of-service for manhole and inlet maintenance was assumed to occur once per year. The minimum level-of-service for maintenance on detention basins and water quality facilities was assumed to occur once a year. Structural maintenance on canal spillways were assumed to be performed once every five years.

Costs for detention basins were estimated using the unit costs for earthwork based on the necessary acre-feet of detention.

Headwalls were assumed on storm drain infrastructure 54 inches in diameter and greater. Flared end sections were assumed on storm drain improvements less than 54 inches in diameter.

Several recent stream restoration projects were analyzed to approximate a stream restoration cost per linear foot of drainageway. An average cost per linear foot of $750 was used to estimate future stream restoration costs along Sharktooth Draw, Poudre Learning Center Tributary, and Wiedeman Creek.

Right-of way, easement costs, and property values were calculated from current Weld County Assessor's information. Easement / ROW acquisition amounts were calculated as a percentage of the total actual land value. For undeveloped parcels, an average value of $88,000 / Acre was estimated from properties throughout the basin.

Asphalt was included as a special item within the UD-Cost spreadsheet at $250 lb. / ton for each roadway crossing.

No alterations were made to default values calculated as a percent of Capital Improvement Costs, such as Engineering, Legal/Administrative, Contract Administration/Construction Management, and Contingency. Dewatering, Traffic Control and Utility Coordination / Relocation were assigned the minimum of $5000 or the following percentages of capital costs for most locations: Dewatering (1%), Traffic Control (5%), Utility Coordination / Relocation (5%).

7.2 MASTER PLAN DESCRIPTION

The Conceptual Design is described on a watershed by watershed basis in Section 7.2.1 through Section7.2.9 . Cost estimates can be found in Table 7-19. A schematic of the master plan improvements can be found in Figure 7.1 and Figure 7.2.

7.2.1 SPUR DRAW

Spur Draw, the western most watershed in the Sharktooth Basin, is located just east of US Highway 257. Stormwater runoff from the basin sheet flows to the Sharktooth Bluffs where the narrow gullies convey water northwest to the Cache La Poudre River. All flow is confined to the bluff areas. The watershed is currently undeveloped and future land use projects the watershed to remain open space. No roadway crossings, or other infrastructure is currently proposed in the watershed. Beyond monitoring runoff and potential sediment transport from the bluffs areas, no improvements are currently proposed for this watershed.

7.2.2 MISSILE PARK DRAW

This 275 acre watershed is bounded by Spur Draw to the west, Hertzke Draw to the east, Sharktooth Draw to the south and Cache La Poudre River to the north. The watershed spans three jurisdictions: Town of Windsor at the downstream end of the watershed, unincorporated Weld County, and the City of Greeley. Similar to Spur Draw, stormwater runoff is conveyed in narrow gullies which converge into a drainageway that bisects the watershed. Near the downstream end of the watershed, in the Town of Windsor and Weld County, there is an approximately 10-foot high embankment which detains flows from continuing north to the Cache La Poudre River. As discussed prior, no records were found regarding this being a regulated detention basin or registered state dam.

With exception to ponding that could occur behind this embankment, no other significant drainage problems were identified for this watershed, particularly within the limits of the City of Greeley. Beyond monitoring runoff and potential sediment transport from the bluffs areas, and monitoring the effects of the embankment for water collection, repair, or need to breach, no improvements are currently proposed for this watershed.

7.2.3 HERTZKE DRAW

Hertzke Draw, located to the east of Missile Park Draw and west of Sharktooth Draw watersheds, primarily consists of steep gullies conveying stormwater runoff to the north. Upstream of the outfall into the Cache La Poudre River, the watershed transitions from the confined gully drainageway to an alluvial fan. The watershed lies within Town of Windsor, unincorporated Weld County, and City of Greeley. The bluffs in the southeastern portion of the watershed, within the City of Greeley, lie on property proposed to be developed as part of the Lake Bluff Development.

Flooding potential within the watershed is minimal with more flooding potential located in the alluvial zones near the Poudre River. No buildings or structures are shown to be inundated and flooding potential will be lessened with future development in the watershed. Beyond monitoring runoff and potential sediment transport from the bluffs areas, no improvements are currently proposed for this watershed.

7.2.4 ORR GULCH

Orr Gulch is bounded by Hertzke Draw to the west and Sharktooth Draw to the south and east. The northern portion of the watershed falls within unincorporated Weld County, while the southern portion is located within the City of Greeley. The portion within the City of Greeley is proposed to remain open space as part of the proposed Lake Bluff Development. The narrow bluff gullies collect stormwater runoff in the headwater of the basin before the flow is spread into an alluvial fan south of County Road 62. North of County Road 62, the William R. Jones Ditch bisects the lower watershed, conveying irrigation flows from the Cache La Poudre River to Siebring Reservoir.

Flooding problems within the watershed are primarily related to ponding south of the William R. Jones Ditch, where flow depths approach 3-feet in what appears to be a historic oxbow from the Cache La Poudre River and potential overtopping of County Road 62. Since this area is located outside of the City of Greeley with no current plans for expansion of this roadway system, no alternatives were evaluated in this watershed.

7.2.5 SHARKTOOTH DRAW

Sharktooth Draw extends from south of 10th Street to the Cache La Poudre River, covering 1,235 acres. The watershed lies within the City of Greeley and unincorporated Weld County. The headwaters of Sharktooth Draw begin south of 10th Street, east of Promontory Circle near the State Farm property. Stormwater runoff then continues in a northeast direction to the river.

Flooding within the watershed is generally confined near 10th Street, then transitions between overland and confined flow through 95th Avenue when entering the bluffs region. Downstream, flood flows again become unconfined when Sharktooth Draw splits to the north and the east, in an alluvial pattern, near County Road 62, diverting up to 541 cfs of the total 100-year discharge of 1063 cfs to the Poudre Learning Center watershed.

Problems areas within the watershed focus around overtopping of existing roadway crossings, including: 95th Avenue, both north of 10th Street and closer to the Poudre River near County Road 62; and County Road 62, which currently has no defined drainage system and is located within Greeley's anticipated expansion area. These areas experience overtopping in both the 10- and 100-year events. In addition to the roadway crossings, the split flow near 95th Avenue and County Road 62 has the potential to impact roadway improvements and future development during the larger storm events (above the 10-year level). Finally, the future expansion of 4th Street will require planning as it crosses drainages within the Sharktooth Draw watershed. Currently, the proposed 4th Street alignment is proposed to cross three local drainages.

7.2.5.1 SHARKTOOTH DRAW – FUTURE 4TH STREET CROSSING WEST

The western most future 4th Street crossing is located approximately 1,600 ft. west of 95th Avenue. A 10 ft. wide by 4.5 ft. high RCBC is proposed to convey 378 cfs of the 431 cfs, 100-yr event design discharge. Flows in excess of the culvert capacity, 53 cfs during the 100-yr event, will overtop at a depth less than 6 inches.

The future roadway crossing was conceptually designed with minimal ground cover over the top of the crossing. The improvement requires installation of headwall and wingwalls on the upstream and downstream side of the box culvert. Riprap will be required for outlet protection on the downstream end. During final design, the culvert height and width may need to be adjusted to accommodate the proposed roadway design section and guidance for a low maintenance stream crossing. Slight changes in geometry would be expected with more design information.

No known water or sanitary conflicts are anticipated at this location. Location of dry utilities are unknown and should be investigated prior to final design. Minor channel improvements to the drainageway will be required upstream and downstream of the crossing in order to promote drainage.

The culvert was sized for existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be added into the existing conditions model to update the design discharge.

Table 7-1: Sharktooth Draw - Future 4th Street Crossing (West)

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Shaktooth Bluffs Storm Drainage Master Plan		
DRAINAGEWAY :	Sharktooth Draw		
REACH :	Future 4th St Crossing (West)		
JURISDICTION :	City of Greeley		
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info	DATE : 12/26/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)			
10	5	1	50	L.F.	$1,081.50	$54,075.00
Headwall and Toewalls						
Individual Box Span (ft)	No. of Barrels	Total Span (ft)				
10	1	12.00	2	EA	$1,158.48	$2,317.00
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels				
10	5	1	2	EA	$12,054.14	$24,108.30
Channel Improvements						
Excavation, Mid Range			296	C.Y.	$32.00	$9,472.00
12-inch Riprap, Type M			22	C.Y.	$80.00	$1,778.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00
Special Items (User Defined)						
Asphalt	<----User Defined Items		29	TON	$250.00	$7,250.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$80,500.00
Hydraulic Structures			$0.00
Channel Improvements			$11,250.00
Detention/Water Quality Facilities			$0.00
Removals			$0.00
Landscaping and Maintenance Improvements			$1,340.00
Special Items (User Defined)			$7,250.00
Subtotal Capital Improvement Costs			**$100,340.00**
Additional Capital Improvement Costs			
Dewatering	$5,000.00	L.S.	$5,000.00
Mobilization	5%		$5,017.00
Traffic Control	$5,017.00	L.S.	$5,017.00
Utility Coordination/Relocation	$5,017.00	L.S.	$5,017.00
Stormwater Management/Erosion Control	5%		$5,017.00
Subtotal Additional Capital Improvement Costs			**$25,068.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$18,811.00
Legal/Administrative	5%		$6,270.00
Contract Admin/Construction Management	10%		$12,541.00
Contingency	25%		$31,352.00
Subtotal Other Costs			**$68,974.00**
Total Capital Improvement Costs			**$194,382.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	50	L.F.	$1.00	$50.00
Total Annual Operation and Maintenance Cost				**$50.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$1,571.00**

7.2.5.1 SHARKTOOTH DRAW – FUTURE 4TH STREET CROSSING CENTRAL

The central, future 4th Street crossing is located approximately 700 ft. west of 95th Avenue, and will experience approximately 151 cfs during a 100-year event. A 48-inch RCP is proposed to convey 122 cfs during a 100-year event, with the remaining 29 cfs overtopping at a depth less than 6 inches.

The future roadway crossing was conceptually designed with minimal ground cover over the top of the crossing. The improvement requires installation of flared end sections, at a minimum, on the upstream and downstream side of the RCP culvert. Riprap will be required for outlet protection on the downstream end. During final design, the culvert height and width may need to be adjusted to accommodate the proposed roadway design section. Slight changes in geometry would be expected with more design information.

No known water or sanitary conflicts are anticipated at this location. Location of dry utilities are unknown and should be investigated prior to final design. Minor channel improvements to the drainageway will be required upstream and downstream of the crossing in order to promote drainage.

The culvert was sized for existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be added into the existing conditions model to update the design discharge.

Table 7-2: Sharktooth Draw - Future 4th Street Crossing (Central)

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan				
DRAINAGEWAY :	Sharktooth Draw				
REACH :	Future 4th Street (Central)				
JURISDICTION :	City of Greeley				
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info		DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
48-inch	50	1	50	L.F.	$193.00	$9,650.00
Flare End Sections						
Diameter (in)	Applicable	No. of Barrels				
48-inch	Yes	1	2	EA	$2,760.00	$5,520.00
Channel Improvements						
Excavation, Mid Range			167	C.Y.	$32.00	$5,344.00
12-inch Riprap, Type M			13	C.Y.	$80.00	$1,040.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00
Special Items (User Defined)						
Asphalt	<----User Defined Items		18	TON	$250.00	$4,500.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$15,170.00
Concrete Box Culverts			$0.00
Hydraulic Structures			$0.00
Channel Improvements			$6,384.00
Detention/Water Quality Facilities			$0.00
Removals			$0.00
Landscaping and Maintenance Improvements			$1,340.00
Special Items (User Defined)			$4,500.00
Subtotal Capital Improvement Costs			**$27,394.00**
Additional Capital Improvement Costs			
Dewatering	$5,000.00	L.S.	$5,000.00
Mobilization	5%		$1,370.00
Traffic Control	$5,000.00	L.S.	$5,000.00
Utility Coordination/Relocation	$5,000.00	L.S.	$5,000.00
Stormwater Management/Erosion Control	5%		$1,370.00
Subtotal Additional Capital Improvement Costs			**$17,740.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$6,770.00
Legal/Administrative	5%		$2,257.00
Contract Admin/Construction Management	10%		$4,513.00
Contingency	25%		$11,284.00
Subtotal Other Costs			**$24,824.00**
Total Capital Improvement Costs			**$69,958.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	50	L.F.	$1.00	$50.00
Total Annual Operation and Maintenance Cost				**$50.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$1,571.00**

7.2.5.1 SHARKTOOTH DRAW – FUTURE 4TH STREET CROSSING EAST

The third of the three 4th Street expansion culverts is the Future 4th Street Crossing (East). This culvert is located approximately 2,000 ft. east of 95th Avenue, and will experience approximately 124 cfs during a 100-year event. A 48-inch RCP is proposed. The culvert will convey 111 cfs during the 100-year event with 13 cfs overtopping at a depth less than 6 inches.

The future roadway crossing was conceptually designed with minimal ground cover over the top of the crossing. The improvement requires installation of flared end sections, at a minimum, on the upstream and downstream side of the RCP culvert. Riprap will be required for outlet protection on the downstream end. During final design, the culvert height and width may need to be adjusted to accommodate the proposed roadway design section. Slight changes in geometry would be expected with more design information.

No known water or sanitary conflicts are anticipated at this location. Location of dry utilities are unknown and should be investigated prior to final design. Minor channel improvements to the drainageway will be required upstream and downstream of the crossing in order to promote drainage.

The culvert was sized for existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be added into the existing conditions model to update the design discharge.

Table 7-3: Sharktooth Draw - Future 4th Street Crossing (East)

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan		
DRAINAGEWAY :	Sharktooth Draw		
REACH :	Future 4th Street Crossing (East)		
JURISDICTION :	City of Greeley		
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info	DATE : 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
48-inch	50	1	50	L.F.	$193.00	$9,650.00
Flare End Sections						
Diameter (in)	Applicable	No. of Barrels				
48-inch	Yes	1	2	EA	$2,760.00	$5,520.00
Channel Improvements						
Excavation, Mid Range			167	C.Y.	$32.00	$5,344.00
12-inch Riprap, Type M			13	C.Y.	$80.00	$1,040.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00
Special Items (User Defined)						
Asphalt	<----User Defined Items		18	TON	$250.00	$4,500.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$15,170.00
Concrete Box Culverts			$0.00
Hydraulic Structures			$0.00
Channel Improvements			$6,384.00
Detention/Water Quality Facilities			$0.00
Removals			$0.00
Landscaping and Maintenance Improvements			$1,340.00
Special Items (User Defined)			$4,500.00
Subtotal Capital Improvement Costs			**$27,394.00**
Additional Capital Improvement Costs			
Dewatering	$5,000.00	L.S.	$5,000.00
Mobilization	5%		$1,370.00
Traffic Control	$5,000.00	L.S.	$5,000.00
Utility Coordination/Relocation	$5,000.00	L.S.	$5,000.00
Stormwater Management/Erosion Control	5%		$1,370.00
Subtotal Additional Capital Improvement Costs			**$17,740.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$6,770.00
Legal/Administrative	5%		$2,257.00
Contract Admin/Construction Management	10%		$4,513.00
Contingency	25%		$11,284.00
Subtotal Other Costs			**$24,824.00**
Total Capital Improvement Costs			**$69,958.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	50	L.F.	$1.00	$50.00
Total Annual Operation and Maintenance Cost				**$50.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$1,571.00**

7.2.5.2 SHARKTOOTH DRAW – 95TH AVENUE CULVERT CROSSING

Approximately 4,200 ft. north of 10th Street, Sharktooth Draw crosses 95th Street. The existing dual 36 inch RCPs are undersized to safely convey the 100-yr design discharge of 793 cfs underneath the roadway. As shown by the hydraulic study, drainage in this area overtops the roadway to the north of the current culvert crossing. Half a foot to 1 foot of overtopping occurs during the 10-year event and 1 foot to 2 foot of overtopping occurs during the 100-year event.

Proposed improvements at 95th Street to meet City of Greeley criteria require a dual cell 8 ft. wide by 4.5 ft. high RCBC. The improved crossing structure will convey 764 cfs, with approximately 29 cfs overtopping the roadway during existing conditions 100-year event. The overtopping depth will be less than 6 inches.

The improvement requires removal of the existing storm culvert crossings, installation of headwall and wingwalls on the upstream and downstream side of the box culvert. Riprap will be required for outlet protection on the downstream end, and should be analyzed in further detail during final design.

No known water or sanitary conflicts are anticipated at this location. Location of dry utilities are unknown and should be investigated prior to final design. Minor channel improvements to the drainageway will be required upstream and downstream of the crossing in order to promote drainage.

The culvert was sized for existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be added into the existing conditions model to update the design discharge.

Table 7-4: Sharktooth Draw - 95th Avenue Crossing

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Draw Storm Drainage		
DRAINAGEWAY :	Sharktooth Draw		
REACH :	95th Avenue		
JURISDICTION :	City of Greeley		
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info	DATE : 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)			
8	5	2	60	L.F.	$1,796.98	$107,819.00
Headwall and Toewalls						
Individual Box Span (ft)	No. of Barrels	Total Span (ft)				
8	2	19.00	2	EA	$1,725.96	$3,452.00
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels				
8	5	2	2	EA	$13,884.19	$27,768.40
Channel Improvements						
Excavation, Mid Range			490	C.Y.	$32.00	$15,680.00
12-inch Riprap, Type M			36	C.Y.	$80.00	$2,880.00
Removals						
Removal of culvert pipe (D<48")			120	L.F.	$27.00	$3,240.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00
Special Items (User Defined)						
Asphalt	<----User Defined Items		48	TON	$250.00	$12,000.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$139,039.00
Hydraulic Structures			$0.00
Channel Improvements			$18,560.00
Detention/Water Quality Facilities			$0.00
Removals			$3,240.00
Landscaping and Maintenance Improvements			$1,340.00
Special Items (User Defined)			$12,000.00
Subtotal Capital Improvement Costs			**$174,179.00**
Additional Capital Improvement Costs			
Dewatering	$5,000.00	L.S.	$5,000.00
Mobilization	5%		$8,709.00
Traffic Control	$8,708.95	L.S.	$8,709.00
Utility Coordination/Relocation	$8,708.95	L.S.	$8,709.00
Stormwater Management/Erosion Control	5%		$8,709.00
Subtotal Additional Capital Improvement Costs			**$39,836.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$32,102.00
Legal/Administrative	5%		$10,701.00
Contract Admin/Construction Management	10%		$21,402.00
Contingency	25%		$53,504.00
Subtotal Other Costs			**$117,709.00**
Total Capital Improvement Costs			**$331,724.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	120	L.F.	$1.00	$120.00
Total Annual Operation and Maintenance Cost				**$120.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$3,771.00**

7.2.5.3 SHARKTOOTH DRAW – BELLEVUE PIPELINE STABILIZATION

After completion of the alternative analysis, stability concerns of Sharktooth Draw were evaluated at the Bellevue Pipeline crossing east of 95th Avenue. Three water mains, ranging in diameter from 20 to 27 inches, cross the drainageway approximately 1,725 ft. downstream of 95th Avenue as Sharktooth Draw turns to the north. The constant flow in Sharktooth Draw has the potential to erode the channel, exposing the Bellevue Treatment Water Plant water mains.

Sharktooth Draw conveys flow at an approximate longitudinal slope of 1.5 percent downstream of 95th Avenue. During the existing conditions 100-year event, approximately 890 cfs is conveyed at a velocity of 9.8 ft./sec. The resulting shear stress in the channel is approximately 4.5 lbs/ft2. For comparison, the 5-year event results in approximately 30 cfs in the channel at a velocity of 4.0 ft./sec. To protect the water mains against erosion, sheet piling at a depth of 20 feet is proposed. To further protect the crossing, riprap should be installed.

The depth and exact location of the water mains were not determined for the conceptual design. GIS shapefiles were used to approximate the location of the water lines and depths are expected to be 3 feet in depth to top of pipes at a minimum. During final design the water mains should be potholed to verify location and depth. Once the exact location of the water lines is known, potential scour should be calculated and depth of the cut off walls and rip rap sizing adjusted accordingly.

Table 7-5: Sharktooth Draw - Bellevue Pipeline Stabilization

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan				
DRAINAGEWAY :	Sharktooth Draw				
REACH :	Bellevue Pipeline Stabilization				
JURISDICTION :	City of Greeley				
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info	DATE :	6/8/2019	

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST
Channel Improvements					
12-inch Riprap, Type M		50	C.Y.	$80.00	$4,000.00
Special Items (User Defined)					
Sheet Piling	<----User Defined Items	1000	S.F.	$55.00	$55,000.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$0.00
Hydraulic Structures			$0.00
Channel Improvements			$4,000.00
Detention/Water Quality Facilities			$0.00
Removals			$0.00
Landscaping and Maintenance Improvements			$0.00
Special Items (User Defined)			$55,000.00
Subtotal Capital Improvement Costs			**$59,000.00**
Additional Capital Improvement Costs			
Dewatering	$5,000.00	L.S.	$5,000.00
Mobilization	5%		$2,950.00
Traffic Control	$5,000.00	L.S.	$5,000.00
Utility Coordination/Relocation	$5,000.00	L.S.	$5,000.00
Stormwater Management/Erosion Control	5%		$2,950.00
Subtotal Additional Capital Improvement Costs			**$20,900.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$11,985.00
Legal/Administrative	5%		$3,995.00
Contract Admin/Construction Management	10%		$7,990.00
Contingency	25%		$19,975.00
Subtotal Other Costs			**$43,945.00**
Total Capital Improvement Costs			**$123,845.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$670.00	$670.00
Total Annual Operation and Maintenance Cost				**$670.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$21,054.00**

7.2.5.4 SHARKTOOTH DRAW – COUNTY ROAD 62

As part of the alternatives review process, the Central Colorado Water Conservancy District (CCWCD), the owners of Siebring Reservoir, were engaged to discuss the possibility of discharging stormwater into the reservoir. After discussions with CCWCD, concerns regarding costs to manage the system and water rights of any stormwater discharged in the reservoir determined that the outfall as proposed in one of the alternatives was not feasible. The alternate alignment proposed, channel downstream of County Road 62 parallel to 95th Avenue, was also determined to be infeasible due to the recent development of a gas extraction site spanning west from 95th Avenue.

A supplemental alternative analysis developed four additional alternatives. After discussion with City staff, the chosen improvements were Alternative C from the analysis memorandum. Alternative C is comprised of an 88 Ac-ft. regional detention basin to manage existing runoff to the area; a drainage channel paralleling 95th Avenue; and a 38 inch by 60 inch horizontal elliptical reinforced concrete pipe (HERCP) storm drain system in 95th Avenue, downstream of County Road 62 to the Cache La Poudre River.

The proposed detention facility, located east of 95th Avenue, intercepts Sharktooth Draw as the drainageway exits the bluffs. Approximately 88 Ac-ft. of storage is provided to detain the 100-year existing conditions discharge of 1,063 cfs and release a maximum flow rate of 230 cfs. Downstream of the detention facility, flow will be conveyed in a drainage channel with a top width of 30 ft. parallel to 95th Avenue north to the intersection with County Road 62. A storm drain system is proposed to intercept flow at the County Road 62 intersect and convey runoff north approximately 1,660 ft. to the Cache La Poudre River. The storm drain system is designed to convey 75 cfs, the 100-year future conditions discharge. Limited ground cover north of County Road 62 requires a 38 inch tall by 60 inch wide horizontal elliptical reinforced concrete pipe (HERCP) to convey the flow. In the interim condition, before development occurs upstream which will detain flows leaving each development to historic 5-year flow rates, overtopping of County Road 62 will occur but be limited to six inches or less in depth. Flows overtopping the roadway will continue along the existing flow path north to the Cache La Poudre River.

The proposed detention basin layout for the conceptual design is such that it does not exceed the requirements of a jurisdictional dam in the State of Colorado. However, given the changing dam safety requirements, it is still recommended that the City consult the State for current guidance prior to purchasing land or designing the detention facility.

Similar to other improvements mentioned, the pond has been sized for existing conditions discharges to reduce overtopping at 95th Avenue and County Road 62 to meet City Criteria, as if no changes in hydrology occur upstream. Prior to implementation, the pond site should be reevaluated to determine if upstream development has reduced flows and volume into the pond. The downstream channel and pipe system at 95th Avenue and County Road 62 has been sized for future discharges as if all proposed development is in place. At this point in time, the pond may be significantly reduced, or not needed altogether. This scenario would be indicative of Alternative D, as presented in the supplemental alternatives analysis found in Appendix A. Regardless of the proposed detention facility, all developments in the Sharktooth Daw Basin are proposed to adhere to current City of Greeley detention standards, detaining to the 5-yr historic discharge.

The detention basin as proposed will provide a multi-objective function for the local natural area in Sharktooth Draw, providing flood management, but also improving the ecological function, wildlife habitat, and public access within the site. Future trails currently proposed along Sharktooth could be incorporated into the facility located through the bottom and along the top of the facility. The detention facility area would also help promote wildlife through preservation of native vegetation and habitat areas, as well as be designed to provide regional water quality benefits. Natural hydrologic function could continue to exit by conveying bankfull, base, flows undetained through the pond area, up to the capacity of the proposed downstream infrastructure and acceptable roadway overtopping. Pond landscaping could include seeding with drought-tolerant native seed mixes, infrequent or no-mow areas. Any needed mowing practices could occur outside of ground-nesting bird seasons in the spring.

The improvements also consist of the removal of the existing storm culvert crossing at County Road 62, installation of headwall and wingwalls on the upstream and downstream side of pond culvert outlet, and the installation of riprap stilling basin for outlet protection. Several drop structures are proposed along the proposed alignment in the detention basin to ensure the long-term stability of the stream system.

The proposed improvement requires purchase of approximately 23 acres of land for the detention pond and drainage channel. It is assumed that the 38” x 60” HERCP will be installed within City right-of-way. Utilities along the proposed improvements are unknown, but conflicts with the gas extraction site should be anticipated. Adjustment of the William R. Jones Ditch will be required in addition to the headgate structure located just east of 95th Avenue. Upstream of the detention pond, three Bellevue pipelines should be located prior to final design in order to ensure that the water mains will not be impacted.

CLICK HERE TO VIEW SHARKTOOTH DRAW OVERVIEW

CLICK HERE TO VIEW SHARKTOOTH DRAW DETENTION BASIN DETAIL

Table 7-6: Sharktooth Draw - County Road 62

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan		
DRAINAGEWAY :	Sharktooth Draw		
REACH :	County Road 62		
JURISDICTION :	City of Greeley		
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info	DATE : 6/6/2019

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
48-inch	190	1	190	L.F.	$193.00	$36,670.00
48-inch	1660	1	1660	L.F.	$193.00	$320,380.00
Flare End Sections						
Diameter (in)	Applicable	No. of Barrels				
48-inch	Yes	1	2	EA	$2,760.00	$5,520.00
Manholes and Inlets						
Manhole, 6' Dia. (Pipe Dia. = 48")			4	EA	$5,762.00	$23,048.00
Hydraulic Structures						
Sloping Drop Structures						
Height (ft)	Bottom Width (ft)	Yn (ft)				
4	10	0.5	2	EA	$25,595.02	$51,190.00
1.5	10	0.5	2	EA	$21,393.82	$42,788.00
4	10	0.5	2	EA	$25,595.02	$51,190.00
Channel Improvements						
12-inch Riprap, Type M			300	C.Y.	$80.00	$24,000.00
Excavation, Low Range			8000	C.Y.	$15.00	$120,000.00
Detention/Water Quality Facilities						
Detention (User Entered Quantities)						
Excavation, Low Range			175200	C.Y.	$15.00	$2,628,000.00
Removals						
Removal of culvert pipe (D<48")			100	L.F.	$27.00	$2,700.00
Landscaping and Maintenance Improvements						
Wetlands Plantings			1	ACRE	$33,500.00	$33,500.00
Reclamation & seeding (native grasses)			23	ACRE	$1,340.00	$30,820.00
Trail/Path, Crusher Fines (10' Width)			5500	L.F.	$15.00	$82,500.00
Special Items (User Defined)						
Excavation Haul Pond	<----User Defined Items		156000	CY	$12.00	$1,872,000.00
Asphalt	<----User Defined Items		1334	TON	$250.00	$333,500.00
Pond Park Improvements	<----User Defined Items		1	LS	$500,000.00	$500,000.00
Spillway/Berm	<----User Defined Items		1	LS	$500,000.00	$500,000.00
Landscape	<----User Defined Items		1	LS	$150,000.00	$150,000.00
Outfall Backflow Prevention	<----User Defined Items		1	EA	$25,000.00	$25,000.00
Land Acquisition						
Temporary Easements			3	EA	$30,000.00	$90,000.00
Easement/ROW Acquisition			23.00	ACRE	$88,000.00	$2,024,000.00

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs			
Pipe Culverts and Storm Drains			$385,618.00
Concrete Box Culverts			$0.00
Hydraulic Structures			$145,168.00
Channel Improvements			$144,000.00
Detention/Water Quality Facilities			$2,628,000.00
Removals			$2,700.00
Landscaping and Maintenance Improvements			$146,820.00
Special Items (User Defined)			$3,380,500.00
Subtotal Capital Improvement Costs			**$6,832,806.00**
Additional Capital Improvement Costs			
Dewatering	$35,000.00	L.S.	$35,000.00
Mobilization	5%		$341,640.00
Traffic Control	$25,000.00	L.S.	$25,000.00
Utility Coordination/Relocation	$50,000.00	L.S.	$50,000.00
Stormwater Management/Erosion Control	5%		$341,640.00
Subtotal Additional Capital Improvement Costs			**$793,280.00**
Land Acquisition Costs			
ROW/Easements			$2,114,000.00
Subtotal Land Acquisition Costs			**$2,114,000.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$1,143,913.00
Legal/Administrative	5%		$381,304.00
Contract Admin/Construction Management	10%		$762,609.00
Contingency	25%		$1,906,522.00
Subtotal Other Costs			**$4,194,348.00**
Total Capital Improvement Costs			**$13,934,434.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	1850	L.F.	$1.00	$1,850.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	4	EA	$67.00	$268.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	4	EA	$670.00	$2,680.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	3000	L.F.	$3.00	$9,000.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal	18	ACRE	$2,010.00	$36,180.00
Mowing (e.g. channels, ponds, etc.)	23	ACRE	$67.00	$1,541.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	5500	L.F.	$7.00	$38,500.00
Total Annual Operation and Maintenance Cost				**$90,019.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$2,828,722.00**

7.2.6 POUDRE LEARNING CENTER

The Poudre Learning Center watershed extends from the Cache La Poudre River south to 10th Street, between N 83rd Avenue to the east and N 95th Avenue to the west. Flow in the upper portion of the watershed primarily consists of sheet flow down into the bluffs. The stormwater runoff spreads from the confined flow in the bluffs into an alluvial fan south of County Road 62. Flow crosses the William R. Jones Ditch and County Road 62 into Siebring Reservoir. An outlet channel from the most eastern portion of Siebring Reservoir conveys flow east to 83rd Avenue before the outfall location into the Cache La Poudre River.

Future development near the Poudre Learning Center Basin is zoned to occur in the areas where potential flooding is shown in the models. For these future developments to be protected, careful consideration should be taken in site layout and future storm drainage infrastructure.

An out-building is potentially inundated from flooding, north of the Jones Ditch near the westernmost sump location. Even after improvements are made to the western spill flows in the Sharktooth Draw basin, this building may remain in a potential inundation area due to its proximity with the canal. No other buildings are identified to be inundated during the existing conditions 100-year event; however, it should be noted that an oil and gas well site does exist within the headwaters channel of the draw, near the future 4th Street alignment.

Discharges at the future 4th Street alignment remain less than 100-cfs at this location; therefore, improvement alternatives were not developed within the Poudre Learning Center watershed for the roadway system.

7.2.6.1 POUDRE LEARNING CENTER - COUNTY ROAD 62 (WEST) CROSSING

The westernmost crossing of the Poudre Learning Center is located approximately 3,000 ft. east of 95th Avenue. The crossing proposes to convey 692 cfs during the 100-year design storm through dual 10 ft. wide by 4 ft. high RCBCs. Approximately 40cfs will overtop the roadway during the existing conditions, at a depth less than 6 inches. The culvert is proposed to be installed in a sump condition discharging towards the quarry area located in the center of the western flow path.

The roadway crossing was conceptually designed with minimal ground cover over the top of the crossing. The improvement requires installation of headwalls and wingwalls, at a minimum, on the upstream and downstream side of the RCBC culvert. Riprap will be required for outlet protection on the downstream end. During final design, the culvert height and width may need to be adjusted to accommodate the proposed roadway design section. Slight changes in geometry would be expected with more design information.

No known water or sanitary conflicts are anticipated at this location. Location of dry utilities are unknown and should be investigated prior to final design. Minor channel improvements to the drainageway will be required upstream and downstream of the crossing in order to promote drainage.

The culvert was sized for the existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be considered to update the design discharge.

Table 7-7: Poudre Learning Center – County Road 62 (West) Crossing

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan					
DRAINAGEWAY :	Poudre Learning Center					
REACH :	County Road 62 (West) Crossing					
JURISDICTION :	City of Greeley					
REACH ID:	SKD Conceputal Design	Enter Estimator Name on Project Info			DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)			
10	4	2	100	LF	$1,940.94	$194,094.00
Headwall and Toewalls						
Individual Box Span (ft)	No. of Barrels	Total Span (ft)				
10	2	20.00	2	EA	$2,220.42	$4,441.00
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels				
10	4	2	2	EA	$11,842.43	$23,684.90
Channel Improvements						
Excavation, Mid Range			630	C.Y.	$32.00	$20,160.00
12-inch Riprap, Type M			50	C.Y.	$80.00	$4,000.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00
Trail/Path, Concrete (10' Width)			50	L.F.	$59.00	$2,950.00
Special Items (User Defined)						
Asphalt	<----User Defined Items		18	TON	$250.00	$4,500.00

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$222,220.00
Hydraulic Structures				$0.00
Channel Improvements				$24,160.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$4,290.00
Special Items (User Defined)				$4,500.00
Subtotal Capital Improvement Costs				**$255,170.00**
Additional Capital Improvement Costs				
Dewatering	$5,000.00	L.S.		$5,000.00
Mobilization	5%			$12,759.00
Traffic Control	$12,758.50	L.S.		$12,759.00
Utility Coordination/Relocation	$12,758.50	L.S.		$12,759.00
Stormwater Management/Erosion Control	5%			$12,759.00
Subtotal Additional Capital Improvement Costs				**$56,036.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$46,681.00
Legal/Administrative	5%			$15,560.00
Contract Admin/Construction Management	10%			$31,121.00
Contingency	25%			$77,802.00
Subtotal Other Costs				**$171,164.00**
Total Capital Improvement Costs				**$482,370.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	100	L.F.	$1.00	$100.00
Total Annual Operation and Maintenance Cost				**$100.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$3,142.00**

7.2.6.2 POUDRE LEARNING CENTER - COUNTY ROAD 62 (CENTRAL) CROSSING

The County Road 62 (East) crossing is located approximately 2,300 ft. west of North 83rd Avenue. A 36 inch RCP culvert is proposed to provide adequate conveyance underneath the roadway and Poudre River trail for the localized sump. The proposed culvert will discharge into the swale in the Poudre Learning Center property.

The improvement requires installation of a flared end section on the upstream and downstream side of the culvert. Riprap will be required for outlet protection on the downstream end. Sizing should be reevaluated during final design considering the upstream inflows tributary to the crossing and downstream channel capacity.

No known water or sanitary conflicts are anticipated at this location. Location of dry utilities are unknown and should be investigated prior to final design. Minor channel improvements to the drainageway will be required upstream and downstream of the crossing in order to promote drainage.

The culvert was sized for the existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be considered to update the design discharge.

Table 7-8: Poudre Learning Center – County Road 62 (Central) Crossing

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan		
DRAINAGEWAY :	Poudre Learning Center		
REACH :	County Road 62 (Central) Crossing		
JURISDICTION :	City of Greeley		
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info	DATE : 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
36-inch	50	1	50	L.F.	$145.00	$7,250.00
Flare End Sections						
Diameter (in)	Applicable	No. of Barrels				
36-inch	Yes	1	2	EA	$2,157.00	$4,314.00
Channel Improvements						
Excavation, Mid Range			133	C.Y.	$32.00	$4,256.00
12-inch Riprap, Type M			7	C.Y.	$80.00	$560.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00
Special Items (User Defined)						
Asphalt	<---User Defined Items		16	TON	$250.00	$4,000.00

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$11,564.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$4,816.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$4,000.00
Subtotal Capital Improvement Costs				**$21,720.00**
Additional Capital Improvement Costs				
Dewatering	$5,000.00	L.S.		$5,000.00
Mobilization	5%			$1,086.00
Traffic Control	$5,000.00	L.S.		$5,000.00
Utility Coordination/Relocation	$5,000.00	L.S.		$5,000.00
Stormwater Management/Erosion Control	5%			$1,086.00
Subtotal Additional Capital Improvement Costs				**$17,172.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$5,834.00
Legal/Administrative	5%			$1,945.00
Contract Admin/Construction Management	10%			$3,889.00
Contingency	25%			$9,723.00
Subtotal Other Costs				**$21,391.00**
Total Capital Improvement Costs				**$60,283.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	50	L.F.	$1.00	$50.00
Total Annual Operation and Maintenance Cost				**$50.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$1,571.00**

7.2.6.3 POUDRE LEARNING CENTER - COUNTY ROAD 62 (EAST) CROSSING

The easternmost crossing of County Road 62 is located approximately 150 ft. west of North 83rd Avenue. The 100-year design discharge at the crossing is 251 cfs during the existing conditions 100-year event. A 6 ft. wide by 4 ft. tall RCBC is proposed to convey 194 cfs, with 57 cfs overtopping at a depth less than 6 inches. The culvert will replace the existing 24" CMP and discharge west of 83rd Avenue on the Poudre Learning Center property. Downstream of the culvert, channel grading is proposed to convey the flow to the main stem of Poudre Learning Center just west of 83rd Avenue.

The roadway crossing was conceptually designed with minimal ground cover over the top of the crossing. The improvement requires installation of headwalls and wingwalls, at a minimum, on the upstream and downstream side of the RCBC culvert. Riprap will be required for outlet protection on the downstream end. During final design, the culvert height and width may need to be adjusted to accommodate the proposed roadway design section. Slight changes in geometry would be expected with more design information.

No known water or sanitary conflicts are anticipated at this location. Location of dry utilities are unknown and should be investigated prior to final design. Minor channel improvements to the drainageway will be required upstream and downstream of the crossing in order to promote drainage.

The culvert was sized for the existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be considered to update the design discharge.

Table 7-9 Poudre Learning Center – County Road 62 (East) Crossing

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan				
DRAINAGEWAY :	Poudre Learning Center				
REACH :	County Road 62 (East) Crossing				
JURISDICTION :	City of Greeley				
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info		DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)			
12	5	1	100	L.F.	$1,239.66	$123,966.00
Headwall and Torewalls						
Individual Box Span (ft)	No. of Barrels	Total Span (ft)				
12	1	14.00	2	EA	$1,343.16	$2,686.00
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels				
12	5	1	2	EA	$12,577.01	$25,154.00
Channel Improvements						
Excavation, Mid Range			670	C.Y.	$32.00	$21,440.00
12-inch Riprap, Type M			18	C.Y.	$80.00	$1,440.00
Excavation, Mid Range			2300	C.Y.	$32.00	$73,600.00
12-inch Riprap, Type M			16	C.Y.	$80.00	$1,280.00
Removals						
Removal of culvert pipe (D<48")			50	L.F.	$27.00	$1,350.00
Landscaping and Maintenance Improvements						
Wetlands Plantings			2	ACRE	$33,500.00	$67,000.00
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00
Trail/Path, Concrete (10' Width)			50	L.F.	$59.00	$2,950.00
Special Items (User Defined)						
Asphalt	<----User Defined Items		33	TON	$250.00	$8,250.00
Land Acquisition						
Easement/ROW Acquisition			1.10	ACRE	$88,000.00	$96,800.00

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$151,806.00
Hydraulic Structures			$0.00
Channel Improvements			$97,760.00
Detention/Water Quality Facilities			$0.00
Removals			$1,350.00
Landscaping and Maintenance Improvements			$71,290.00
Special Items (User Defined)			$8,250.00
Subtotal Capital Improvement Costs			**$330,456.00**
Additional Capital Improvement Costs			
Dewatering	$5,000.00	L.S.	$5,000.00
Mobilization	5%		$16,523.00
Traffic Control	$16,522.80	L.S.	$16,523.00
Utility Coordination/Relocation	$16,522.80	L.S.	$16,523.00
Stormwater Management/Erosion Control	5%		$16,523.00
Subtotal Additional Capital Improvement Costs			**$71,092.00**
Land Acquisition Costs			
ROW/Easements			$96,800.00
Subtotal Land Acquisition Costs			**$96,800.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$60,282.00
Legal/Administrative	5%		$20,077.00
Contract Admin/Construction Management	10%		$40,155.00
Contingency	25%		$100,387.00
Subtotal Other Costs			**$220,951.00**
Total Capital Improvement Costs			**$719,199.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	100	L.F.	$1.00	$100.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	675	L.F.	$3.00	$2,025.00
Total Annual Operation and Maintenance Cost				**$2,125.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$66,775.00**

7.2.6.1 POUDRE LEARNING CENTER – 83RD AVENUE CROSSING

Approximately 650 ft. north of County Road 62, a dual cell 13 foot wide by 6 foot tall RCBC is proposed to convey flow underneath 83rd Avenue to the Cache La Poudre River. The existing 48 inch RCP is proposed to be replaced with a dual 13 foot by 6 foot RCBC in order to meet City criteria. 83rd Avenue is a major arterial, requiring 100-year conveyance capacity of the culvert with no overtopping. The RCBC will convey the 100-year existing conditions design flow of 1,110 cfs with no roadway overtopping.

This improvement will require installation of headwalls and wingwalls, at a minimum, on the upstream and downstream side of the RCBC culvert. Riprap will be required for outlet protection on the downstream end. During final design, the culvert height and width may need to be adjusted to accommodate the proposed roadway design section. Slight changes in geometry would be expected with more design information.

No known water or sanitary conflicts are anticipated at this location. Location of dry utilities are unknown and should be investigated prior to final design. Minor channel improvements to the drainageway will be required upstream and downstream of the crossing in order to promote drainage.

The proposed improvement requires approximately 1 acre of property acquisition.

The culvert was sized for the existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be considered to update the design discharge.

Table 7-10: Poudre Learning Center – North 83rd Avenue Crossing

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan				
DRAINAGEWAY :	Poudre Learning Center				
REACH :	North 83rd Avenue Crossing				
JURISDICTION :	City of Greeley				
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info		DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)			
13	6	2	80	L.F.	$3,079.08	$246,326.00
Headwall and Toewalls						
Individual Box Span (ft)	No. of Barrels	Total Span (ft)				
13	2	29.00	2	EA	$2,782.26	$5,565.00
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels				
13	6	2	2	EA	$20,131.04	$40,262.10
Channel Improvements						
Excavation, Mid Range			1043	C.Y.	$32.00	$33,376.00
12-inch Riprap, Type M			33	C.Y.	$80.00	$2,607.00
Removals						
Removal of culvert pipe (D<48")			70	L.F.	$27.00	$1,890.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00
Special Items (User Defined)						
Asphalt	<----User Defined Items		58	TON	$250.00	$14,500.00

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$292,153.00
Hydraulic Structures			$0.00
Channel Improvements			$35,983.00
Detention/Water Quality Facilities			$0.00
Removals			$1,890.00
Landscaping and Maintenance Improvements			$1,340.00
Special Items (User Defined)			$14,500.00
Subtotal Capital Improvement Costs			**$345,866.00**
Additional Capital Improvement Costs			
Dewatering	$5,000.00	L.S.	$5,000.00
Mobilization	5%		$17,293.00
Traffic Control	$17,293.30	L.S.	$17,293.00
Utility Coordination/Relocation	$17,293.30	L.S.	$17,293.00
Stormwater Management/Erosion Control	5%		$17,293.00
Subtotal Additional Capital Improvement Costs			**$74,172.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$63,006.00
Legal/Administrative	5%		$21,002.00
Contract Admin/Construction Management	10%		$42,004.00
Contingency	25%		$105,010.00
Subtotal Other Costs			**$231,022.00**
Total Capital Improvement Costs			**$651,060.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	80	L.F.	$1.00	$160.00
Total Annual Operation and Maintenance Cost				**$160.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$5,028.00**

7.2.6.2 POUDRE LEARNING CENTER – WILLIAM R. JONES CANAL BASEFLOW SEPARATION

In the Poudre Learning Center Basin, flow crosses an old remnant of the William R. Jones Ditch and County Road 62, flowing into Siebring Reservoir. The Jones Ditch downstream of Siebring Reservoir is no longer used for irrigation purposes. During storm events, the Jones Ditch has the potential to intercept runoff from flow exiting the Poudre Learning Center main draw, and from backwater behind County Road 62. Due to the alignment differences between the ditch, roadway, and draw exit location, separation of the inflows did not appear practical. Formalizing a spill location just upstream of 83rd Avenue is proposed to help mitigate flooding hazards on downstream property created from uncontrolled spill flows.

The proposed 50 ft. wide concrete spillway will passively discharge flow from the William R. Jones Ditch along an existing flowpath to the County Road 62 East Crossing. The spillway will prevent uncontrolled spill flow at 83rd Avenue where a pipe intercepts any flow in the ditch, conveying flow north to the Cache La Poudre River.

The proposed improvements require approximately 1 acre of property acquisition.

No known water or sanitary conflicts are anticipated at this location. Location of dry utilities are unknown and should be investigated prior to final design.

Table 7-11: Poudre Learning Center - William R. Jones Ditch Canal Baseflow Separation

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan		
DRAINAGEWAY :	Poudre Learning Center		
REACH :	William R. Jones Ditch Canal Baseflow Separation		
JURISDICTION :	City of Greeley		
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info	DATE : 12/21/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST
Channel Improvements					
Excavation, Mid Range		890	C.Y.	$32.00	$28,480.00
12-inch Riprap, Type M		100	C.Y.	$80.00	$8,000.00
Landscaping and Maintenance Improvements					
Reclamation & seeding (native grasses)		1	ACRE	$1,340.00	$769.00
Special Items (User Defined)					
Concrete Spillway	<----User Defined Items	50	C.Y.	$804.00	$40,200.00
Land Acquisition					
Easement/ROW Acquisition		1.10	ACRE	$88,000.00	$96,800.00

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$36,480.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$769.00
Special Items (User Defined)				$40,200.00
Subtotal Capital Improvement Costs				**$77,449.00**
Additional Capital Improvement Costs				
Dewatering	$5,000.00	L.S.		$5,000.00
Mobilization	5%			$3,872.00
Traffic Control	$5,000.00	L.S.		$5,000.00
Utility Coordination/Relocation	$5,000.00	L.S.		$5,000.00
Stormwater Management/Erosion Control	5%			$3,872.00
Subtotal Additional Capital Improvement Costs				**$22,744.00**
Land Acquisition Costs				
ROW/Easements				$96,800.00
Subtotal Land Acquisition Costs				**$96,800.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$15,029.00
Legal/Administrative	5%			$5,010.00
Contract Admin/Construction Management	10%			$10,019.00
Contingency	25%			$25,048.00
Subtotal Other Costs				**$55,106.00**
Total Capital Improvement Costs				**$252,099.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$670.00	$134.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	600	L.F.	$3.00	$900.00
Total Annual Operation and Maintenance Cost				**$1,034.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$32,492.00**

7.2.7 WIEDEMAN CREEK

The Wiedeman Creek watershed extends from the Cache La Poudre River south beyond 10th Street. The watershed lies within the City of Greeley and unincorporated Weld County. Runoff generally drains south of 10th Street, north to the Cache La Poudre River. Poudre River Ranch Phase III and the River Run at Poudre River Ranch Phases I and II developments are present within this watershed. Two main drainage patterns convey flow through Poudre River Ranch. During the 100-year design storm, depths exceed five feet near the entrance to both culverts along the North 81st Avenue drainageway. Street flooding along Poudre River Road and North 81st Avenue pose flooding hazards with flooding depths exceeding the City maximum flow depth criteria of 18-inches. Additional flood hazards were identified south of the future 4th Street roadway expansion, east of Wiedeman Creek in a localized sump area.

7.2.7.1 WIEDEMAN CREEK –4TH STREET CROSSING

Wiedeman Creek crosses 4th Street approximately 900 ft. east of 83rd Avenue. A proposed 6 ft. wide by 4 ft. high RCBC will convey approximately 238 of the 264 cfs during the 100-year design storm. Flows in excess of the culvert capacity, 26 cfs during the existing conditions 100-year event, will overtop the roadway at a depth less than 6-inches.

The roadway crossing was conceptually designed with minimal ground cover over the top of the crossing. The improvement requires installation of headwalls and wingwalls, at a minimum, on the upstream and downstream side of the RCBC culvert. Riprap will be required for outlet protection on the downstream end. During final design, the culvert height and width may need to be adjusted to accommodate the proposed roadway design section. Slight changes in geometry would be expected with more design information.

No known sanitary conflicts are present at the crossing. A 27 inch Bellevue water main is present along the north side of the roadway but is not anticipated to be in conflict with the proposed improvements. Other dry utilities are unknown for this crossing and should be investigated prior to final design. Minor channel improvements to the drainageway will be required upstream and downstream of the crossing in order to promote drainage.

The culvert was sized for the existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be considered to update the design discharge.

Table 7-12: Wiedeman Creek - 4th Street Crossing

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan					
DRAINAGEWAY :	Wiedeman Creek					
REACH :	4th Street Crossing					
JURISDICTION :	City of Greeley					
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info			DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)			
6	4	1	50	L.F.	$722.88	$36,144.00
Headwall and Torwalls						
Individual Box Span (ft)	No. of Barrels	Total Span (ft)				
6	1	8.00	2	EA	$723.52	$1,447.00
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels				
6	4	1	2	EA	$8,330.86	$16,661.70
Channel Improvements						
Excavation, Mid Range			200	C.Y.	$32.00	$6,400.00
12-inch Riprap, Type M			13	C.Y.	$80.00	$1,066.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00
Special Items (User Defined)						
Asphalt	<----User Defined Items		22	TON	$250.00	$5,500.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$54,253.00
Hydraulic Structures			$0.00
Channel Improvements			$7,466.00
Detention/Water Quality Facilities			$0.00
Removals			$0.00
Landscaping and Maintenance Improvements			$1,340.00
Special Items (User Defined)			$5,500.00
Subtotal Capital Improvement Costs			**$68,559.00**
Additional Capital Improvement Costs			
Dewatering	$5,000.00	L.S.	$5,000.00
Mobilization	5%		$3,428.00
Traffic Control	$5,000.00	L.S.	$5,000.00
Utility Coordination/Relocation	$5,000.00	L.S.	$5,000.00
Stormwater Management/Erosion Control	5%		$3,428.00
Subtotal Additional Capital Improvement Costs			**$21,856.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$13,562.00
Legal/Administrative	5%		$4,521.00
Contract Admin/Construction Management	10%		$9,042.00
Contingency	25%		$22,604.00
Subtotal Other Costs			**$49,729.00**
Total Capital Improvement Costs			**$140,144.00**

7.2.7.2 WIEDEMAN CREEK – 81ST AVENUE

Primary problems within the Wiedeman Creek watershed focus on drainage within the Poudre River Ranch Phase III development. Infrastructure within the development is undersized for existing conditions design flows. As flow enters the development, the undersized 7 ft. wide by 4 ft. tall RCBC leads to flow overtopping Skyview Street in excess of City criteria. Downstream of Skyview Street, the drainage system continues in an open channel parallel 81st Avenue before the system is intercepted in a 5 foot wide by 4 foot tall RCBC. Flows in excess of the 140 cfs storm drain capacity spill onto 81st Avenue, exceeding City criteria of 18 inch ponding depth. Two homes are inundated west of the 5 foot by 4 foot box culvert entrance where flow spills onto 81st Avenue.

Upstream of the development, a 22.7 Ac-ft. regional detention basin is proposed to mitigate the flooding hazards. The detention facility would capture the 100-year event (703 cfs) prior to entering Poudre River Ranch Phase III development area at 81st Avenue. A 72 inch RCP is proposed as the outlet structure to the facility, limiting the peak release to 325 cfs. From the pond, flow will be conveyed downstream through the existing storm drain system at Skyview Street. The reduced flow out of the pond will reduce the overtopping at Skyview Street to less than 6 inches in depth. The overtopping flow at 81st Avenue will also be reduced to 185 cfs, meeting the City's criteria of less than 18 inches in depth.

Construction of a detention basin could provide the City can opportunity to work with the surrounding land owners to minimize costs of the pond while maximizing the potential benefit of the pond. Future development in the area could use the detention pond footprint to help minimize the remaining on-site detention requirements, thus promoting a working relationship between the City and development groups.

The proposed detention pond has been designed such that it does not exceed the requirements of a jurisdictional dam in the State of Colorado, with a maximum depth of less than 10 ft. deep, surface area less than 20 acres, and less than 100 acre-feet in size. However, given the changing dam safety requirements, it is still recommended that the City consult the State for current guidance prior to purchasing land or designing the detention facility.

Prior to implementation, the basin volume would need to be re-evaluated based upon upstream development and possible reduction in volume. Regardless of the proposed detention facility, all developments in the Wiedeman Creek Basin are to adhere to current City of Greeley detention standards, detaining to the 5-yr historic discharge.

Similarly to Sharktooth Draw, the proposed detention basin could provide a multi-objective function for the local natural area in Wiedeman Creek, providing flood management, but also improving the ecological function, wildlife habitat, and public access within the site. A future trail is currently proposed to extend along Wiedeman Creek through the proposed detention basin. The detention facility would also help promote wildlife through the preservation of native vegetation and habitat areas, as well as be designed to provide regional water quality benefits. Natural hydrologic function could continue to exist by conveying bankfull, base flows undetained through the pond area, up to the capacity of the proposed downstream infrastructure and acceptable roadway overtopping. Pond landscaping could include seeding with drought-tolerant native seed mixes, infrequent or no-mow areas. Any needed mowing practices could occur outside of ground-nesting bird seasons in the spring. Conceptual cost estimate of the pond assumes minimal facility enhancements as the storage capacity of this detention basin will not be required when the upstream property develops.

The proposed improvement requires purchase of approximately 11 acres of land for the detention basin.

No known water or sanitary conflicts have been identified in the area. Dry utilities in the location of the pond are unknown, but assumed to be minimal. The improvements also consist of the installation of headwalls and wingwalls on the upstream and downstream side of pond outlet, and the installation of a riprap stilling basin for outlet protection. Channel improvements to the drainageway will be required downstream of the crossing in order to promote drainage. The low flow channel through the pond will require drop structures in order to ensure the long-term stability of the stream system.

The detention basin was sized for the existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be considered to update the design discharge.

CLICK HERE TO VIEW WIEDEMAN CREEK EXHIBITS

Table 7-13: Wiedeman Creek - 81st Avenue

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan
DRAINAGEWAY :	Wiedeman Creek
REACH :	81st Avenue Detention
JURISDICTION :	City of Greeley
REACH ID:	SKD Conceptual Design — Enter Estimator Name on Project Info T — DATE: 6/10/2019

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
88-inch	72	1	72	L.F.	$354.00	$25,488.00
Headwalls						
Diameter (in)	Applicable	No. of Barrels				
88-inch	Yes	1	2	EA	$2,339.40	$4,679.00
Wingwalls (includes concrete apron)						
Diameter (in)		No. of Barrels				
88-inch		1	2	EA	$13,825.58	$27,651.00
Hydraulic Structures						
Sloping Drop Structures						
Height (ft)	Bottom Width (ft)	Yn (ft)				
2	10	0.5	2	EA	$22,233.52	$44,467.00
Detention/Water Quality Facilities						
Detention (User Entered Quantities)						
Excavation, Low Range			51720	C.Y.	$15.00	$775,800.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			11	ACRE	$1,340.00	$14,740.00
Trail/Path, Crusher Fines (10' Width)			3300	L.F.	$15.00	$49,500.00
Special Items (User Defined)						
Excavation Haul	<----User Defined Items		51720	CY	$12.00	$620,640.00
Land Acquisition						
Temporary Easements			1	EA	$30,000.00	$30,000.00
Easement/ROW Acquisition			11.00	ACRE	$88,000.00	$968,000.00

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs			
Pipe Culverts and Storm Drains			$57,818.00
Concrete Box Culverts			$0.00
Hydraulic Structures			$44,467.00
Channel Improvements			$0.00
Detention/Water Quality Facilities			$775,800.00
Removals			$0.00
Landscaping and Maintenance Improvements			$64,240.00
Special Items (User Defined)			$620,640.00
Subtotal Capital Improvement Costs			**$1,562,965.00**
Additional Capital Improvement Costs			
Dewatering	$50,000.00	L.S.	$50,000.00
Mobilization	5%		$78,148.00
Traffic Control	$5,000.00	L.S.	$5,000.00
Utility Coordination/Relocation	$25,000.00	L.S.	$25,000.00
Stormwater Management/Erosion Control	5%		$78,148.00
Subtotal Additional Capital Improvement Costs			**$236,296.00**
Land Acquisition Costs			
ROW/Easements			$998,000.00
Subtotal Land Acquisition Costs			**$998,000.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$269,889.00
Legal/Administrative	5%		$89,963.00
Contract Admin/Construction Management	10%		$179,926.00
Contingency	25%		$449,815.00
Subtotal Other Costs			**$989,593.00**
Total Capital Improvement Costs			**$3,786,854.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	72	L.F.	$1.00	$72.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$670.00	$670.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structu	11	ACRE	$2,010.00	$22,110.00
Mowing (e.g. channels, ponds, etc.)	11	ACRE	$67.00	$737.00
Total Annual Operation and Maintenance Cost				**$23,589.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$1,179,450.00**

7.2.7.3 WIEDEMAN CREEK – 78TH AVENUE

At the upstream end of Poudre River Ranch Phase III at 78th Avenue, offsite flow inundates one structure along the west side of 78th Avenue. A swale is proposed south of the Poudre River Ranch Phase III development to capture flows east to 78th Avenue. The swale, with a five foot bottom, conveys the 100-year existing discharge of 54 cfs at a depth of 2.1 feet. A combination of storm drain and surface flow conveyance will carry the flow north on 78th Avenue within the City of Greeley depth criteria.

The north side of the swale will be covered in an reinforcement turf mat to help prevent bank erosion along the channel, further protecting the homes in Poudre River Ranch Phase III.

No known water or sanitary conflicts are anticipated at this location. Location of dry utilities are unknown and should be investigated prior to final design.

The swale was sized for the existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be considered to update the design discharge.

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Table 7-14: Wiedeman Creek - 78th Avenue Flood Mitigation

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan				
DRAINAGEWAY :	Wiedeman Creek				
REACH :	78th Avenue				
JURISDICTION :	City of Greeley				
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info		DATE :	6/10/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST
Channel Improvements					
Excavation, Low Range		100	C.Y.	$15.00	$1,500.00
Landscaping and Maintenance Improvements					
Reclamation & seeding (native grasses)		1	ACRE	$1,340.00	$670.00
Special Items (User Defined)					
Excavation Haul	<----User Defined Items	100	CY	$12.00	$1,200.00
Turf Reinforcing Mat	<----User Defined Items	6170	SF	$12.00	$74,040.00
Land Acquisition					
Temporary Easements		1	EA	$30,000.00	$15,000.00
Easement/ROW Acquisition		0.50	ACRE	$88,000.00	$44,000.00

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$1,500.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$670.00
Special Items (User Defined)				$75,240.00
Subtotal Capital Improvement Costs				**$77,410.00**
Additional Capital Improvement Costs				
Dewatering	$5,000.00	L.S.		$5,000.00
Mobilization	5%			$3,871.00
Traffic Control	$5,000.00	L.S.		$5,000.00
Utility Coordination/Relocation	$5,000.00	L.S.		$5,000.00
Stormwater Management/Erosion Control	5%			$3,871.00
Subtotal Additional Capital Improvement Costs				**$22,742.00**
Land Acquisition Costs				
ROW/Easements				$59,000.00
Subtotal Land Acquisition Costs				**$59,000.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$15,023.00
Legal/Administrative	5%			$5,008.00
Contract Admin/Construction Management	10%			$10,015.00
Contingency	25%			$25,038.00
Subtotal Other Costs				**$55,084.00**
Total Capital Improvement Costs				**$214,236.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	408	L.F.	$3.00	$1,224.00
Total Annual Operation and Maintenance Cost				**$1,224.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$61,200.00**

7.2.7.4 WIEDEMAN CREEK – AMOUR HILL DRIVE

An existing 30 inch storm drain intercepts stormwater runoff from the farm land east of Amour Hill Drive. The shallow unconfined flow from the Wiedeman Family Farm inundates two structures as the stormwater continues west to Amour Hill Drive. The storm drain flow is conveyed west between two residential properties where the flow is discharged into an open channel between N 78th Avenue and Amour Hill Drive. The open channel is conveyed underneath Poudre River Road in a 36 inch storm drain which outfalls in the same open channel as the storm drain in N 78th Avenue. The capacity in the existing storm drain is greatly reduced by the slope of the system, currently less than 0.1 percent.

Improving the slope of the system at Amour Hill Drive will greatly increase the capacity of the system. Relaying the 30 inch storm drain at 0.5 percent as it crosses Amour Hill Drive will collect the majority of the flow. The flow that is not collected in the proposed system will travel overland through a defined channel to Amour Drive.

The improvements also consist of replacing two inlets on Amour Hill Drive, one manhole and relaying 55 ft. of 30inch pipe. It is assumed that utility conflicts will be minimal as the proposed system will be located in the alignment of the existing storm drain. Since this project improves the drainage on the existing system, any changes to future hydrology are not anticipated to impact this proposed improvement.

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Table 7-15: Wiedeman Creek – Amour Hill Drive

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan		
DRAINAGEWAY :	Wiedeman Creek		
REACH :	Armour Hill Drive		
JURISDICTION :	City of Greeley		
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info	DATE : 6/10/2019

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
30-inch	55	1	55	L.F.	$121.00	$6,655.00
Manholes and Inlets						
Manhole, 6' Dia. (Pipe Dia. = 48")			1	EA	$5,762.00	$5,762.00
Storm Inlet, Type R/Type 14, 5-foot			2	EA	$6,164.00	$12,328.00
Special Items (User Defined)						
Curb and Gutter	<----User Defined Items		40	LF	$26.00	$1,040.00
Asphalt	<----User Defined Items		33	TON	$250.00	$8,250.00
Sidewalk	<----User Defined Items		30	LF	$78.00	$2,340.00
Land Acquisition						
Easement/ROW Acquisition			0.25	ACRE	$88,000.00	$22,000.00

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$24,745.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$11,630.00
Subtotal Capital Improvement Costs				**$36,376.00**
Additional Capital Improvement Costs				
Dewatering	$5,000.00	L.S.		$5,000.00
Mobilization	5%			$1,819.00
Traffic Control	$15,000.00	L.S.		$15,000.00
Utility Coordination/Relocation	$50,000.00	L.S.		$50,000.00
Stormwater Management/Erosion Control	5%			$1,819.00
Subtotal Additional Capital Improvement Costs				**$73,638.00**
Land Acquisition Costs				
ROW/Easements				$22,000.00
Subtotal Land Acquisition Costs				**$22,000.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$16,502.00
Legal/Administrative	5%			$5,501.00
Contract Admin/Construction Management	10%			$11,001.00
Contingency	25%			$27,503.00
Subtotal Other Costs				**$60,507.00**
Total Capital Improvement Costs				**$192,520.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	415	L.F.	$1.00	$415.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	4	EA	$67.00	$268.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	130	L.F.	$3.00	$390.00
Total Annual Operation and Maintenance Cost				**$1,073.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$53,650.00**

7.2.8 FAIRWAY TRIBUTARY

The Fairway Tributary Watershed extends from the Greeley No. 3 Canal south past Dundee Court. The watershed lies within the City of Greeley and unincorporated Weld County. Stormwater runoff is conveyed from the south through Boomerang Links Golf Course north to Poudre River Road in the Poudre River Ranch Phase I development. Runoff is ultimately discharged into the Greeley No. 3 Canal.

Flows near the upstream end of the watershed meander through the golf course converging at the corner of C Street and Melbourne Street. Baseline hydrologic modeling does not account for the unformalized and inadvertent detention on the golf course and indicates overtopping of Melbourne Street at a depth less than 6 inches. Overtopping flows not intercepted by the storm drain inlet at the C Street and Melbourne Street intersection continue north along 71st Avenue into the Northridge Draw Watershed.

Runoff from the Wiedeman Family Farm property on the northwest edge of the watershed is conveyed in a northeast direction, crossing Vallevue Drive to the east where flows enter a storm drain crossing Poudre River Road. The storm drain continues north and is flumed in the 36 inch storm drain over the Greeley No. 3 Canal.

7.2.8.1 FAIRWAY TRIBUTARY - MELBOURNE STREET

The proposed storm drain system improvements at Melbourne Street include intercepting 67 cfs from Boomerang Links Golf Course south of Melbourne Street. A proposed 42 inch RCP storm drain will convey the discharge into the existing Northridge Draw channel north of C Street.

The improvement requires removal of a portion of the existing storm drain system, resetting the existing inlet laterals at West C Street and 71st Avenue, and CDOT Type D inlets to collect water from the fairway.

No sanitary conflicts are known along the proposed alignment. A water line crossing is anticipated in 71st Avenue. Dry utilities are unknown for this crossing and should be investigated prior to final design.

Minor channel improvements to the drainageway will be required upstream and downstream of the storm drain system in order to promote drainage.

The culvert was sized for the existing conditions land use scenario. Prior to final design and construction, any development that has occurred upstream of the roadway crossing should be considered to update the design discharge.

Table 7-16: Fairway Tributary: Melbourne Street

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan		
DRAINAGEWAY :	Fairway Tributary		
REACH :	Melbourne Street		
JURISDICTION :	City of Greeley		
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info	DATE : 12/19/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
42-inch	50	1	50	L.F.	$169.00	$8,450.00
18-inch	50	2	100	L.F.	$72.00	$7,200.00
Manholes and Inlets						
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			1	EA	$5,226.00	$5,226.00
Storm Inlet, Type R/Type 14, 5-foot			2	EA	$6,164.00	$12,328.00
Channel Improvements						
Excavation, Mid Range			150	C.Y.	$32.00	$4,800.00
Removals						
Removal of culvert pipe (D<48")			100	L.F.	$27.00	$2,700.00
Special Items (User Defined)						
Asphalt	<-----User Defined Items		9	TON	$250.00	$2,250.00
Curb and Gutter	<-----User Defined Items		50	LF	$50.00	$2,500.00
Type D Inlet	<-----User Defined Items		3	EA	$8,500.00	$25,500.00
Land Acquisition						
Easement/ROW Acquisition			0.10	ACRE	$88,000.00	$8,800.00

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$33,204.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$4,800.00
Detention/Water Quality Facilities				$0.00
Removals				$2,700.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$30,250.00
Subtotal Capital Improvement Costs				**$70,954.00**
Additional Capital Improvement Costs				
Dewatering	$5,000.00	L.S.		$5,000.00
Mobilization	5%			$3,548.00
Traffic Control	$5,000.00	L.S.		$5,000.00
Utility Coordination/Relocation	$5,000.00	L.S.		$5,000.00
Stormwater Management/Erosion Control	5%			$3,548.00
Subtotal Additional Capital Improvement Costs				**$22,096.00**
Land Acquisition Costs				
ROW/Easements				$8,800.00
Subtotal Land Acquisition Costs				**$8,800.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$13,958.00
Legal/Administrative	5%			$4,653.00
Contract Admin/Construction Management	10%			$9,305.00
Contingency	25%			$23,263.00
Subtotal Other Costs				**$51,179.00**
Total Capital Improvement Costs				**$153,029.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	100	L.F.	$1.00	$100.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	3	EA	$67.00	$201.00
Total Annual Operation and Maintenance Cost				**$301.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$9,459.00**

7.2.8.2 FAIRWAY TRIBUTARY – CACHE COURT CANAL BASEFLOW SEPARATION

To separate stormwater flow from the Greeley No. 3 Canal, a flume is proposed just west of Cache Court. Conveying the flows over the canal and discharging the stormwater into the open space north of the canal will reduce flows in excess of the decreed flow entering the canal that pose flooding hazards downstream. Improvements to the open space north of the canal include a low flow crossing such that the open space trail is not inundated by nuisance runoff.

A 30 inch sanitary sewer line is present along the north side of the canal. No conflicts are anticipated with this utility as all proposed improvements will be at grade. No known water line conflicts are present. Dry utilities are unknown for this crossing and should be investigated prior to final design.

Table 7-17: Fairway Tributary - Cache Court Canal Baseflow Seapartion

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan		
DRAINAGEWAY :	Fairway Tributary		
REACH :	Cache Court Canal Baseflow Separation		
JURISDICTION :	City of Greeley		
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info	DATE : 12/19/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
36-inch	75	1	75	L.F.	$145.00	$10,875.00
18-inch	30	1	30	L.F.	$72.00	$2,160.00
Flare End Sections						
Diameter (in)	Applicable	No. of Barrels				
36-inch	Yes	1	2	EA	$2,157.00	$4,314.00
18-inch	Yes	1	2	EA	$1,233.00	$2,466.00
Manholes and Inlets						
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			2	EA	$20,100.00	$40,200.00
Channel Improvements						
Excavation, Mid Range			50	C.Y.	$32.00	$1,600.00
Landscaping and Maintenance Improvements						
Trail/Path, Concrete (10' Width)			50	L.F.	$59.00	$2,950.00

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs			
Pipe Culverts and Storm Drains			$60,015.00
Concrete Box Culverts			$0.00
Hydraulic Structures			$0.00
Channel Improvements			$1,600.00
Detention/Water Quality Facilities			$0.00
Removals			$0.00
Landscaping and Maintenance Improvements			$2,950.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$64,565.00**
Additional Capital Improvement Costs			
Dewatering	$5,000.00	L.S.	$5,000.00
Mobilization	5%		$3,228.00
Traffic Control	$5,000.00	L.S.	$5,000.00
Utility Coordination/Relocation	$5,000.00	L.S.	$5,000.00
Stormwater Management/Erosion Control	5%		$3,228.00
Subtotal Additional Capital Improvement Costs			**$21,456.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$12,903.00
Legal/Administrative	5%		$4,301.00
Contract Admin/Construction Management	10%		$8,602.00
Contingency	25%		$21,505.00
Subtotal Other Costs			**$47,311.00**
Total Capital Improvement Costs			**$133,332.00**

7.2.9 NORTHRIDGE DRAW

On the eastern edge of the basin, Northridge Draw is home to Northridge High School, Winograd K-8, and Northridge Estates. Runoff drains from south to north, passing through the school property to C Street where the existing drainageway continues north onto private property. No formal conveyance is provided north of C Street with flows overtopping 71st Avenue to the north at a depth less than six inches into the Foothills Tributary Watershed. At the downstream end of the watershed stormwater runoff is discharged into the Greeley No. 3 Canal.

7.2.9.1 NORTHRIDGE DRAW – C STREET AND 71ST AVENUE

The proposed storm drain system proposed in the Fairway Tributary discharges into an existing swale north of C Street. The Winograd detention basin also contributes to the existing swale, conveying flow from south of C Street to the north through the 18 inch RCP outlet. The existing drainage swale is proposed to convey flow north to an existing retention pond. The existing swale has drainage capacity to convey the 100-year discharge of 71 cfs. The existing retention pond is proposed to be formalized with the installation of an outlet to the existing pond to convey stormwater through the retention pond. The outlet, a 42 inch RCP, is designed to intercept any runoff in excess of the normal water pool elevation and discharge to the northwest. A CDOT Type D inlet will intercept flow near 71st Avenue in a 42 inch RCP storm drain system. The culvert will discharge into an existing drainage swale that will convey flow north to 71st Street.

At 71st Street, a proposed inlet will collect the 100-year flow of 71 cfs and convey it into a proposed 42 inch storm drain system that will discharge into a drainage swale along the south side of 71st Street. The swale will be conveyed under 71st Street in dual 2 foot high x 6 foot wide RCBC culverts and into an existing detention pond located at the bend in 71st Avenue. Slight regrading of the existing detention basin from Poudre River Drive downstream is proposed to encourage better drainage in the area.

Local drainage combines with the pond outfall flows, increasing the 100-year peak flow to 102 cfs. A 7 foot by 3 foot RCBC flume will be installed at the 100-year water surface elevation in the pond. The flume will convey flows in excess of the outlet structure to the north side of the Greeley No. 3 ditch, separating stormwater runoff from the Greeley No. 3 Canal. On the north side of the canal, flow will travel to 71st Street where a proposed 24 inch culvert will increase the drainage capacity of the two existing RCP crossing. East of 71st Avenue, the flow is conveyed along the historic flow path in a wetland channel continuing into the Sheep Draw Basin and ultimately the Poudre River.

A CDOT Type D inlet was estimated as the pond outlet to maintain the existing pool elevation in the pond such that the facility is used for stormwater detention beyond the current storage elevations. The sizing of the Type D should be confirmed during final design once survey is available to determine the available head on the inlet to intercept the 100-year discharge. The official water right requirements associated with the existing retention pond should also be investigated prior to implementation.

A water main conflict is anticipated at the 71st Avenue crossing as a 16 inch water main is present. Multiple sanitary sewer lines are also present, including a 30 inch sanitary north of the Greeley No. 3 Canal. None of the sanitary utilities are anticipated to be in conflict as the improvements near the Greeley No. 3 Canal are proposed at grade. Dry utilities are unknown and should be investigated prior to final design. Minor channel improvements to the drainageway will be required upstream and downstream of the crossing in order to promote drainage.

CLICK HERE TO VIEW EXHIBITS

Table 7-18: Northridge Draw: C Street and 71st Avenue

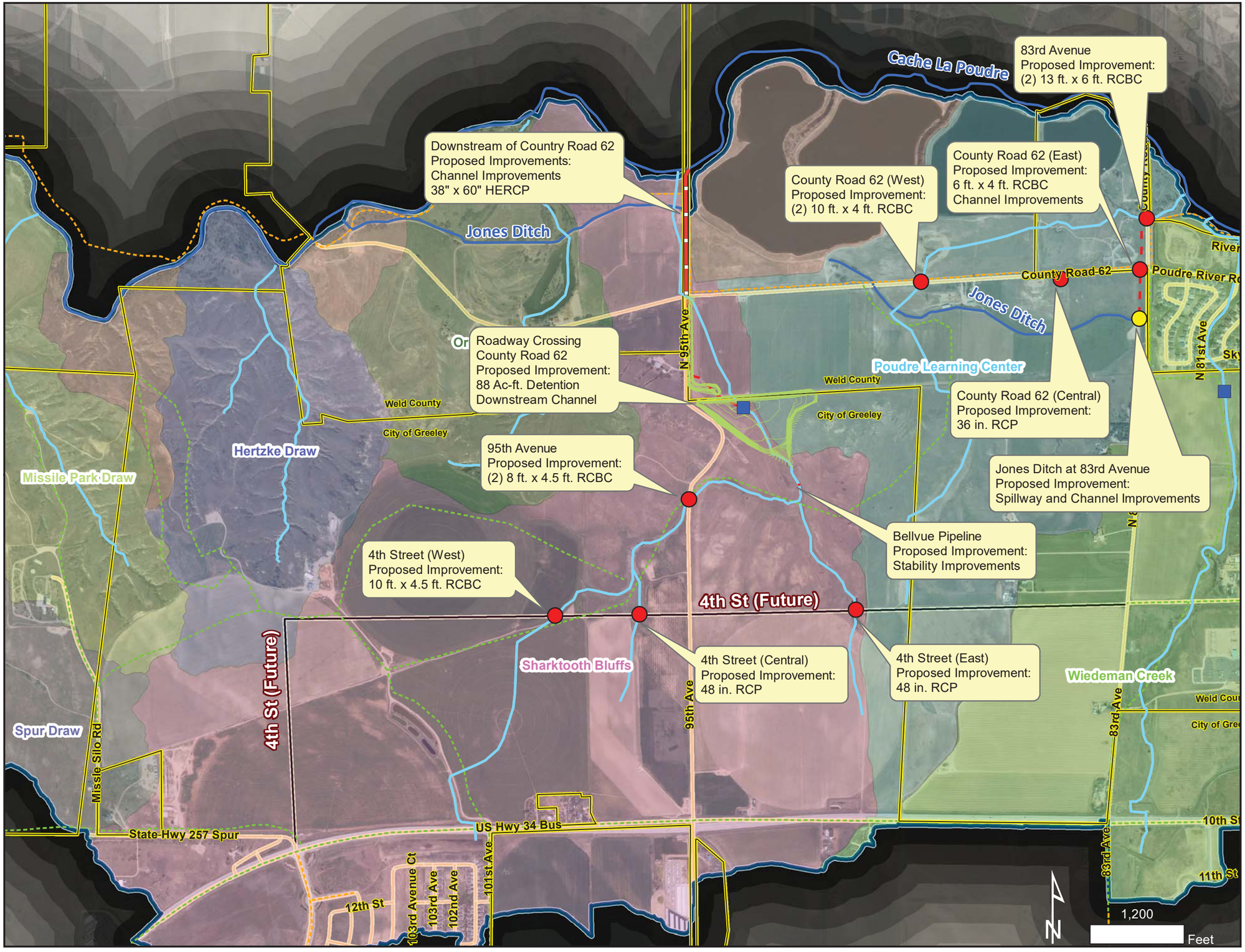
MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH						
PROJECT :	Sharktooth Bluffs Storm Drainage Master Plan					
DRAINAGEWAY :	Northridge Draw					
REACH :	71st Avenue and C Street					
JURISDICTION :	City of Greeley					
REACH ID:	SKD Conceptual Design	Enter Estimator Name on Project Info		DATE :	12/19/2018	
DESCRIPTION			**QUANTITY**	**UNIT**	**UNIT COST**	**TOTAL COST**
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
24-inch	52	1	52	L.F.	$96.00	$4,992.00
42-inch	207	1	207	L.F.	$169.00	$34,983.00
42-inch	78	1	78	L.F.	$169.00	$13,182.00
42-inch	665	1	665	L.F.	$169.00	$112,385.00
Flare End Sections						
Diameter (in)	Applicable	No. of Barrels				
24-inch	Yes	1	2	EA	$1,300.00	$2,600.00
42-inch	Yes	1	1	EA	$2,278.00	$2,278.00
42-inch	Yes	1	1	EA	$2,278.00	$2,278.00
42-inch	Yes	1	1	EA	$2,278.00	$2,278.00
Manholes and Inlets						
Manhole, 6' Dia. (Pipe Dia. = 48")			3	EA	$5,762.00	$17,286.00
Storm Inlet, Type R/Type 14, 5-foot			1	EA	$6,164.00	$6,164.00
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)			
7	3	1	61	L.F.	$722.88	$44,096.00
6	2	2	92	L.F.	$1,197.98	$110,214.00
Headwall and Toewalls						
Individual Box Span (ft)	No. of Barrels	Total Span (ft)				
7	1	9.00	2	EA	$813.96	$1,628.00
6	2	15.00	2	EA	$1,356.60	$2,713.00
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels				
7	3	1	2	EA	$6,827.66	$13,655.30
6	2	2	2	EA	$7,484.16	$14,968.30
Hydraulic Structures						
Sloping Drop Structures						
Height (ft)	Bottom Width (ft)	Yn (ft)				
4	10	0.5	1	EA	$25,595.02	$25,595.00
Channel Improvements						
Excavation, Mid Range			1000	C.Y.	$32.00	$32,000.00
12-inch Riprap, Type M			200	C.Y.	$80.00	$16,000.00
Concrete Low Flow Channel			375	L.F.	$54.00	$20,250.00
Removals						
Removal of culvert pipe (D<48")			20	L.F.	$27.00	$540.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00
Special Items (User Defined)						
Asphalt	<----User Defined Items		1	LS	$100,000.00	$100,000.00
Regrade Access Road	<----User Defined Items		1	LS	$75,000.00	$75,000.00
Turf Reinforcing Mat	<----User Defined Items		3450	SF	$12.00	$41,400.00
CDOT Type D Area Inlet	<----User Defined Items		7	EA	$8,500.00	$59,500.00
Curb and Gutter	<----User Defined Items		30	LF	$50.00	$1,500.00
Water line relocation	<----User Defined Items		2	EA	$10,000.00	$20,000.00
Land Acquisition						
Temporary Easements			1	EA	$30,000.00	$30,000.00
Easement/ROW Acquisition			5.00	ACRE	$88,000.00	$440,000.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$198,426.00
Concrete Box Culverts			$187,275.00
Hydraulic Structures			$25,595.00
Channel Improvements			$68,250.00
Detention/Water Quality Facilities			$0.00
Removals			$540.00
Landscaping and Maintenance Improvements			$1,340.00
Special Items (User Defined)			$297,400.00
Subtotal Capital Improvement Costs			**$778,826.00**
Additional Capital Improvement Costs			
Dewatering	$7,788.26	L.S.	$7,788.00
Mobilization	5%		$38,941.00
Traffic Control	$38,941.30	L.S.	$38,941.00
Utility Coordination/Relocation	$38,941.30	L.S.	$38,941.00
Stormwater Management/Erosion Control	5%		$38,941.00
Subtotal Additional Capital Improvement Costs			**$163,552.00**
Land Acquisition Costs			
ROW/Easements			$470,000.00
Subtotal Land Acquisition Costs			**$470,000.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$141,357.00
Legal/Administrative	5%		$47,119.00
Contract Admin/Construction Management	10%		$94,238.00
Contingency	25%		$235,595.00
Subtotal Other Costs			**$518,309.00**
Total Capital Improvement Costs			**$1,930,687.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	1002	L.F.	$1.00	$1,002.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	11	EA	$67.00	$737.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	1000	L.F.	$3.00	$3,000.00
Total Annual Operation and Maintenance Cost				**$4,739.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$148,916.00**

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 7.1 - Master Plan Schematic - Sharktooth Draw and Poudre Learning Center



- Detention Basin
- Canal Crossing Improvement
- Roadway Crossing Improvement
- Proposed Grading
- Channel Improvement
- Storm Drain Improvements
- Drainageway
- Jurisdictional Boundary
- Existing Trails
- Future Trails

City of Greeley Colorado

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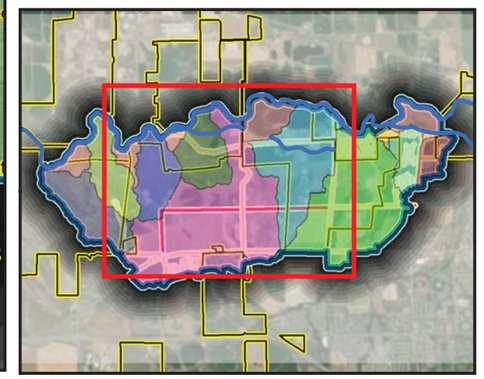


Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 7.2 - Master Plan Schematic - Wiedeman Creek, Fairway Tributary, and Northridge Draw

Cache Court
Proposed Improvement:
Greeley No. 3 Canal Flume

71st Avenue
Proposed Improvement:
24 in. RCP

Poudre River Ranch Phase I
Proposed Improvement:
Easement Acquistion
Greeley No. 3 Canal Flume

71st Avenue
Proposed Improvement:
(2) 6 ft. x 2 ft. RCBC

C Street
Proposed Improvement:
Drainage Easement
Formalize Retention
Drainage Channel

Melbourne Street
Proposed Improvement:
42 in. RCP

Amour Hill Dr
Proposed Improvement:
30 in. RCP

81st Avenue
Proposed Improvement:
Detention 22 Ac-ft.

78th Avenue
Proposed Improvement:
Channel Improvements

Roadway Crossing
4th Street Crossing
Proposed Improvement:
6 ft. x 4 ft. RCBC

Cache La Poudre
Greeley No. 3 Ditch
Jones Ditch
Fairway Tributary
Northridge Draw
Wiedeman Creek
Poudre River Ranch
Poudre Learning C
Sharktooth Bluffs
Plateau Rd
County Road 62
County Road 27
Surrey St
Deville Dr
Skyview St
Sage Ave
Riverside Ct
N 81st Ave
N 78th Ave
N 83rd Ave
N 71st Ave
N 67th Ave
71st Ave
F St
C St
W Canberra St
Dundee Ave
4th St
4th St (Future)
10th St
11th St
US Hwy-34-Bus
83rd Ave
Weld County
City of Greeley

1,000 Feet

- Detention Basin Improvement
- Storm Drain Improvements
- Roadway Crossing Improvement
- Canal Crossing Improvement
- Proposed Grading
- Drainageway
- Jurisdictional Boundary
- Approximate Easement
- Existing Trails
- Future Trails

City of Greeley Colorado

ICON ENGINEERING, INC.

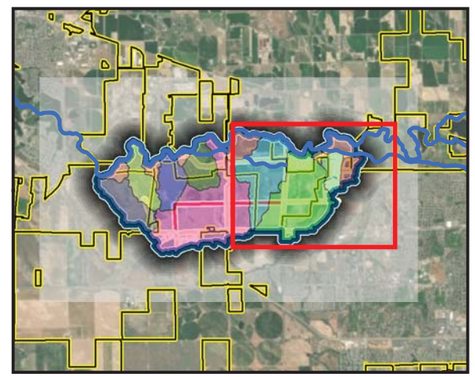


Table 7-19: Master Plan Cost Estimate Summary

Watershed	Location	Priority	Capital	Easement / ROW	Engineering	Legal / Admin	Contract Admin / CM	Contingency	Total Capital Cost	Annual O&M	50-year O&M
Sharktooth Draw	Future 4th Street (West) Roadway Crossing	Low	$ 125,408	$ -	$ 18,811	$ 6,270	$ 12,541	$ 31,352	$ 194,382	$ 50	$ 1,571
	Future 4th Street (Central) Roadway Crossing	Low	$ 45,134	$ -	$ 6,770	$ 2,257	$ 4,513	$ 11,284	$ 69,958	$ 50	$ 1,571
	Future 4th Street (East) Roadway Crossing	Low	$ 45,134	$ -	$ 6,770	$ 2,257	$ 4,513	$ 11,284	$ 69,958	$ 50	$ 1,571
	95th Avenue Roadway Crossing	Low	$ 214,015	$ -	$ 32,102	$ 10,701	$ 21,402	$ 53,504	$ 331,724	$ 120	$ 3,771
	County Road 62 Improvements & Upstream Detention Pond	Medium	$ 7,626,086	$ 2,114,000	$ 1,143,913	$ 381,304	$ 762,609	$ 1,906,522	$ 13,934,434	$ 90,019	$ 2,828,722
	Bellevue Pipeline Stabilitization	Medium	$ 79,900	$ -	$ 11,985	$ 3,995	$ 7,990	$ 19,975	$ 123,845	$ 670	$ 21,054
	Total		$ 8,135,677	$ 2,114,000	$ 1,220,351	$ 406,784	$ 813,568	$ 2,033,921	$ 14,724,301	$ 90,959	$ 2,858,260
Poudre Learning Center	County Road 62 (West) Roadway Crossing	Low	$ 311,206	$ -	$ 46,681	$ 15,560	$ 31,121	$ 77,802	$ 482,370	$ 100	$ 3,142
	County Road 62 (Central) Roadway Crossing	Low	$ 38,892	$ -	$ 5,834	$ 1,945	$ 3,889	$ 9,723	$ 60,283	$ 50	$ 1,571
	County Road 62 (East) Roadway Crossing	Low	$ 401,548	$ 96,800	$ 60,232	$ 20,077	$ 40,155	$ 100,387	$ 719,199	$ 2,125	$ 66,775
	83rd Avenue Roadway Crossing	Low	$ 420,038	$ -	$ 63,006	$ 21,002	$ 42,004	$ 105,010	$ 651,060	$ 160	$ 5,028
	Jones Ditch at 83rd Avenue Canal Baseflow Seperation	Medium	$ 100,193	$ 96,800	$ 15,029	$ 5,010	$ 10,019	$ 25,048	$ 252,099	$ 1,034	$ 32,492
	Total		$ 1,271,877	$ 193,600	$ 190,782	$ 63,594	$ 127,188	$ 317,970	$ 2,165,011	$ 3,469	$ 109,008

Watershed	Location	Alternative Type	Capital	Easement / ROW	Engineering	Legal / Admin	Contract Admin / CM	Contingency	Total Capital Cost	Annual O&M	50-year O&M
Wiedeman Creek	4th Street Roadway Crossing	Low	$ 90,415	$ -	$ 13,562	$ 4,521	$ 9,042	$ 22,604	$ 140,144	$ 100	$ 3,142
	Skyview Street	---	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,502	$ 47,198
	81st Avenue Detention Basin	High	$ 1,799,261	$ 998,000	$ 269,889	$ 89,963	$ 179,926	$ 449,815	$ 3,786,854	$ 23,589	$ 1,179,450
	78th Avenue	High	$ 100,152	$ 59,000	$ 15,023	$ 5,008	$ 10,015	$ 25,038	$ 214,236	$ 1,224	$ 61,200
	Amour Hill Drive	High	$ 110,013	$ 22,000	$ 16,502	$ 5,501	$ 11,001	$ 27,503	$ 192,520	$ 1,073	$ 53,650
	Total		$ 2,099,841	$ 1,079,000	$ 314,976	$ 104,993	$ 209,984	$ 524,960	$ 4,333,754	$ 27,488	$ 1,344,640
Poudre River Ranch Phase I and II	Poudre River Road	---	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 818	$ 25,705
	Total		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 818	$ 25,705
Fairway Tributary	Cache Court Canal Baseflow Seperation	Medium	$ 86,021	$ -	$ 12,903	$ 4,301	$ 8,602	$ 21,505	$ 133,332	$ 434	$ 13,638
	Melbourne Street	High	$ 93,050	$ 8,800	$ 13,958	$ 4,653	$ 9,305	$ 23,263	$ 153,029	$ 301	$ 9,459
	Detention North of Melbourne Street	---	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 702	$ 22,059
	Total		$ 179,071	$ 8,800	$ 26,861	$ 8,954	$ 17,907	$ 44,768	$ 286,361	$ 1,437	$ 45,156
Northridge Draw	C Street and 71st Avenue	High	$ 942,378	$ 470,000	$ 141,357	$ 47,119	$ 94,238	$ 235,595	$ 1,930,687	$ 4,739	$ 148,916
	Total		$ 942,378	$ 470,000	$ 141,357	$ 47,119	$ 94,238	$ 235,595	$ 1,930,687	$ 4,739	$ 148,916

7.3 BENEFIT COST ANALYSIS

A benefit cost analysis was performed to determine the potential benefits of implementing flood mitigation alternatives along North 81st Avenue. No other proposed improvements mitigated significant damage on insurable structures warranting a benefit cost analysis.

For the purposes of this analysis, all residential structures were assumed to have finished basements with window openings at ground level. Structure values were obtained from the Weld County Assessor's website. Contents value was assumed to be 50 percent of the structure value. A standard FEMA discount rate of seven percent was used along with the project useful lifetime of 50 years when computing present value of damages.

An Excel spreadsheet was developed to simulate FEMA's calculations of benefit-cost ratio. All flood return intervals (2-, 5-, 10-, 50-, and 100-yr) were accounted for when computing expected annual damages before mitigation for each structure. All proposed alternatives along 81st Avenue mitigated flooding from all structures and therefore an expected annual damage after mitigation of zero was used. Expected annual benefits were converted to total project benefits to include damages incurred over the entire lifetime of the project.

As seen below, the benefit-cost ratio for the 81st Avenue improvement is 0.04. Although the benefit from mitigating flood damages does not solely justify the project, the proposed improvements at 81st accomplish several other project goals such as removing overtopping of roadways in excess of six inches and flooding depths in streets of greater than 18 inches.

Table 7-20: Benefit-Cost Analysis

81st Avenue Benefit Cost Analysis		
Expected Annual Damages Before Mitigation	$	12,728
Expected Annual Damages After Mitigation	$	-
Expected Annual Benefit	$	12,728
Total Project Benefits Over Project Useful Life	$	175,656
Total Project Cost Including Maintenance	$	4,966,304
Benefit - Cost Ratio		0.04

7.4 PRIORITIZATION AND PHASING

In general, drainage improvements should be constructed from downstream to upstream within each watershed, with exception to improvements which may reduce downstream discharges, such as detention basin projects. Proposed improvements were ranked based on: effectiveness in mitigating flood hazards, feasibility of construction, and performance of existing storm drainage infrastructure in the vicinity of each project.

Prioritization and costs of each improvement can be found in Table 7-19.

7.4.1 HIGH PRIORITIZATION

High priority should be given to any project that mitigates flooding hazards and increases public health and safety. High prioritization was given to projects within Wiedeman Creek to reduce flow into Poudre River Ranch Phase III that inundated structures and exceeded street overtopping and depth criteria. Both the detention facility along 81st Avenue and the improvements proposed at Armor Hill Drive would remove structures from being inundated and mitigate flooding hazards on existing systems that do not currently meet City criteria.

Proposed improvements in both Fairway Tributary and Northridge Draw also provide flood protection to homes and businesses were assigned a high priority ranking. Design flows are much less than what are experienced along Wiedeman Creek but do aim at increasing the public health and safety.

7.4.2 MEDIUM PRIORITIZATION

Canal baseflow separation projects were assigned a medium priority. Excess storm flow in the irrigation canals can overwhelm the ditches and spill flow out at unknown locations, leading to flooding of downstream structures, land, and streets. Overtopping of the irrigation canals are not known to currently pose flooding hazards to homes and businesses but detailed hydraulic modeling of the irrigation canals was not completed as part of this study.

The improvements along Sharktooth Draw at County Road 62, which include the detention pond, drainage channel and storm drain in 95th Avenue have been assigned a medium priority. The downstream channel and storm drain system provide a path for the future 100-year flow to discharge safely to the river; however the existing overland flow paths do not pose hazards to structures.

7.4.3 LOW PRIORITIZATION

Roadway crossings designed to enhance the drainage system to meet current City criteria were assigned a low priority. The improved roadway crossings should be made in conjunction with the planned widening of roads and the addition of the future roadways. Development immediately upstream of the proposed crossings should evaluate the need for the crossing at the time of development, as current crossings have a tendency to constrict flow prior to eventually overtopping the roadway. This could lead to an easily avoidable situation in new development. Downstream impacts should also be evaluated with any improved crossing plan.

7.4.4 PHASING

The following projects have phasing impacts that need to be considered prior to final design and construction:

- The County Road 62 (east) roadway crossing in the Poudre Learning Center watershed needs to be constructed prior to, or in conjunction with, the Jones ditch canal baseflow separation.
- The flood mitigation project at Melbourne Street, in the Fairway Tributary watershed, cannot be installed until the flood mitigation projects in the Northridge Draw watershed have been completed.

7.5 STREAM BUFFER WIDTH

In order to ensure the long-term stability of a stream system, a buffer is recommended to be preserved between the stream and anthropogenic influences. In natural streams, the stream belt width or floodplain width often serves as the buffer. The stream belt width is diagrammatically shown in Figure ES 3. Belt width is the lateral distance from the outside edge of one meander to the outside edge of the next meander (Figure 1). Channel meanders shift through time, generally moving in a downstream direction. By preserving the land within the belt width of a stream, one can allow the channel to continue to evolve and change its planform without coming into conflict with human infrastructure.

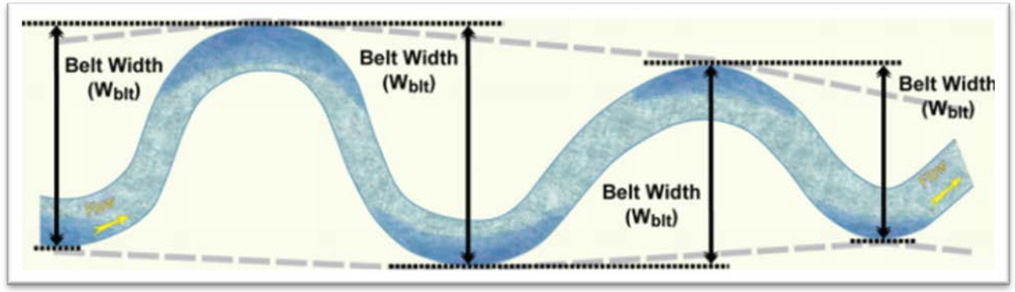


Figure 7.3: Stream Belt Width (Wildland Hydrology, 2013)

Two methods were used to estimate stream belt widths for major drainages within the Sharktooth Basin. The Stream Belt Width method is an empirical procedure based on a relationship of data from stream systems across many physiographical regions, developed by Williams in 1986, this procedure related the meander belt width to channel bankfull width through a power equation. The second method utilized to calculate the ideal stream belt width was based on shear stress. If the shear stress applied on a floodplain by flowing water exceeds the carrying capacity of the floodplain vegetation, the vegetation will be destroyed, and subsequent erosion, scour, and channel avulsions could occur. In order to prevent this, the critical shear stress at which the vegetation will begin to fail was reviewed.

Table 7-21: Stream Buffer Width

Drainageway	Channel Buffer Width	
	Ex. Conditions	Fut. Conditions
Sharktooth Draw	186	73
Poudre Learning Center	130 [1]	56
Wiedeman Creek	119	64

1- Value adjusted based on Rosgen classification

As shown by the table, the required belt or floodplain width has the potential to change over time with projected hydrology changes from new development. It is recommended that at a minimum, the existing stream belt widths be preserved within the basin to maintain stream health and maximize drainageway resiliency. Belt widths for each drainageway for both existing and future hydrologic scenarios can be found in Figure 7.4.

As development occurs in each watershed, City detention criteria will reduce peak flows along the drainageways. As such, channel buffer widths may reduce accordingly to the future condition widths shown above. It is recommended that this transition be considered after the upstream watershed has reached approximately 80 percent development density. At this time it is also recommended that a more detailed geomorphic study be completed to best determine the appropriate thresholds for the bankfull channel and floodplain areas within the buffer width. Additional design considerations are discussed below.

7.6 STREAM MANAGEMENT CORRIDOR

Given an adequate floodplain corridor, natural streams adjust to changing hydrologic and sediment supply regimes, have well-established, healthy riparian corridors that provides bank stabilization, and have increased resiliency to higher flow rates. A healthy stream corridor is comprised of a multi-stage channel that promotes riparian vegetation during smaller flows while providing flood terraces to relieve pressure on the system by allowing higher flows to periodically activate the overbanks. The multi-stage channel allows for energy to dissipate as flow spreads on the floodplain terraces, sediment to flow freely, and promote a healthy biodiversity of vegetation.

As urbanization occurs within a basin, buildings, roadways, and infrastructure often encroach on a stream corridor. Allowable widths and depths of floodplains are often restricted, increasing the velocities and erosive power of flood flows. With development anticipated throughout the Sharktooth Basin in coming years, existing stream corridors should be protected in order to maintain or establish High-Functioning, Low Maintenance (HFLM) stream systems and promote the overall health of the drainageway.

Channel parameters for the stream management corridor were developed using Rosgen stream classifications. Bankfull areas were estimated using regional regression equations developed for the Front Range based on tributary area to each design reach. A Rosgen stream type was assigned to each reach based on the longitudinal slope of the existing drainageway. Reaches ranging between 0.2 percent and 0.4 percent were assigned a Type E, between 0.4 percent and 2 percent assigned a Type C, and greater than 2 percent assigned a Type B stream classification.

A range of bankfull channel dimensions were developed from width to depth ratios based on each stream type. Rosgen Type B and E streams are proposed to have a width to depth ratio of 10-12, while Type C streams were designed to have a width to depth ratio of 18 to 20.

Guidance for other stream parameters such as pool to pool spacing, entrenchment ratio, meander width, and sinuosity for each reach are summarized in Table 7-22, below. These geomorphic parameters were developed from a desktop assessment for planning purposes. An on-site geomorphic analysis will be required prior to development of channel design. The complete geomorphic analysis for each reach can be found in Appendix D.

Several recent stream restoration projects were analyzed to approximate a stream restoration cost per linear foot of drainageway. The unit cost per linear foot was developed to include: earthwork, riffle structures, bank protection, riprap, and other stabilization techniques that might be required. An average cost per linear foot of $750 was used to estimate future stream restoration costs along Sharktooth Draw, Poudre Learning Center Tributary, and Wiedeman Creek stream reaches. It is recommended that through a City budget, or property reimbursement fees, the costs presented in Table 7-21 be used to plan for future stream restoration needs which may develop as the hydrology changes overtime within each basin. As an alternate, the stream restoration improvements recommended are constructed alongside the new development should the stream corridor be in need of rehabilitation at the time of development.

Table 7-22: Geomorphic Assessment

Watershed	Design Pt	Area (mi^2)	Reach Length (ft)	Slope (ft/ft)	Stream Type	Width Range	Depth Range	Pool Spacing	Entrenchment Ratio	Meander Width	Cost Estimate
Sharktooth Draw	95th Ave	1.22	4050	0.020	B	9.2 ft - 10.1 ft	0.8 ft - 0.9 ft	38.5 ft - 48.1 ft	Greater than 2.2	20.9 ft - 83.5 ft	$3,037,500
Sharktooth Draw	Sharktooth Bluffs to CR 62	1.56	2660	0.020	B	10 ft - 10.9 ft	0.9 ft - 1 ft	41.7 ft - 52.2 ft	Greater than 2.2	20.9 ft - 83.5 ft	$1,995,000
Poudre Learning Center	CR 62 to Poudre	0.47	3900	0.014	C	9 ft - 9.5 ft	0.5 ft - 0.5 ft	46.3 ft - 55.6 ft	Greater than 2.2	74.1 ft - 129.7 ft	$2,925,000
Poudre Learning Center	DS of Bluffs to CR 62	0.28	2140	0.040	B	5.6 ft - 6.2 ft	0.5 ft - 0.6 ft	23.6 ft - 29.5 ft	Greater than 2.2	11.8 ft - 47.2 ft	$1,605,000
Wiedeman Creek	4th St. to 81st Ave	1.08	2860	0.022	B	8.8 ft - 9.7 ft	0.8 ft - 0.9 ft	37 ft - 46.3 ft	Greater than 2.2	18.5 ft - 74 ft	$2,145,000
Wiedeman Creek	10th St to 4th St	0.52	3240	0.020	B	7 ft - 7.6 ft	0.6 ft - 0.7 ft	29.1 ft - 36.4 ft	Greater than 2.2	14.6 ft - 58.3 ft	$2,430,000

7.7 GEOMORPHIC ROADWAY CROSSINGS

Roadway crossings sized to compliment high functioning streams are safer, more resilient to large flood events, better convey sediment and debris, require less maintenance over time, and also provide better conditions for aquatic passage than traditionally designed crossings. The Urban Drainage and Flood Control District (UDFCD), now operating as the Mile High Flood District, supports this concept but understands that in some cases, site conditions will limit the design.

For new stream crossings within developing areas, and also for the replacement of old structures at already established crossings, geomorphic crossing design should be considered. It is recognized that geomorphic design is not possible for all stream crossing situations. Economically, Geomorphically Sized Crossing (GSCs) are more expensive initially than traditional designs. Additionally, GSCs generally require more space than traditional crossings. Sometimes these or other constraints may limit geomorphic design. In these instances, the reasons why a geomorphic design is not feasible at a particular site, should be clearly demonstrated prior to undertaking a different design approach.

The key principle of GSCs is that rather than being sized primarily on a hydraulic basis where the primary goal is to pass a design discharge, the crossing is sized based on the dimensions and characteristics of the upstream and downstream channel and floodplain. Further information regarding the design of GSCs is available from the UDFCD.

Alongside the GSCs, auxiliary floodplain culverts should be considered as a means of minimizing contraction and expansion of high flows at the crossing, where practical. Many small floodplain culverts function more efficiently than just one large floodplain culvert. Floodplain relief culverts should be sized large enough to allow for maintenance as needed.

7.8 WATER QUALITY IMPACTS

No specific regional water quality improvements are proposed for the Sharktooth Bluffs Basin. Water quality will be provided on a site specific basis throughout the basin as development occurs.

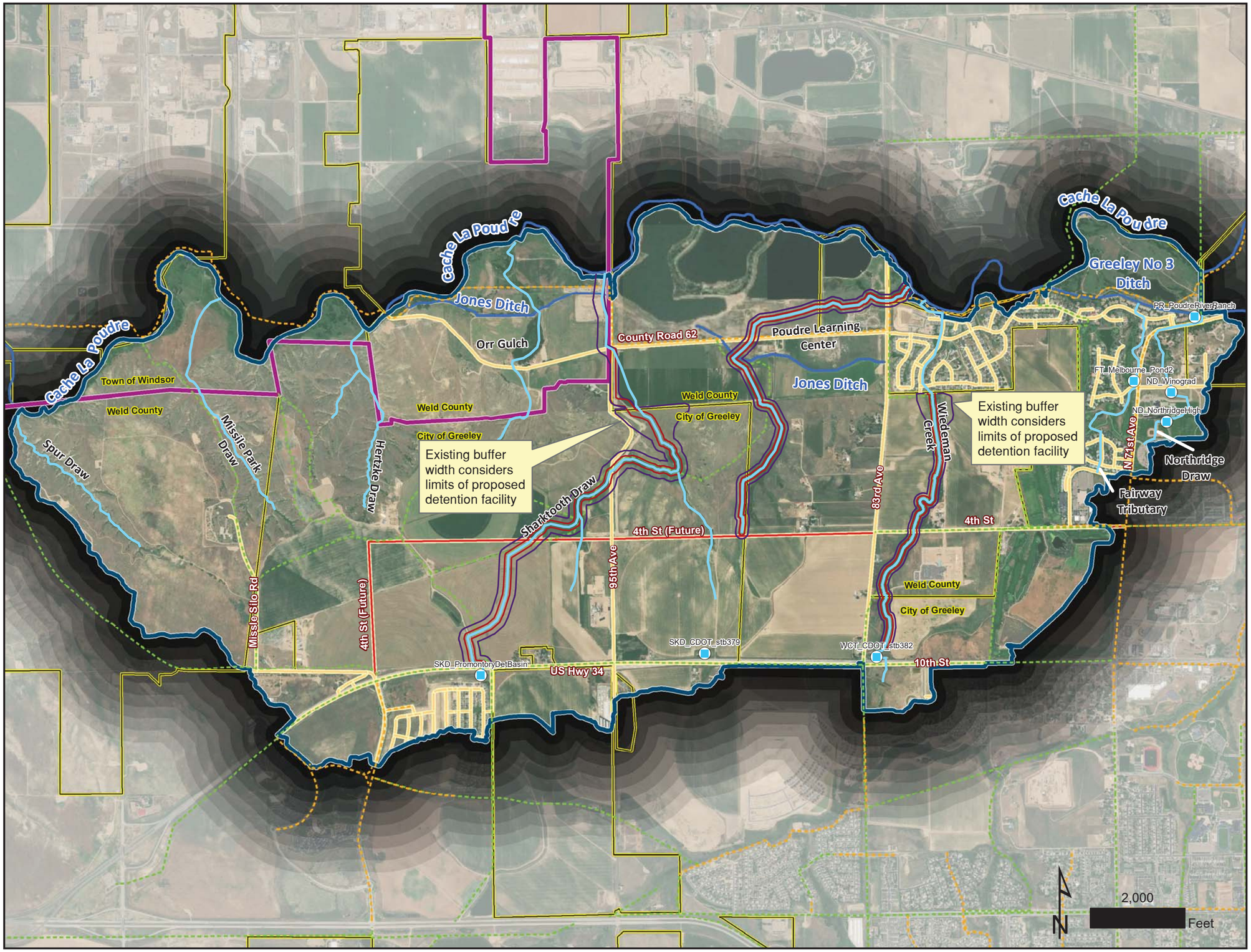
Eroding channel banks also can lead to degradation in water quality throughout a basin. By monitoring the bluffs for erosion and sediment transport, providing adequate channel preservation or restoration, and through the promotion of riparian vegetation, less erosion and sediment transport would be expected to occur, and the overall water quality for the basin would increase.

7.9 OPERATIONS AND MAINTENANCE

Maintenance costs were included in the detailed cost estimates for sediment and debris removal and structural repairs for manholes and inlets once every five years. Maintenance costs for the detention and water quality facilities which include sediment and debris removal, structural repairs, tree and weed removal was assumed to occur every other year. Costs were included on detention facilities for maintenance roads to provide access around the facility.

Sharktooth Bluffs Basin Storm Drainage Master Plan

Figure 7.4 - Stream Buffer Width



- Existing Detention Basin
- Drainageway
- Existing Buffer
- Future Buffer
- Existing Trails
- Future Trails
- Basin Boundary
- Long Range Expected Growth Boundary
- Jurisdictional Boundary

City of Greeley Colorado

ICON ENGINEERING, INC.

8.0 REFERENCES

1) Urban Drainage and Flood Control District (2016) Urban Storm Drainage Criteria Manual Volume 1 and 2
2) Urban Drainage and Flood Control District (2016) CUHP_Users_Manual_2016-09-09
3) City of Greeley Public Works (2007 Addendum June 2008), Design Criteria and Construction Specifications Storm Drainage Volume II
4) Williams, G. P. (1986). River meanders and channel size.Journal of hydrology,88(1-2), 147-164.
5) Pickett Engineering Company (2001), Final Drainage Report for Boomerang Ranch Subdivision First Filing
6) Pickett Engineering Company (1998), Drainage Report for Poudre River Ranch Phase I
7) Pickett Engineering Company (1999), Final Drainage Report for Poudre River Ranch Second Filing
8) Futura Engineering Company (2001), Addendum to Drainage Report for Boomerang Ranch First Filing
9) North Star Design (2002), Drainage and Erosion Control Study for Poudre River Ranch Third Filing
10) Westside Investment Partners, Inc. (2008), Lake Bluff Preliminary Planned Unit Development Plan
11) City of Greeley (2011), 2035 Comprehensive Transportation Plan
12) North Star Design (2016), Final Drainage and Erosion Control Study for River Run at Poudre River Ranch, Second Filing
13) Design Workshop, Inc (2016), City of Greeley Parks, Trails and Open Lands
14) City of Greeley (2018), Imagine Greeley Comprehensive Plan
15) Westside Investment Partners, Inc. (2018) Imagine Greeley Comprehensive Plan

APPENDIX A - PROJECT CORRESPONDENCE

MINUTES

ATTENDANCE:

Andrew Fisher	City of Greeley
Craig Jacobson	ICON Engineering
Jaclyn Michaelsen	ICON Engineering
Jeremy Deischer	ICON Engineering

1) COMMUNICATION

- Progress meetings will be held on a bi-weekly basis in conjunction with the 7th Avenue Storm Drainage Final Design. Meetings will between rotate between teleconference meetings and City of Greeley offices.

2) PROJECT SCOPE REVIEW:

a) Data Collection

- The team discussed the GIS data available from the City. ICON had already obtained the GIS data available through the City of Greeley website. The City will provide ICON additional GIS shapefiles for: Land Use, Storm Drain, and Storm Sewer. The land use information includes asphalt, concrete, gravel, hard packed earth, and building footprints that will be used to determine existing imperviousness. The City will also provide ICON recent aerial imagery for the basin.
- The team discussed the future development in the basin. The City zoning shapefile identifies the area within the City planned for development. No further information is available on these developments at this time and subwatershed boundaries will not be adjusted to account for any future development.
- Several areas of detention were discussed. ICON will provide the City with a list of possible areas to consider for detention in the hydrologic analysis. The City will review the operation and maintenance plan for each facility to ensure that adequate assurances are in place for the detention characteristics to remain and therefore should be included in the master plan hydrology. Once these areas are identified the City will provide the development plans for the detention basins, if available.

b) Hydrology & Hydraulics

- Craig described different approaches to the SWMM modeling to account for future development in the watershed. The current City of Greeley criteria requires any future development to detain the 100-year post development flows to a 5-year historic level. Craig described conceptual ponds that would be placed in the future development EPA SWMM models that will detain the site runoff to 5-yr historic levels. This will allow the team to have accurate peak flows along the tributaries, while accounting for the increased volume of runoff associated with any future development.
- The SWMM model will include storm drains that are 30-inches or greater in diameter or are hydrologically significant.
- FLO-2D, utilizing a 10-ft grid cell, will be used to evaluate residual flooding in the watershed.
- The irrigation canals will be assumed full in the analysis and will not incorporated in the EPA SWMM model.
- Basins will be named using hydraulic features (ie: Shark Tooth Gulch) and street names. This can be determined by ICON with input from the City.
- After the master plan is completed it will be presented to the community. Input will not be sought from the public since it is a master plan.

KICK-OFF MEETING
SHARKTOOTH BLUFFS MASTER PLAN
CITY OF GREELEY
APRIL 24, 2018 AT 2:00 PM

MINUTES

- Environmental assessment (water quality) will be focused at the outfall locations in the basin. Urban drainage recommendations for water quality treatment will be consulted for treatment in the basin.
- The City will host a web-site for the project. The City may ask ICON for exhibits.
- The approach to analyze irrigated farm land should be evaluated further. Since farmland is typically being irrigated during flood season, infiltration during a storm event is greatly reduced.

c) Alternatives Analysis

- The main goal of the alternatives analysis is to reduce flooding levels on structures and provide water quality for the watershed.
- The significance of the benefit-cost analysis when evaluating proposed alternatives will be discussed further later on in the project since the basin is predominately undeveloped.

3) SCHEDULE

- The schedule, as originally proposed, was agreed to with no modifications.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by: Jeremy Deischer

Jeremy Deischer — April 25, 2018
ICON Engineering, Inc.

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MINUTES

ATTENDANCE:

Andrew Fisher,	City of Greeley
Heather Seitz,	City of Greeley
Craig Jacobson,	ICON Engineering
Jaclyn Michaelsen,	ICON Engineering
Jeremy Deischer,	ICON Engineering

1) **Hydrology Development**
   a) ICON provided an overview of the hydrology. Subwatershed delineations were close to being final and basin parameters were beginning to be developed. Names for each tributary in the basin were provided by the City.

2) **Data Collection Review:**
   a) The team reviewed the existing land use shapefiles provided by the City of Greeley. The GIS information included polygon shapefiles for roads, building footprints, sidewalks, and a shapefile called LandUse. It was believe the LandUse shapefile represented hard packed earth. ICON noted information on driveways was not provided in the initial shapefiles. The City will investigate whether the current GIS information exists, and is updated for the basin. If the data does not exist, ICON will investigate whether to create a shapefile and digitize all the information or to digitize a representative section of the basin and apply to developed areas.
   b) The team discussed how to handle the future land use projections. The City had not been able to obtain a shapefile of the Imagine Greeley Land Use Guidance Map. ICON will proceed with digitizing relevant information off of the guidance map. Following the kick off meeting the City provided ICON the Lake Bluff Preliminary Planned Unit Development Plan. The team will develop an area weighted average of the projected land use and apply that to the whole development area. As discussed in the kick off meeting, conceptual detention basins will be placed in the future conditions SWMM model to simulate Greeley criteria of detaining 100-year future development runoff to a 5-year historic levels while considering the additional stormwater runoff volume.
   c) Andrew informed the team he had collected several drainage plans for the developments within the basin and they were in progress of being scanned. These plans will be used to verify drainage patterns not reflected in the 2014 LiDAR and verify outlet structure parameters for any detention basins.
   d) ICON asked the City if they could obtain drainage plans for the State Farm Development and Boomerang Ranch. Both of these developments are south of 10th Street and on the southern boundary of the basin.
   e) The team discussed the detention area in the Town of Windsor / Weld County. This area was not identified as a storage basin in the shapefiles provided by the City. ICON will look into whether this area is a dam registered with the State of Colorado. The area also did not appear to affect City of Greeley infrastructure should the inflows not be increased. It will be determined how to handle this area in the future should the site not be accessible.

PROGRESS MEETING
SHARKTOOTH BLUFFS MASTER PLAN
CONFERENCE CALL
MAY 9, 2018 AT 3:30 PM

MINUTES

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by: Jeremy Deischer

Jeremy Deischer
ICON Engineering, Inc.

May 10, 2018

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MINUTES

ATTENDANCE:

Andrew Fisher,	City of Greeley
Craig Jacobson,	ICON Engineering
Jaclyn Michaelsen,	ICON Engineering
Jeremy Deischer,	ICON Engineering

1) **Hydrology Development**
   a) ICON provided an overview of the hydrology development for the basin. Subwatershed boundaries have been refined and SWMM model elements are being developed. The rain-on-grid FLO-2D is being used to help guide the subwatershed delineations and SWMM routing.
   b) Watersheds names will be based off of the tributary shapefile provided by the City.
   c) The team discussed the approach for future land use in areas not within the City. The team decided to use the designations in the Imagine Greeley land use document to determine future land use.

2) **Data Collection Review:**
   a) ICON reviewed the approach taken to the Lake Bluff development. Projected land use has been digitized and an area weighted percent impervious value will be computed for the entire development. When determining future land use the area weighted value will be applied to the entire parcel.
   b) ICON was unable to find any record of the dam on the Broe Land Property in the state records for both jurisdictional and non-jurisdictional land. The City will reach out to a contact at the Town of Windsor to see if they have any information about the property.
   c) ICON scanned and ran the OCR process to make the documents searchable. ICON was beginning to review the documents for any applicable information to be included in the development of the hydrology model.

3) **Data Request:**
   a) The City provided a flash drive containing the basefiles for existing land use. For future land use projections not defined in the City of Greeley Zoning shapefile, ICON will use the projections from the Imagine Greeley document.
   b) The City is in the process of obtaining the drainage reports for Boomerang Ranch, State Farm, and Winograd K-8 and Northridge High School.
   c) ICON asked if the City had any information on the Hertzel Property, located west of Lake Bluff. The area was zoned PUD but was not covered in the development plans for Lake Bluff. The City will inquire about any more information available on the future land use for the area. If no information is available, the Imagine Greeley future land use document will be used.

PROGRESS MEETING
SHARKTOOTH BLUFFS MASTER PLAN
CITY OF GREELEY
MAY 24, 2018 AT 9:00 AM

MINUTES

4) **Schedule:**
   a) Draft SWMM results and existing conditions inundation mapping will be presented at the two meetings. The baseline hydrology report will be submitted by June 29th.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by:

Jeremy Deischer
ICON Engineering, Inc.

May 25, 2018

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MINUTES

ATTENDANCE:

Andrew Fisher,	City of Greeley
Heather Seitz,	City of Greeley
Craig Jacobson,	ICON Engineering
Jaclyn Michaelsen,	ICON Engineering
Jeremy Deischer,	ICON Engineering
Wyatt Reis,	ICON Engineering

1) Basin Boundaries Review

a) ICON provided an overview of the hydrology basin extents, providing reasoning for development for the basin boundaries due to existing topography and storm systems along the southern boundary.

b) The team discussed the use of Greeley No. 3 Canal as the basin outflow for select subwatersheds that currently drain into the canal. While delineating subwatersheds, all irrigation canals were assumed full and provided no conveyance during the design storm. The team decided although the canal was assumed full in the hydrology development, the outfall locations for the eastern Poudre River Ranch subwatershed would be the Greeley No. 3 Canal.

2) Detention Facilities Review

a) The team reviewed areas where ICON identified possible detention to consider in the hydrologic model. Any basin that only provides water quality would not be considered in the model. The City was going to look into whether adequate assurances could be made for the maintenance of the detention areas and whether to include them in the hydrologic model. The team agreed to use a survey grade GPS unit to gather elevation information on the detention facilities.

i. Promontory – Will be considered for this study

ii. CDOT Ponds – The City will see what information is available on these detention basins and whether there are enough assurances they will remain and be maintained into the future to consider in the hydrologic models.

iii. Boomerang Golf Course – ICON asked Greeley if they knew about the 8” pipe running from the sump area at 4th Street and Dundee Street into the field northwest of Dundee Ave and 4th St. Greeley recalled recent work in that area but needed to look into the scope of that work.

iv. Boomerang Run South – Will be considered for this study

v. Boomerang Run North – The Poudre River Ranch drainage report states this basin provides detention.

vi. North Ridge High School – The City hasn’t been able to obtain the drainage report for the area but the basin will be considered in the hydrologic model.

vii. Poudre River Ranch PUD 1A – The drainage report notes both water quality and stormwater detention is provided.

viii. Poudre River Ranch Phase 2 & 3 – All 3 basins in the Poudre River Ranch Phase 2 & 3 developments are water quality and will not be considered for the hydrologic model.

ix. Broe Land – Prior to the meeting, Andrew provided the team with information he had obtained from Kellie Bauer (Colorado DNR Dam Safety Engineer), Craig Stith (Great Western Industrial Park PM/Omnitrax), Doug Roth (City of Windsor Floodplain Administrator), Diana Aungst (Weld County Floodplain Administrator), and Mark Simpson (Colorado DNR Water Commissioner) about the property. No one had any knowledge the area was designed to detain stormwater runoff or was registered as a dam or had water rights.

PROGRESS MEETING
SHARKTOOTH BLUFFS MASTER PLAN
CONFERENCE CALL
JUNE 7, 2018 AT 9:00 AM

MINUTES

3) Basin Parameters Review

a) Existing Land Use

i. The team discussed inaccuracies and missing information found in the existing land use shapefiles due to recent development in the watershed. It was decided to forgo completing the existing land use layer shapefiles and instead use representative sections of each development to determine the impervious area.

ii. The “hard pack” areas, such as the golf course, were decided to be modeled at 20% impervious.

b) Future Land Use

i. Future conditions land use will use a combination of City Zoning shapefiles, Lake Bluff project land use, and the Imagine Greeley document.

c) Soils

i. The team discussed how to handle the saturated soils associated with the irrigated farm land. For the existing condition, ICON will identify areas that appear as irrigated farm land and conservatively reduce the soil infiltration to a level associated with soil type C/D.

4) SWMM Routing Elements

a) For two areas south of County Road 62, ICON will be run a FLO-2D model to define a trans basin flow split. A range of steady state discharges will be used to generate a rating curve for each flow split that will be used in the FLO-2D model.

5) Schedule:

a) ICON will schedule King Surveyors to collect invert information on hydrologically significant storm drains or storm drains 30-inches in diameter or greater.

b) At the next meeting, hydrologic results will be reviewed.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by: Wyatt Reis

Wyatt Reis — June 7, 2018
ICON Engineering, Inc.

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PROGRESS MEETING
SHARKTOOTH BLUFFS MASTER PLAN
CONFERENCE CALL
JUNE 21, 2018 AT 11:00 AM

MINUTES

ATTENDANCE:

Andrew Fisher,	City of Greeley
Heather Seitz,	City of Greeley
Craig Jacobson,	ICON Engineering
Jaclyn Michaelsen,	ICON Engineering
Jeremy Deischer,	ICON Engineering

1) Basin Boundaries Review

a) ICON reviewed the revisions to the basin boundaries following the previous progress meeting. Subwatersheds for the CDOT detention basins were delineated and routing elements were added to the SWMM model. Subwatershed boundaries were adjusted near C Street to account for two inlets on the south side of the street that intercepts flow back to the detention basin near Winograd K-8 School. Any flow not intercepted by these inlets will continue north into the drainageway on private property.

2) Detention Facilities Survey Review

a) On Monday June 18th, Wyatt completed their survey of the detention facilities in the watershed. Jeremy reviewed each facility and the outlet structure characteristics of each detention facility.

i. While gathering the survey information, Wyatt visited the area south of 4th Street and Dundee Ave to determine if there was any other stormwater infrastructure other than the 8-inch diameter pipe in the GIS shapefile. No other infrastructure was seen on the site visit and the area will be modeled as a sump with the 8-inch pipe conveying flows to the west.

ii. ICON reviewed the outlet structure of an area on the Boomerang Links Golf Course. Andrew informed the team the area used to be drained by perforated pipe conveying flows to the north to C Street. The perforated pipe was believed to be causing groundwater issues for local residents and has been capped.

3) Survey of Existing Storm Drain

a) ICON has contacted King Surveyors to collect information on storm drains with diameters 30 inches and larger. King is currently scheduled to collect information on July 9th and July 11th.

4) Hydraulic Modeling Approach

a) The team discussed the approach to the FLO-2D hydraulic modeling. The FLO-2D model will be broken into 3 separate areas to increase the stability and run time of the model.

- END OF MEETING--

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Minutes prepared by:

Jeremy Deischer
ICON Engineering, Inc.

June 25, 2018

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PROGRESS MEETING
SHARKTOOTH BLUFFS MASTER PLAN
CONFERENCE CALL
AUGUST 2, 2018 9:00 AM

MINUTES

ATTENDANCE:

Andrew Fisher,	City of Greeley
Heather Seitz,	City of Greeley
Craig Jacobson,	ICON Engineering
Jaclyn Michaelsen,	ICON Engineering
Jeremy Deischer,	ICON Engineering
Wyatt Reis,	ICON Engineering

1) Data Collection and Review

a) ICON provided an overview of invert information for the storm drain pipe from King Surveyors. There were a few locations in Poudre River Ranch that the initial survey information reported adverse pipe slopes. ICON will verify with King that the report depths are accurate.

b) ICON asked the City if any additional information for the pond on Boomerang Links Golf Course was available. It was unclear based on the field inspection by ICON whether this facility served as detention and should be considered in the hydrologic model. The City will discuss internally and update ICON of any additional information available.

2) Future Land Use

a) ICON reviewed the future land use shapefile to be used when developing future percent imperviousness for each subwatershed. The shapefile was a combination of City of Greeley Zoning shapefile and the Imagine Greeley plan. The shapefile did not include any right-of-way for 10th Street. ICON will edit the shapefile to account for the existing extents of 10th Street in the future imperviousness shapefile.

3) Existing SWMM Model

a) The existing SWMM model was reviewed after incorporating all of the storm drain invert information from King Surveyors.

a) The diversion curves for Sharktooth Draw and Poudre Learning Center were reviewed. A FLO-2D model with steady state discharges was created to generate a tabular rating curve that could be placed into SWMM. The diversion in Sharktooth predominately conveyed flow west at lower discharges, while at high flows the diversion was more evenly split between the western and east flow path. The Poudre Learning Center diversion was approximately an equal split at all design flows.

4) Existing Residual Flood Mapping

a) The existing conditions FLO-2D results were reviewed. Both the rain-on-grid and CUHP hydrology models will be presented in the report. The rain-on-grid model provided more information about general flow paths within each subwatershed while the CUHP hydrology FLO-2D model used same basin runoff as in the SWMM at the design point of each subwatershed.

5) Future Conditions SWMM Model

a) The team reviewed the approach to generate the future conditions SWMM model. City criteria requires any future development to detain the developed 100-year peak flow rate to the historic 5-year. Conceptual detention basins were inserted into each subwatershed with the possibility of future development to restrict the outflow to the existing 5-year discharge.

6) SWMM Peak Discharge Comparison

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MINUTES

a) Comparisons at several design points were reviewed for the 10-, and 100-year for the existing and future conditions model. In general, the future detention in the watershed reduces the peak flow rates when comparing future conditions land use to existing.

7) Schedule

a) ICON will submit the Baseline Hydrology Report by the next progress meeting on August 16th.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by:

Jeremy Deischer
ICON Engineering, Inc.

August 3, 2018

MINUTES

ATTENDANCE:

	Andrew Fisher,	City of Greeley
	Craig Jacobson,	ICON Engineering
	Jaclyn Michaelsen,	ICON Engineering
	Jeremy Deischer,	ICON Engineering

1) Integrated SWMM / FLO-2D Model Review

- A coupled FLO-2D / SWMM was used to analyze the residual flooding throughout the basin. FLO-2D computes the routing calculations for the overland flow while SWMM is used for closed conduit calculations. Discharge is transferred between the models at each time step based on the water surface elevation at each inlet and outlet node. This approach will assist the team in evaluating alternatives more efficiently in the next phase of the project.

2) Review Draft Baseline Hydrology and Hydraulics Report

- The team reviewed the format of the draft baseline report. Each section of the report and report figure was reviewed. The report will include FLO-2D figures for both the rain-on-grid analysis and the baselines conditions analysis for the 10-year and 100-year design storm. An additional figure will be added to the report to show where and the required volume for future detention to meet City criteria as the basin develops.

3) Schedule

- ICON will finalize the draft baseline hydraulics and hydrology report and will submit to the City for comments.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by:

Jeremy Deischer
ICON Engineering, Inc.

August 20, 2018

PROGRESS MEETING
SHARKTOOTH BLUFFS MASTER PLAN
CONFERENCE CALL
AUGUST 30, 2018 9:00 AM

MINUTES

ATTENDANCE:	Andrew Fisher,	City of Greeley
	Heather Seitz,	City of Greeley
	Craig Jacobson,	ICON Engineering
	Jaclyn Michaelsen,	ICON Engineering
	Jeremy Deischer,	ICON Engineering
	Wyatt Reis,	ICON Engineering

1) **Survey**
   - King Surveyors resurveyed the two areas which were originally identified to have inverse slopes. The area to the north of Poudre River Rd and Vallevue Dr was determined to have a minimal, but positive slope to the north. The other area in question, west of Cache Ct on Poudre River Rd, was determined to have no change in elevation between the invert and outlet, instead of the inverse slope which was originally surveyed.

   - King Surveyors notified us of an error in the eastern portion of their data which they have now corrected. In this area, a majority of the points were affected by a conversion error which produced uniformly incorrect elevations. These elevation corrections will be incorporated into the final baseline hydrology model.

2) **Boomerang Links Pond**
   - The pond on the north end of Boomerang Links Golf Course was determined to be a retention pond for the golf course and thus will not be included in the baseline hydrology.

3) **Overview of Baseline Hydrology and Hydraulics Report**
   - ICON provided a chapter by chapter overview of the draft Hydrology and Hydraulics report. Design flows for existing and future conditions land use at key locations throughout the basin were reviewed. In general, due to City criteria requiring detention in areas of future development, a reduction in peak discharge was observed from existing to future conditions. The team reviewed the approximate detention volumes for each subwatershed that would be required to meet City criteria of detaining the developed 100-year peak discharge to the historic 5-year peak discharge.

4) **Submit Baseline Hydrology and Hydraulics Report**
   - ICON will provide the baseline report to the City of Greely on Friday, August 30th.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by:

Wyatt Reis
ICON Engineering, Inc.

September 7, 2018

PROGRESS MEETING
SHARKTOOTH BLUFFS MASTER PLAN
CITY OF GREELEY
SEPTEMBER 13, 2018 9:00 AM

MINUTES

ATTENDANCE:	Andrew Fisher,	City of Greeley
	Heather Seitz,	City of Greeley
	Craig Jacobson,	ICON Engineering
	Jaclyn Michaelsen,	ICON Engineering
	Jeremy Deischer,	ICON Engineering

1) **Discussion of Baseline Hydrology Comments:**
   - Comment 5:
     - The figures will be revised or an additional figure included displaying the original Bity basin boundaries and the additional area originally within the Sheep Draw Basin that was included in the analysis for Sharktooth Bluffs.
   - Comment 8:
     - The report will be revised to include a reference to the City of Greeley Comprehensive Transportation Plan as the source of the projected population growth within the City.
   - Comment 18:
     - ICON estimated the 10th Street improvements were constructed ~2006 based on historical aerials from Google Earth. Andrew mentioned the 10th Street improvements were in conjunction with the relocation of the POW camp columns. ICON will investigate what information about the column relocation is available for a better estimate of when the 10th Street improvements occurred.
   - Comment 25:
     - A table will be added to the report showing the existing percentage of each watershed within the City of Greeley and what percentage of each watershed is within the expected long term growth area.
   - Comment 27, 29, 30, 39
     - The figures will be revised to include the future trails alignment, and long term expected growth area shapefiles.
   - Comment 42:
     - The team discussed the approach to determining the maximum pipe capacity for existing infrastructure. The baseline SWMM model, using normal depth pipe capacity, was used to determine the maximum flow for existing infrastructure. During the alternative analysis, pipe capacity analysis will be refined based on headwater and tail water conditions.
   - Comment 45:
     - The team discussed several options the City has to regulate Sharktooth Draw and Wiedeman Creek and whether to pursue developing a floodplain / floodway on these drainageways. ICON will develop a high hazard shapefile for the City to review showing all areas were the product of flow depth and velocity exceed seven. After review of this analysis the team will discuss further whether the pursuit of a regulatory floodplain / floodway is warranted.
   - Comment 57:
     - ICON will identify areas within the watershed that exceed the City's criteria of 18 inches of depth during the 100-year storm. These areas will be discussed further during the problem area identification of alternative analysis.

ICON ENGINEERING, INC.

PROGRESS MEETING
SHARKTOOTH BLUFFS MASTER PLAN
CITY OF GREELEY
SEPTEMBER 13, 2018 9:00 AM

MINUTES

2) Schedule

- The comments from the Draft Baseline Hydrology Report will be incorporated into the Alternative Analysis Report and will not require a resubmittal of the Baseline Hydrology Report.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by:

Jeremy Deischer

Jeremy Deischer
ICON Engineering, Inc.

September 16, 2018

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Sharktooth Bluffs Basin Masterplan
Comment and Response Tracking
Draft Baseline H+H Report

No.	YOUR NAME (last name, first name)	SECTION #	PAGE	LINE	COMMENT	S, R, E (Substantive, Requested, Editorial)	A, R, C (Accepted, Rejected with explanation, Needs Clarification)	RESPONSE (by consultant)
1	Fisher, Andrew	Cover Letter	i	Title	Correct name of project	E	**A**	Name has been corrected
2	Fisher, Andrew	Cover Letter	i	3	Revise 71st Street to 71st Avenue	E	**A**	Comment addressed
3	Fisher, Andrew	Cover Letter	i	4	Please specifiy Highway 257 is to the west.	E	**A**	Comment addressed
4	Fisher, Andrew	Introduction	1	Tbl 1-1	Some reports seem to be missing that were evaluated and incorporated at some level, including the State Farm Development, Promontory, Boomerang Ranch, River Run, 1st Filing, the 2035 Comprehensive Transportation Plan, and City of greeley Parks and Trails Master Plan. Some of these are mentioned in the report and definitely should be listed here.	R	**A**	reports have been aded to table
5	Fisher, Andrew	Study Area Description	3	2.1	This study revises the boundary between West Poudre (now Sharktooth) and Sheep Draw basins. Please reference the Comprehensive Drainage Plan for Sheep Draw Basin (ACE, 2006), and identify which tributaries and subbasins have been incorporated in this report that were addressed in that report. Add pertinent discussion and any comparison in data between the 2006 report and your findings, if any exist.	S	**A**	As discussed in the progress meeting, the Sheep Draw Plan boundary will be added to the exhibit. No detailed analysis was included in the Sheep Draw Plan to be compared to this study
6	Fisher, Andrew	Study Area Description	3	2.1	Please add to this report the assumption that irrigation ditches were considered to be full and unavailable for storm drainage conveyance, as the City does not desire to count on conveyance capacity of irrigation structures for storm runoff protection. Maybe this should occur in 3.5.2	R	**A**	Added to section 3.5.2
7	Fisher, Andrew	Study Area Description	3	2.1	Please identify total area in City of Greeley now and how tota area within Long-Range Growth Boundary of Greeley	R	**A**	Comment addressed
8	Fisher, Andrew	Study Area Description	3	2.1	Do you have a source for Greeley's expected population growth? I could provide one if needed.	R	**A**	2035 Transportation Plan
9	Fisher, Andrew	Study Area Description	3	2.1	Please reference 2035 Transportation Plan regarding 83rd Ave and 4th Street	R	**A**	Comment addressed
10	Fisher, Andrew	Missile Park Draw	4	2.3.2	Revise to gullies and converge as noted	E	**A**	Comment addressed
11	Fisher, Andrew	Missile Park Draw	4	2.3.2	Revise spelling of Missile in photo caption	E	**A**	Comment addressed
12	Fisher, Andrew	Missile Park Draw	4	2.3.2	Please specify rationale for assumption Missile Park Draw is not expected to develop. Clarify if comment is in regards to the draw itself or entire sub-basin contributing to Missile Park Draw	R	**A**	Missle Park Draw basin is not expected to develop due to the open space zoning assignment
13	Fisher, Andrew	Missile Park Draw	4	2.3.2	Add comma as noted	E	**A**	Comment addressed
14	Fisher, Andrew	Hertzke Draw	4	2.3.3	Hertzke Draw is referred to as a basin, all others as watershed. Please use consistent terminology	E	**A**	Comment addressed
15	Fisher, Andrew	Orr Gulch	4	2.3.4	Please reword last sentence for clarity	E	**A**	Comment addressed
16	Fisher, Andrew	Sharktooth Draw	4	2.3.5	Acreage of Sharktooth Draw not listed. Please add.	R	**A**	Comment addressed
17	Fisher, Andrew	Sharktooth Draw	5	2.3.5	Revise commas as noted	E	**A**	Comment addressed
18	Fisher, Andrew	Wiedeman Creek	5	2.3.7	If you have a ballpark time for when 10st Street Improvements were completed, add this.	R	**A**	POW Camp Pillars moved in 2005 for these improvements
19	Fisher, Andrew	Wiedeman Creek	5	2.3.7	Please add additional detail to the water quality basin or use the indefinite article to refer to it.	R	**A**	Comment addressed
20	Fisher, Andrew	Poudre River Ranch Tributary	5	2.3.8	Erroneous Foothills reference	E	**A**	Comment addressed
21	Fisher, Andrew	Poudre River Ranch Tributary	5	2.3.8	Please add acreage of this watershed	R	**A**	Comment addressed
22	Fisher, Andrew	Fairway Tributary	5	2.3.9	Please add comma as noted	E	**A**	Comment addressed
23	Fisher, Andrew	Northridge Draw	5	2.3.10	Please write as easternmost	E	**A**	Comment addressed
24	Fisher, Andrew	Northridge Draw	5	2.3.10	Please add acreage of watershed	E	**A**	Comment addressed
25	Fisher, Andrew	Outfall Descriptions	6	2.3	Please add a table showing the tabular properties of each watershed, including size, area withing City of Greeley currently and area in future long-range growth boundary	R	**A**	Table has been added
26	Fisher, Andrew	Outfall Descriptions	6	2.3	Please note that watersheds Wiedeman Creek, Fairway Tributary, Northridge Draw, Poudre River Ranch and the direct flow area north of Greeley No 3 Canal were previously considered part of the Sheep Draw Basin in the 2006 Anderson report.	R	**A**	Note added to each of the watersheds

Sharktooth Bluffs Basin Masterplan

Comment and Response Tracking
Draft Baseline H+H Report

No.	YOUR NAME (last name, first name)	SECTION #	PAGE	LINE	COMMENT	S, R, E (Substantive, Requested, Editorial)	A, R, C (Accepted, Rejected with explanation, Needs Clarification)	RESPONSE (by consultant)
27	Fisher, Andrew	Study Area Map	7	Figure 2.1	Please add Long Range Growth boundary to map as well, if it can be depicted clearly. This may require a Study Area Map for present day boundaries and a separate map for future forecasted boundaries.	R		A vincity map was added to show the LRG boundary in relationship to the Sharktooth Bluffs Boundary
28	Fisher, Andrew	Subwatershed Map	8	Figure 2.2	Please increase the size of Tributary labels to the size of the Jones Ditch and No.3 canal at minimum	R		Size has been increased
29	Fisher, Andrew	Subwatershed Map	8	Figure 2.2	Please add Long Range Growth boundary to map as well, if it can be depicted clearly. This may require a Study Area Map for present day boundaries and a separate map for future forecasted boundaries.	R		Long Range Growth Boundary has been added
30	Fisher, Andrew	Subwatershed Map	8	Figure 2.2	Please either show the original boundary between West Poudre and Sheep Draw basins, or if the boundary is sufficiently close, add a note that Wiedeman Creek, Fairway Tributary, Northridge Draw, Poudre River Ranch and the direct flow area north of Greeley No 3 Canal were previously considered part of the Sheep Draw Basin in the 2006 Anderson report	R		Boundary is now shown
31	Fisher, Andrew	3.2	9	6	Please spell out UDFCD acronym at first mention	E	**A**	Comment addressed
32	Fisher, Andrew	3.4.1	9	2	Revise spelling of Missile, Hertzke and Orr	E	**A**	Comment addressed
33	Fisher, Andrew	3.4.2.2	10	2	Please revise to state Imagine Greeley Land Use Guidance Map, adopted in January 2018.	R	**A**	Comment addressed
34	Fisher, Andrew	3.4.3	10	2	Please clarify source of topographic data	R	**A**	Comment addressed
35	Fisher, Andrew	3.4.5	10	Paragraph 3	In this paragraph, please clarify that this procedure was completed on Type A and B soils in areas found to be actively irrigated agricultural land, as identified by inspection or historic aerial photographs.		**A**	Paragraph was revised to clarify
36	Fisher, Andrew	3.5.3	10	9	Add comma as noted	E	**A**	Comment addressed
37	Fisher, Andrew	3.5.3	10	11	Add "likely" as noted. Disruption not guaranteed by development	R	**A**	Comment addressed
38	Fisher, Andrew		12	Figures 3.1, 3.2	Please display the Figures in the same order they are initially mentioned in the report. This appears to be preferred to have Detention Facility Locations first and Peak Flow Design Points second based on the wording	R	A	Figures have been revised to reflect the order they are mentioned in the report
39	Fisher, Andrew		12/14	Figure 3.1	Please add Long Range Growth boundary and future trails alignments	R	**A**	Long Range Growth Boundary has been added
40	Fisher, Andrew		13	Table 3.3	There are frequent instances of increased peak flows from existing to future year conditions. Please speak to these, particularly for the Northridge and Poudre River Ranch watersheds that are predominantly developed already. Is detenrion required to increase beyond what is presented?	S	**A**	Table has been revised to accurately reflect detaining all future conditions discharges to historic 5 yr release rates as required by Greeley criteria
41	Fisher, Andrew	4.0	15	1	Clarify meaning of "storm drain system"	S	**A**	Comment addressed
42	Fisher, Andrew	4.0	15	1	Do we have enough information to deduce headwater and tailwater depths and refine culvert capacities with various culvert type equations?	R	**A**	This comment was discussed in the progress meeting. HY-8 models will be created for roadway crossings to verify capacity initially determined by normal depth pipe capacities
43	Fisher, Andrew	4.1	15	2	Reference Sheep Draw Basin Conceptual Plan and which subbasins the report provides any additional information on.	S	**A**	Comment addressed
44	Fisher, Andrew	4.2.1	15	8	Please clarify how the building footprints are incorporated in the model to affect flow patterns. Elevations? Mannings n?	R	**A**	Buildings were incorporated as blocked obstructions. Texted has been revised
45	Fisher, Andrew	4.3	15	1	Would you recommend pursuing development of a regulatory floodplain and/or floodway in this basin, particularly for Wiedeman Creek or Sharktooth Draw?	S	**A**	This comment was discussed in the progress meeting. Hazard identification was completed for the watershed using a threshold of 4. Future detention will reduce flows below the threshold of a major drainageway and a floodplain / floodway will not be developed with this study
46	Fisher, Andrew	4.3.1	15	4	State why development is not expected in Spur Draw	S	**A**	According to City of Greeley 's future Zoning plan development is not expected
47	Fisher, Andrew	4.3.2	15	1	I am aware of where the Broe Land embankment is based on our conversations but please specify with a figure or Design Point	S		Broe Land added to study area map
48	Fisher, Andrew	4.3.3	15	3	Add comma and word as noted.	E	**A**	Comment addressed
49	Fisher, Andrew	4.3.3	15	3	What is "considerable" depth?	E		Comment addressed
50	Fisher, Andrew	4.3.4	15	1	Please revise for clarity as noted	E	**A**	Comment addressed
51	Fisher, Andrew	4.3.4	15	5	Please add comma as noted	E	**A**	Comment addressed
52	Fisher, Andrew	4.3.4	16	1	Revise "planning document" to "Land Use Guidance Map	E	**A**	Comment addressed

Sharktooth Bluffs Basin Masterplan

Comment and Response Tracking
Draft Baseline H+H Report

No.	YOUR NAME (last name, first name)	SECTION #	PAGE	LINE	COMMENT	S, R, E (Substantive, Requested, Editorial)	A, R, C (Accepted, Rejected with explanation, Needs Clarification)	RESPONSE (by consultant)
53	Fisher, Andrew	4.3.6	16	4	Please revise word choice	E	**A**	Comment addressed
54	Fisher, Andrew	4.3.6	16	7	"To one the primary"?	E	**A**	Sentence has been revised
55	Fisher, Andrew	4.3.6	16	8	I think I understand the point. Can this be worded cleaner?	E	**A**	Comment addressed
56	Fisher, Andrew	4.3.7	16	3	culverts?	E	**A**	Comment addressed
57	Fisher, Andrew	4.3.7	16	5	The City's standard currently and at the time of development allows for 18". It is noteworthy whether flow exceeds 18" specifically. Please identify this as a critical measurement for this watershed and all street flooding for 100-year events.	S	**A**	Comment addressed
58	Fisher, Andrew	4.3.8	16	5	Specify this is identifying the PRR watershed, not planned neighborhood Filing	R	**A**	Comment addressed
59	Fisher, Andrew	Table 4.1	17	Watershed	Wiedeman spelling	E	**A**	Comment addressed
60	Fisher, Andrew	Table 4.1	17	Pipe Char	Please add pipe material to characteristics.	R	**A**	Comment addressed
61	Fisher, Andrew	Figure 4.1	18-21		Please add future trails and long range growth boundary	R	**A**	Future trails and long range growth boundary has been added
60	Fisher, Andrew	Appendix B	B-21	Rating Curves	Overtopping elevation on Orr Pond is certainly incorrect	E	**A**	Table has been revised
61	Fisher, Andrew	Appendix B	B-21	Rating Curves	Please add a row to each table corresponding to overtopping elevation with interpolated surface area, storage and discharge	R	**A**	Table revised
62	Fisher, Andrew	Diversion Curves	56-57		Can you add a zoomed out vicinity map to help identify where these locations are within the basin?	R	**A**	Figures revised

MINUTES

ATTENDANCE:

Andrew Fisher,	City of Greeley
Heather Seitz,	City of Greeley
Craig Jacobson,	ICON Engineering
Jaclyn Michaelsen,	ICON Engineering
Jeremy Deischer,	ICON Engineering
Wyatt Reis,	ICON Engineering

1) **Remaining Baseline Hydrology Comments**
   a) Exhibit for Long Range Growth
      i. ICON will create a vicinity map to better depict the extent of the Sharktooth Bluffs Basin within the future growth boundary.
   b) Original Greeley Basin Boundaries
      i. The original basin boundary between the West Poudre and Sheep Draw Basins was added to the report figures. The report text will be revised to mention the areas previously studied as part of the Sheep Draw Basin.

2) **Problem Area and Alternative Plan Identification**
   a) West SBB
      i. Potential erosion from the bluffs is the main concern; a quick review of the area in Google Earth did not raise any concern. It was agreed ICON will not perform a site visit when evaluating the area.
   b) Sharktooth Draw
      i. Downstream in the basin the concerns are with confining the flows as they exit the bluffs and convey the flows safely the Poudre River. Alternatives will also be developed for roadway crossing improvements at 95th, CR 62, and 4th Street. The spill flows from Sharktooth Draw to Poudre Learning Center would also be removed with these improvements.
   c) Poudre Learning Center
      i. Similar to Sharktooth Draw, the formalization of flows exiting the bluffs is a major concern in the subwatershed. Canal separation will be encouraged to prevent stormwater runoff entering Jones Ditch. Alternatives will be developed for roadway crossings at 83rd Ave, CR 62 and 4th Street.
   d) Wiedeman Creek
      i. Alternatives will be developed to mitigate flooding exceeding City criteria within the Poudre River Ranch subdivision on 81st Street. Known flooding also exists on the east side of the Poudre River Run neighborhood. Upstream of the neighborhood on Wiedeman Creek, roadway crossing improvements will be developed for 4th Street and 83rd Avenue.
   e) Poudre River Ranch
      i. Although stormwater is conveyed on the street, depths do not exceed the City criteria of 18” criteria so no problem areas were identified.
   f) Foothills Tributary
      i. Flows overtopping 71st Ave do not exceed the 6” limit but do contribute to overland flooding in Northridge Draw. Alternatives will be developed to convey flow to the Poudre maintaining separation from the Greeley No. 3 Canal.
   g) Northridge Draw
      i. In an effort to encourage separation with the Greeley No. 3 Canal, alternatives will be developed to formalize conveyance just south of 71st Ave.

PROGRESS MEETING
SHARKTOOTH BLUFFS BASIN MASTERPLAN
CITY OF GREELEY
OCTOBER 2, 2018 AT 2:30 PM

MINUTES

3) **Alternative Analysis Criteria**
   a) Design Flows (Existing or Future?)
      i. Two separate alternative sets will be developed, one the city may want to consider in the coming years to address current issues and a separate set for future development and the issues that will need to be addressed at the time of development.
      ii. A high hazard identification using the CWCB threshold of 7 will be used to help identify additional problem areas throughout the basin.

- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by:

Wyatt Reis
ICON Engineering, Inc.

October 3, 2018

P:\P\18019SBB\03_Meetings\2018_10_02 Progress Meeting\Minutes\Sharktooth Bluffs Masterplan October 2 Alternatives Kickoff Meeting Minutes.docx

MINUTES

ATTENDANCE:

Andrew Fisher,	City of Greeley
Heather Seitz,	City of Greeley
Craig Jacobson,	ICON Engineering
Jaclyn Michaelsen,	ICON Engineering
Jeremy Deischer,	ICON Engineering
Wyatt Reis,	ICON Engineering

1) Sheep Draw Comprehensive Drainage Plan Review

A. Previously studied areas now within Sharktooth Bluffs Basin
   a. The over lapping basins from the Sheep Draw Master Plan (Wiedeman Creek, Poudre River Run, Fairway Tributary, Northridge Draw) line up well with the basins in the Sharktooth study. These basins do not have any proposed improvements or additional information to incorporate in the current study with the main focus of this report was the main tributary of Sheep Draw.

2) Lake Bluff PUD First Submittal

A. Decreased size of development
   a. The first submittal of the Lake Bluff PUD decreases the overall size of the development from nearly 800 acres to just less than 300 acres
   b. The area that is included to be developed is in the central portion of the original development area with 95th paralleling the development to the east.

B. Changes in land use
   a. There are some minor changes in the land uses in the area but it was determined that redoing the future conditions was not necessary due to the limited changes and the need to still assume the conditions on the remainder of the development based of an area weighted average which was used originally. These minor changes were also not included because the development will still have to develop according to the city of Greeley's development criteria which are based on the existing conditions.

C. No significant changes to drainage patterns
   a. The basins for this area also have no change from this new PUD submittal due to the drainage basins and flow paths not changing in this area from the original submittal.

3) High Hazard Identification

A. Max Depth * Max Velocity >= 7
   a. A high hazard layer was created using a product of 7. This layer will be included on figures in the report and was used to help identify problem areas.
   b. The high hazard areas from Wiedeman Creek within the Poudre River Ranch development and upstream were larger than expected. There were also areas of high hazard in Spur Draw but does not currently impact any structures in the basin.

4) Benefit / Cost Evaluation of Alternatives

A. Similar approach to NGD Master Plan
   a. The approach to the benefit cost analysis was reviewed. A benefit cost analysis will only be performed on alternatives that impact structures. Those alternatives will be evaluated using a similar method to the North Greeley and Downtown Basin Storm Drainage Master Plan. Equations from the FEMA BCA Toolkit will be used to determine the pre and post project damages on impacted structures.

PROGRESS MEETING
SHARKTOOTH BLUFFS BASIN MASTERPLAN
CITY OF GREELEY
OCTOBER 11, 2018 AT 9:00 AM

MINUTES

5) Schedule

A. Draft Alternatives Report – End of November

-- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by:

Wyatt Reis
ICON Engineering, Inc.

October 11, 2018

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PROGRESS MEETING
SHARKTOOTH BLUFFS BASIN MASTERPLAN
CITY OF GREELEY
OCTOBER 26, 2018 AT 9:00 AM

MINUTES

ATTENDANCE:	Andrew Fisher,	City of Greeley
	Heather Seitz,	City of Greeley
	Craig Jacobson,	ICON Engineering
	Jaclyn Michaelsen,	ICON Engineering
	Jeremy Deischer,	ICON Engineering

1) **Alternative Plans**
   A. The team reviewed the alternative plans that were being developed. ICON has developed HY-8 models to confirm the capacity of the existing storm drain infrastructure at each roadway crossing. Crossing improvements were being designed for both minimum City criteria and 100-year design flow crossings.

2) **Poudre River Ranch Phase III Drainage Report**
   A. The Poudre River Ranch subdivision had been identified during the problem area identification as an area that exceeded current City criteria for flow depth on the street. The team reviewed the hydrologic analysis in the drainage report for the development compared to the hydrology being developed as part of this study. Several differences between the studies were noted including tributary area for offsite basin, existing conditions soil hydrologic properties, and as-built condition for the storm drain infrastructure. This area will be further evaluated with alternatives developed to mitigate the flooding hazards in excess of City criteria.

3) **Schedule**
   A. ICON will revised the Baseline Hydrology Chapter of the master plan report to address all City comments and provide the updated report to the City.

-- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by:

Jeremy Deischer
ICON Engineering, Inc.

October 29, 2018

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PROGRESS MEETING
SHARKTOOTH BLUFFS BASIN MASTERPLAN
CONFERENCE CALL
NOVEMBER 8, 2018 AT 9:00 AM

MINUTES

ATTENDANCE:	Andrew Fisher,	City of Greeley
	Heather Seitz,	City of Greeley
	Craig Jacobson,	ICON Engineering
	Jaclyn Michaelsen,	ICON Engineering
	Jeremy Deischer,	ICON Engineering

1) **Alternative Plans**
   A. The team reviewed the alternatives that were being developed. An alternative was developed to alleviate the flooding associated with Poudre River Ranch Phase III. The drainage report prepared for that development had significant less tributary area draining to the neighborhood than the master plan. The additional flow associated with the increased tributary area and differences in hydrology lead to the drainage facilities built for this development no longer meeting City criteria. ICON requested any as-built storm drainage information available from River Run at Poudre River Ranch Phase I to verify storm drainage capacity. Detention alternatives will be developed to detain flow upstream of the development to alleviate the flooding concerns.

   B. Alternatives will be developed for the Poudre River Ranch subdivision to separate stormwater from discharging into the Greeley No. 3 Canal. Additional alternatives will be developed for problem areas identified in the FLO-2D modeling in Northridge Draw.

-- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by:

Jeremy Deischer
ICON Engineering, Inc.

December 5, 2018

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MINUTES

ATTENDANCE:

Andrew Fisher,	City of Greeley
Florian Fiebig,	City of Greeley
Craig Jacobson,	ICON Engineering
Jeremy Deischer,	ICON Engineering

1) Review Draft Alternative Report Comments

The team reviewed all substantive comments noted received on the DRAFT Alternative Analysis Report:

- Comment 5: The table will be revised to clarify the areas listed are a comparison of the watershed size currently within City of Greeley boundaries and the long term expected growth boundary area.
- Comment 16: The text will be revised to indicated UD-MP Cost 2012 was used for all cost estimates.
- Comment 21: The term inundated area will replace any reference to floodplain since a regulated floodplain will not be established for Sharktooth Draw.
- Comment 31: A detention alternative will be added upstream of Amour Hill Drive to mitigate the flooding hazard.
- Comment 32: An additional exhibit will be created to show the Canal Base Flow Separation Alternative.
- Comment 36: The team discussed the best way to present the recommended plan. A matrix will be created indicating the selected alternative for each area.
- Comment 38: An index will be created to help easily identify the cost estimates in Appendix C.

2) Conceptual Design

Given the nature of the isolated improvements, the format of the Conceptual Design will not follow the standard UDFCD E-Plan format. The format will be further discussed at subsequent meetings but a text description and cost estimate of the selected plan will be followed by an exhibit of the improvement.

The City will research possible additional stakeholders for the master plan to help evaluate the feasibility of certain improvements for the Conceptual Design. Possible stakeholders include the Jones Ditch, Greeley No. 3 Canal, Seibring Reservoir, and Poudre Learning Center.

3) Preparation for Public Meeting

The City will prepare a presentation for the public meeting. The team decided four of the exhibits presented in the DRAFT Alternative Analysis Report would be printed at 22” x 34” to be distributed around the room. The High Hazard Area would be incorporated into the Baseline 100-year FLO-2D exhibit. The Study Area and Recommended Plan Exhibits would also be presented.

4) Schedule

a) Public Meeting – February 13th
b) Final Alternative Analysis Report – March 6th

Action Items:

ICON:

1. Revise exhibits based on comments received prior to the public meeting
2. Submit final Alternative Analysis Report by March 6th.

PROGRESS MEETING
SHARKTOOTH BLUFFS BASIN MASTERPLAN
CITY OF GREELEY
FEBRUARY 6 AT 2:00 PM

MINUTES

City of Greeley:

1. Prepare presentation for public meeting.
2. Research decreed flow for both Greeley No. 3 Canal and Jones Ditch.

-- END OF MEETING--

To the best of my knowledge, these minutes are a factual account of the business conducted, the discussions that took place, and the decisions that were reached at the subject meeting. Please direct any exceptions to these minutes in writing to the undersigned within ten (10) days of the issue date appearing herein.

Minutes prepared by:

Jeremy Deischer
ICON Engineering, Inc.

February 11, 2019

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Memorandum

TO: Andrew Fisher, P.E., CFM

FROM: ICON Engineering, Inc.

DATE: June 11, 2019

RE: Sharktooth Draw Alternative Analysis

Purpose

The purpose of this memorandum is to summarize several alternatives developed for Sharktooth Draw following the submittal of the DRAFT Alternative Analysis Report. Following the submittal of the report, the recommended plan for Sharktooth Draw downstream of County Road 62 and the alternative channel alignment were both deemed infeasible.

Drainage Pattern

The Sharktooth Draw Watershed extends from south of 10th Street to the Cache La Poudre River, covering 1,235 acres. The headwaters of Sharktooth Draw begin south of 10th Street, east of Promontory Circle near the State Farm property. North of 10th Street, west of 95th Avenue, sheet flow conveys the runoff through existing farm fields before reaching the bluffs and to a defined drainageway. Once the runoff reaches the drainageway, the 100-yr flow (1063 cfs) travels north through the bluffs to an open field. The flow splits in two directions through the field in an alluvial fan pattern; approximately 514 cfs heads northwest to the intersection of 95th Avenue and County Road 62, and 542 cfs heads northeast to Jones Ditch.

Problem areas within the watershed focus around overtopping of existing roadway crossings, including 95th Avenue and County Road 62. No significant culvert crossings currently exist for either 95th Avenue or County Road 62 at this location. Only an 18" CMP currently crosses 95th Avenue, conveying flow east to west. As shown by the FLO-2D analysis performed as part of this study, drainage in this area overtops each roadway splitting flow between Sharktooth Draw and the Poudre Learning Center Watersheds. 10-year overtopping depths are approximately 3 to 6 inches, whereas 100-year depths exceed one foot. The road overtopping poses significant flooding hazards.

The Sharktooth Draw Watershed is located within the City of Greeley's Long Range Expected Growth Boundary. However, there is no defined drainageway downstream of the bluffs for future development to discharge into.

Master Plan Alternative

The DRAFT Alternative Analysis Report recommended a drainage channel that extended from immediately downstream of the bluffs to Siebring Reservoir. The channel would convey runoff under County Road 62 in dual 10ft wide x 6ft high reinforced concrete box culverts (RCBCs). The proposed solution would eliminate overtopping of 95th Avenue and County Road 62, as well as providing a drainageway for future development. Soon after completion of the DRAFT Alternatives Analysis Report, the City discussed the plan with the Central Colorado Water Conservancy District (CCWCD), the owners of Siebring Reservoir. After discussions with CCWCD, concerns regarding costs to manage the system and water rights of any stormwater discharged in the reservoir eliminated this alternative for further

ICON ENGINEERING, INC.

consideration, as any stormwater that entered the reservoir would be required to be pumped to the river and a natural outlet could not be provided as intended. An alternate alignment was developed during the initial alternative analysis proposing to cross 95th Avenue to the west at the intersection with County Road 62. The channel downstream of County Road 62 would parallel 95th Avenue to the west conveying runoff to the Cache La Poudre River. Recent development of a gas extraction site spanning west from 95th Avenue also prohibited this channel alignment. With both alternatives deemed infeasible, additional alternatives were developed for the area.

Proposed Alternatives

Four main alternatives were analyzed to address the overtopping of 95th Avenue and County Road 62. These alternatives also were proposed to formalize Sharktooth Draw channel downstream of the bluffs where the existing flow patterns become alluvial. The formalized channel will provide a drainageway for future development in the area. A description of each alternative can be found below and can be seen in the attached exhibits.

Alternative A – Drainageway to the west

Alternative A is a proposed 170-ft wide drainage channel that begins immediately downstream of the bluffs. The channel contains a 10-ft wide low flow channel that would meander through the bottom of the channel. The 100-year flow from the bluffs will sheet flow across undeveloped land where it is collected in the proposed drainage channel. The proposed channel will convey the flow to the west to the intersection of 95th Avenue and County Road 62. A 16ft wide x 6ft high reinforced concrete box culvert (RCBC) is proposed under 95th Avenue, eliminating any overtopping of the 95th Avenue and County Road 62 intersection. Improvements are also proposed to 95th Avenue in order to provide cover over the proposed culvert.

Downstream of 95th Avenue the 100-year drainage channel continues to the extension of County Road 62, where the roadway is proposed to be realigned to convey the 100-year flows through another 16ft wide x 6ft high RCBC. Downstream of County Road 62, the flow will continue in a 100yr drainage channel to the existing oxbow channel, located approximately 2,000 ft south of the Cache La Poudre River. From here, a low flow channel is proposed to convey runoff north to the Cache La Poudre River.

The alternative also consists of a proposed pedestrian bridge to raise the Poudre River bike trail over the proposed low flow channel. This alternative also proposes to siphon the Jones Ditch under the proposed channel.

Alternative B – Drainageway to the east

Alternative B is also a proposed 170ft wide drainage channel that begins immediately downstream of the bluffs. However, this channel conveys the flow to the east, through the Poudre Learning Center, and 83rd Avenue to the Cache La Poudre River. The proposed channel will convey the 100-year flows to County Road 62, in the vicinity of Jones Ditch. At County Road 62 a 16ft wide x 6ft high RCBC is proposed to convey the 100-year flows under the road. Downstream of County Road 62 the 100-year channel will continue to the east, south of the Siebring Reservoir, through the Poudre Learning Center property to 83rd Avenue. At 83rd Avenue, an improved crossing of a 12ft wide x 4ft high RCBC conveys flow underneath 83rd Avenue to the east. The conveyance capacity at 83rd Avenue is restricted by the existing channel capacity on the eastern side of the road due to a conservation easement which

prohibits any channel improvements. Therefore, to convey flows in excess of the 83rd Avenue crossing, passive overflow paths are proposed along the slough adjacent to Siebring Reservoir and along the west side of 83rd Avenue north to the Cache La Poudre River.

The alternative also proposes to flume the Jones Ditch over the proposed drainage channel and proposes a pedestrian bridge to raise the Poudre River bike trail over the proposed low flow channel.

Alternative C – Existing Detention with Future Conditions Outfall

Alternative C proposes a large 88 acre-ft detention facility at the downstream end of the bluffs. The detention facility would capture the 100-year event (1063 cfs) and release it at approximately 230 cfs. The outflows will be conveyed in a 30ft drainage channel that will travel to the intersection of County Road 62 and 95th Avenue. A proposed storm drain system is proposed, starting at the intersection, and discharging 1660 ft north into the Cache La Poudre River. Due to cover constraints, the storm drain would need to be a 38" x 60" horizontal elliptical reinforced concrete pipe (HERCP). The system will convey the future 100-year event of 75cfs. The rest of the flow will overtop the intersection of 95th Avenue and County Road 62, with less than 6 inches in depth. The overtopping flow will continue in the same path as the existing flows, heading north to the Cache La Poudre River.

The detention pond is proposed in the same location as a pond proposed in the original Lake Bluff Preliminary Planned Unit Development Plan (April 2009). In October 2018, the City received a revised development plan for Lake Bluff with all development now proposed west of 95th Avenue. At the time of this study, the City is awaiting an updated submittal showing the updated drainage plan for Lake Bluff. Construction of a detention pond at the downstream end of the bluffs would provide the City can opportunity to work with the developer to minimize costs of the pond while maximizing the potential benefit of the pond. Any proposed development in the area could use the detention pond footprint to help minimize the remaining on-site detention requirements, thus promoting a working relationship between the City and development groups. Detaining the flows at the downstream end of the bluffs greatly reduces the size of the downstream infrastructure.

The proposed detention pond has been designed such that it does not exceed the requirements of a jurisdictional dam in the State of Colorado, with a maximum depth of less than 10 ft deep, surface area less than 20 acres, and less than 100 acre-feet in size. However, given the changing dam safety requirements, it is still recommended that the City consult the State for current guidance prior to purchasing land or designing the detention facility.

Alternative D – Future Conditions Outfall

This alternative proposes an outfall channel that would convey the future conditions 100-year flow (75cfs). This channel is proposed to begin immediately downstream of the bluffs and would run along the east side of 95th Avenue to the intersection of 95th Avenue and County Road 62. At the roadway intersection a 38" X 60" HERCP storm drain would convey the 75cfs north in 95th Avenue and into the Cache La Poudre River. Alternative D provides a solution for future drainage but does not reduce or eliminate road overtopping depths significantly during the existing conditions.

Future Trails and Open Space

The City of Greeley Natural Resources Department strongly supports a naturalized stormwater management strategy that not only provides stormwater management for the benefit of the life, safety and property of the citizens of Greeley, but also considers and supports sustainable natural systems in the installation and maintenance of stormwater management facilities. Small creeks and drainages only encompass approximately one percent of the land mass in Colorado but supports nearly 85 percent of the state's wildlife species, making these areas critical for wildlife. These areas are also important movement corridors for wildlife between larger habitat areas.

The 100-year flood control channels in Alternatives A and B can be incorporated into the City's future trail system as well as provide opportunities for habitat creation. The proposed channels are proposed to be multi-staged, incorporating a natural, meandering bankfull channel concept and floodplain bench. The bench can support a meandering pathway through the natural areas.

The proposed detention pond in Alternative C could also provide a multi-objective function for the natural area. The City's trail system could cross through the bottom and along the top of the facility. The detention facility would also help promote wildlife habitat by maintaining adequate flows downstream (both in volume and timing) to preserve native vegetation and wildlife habitat, as well as be designed to provide water quality benefits. Finally, the detention facility itself could function as a natural area for both wildlife habitat and public access.

Both the proposed channel and ponds would be designed as native as possible. This includes seeding with drought-tolerant native seed mixes, infrequent or no-mow practices and mowing outside of ground-nesting bird seasons in the spring, and leaving native vegetation where possible to provide habitat while maintaining storage capacity needs.

Preliminary Cost Estimate

A preliminary cost estimate was created for each of the alternatives using the UD-MP Cost tool. The total costs include property acquisition, City project management, and engineering costs. Costs are presented consistent with the current Alternatives Analysis Section of the master planning document.

Table 1: Preliminary Cost Estimate

Alternative	Construction Costs	Land Cost	Engineering, Legal/Administration, Construction Management	Contingency (25%)	Total Costs
A – West Drainageway	$ 4,000,309	$ 2,554,000	$ 1,200,092	$ 1,000,077	$ 8,754,478
B – East Drainageway	$ 8,241,353	$ 3,082,000	$ 2,472,406	$ 2,060,338	$ 15,856,097
C – Detention with Future Outfall	$ 7,247,827	$ 2,114,000	$ 2,174,348	$ 1,811,957	$ 13,348,132
D – Future Outfall Only	$ 643,777	$ 206,000	$ 193,134	$ 160,944	$ 1,203,855

Pros and Cons

Each alternative has pros and cons that should be reviewed prior to selecting a recommended alternative.

Table 2: Alternative Pros and Cons

Alternative	Pros	Cons
A	Least expensive alternative that solves the existing conditions flooding concerns	Channel divides developable land
	Conveys 100-year event	Requires extensive roadwork
	Eliminates overtopping of 95th Ave and County Road 62 in existing conditions	Constructability concerns with minimal longitudinal slopes of 0.1% to 0.2%, interaction with oxbox
	Can incorporate the channel into the City's trail system	Requires large amount of acquisition given channel footprint
	Provides an outfall for development	
B	Conveys 100-year event	Most expensive alternative
	Uses land would be less likely to develop	Least desirable alignment from feedback from property owner
	Eliminates overtopping of 95th Ave and County Road 62 in existing conditions	Requires the most land acquisition out of all the alternatives
	Can incorporate the channel into the City's trail system	
	Provides an outfall for development	
	Higher construction feasibility, proposed channel has steeper longitudinal slopes	
C	Provides regional detention	Requires a large amount of property acquisition
	Uses land that is currently being proposed for developer's detention, potential buy-back for future development	Construction costs of detention facility
	Can incorporate the channel and the pond into the City's trail system	Possibility of being regulated as a jurisdictional dam
	Provides an outfall for development	May be difficult to work together with a developer
	Can be utilized as a natural area for the City	
	Reduces the overtopping of 95th Ave and County Road 62 to City criteria	
D	Cheapest alternative	Does not reduce flood risk or bring overtopping of 95th Ave and CR 62 into criteria during the existing conditions, a general goal of this Master Plan
	Provides an outfall for development	
	Requires the least amount of land acquisition	

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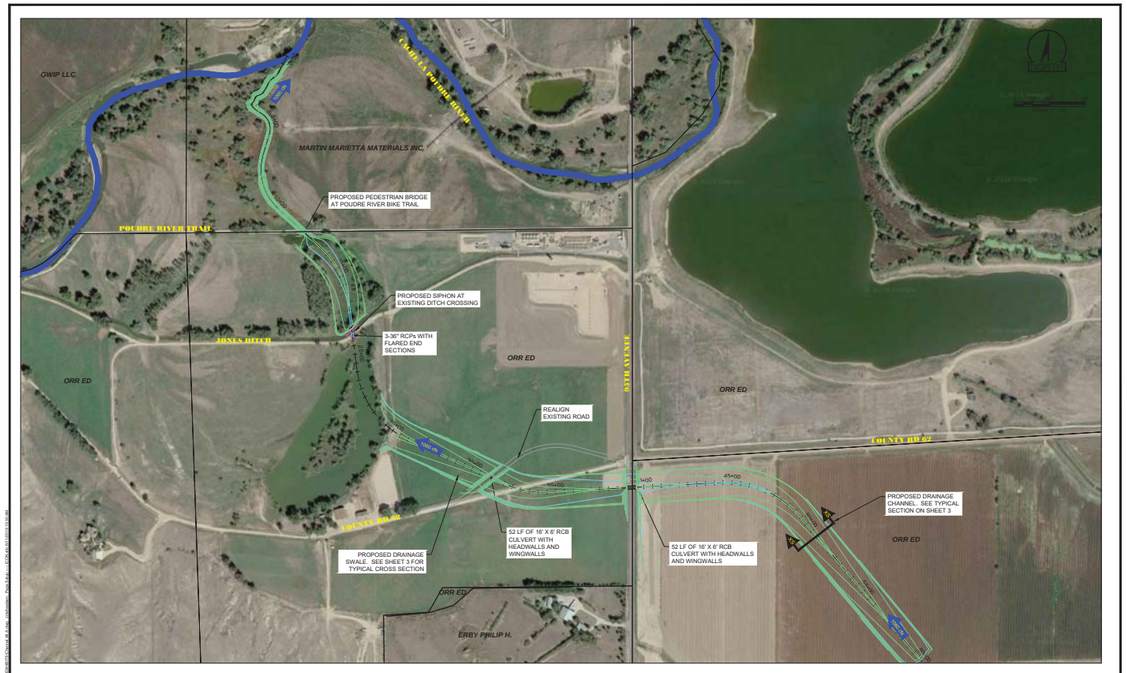
Recommended Alternative

Alternative C is the recommended alternative. In general, it achieves the main objectives presented in the Sharktooth Basin Master Plan, as well as provides a benefit through the potential natural area that the citizens of Greeley can use for years to come. It would be encouraged that the City develop a plan to fund the alternative through reimbursement from development which may also make use of the pond to minimizing detention requirements or share in the land open space amenity.



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No.	DATE	REVISIONS	APPR.

Know what's below. Call before you dig. 811

PREPARED FOR: City of Greeley

PREPARED BY: ICON ENGINEERING, INC

PLAN
DRAWN JYM
DESIGNED JD
CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTERPLAN
CHANNEL DESIGN - TO THE WEST
ALTERNATIVE A

ICON PROJECT No. 18-019-SBB

DATE JUNE 2019

SHEET 1 OF 5

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No.	DATE	REVISIONS	APPR.

Know what's below. Call before you dig. 811

PREPARED FOR: City of Greeley

PREPARED BY: ICON ENGINEERING, INC

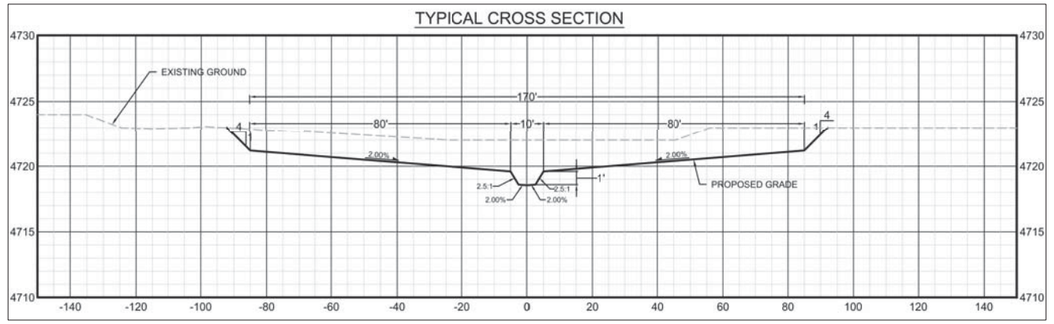
PLAN
DRAWN JYM
DESIGNED JD
CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTERPLAN
CHANNEL DESIGN - TO THE EAST
ALTERNATIVE B

ICON PROJECT No. 18-019-SBB

DATE JUNE 2019

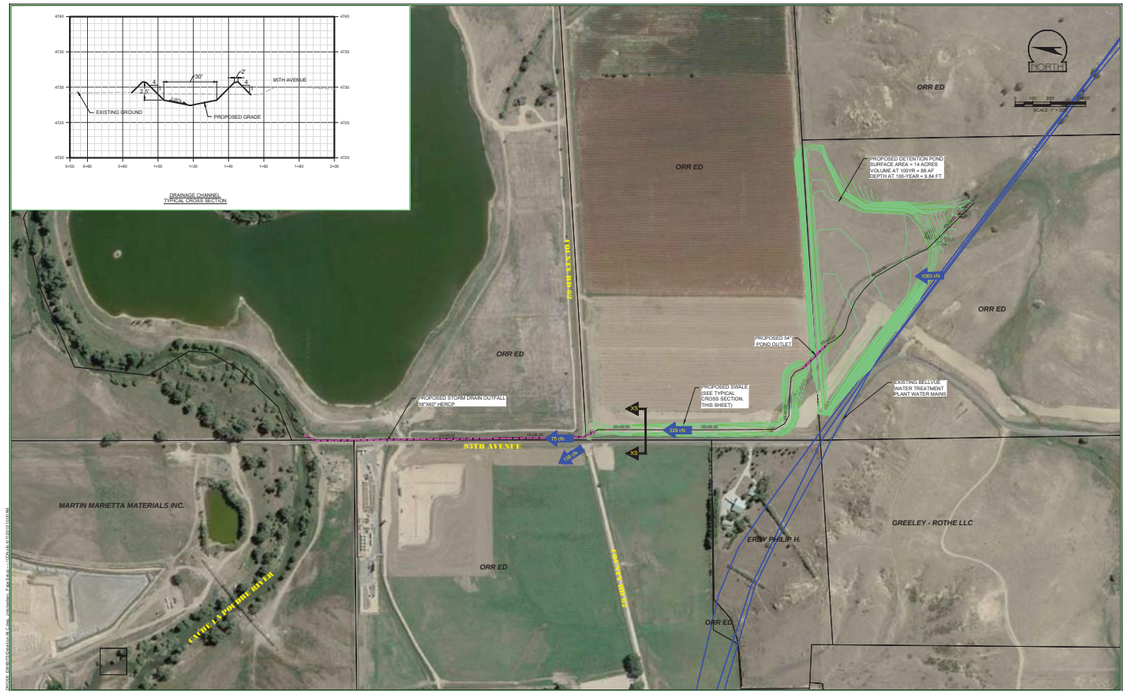
SHEET 2 OF 4



###	####	####	###	PREPARED FOR: City of Greeley	PREPARED BY: ICON ENGINEERING, INC	PLAN	SHARKTOOTH BLUFFS STORM DRAINAGE MASTERPLAN
###	####	####	###			DRAWN JYM	CHANNEL DESIGN
###	####	####	###			DESIGNED JD	TYPICAL CROSS SECTION FOR ALT A AND B
###	####	####	###			CHECKED JD	ICON PROJECT No. 18-019-SBB
###	####	####	###				
No.	DATE	REVISIONS	APPR.	Know what's below. Call before you dig.			

DATE: JUNE 2019

SHEET: 3 OF 5



###	####	####	###	PREPARED FOR: City of Greeley	PREPARED BY: ICON ENGINEERING, INC	PLAN	SHARKTOOTH BLUFFS STORM DRAINAGE MASTERPLAN
###	####	####	###			DRAWN JYM	PROPOSED DETENTION
###	####	####	###			DESIGNED JD	ALTERNATIVE C
###	####	####	###			CHECKED JD	ICON PROJECT No. 18-019-SBB
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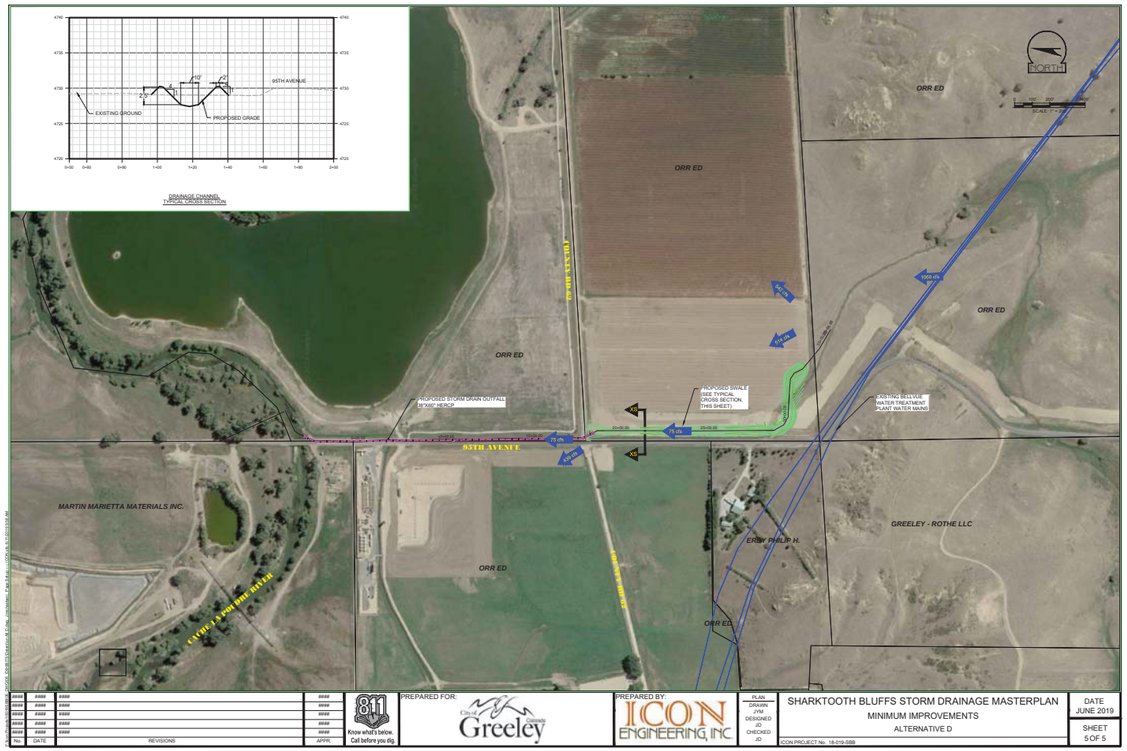
No.	DATE	REVISIONS	APPR.	Know what's below. Call before you dig.			

DATE: JUNE 2019

SHEET: 4 OF 5



MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth
DRAINAGEWAY :	Sharktooth
REACH :	Alt A
JURISDICTION :	City of Greeley
REACH ID:	Alt A-ReachAlt A

Enter Estimator Name on Project Info | DATE : 6/6/2019

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
36-inch	71	3	213	L.F.	$145.00	$30,885.00	
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
36-inch	Yes	3	6	EA	$2,157.00	$12,942.00	
Manholes and Inlets							
Manhole, 4' Dia. (Pipe Dia. < 36")			2	EA	$3,886.00	$7,772.00	MH Risers for the Siphon
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
16	6	1	52	L.F.	$2,116.83	$110,075.00	
10	5	1	75	L.F.	$1,081.50	$81,112.00	Estimated Siphon
16	6	1	65	L.F.	$2,116.83	$137,594.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
16	1	18.00	2	EA	$1,811.52	$3,623.00	
10	1	12.00	2	EA	$1,158.48	$2,317.00	
16	1	18.00	2	EA	$1,811.52	$3,623.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
16	6	1	2	EA	$16,954.63	$33,909.30	
10	5	1	2	EA	$12,054.14	$24,108.30	
16	6	1	2	EA	$16,954.63	$33,909.30	
Channel Improvements							
Excavation, Low Range			88525	C.Y.	$15.00	$1,327,875.00	
12-inch Riprap, Type M			500	C.Y.	$80.00	$40,000.00	
Removals							
Removal of culvert pipe (D<48")			100	L.F.	$27.00	$2,700.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			31	ACRE	$1,340.00	$41,540.00	
Trail/Path, Crusher Fines (10' Width)			4500	L.F.	$15.00	$67,500.00	
Special Items (User Defined)							
Pedestrian Bridge	<----User Defined Items		1	EA	$75,000.00	$75,000.00	
Road Improvements	<----User Defined Items		2222	CY	$85.00	$188,889.00	
Road Realignment	<----User Defined Items		2000	CY	$55.00	$110,000.00	
Road Realignment Grading	<----User Defined Items		1	LS	$300,000.00	$300,000.00	
Excavation Haul	<----User Defined Items		66394	CY	$12.00	$796,725.00	
Landscape	<----User Defined Items		1	LS	$100,000.00	$100,000.00	
Land Acquisition							
Temporary Easements			3	EA	$30,000.00	$90,000.00	
Easement/ROW Acquisition			28.00	ACRE	$88,000.00	$2,464,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains			$51,599.00	
Concrete Box Culverts			$430,271.00	
Hydraulic Structures			$0.00	
Channel Improvements			$1,367,875.00	
Detention/Water Quality Facilities			$0.00	
Removals			$2,700.00	
Landscaping and Maintenance Improvements			$109,040.00	
Special Items (User Defined)			$1,570,614.00	
Subtotal Capital Improvement Costs			**$3,532,099.00**	
Additional Capital Improvement Costs				
Dewatering	$50,000.00	L.S.	$50,000.00	
Mobilization	5%		$176,605.00	
Traffic Control	$15,000.00	L.S.	$15,000.00	
Utility Coordination/Relocation	$50,000.00	L.S.	$50,000.00	
Stormwater Management/Erosion Control	5%		$176,605.00	
Subtotal Additional Capital Improvement Costs			**$468,210.00**	
Land Acquisition Costs				
ROW/Easements			$2,554,000.00	
Subtotal Land Acquisition Costs			**$2,554,000.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$600,046.00	
Legal/Administrative	5%		$200,015.00	
Contract Admin/Construction Management	10%		$400,031.00	
Contingency	25%		$1,000,077.00	
Subtotal Other Costs			**$2,200,169.00**	
Total Capital Improvement Costs			**$8,754,478.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth
DRAINAGEWAY : Sharktooth
REACH : Alt B
JURISDICTION : City of Greeley
REACH ID: Alt B-ReachAlt B — Enter Estimator Name on Project Info — DATE : 6/6/2019

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
16	6	1	65	L.F.	$2,116.83	$137,594.00	
12	4	1	58	L.F.	$1,095.16	$63,520.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
16	1	18.00	2	EA	$1,811.52	$3,623.00	
12	1	14.00	2	EA	$1,343.16	$2,686.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
16	6	1	2	EA	$16,954.63	$33,909.30	
12	4	1	2	EA	$9,735.48	$19,471.00	
Channel Improvements							
Excavation, Low Range			271692	C.Y.	$15.00	$4,075,380.00	
12-inch Riprap, Type M			300	C.Y.	$80.00	$24,000.00	
Removals							
Removal of culvert pipe (D<48")			200	L.F.	$27.00	$5,400.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			40	ACRE	$1,340.00	$53,600.00	
Trail/Path, Crusher Fines (10' Width)			8000	L.F.	$15.00	$120,000.00	
Special Items (User Defined)							
Pedestrian Bridge	<----User Defined Items		1	EA	$75,000.00	$75,000.00	
Flume	<----User Defined Items		100	CY	$1,100.00	$110,000.00	
Excavation Haul	<----User Defined Items		203769	CY	$12.00	$2,445,228.00	
Landscape	<----User Defined Items		1	LS	$150,000.00	$150,000.00	
Land Acquisition							
Temporary Easements			3	EA	$30,000.00	$90,000.00	
Easement/ROW Acquisition			34.00	ACRE	$88,000.00	$2,992,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$260,803.00
Hydraulic Structures				$0.00
Channel Improvements				$4,099,380.00
Detention/Water Quality Facilities				$0.00
Removals				$5,400.00
Landscaping and Maintenance Improvements				$173,600.00
Special Items (User Defined)				$2,780,228.00
Subtotal Capital Improvement Costs				**$7,319,411.00**
Additional Capital Improvement Costs				
Dewatering	$75,000.00	L.S.		$75,000.00
Mobilization	5%			$365,971.00
Traffic Control	$15,000.00	L.S.		$15,000.00
Utility Coordination/Relocation	$100,000.00	L.S.		$100,000.00
Stormwater Management/Erosion Control	5%			$365,971.00
Subtotal Additional Capital Improvement Costs				**$921,942.00**
Land Acquisition Costs				
ROW/Easements				$3,082,000.00
Subtotal Land Acquisition Costs				**$3,082,000.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$1,236,203.00
Legal/Administrative	5%			$412,068.00
Contract Admin/Construction Management	10%			$824,135.00
Contingency	25%			$2,060,338.00
Subtotal Other Costs				**$4,532,744.00**
Total Capital Improvement Costs				**$15,856,097.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth
DRAINAGEWAY : Sharktooth
REACH : Alt C
JURISDICTION : City of Greeley
REACH ID: Alt C-ReachAlt C — Enter Estimator Name on Project Info — DATE : 6/6/2019

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
54-inch	190	1	190	L.F.	$289.00	$54,910.00	
48-inch	1660	1	1660	L.F.	$193.00	$320,380.00	
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
48-inch	Yes	1	2	EA	$2,760.00	$5,520.00	
Headwalls							
Diameter (in)	Applicable	No. of Barrels					
54-inch	Yes	1	2	EA	$1,913.48	$3,827.00	
Wingwalls (includes concrete apron)							
Diameter (in)		No. of Barrels					
54-inch		1	2	EA	$11,727.35	$23,455.00	
Manholes and Inlets							
Manhole, 6' Dia. (Pipe Dia. = 48")			4	EA	$5,762.00	$23,048.00	
Hydraulic Structures							
Sloping Drop Structures							
Height (ft)	Bottom Width (ft)	Yn (ft)					
4	10	0.5	2	EA	$25,595.02	$51,190.00	
1.5	10	0.5	2	EA	$21,393.82	$42,788.00	
Channel Improvements							
12-inch Riprap, Type M			300	C.Y.	$80.00	$24,000.00	
Excavation, Low Range			8000	C.Y.	$15.00	$120,000.00	
Detention/Water Quality Facilities							
Detention (User Entered Quantities)							
Excavation, Low Range			175200	C.Y.	$15.00	$2,628,000.00	
Removals							
Removal of culvert pipe (D<48")			100	L.F.	$27.00	$2,700.00	
Landscaping and Maintenance Improvements							
Wetlands Plantings			1	ACRE	$33,500.00	$33,500.00	
Reclamation & seeding (native grasses)			23	ACRE	$1,340.00	$30,820.00	
Trail/Path, Crusher Fines (10' Width)			5500	L.F.	$15.00	$82,500.00	
Special Items (User Defined)							
Excavation Haul Pond	<----User Defined Items		156000	CY	$12.00	$1,872,000.00	
Road Improvements	<----User Defined Items		369	CY	$55.00	$20,295.00	
Pond Park Improvements	<----User Defined Items		1	LS	$500,000.00	$500,000.00	
Spillway/Berm	<----User Defined Items		1	LS	$500,000.00	$500,000.00	
Landscape	<----User Defined Items		1	LS	$150,000.00	$150,000.00	
Land Acquisition							
Temporary Easements			3	EA	$30,000.00	$90,000.00	
Easement/ROW Acquisition			23.00	ACRE	$88,000.00	$2,024,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$431,140.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$93,978.00
Channel Improvements				$144,000.00
Detention/Water Quality Facilities				$2,628,000.00
Removals				$2,700.00
Landscaping and Maintenance Improvements				$146,820.00
Special Items (User Defined)				$3,042,295.00
Subtotal Capital Improvement Costs				**$6,488,933.00**
Additional Capital Improvement Costs				
Dewatering	$35,000.00	L.S.		$35,000.00
Mobilization	5%			$324,447.00
Traffic Control	$25,000.00	L.S.		$25,000.00
Utility Coordination/Relocation	$50,000.00	L.S.		$50,000.00
Stormwater Management/Erosion Control	5%			$324,447.00
Subtotal Additional Capital Improvement Costs				**$758,894.00**
Land Acquisition Costs				
ROW/Easements				$2,114,000.00
Subtotal Land Acquisition Costs				**$2,114,000.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$1,087,174.00
Legal/Administrative	5%			$362,391.00
Contract Admin/Construction Management	10%			$724,783.00
Contingency	25%			$1,811,957.00
Subtotal Other Costs				**$3,986,305.00**
Total Capital Improvement Costs				**$13,348,132.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth
DRAINAGEWAY :	Sharktooth
REACH :	Alt D
JURISDICTION :	City of Greeley
REACH ID:	Alt D-ReachAlt D

Enter Estimator Name on Project Info | DATE : 6/6/2019

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
48-inch	1660	1	1660	L.F.	$193.00	$320,380.00	
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
48-inch	Yes	1	2	EA	$2,760.00	$5,520.00	
Manholes and Inlets							
Manhole, 6' Dia. (Pipe Dia. = 48")			4	EA	$5,762.00	$23,048.00	
Channel Improvements							
9-inch Riprap, Type L			30	C.Y.	$74.00	$2,220.00	
Excavation, Low Range			4500	C.Y.	$15.00	$67,500.00	
Removals							
Removal of culvert pipe (D<48")			100	L.F.	$27.00	$2,700.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			2	ACRE	$1,340.00	$2,680.00	
Special Items (User Defined)							
Road Improvements	<----User Defined Items		369	CY	$55.00	$20,295.00	
Landscape	<----User Defined Items		1	LS	$50,000.00	$50,000.00	
Land Acquisition							
Temporary Easements			1	EA	$30,000.00	$30,000.00	
Easement/ROW Acquisition			2.00	ACRE	$88,000.00	$176,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$348,948.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$69,720.00
Detention/Water Quality Facilities				$0.00
Removals				$2,700.00
Landscaping and Maintenance Improvements				$2,680.00
Special Items (User Defined)				$70,295.00
Subtotal Capital Improvement Costs				**$494,343.00**
Additional Capital Improvement Costs				
Dewatering	$25,000.00	L.S.		$25,000.00
Mobilization	5%			$24,717.00
Traffic Control	$25,000.00	L.S.		$25,000.00
Utility Coordination/Relocation	$50,000.00	L.S.		$50,000.00
Stormwater Management/Erosion Control	5%			$24,717.00
Subtotal Additional Capital Improvement Costs				**$149,434.00**
Land Acquisition Costs				
ROW/Easements				$206,000.00
Subtotal Land Acquisition Costs				**$206,000.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$96,567.00
Legal/Administrative	5%			$32,189.00
Contract Admin/Construction Management	10%			$64,378.00
Contingency	25%			$160,944.00
Subtotal Other Costs				**$354,078.00**
Total Capital Improvement Costs				**$1,203,855.00**

Sharktooth Bluffs Basin Masterplan

Comment and Response Tracking
Alternatives Analysis Report

No.	YOUR NAME (last name, first name)	SECTION #	PAGE	PARA	COMMENT	S, R, E (Substantive, Requested, Editorial)	A, R, C (Accepted, Rejected with explanation, Needs Clarification)	RESPONSE (by consultant)
1	Fisher, Andrew	2.2	6	1	Sutured should be saturated	E	**A**	Report Updated
2	Fisher, Andrew	2.3.2	9	10	Embankment is referred to as "The Broe Land Embankment" further into report. If calling it so, make first reference here	R	**A**	Report Updated
3	Fisher, Andrew	2.3.10	9	1	Line 5 - should be conveyed	E	**A**	Report Updated
4	Fisher, Andrew	2.3.11	9	2	Capitalize Sheep	E	**A**	Report Updated
5	Fisher, Andrew	Table 2-3	9		I believe this table indicates the amount of each watershed that is expected to one day be within Greeley given the long-range growth boundary. I'm not fully clear though. Please clarify	S	**A**	Report was clarifed to explain the long range growth boundary.
6	Fisher, Andrew	Figure 2-1	10		I like it. Maybe add Highway 34, 83rd Avenue and O Street labels for context. It may be helpful to screen the existing Greeley limits - it's a bit hard to decipher Weld County/Greeley boundaries with the bizarre boundary conditions	R	**A**	Report Updated
7	Fisher, Andrew	Figure 2-2	11		Looks like developments are highlighted from parcel layer, but this makes dense parcel areas look different than more open parcels. For example, parts of River Run look to be different colors. Can you make each dev't off one outside perimeter? Also, Promontory may be too light to see?	E	**A**	Report Updated
8	Fisher, Andrew	3.5.3	14		Can you add a table for each detention pond utilized in the model (as shown in the rating curves later in the report) that displays what design storm each pond provides sufficient storage, a la the NGDTMP?	R	**A**	An existing detention basin table was added to the report in Chapter 4
9	Fisher, Andrew	Table 3-2	15		Can we have a legend or supplemental table to ID which watershed the basin ID shorthand correlates to	R	**A**	A table was added to the report to clarify the watershed abbreviations
10	Fisher, Andrew	Figure 3-1	16		First read seems to imply all displayed detention basins are recommended from future development, but some currently exist. Clarify if figure is "Future Conditions" detention basins, or code in the existing detention basins with a different color.	S	**A**	Figure was revised to only show future detention basin. Existing detention basins can be found on the watershed exhibit
11	Fisher, Andrew	Table 3-3	17		Can you add a description for why peak flow exceeds 5-yr existing peak flow in future conditions	R	**A**	Clarification was added to the report that although each subwatershed was detained to 5-yr historic levels in the future conditions modeling, slight increases in peak flow were observed due hydrograph timing and routing.

Sharktooth Bluffs Basin Masterplan

Comment and Response Tracking
Alternatives Analysis Report

No.	YOUR NAME (last name, first name)	SECTION #	PAGE	PARA	COMMENT	S, R, E (Substantive, Requested, Editorial)	A, R, C (Accepted, Rejected with explanation, Needs Clarification)	RESPONSE (by consultant)
12	Fisher, Andrew	4.2.1	19		Can you add further commentary on which hydrologic method is recommended for which applications? Rain on grid more useful when evaluating X whereas the CUHP method better for X	R	**A**	A paragraph was added to clarify rain-on-grid is typically used for preliminary identification of flow paths while problem areas and flooding depths better correlate to the baseline hydrology using the runoff hydrographs from CUHP
13	Fisher, Andrew	Figure 4.5, Figure 4.6	26-27		Change Color of Future 4th St so it doesn't look like a High Hazard area	R	**A**	Report Updated
14	Fisher, Andrew	Figures 4.5, 4.6	26-27		Can you please add the definition of "high hazard area" to these figures for more convenient referece?	R	**A**	Report Updated
15	Fisher, Andrew	5.3.1	28		Make overtime into over time	E	**A**	Report Updated
16	Fisher, Andrew	5.5	28		Appendix says UD-MP 2012 costs were used, here it says 2014?	S	**A**	Report was updated. All unit costs were updated from 2012
17	Fisher, Andrew	Figure 5.4			Revise Figure title to "Wiedeman Creek"	E	**A**	Report Updated
18	Fisher, Andrew	Figure 5.4			This Figure does not include indundated strcutres but others do.	R		
19	Fisher, Andrew	5.6.5.2	30		Ensure all references to 95th Street are changed to 95th Avenue	E	**A**	Report Updated
20	Fisher, Andrew	5.6.5.2	30	Future 4th St	Sharktooth is misspelled	E	**A**	Report Updated
21	Fisher, Andrew	5.6.5.2	30	5	Can we use an alternative term for floodplain if we aren't recommending establishment of regulatory floodplain for Sharktooth Draw?	R	**A**	References to floodplain were substituted within the report
22	Fisher, Andrew	Table 5.7	31		Separation misspelled	E	**A**	Report Updated
23	Fisher, Andrew	5.6.7.1	33	5	Can we use an alternative term for floodplain if we aren't recommending establishment of regulatory floodplain for Wiedeman Creek?	R	**A**	References to floodplain were substituted within the report
24	Fisher, Andrew	Table 5.10	34		It's a bit unclear which alternatives are pitted against each other as choices. For example, The 7.5ac-ft detention pond is listed in the text as an alternative for Skyview Street but in the Table under 81st Ave. If selected, which alternatives no longer apply?	S	**A**	This comment was discussed during the progress meeting. The selected upstream of 81st Avenue mitigates both the Skyview St and 81st storm drain exceeding City criteria
25	Fisher, Andrew	Table 5-14	36		The table note and text on previous page disagree on which alternative requires Northridge Minimum Criteria Alternative to be implemented	S	**A**	Table has been revised
26	Fisher, Andrew	Table 5-14	36		Separation misspelled	E	**A**	Report Updated
27	Fisher, Andrew	5.8.3	38	5	Wiedeman misspelled	E	**A**	Report Updated

Sharktooth Bluffs Basin Masterplan

Comment and Response Tracking
Alternatives Analysis Report

No.	YOUR NAME (last name, first name)	SECTION #	PAGE	PARA	COMMENT	S, R, E (Substantive, Requested, Editorial)	A, R, C (Accepted, Rejected with explanation, Needs Clarification)	RESPONSE (by consultant)
28	Fisher, Andrew	Table 5-20	38		Ensure all references to 95th Street are changed to 95th Avenue	E	**A**	Report Updated
29	Fisher, Andrew	Figure 5-4			Amour Hill Rd misspelled	E	**A**	Report Updated
30	Fisher, Andrew	Figure 5-4, Section 5.6.7.2			In pursuing a storm drain solution, is laying the pipe at a different slope all that's truly required to mitigate the issues experienced here?	R	**A**	This comment was clarified in the progess meeting. Relaying pipe to increase conveyance in the area reduces the flooding depth to within City criteria
31	Fisher, Andrew	Figure 5-4			Expected detention as a possibility at Amour hill Dr a la on Wiedeman Creek, due to likely detention pond with future development and anecdotal issues with those two inundated structures. Wouldn't this be cheaper than relaying the 30" such that it could be evaluated as an alternative? Alternately, detention pond with development may eliminate this alternative from being required at all	S	**A**	This alternative was incorporated into the alternative analysis. It was not include in the recommended plan or conceptual design.
32	Fisher, Andrew				Canal Base-flow. I think it may be helpful to have a standalone Figure and paragraph showing all locations evaluated for Canal Base-flow, and why the ones not recommended were impractical	R	**C**	All proposed canal baseflow projects were included in the conceptual design. If a stand alone figure is still desired it can be added in the subsequent submittal
33	Fisher, Andrew	6.1	43	2	Change size to sized	R	**A**	Report Updated
34	Fisher, Andrew	Figure 6-1			Separation is misspelled	E	**A**	Report Updated
35	Fisher, Andrew	Figure 6-2			Suggest making Detention Basin icon a different color than Canal Crossing Improvement.	R	**A**	Report Updated
36	Fisher, Andrew				As this Alternatives Analysis will result in an a la carte option rather than a basin-wide alternative, I think it would be instructive to have a master matrix of each Alternative Plan (No Action, Minimum Criteria, Flood Mitigation, Canal Baseflow Separation) for each watershed and within that each location, which each one clearly stated as "Recommended," "Not Recommended" or "Not Applicable." There may be fourth category between Recommended or Not Recommended.	R	**A**	Table 6-1 was added identifying each component of the recommended plan
37	Fisher, Andrew				We will definitely need recommended phasing or priorities.	R	**A**	This will be provided in the conceptual design section

Sharktooth Bluffs Basin Masterplan

Comment and Response Tracking
Alternatives Analysis Report

No.	YOUR NAME (last name, first name)	SECTION #	PAGE	PARA	COMMENT	S, R, E (Substantive, Requested, Editorial)	A, R, C (Accepted, Rejected with explanation, Needs Clarification)	RESPONSE (by consultant)
38	Fisher, Andrew	Cost Estimates			It is difficult to identify the locations some of these cost estimate sheet correspond to, given shorthand, Reach numbers, and missing Drainageway names. I did not closely scrutinize these costs in part due to this.	R	**A**	The cost estimates were revised to include an index on the cover sheets providing page numbers for each cost estimate
39	Fisher, Andrew	Cost Estimates			I cannot find the Cost Estimate sheet that corresponds to the Amour Hill Drive pipe replacement cost estimate, but that estimate strikes me as quite low	R	**A**	see above

Sharktooth Bluffs Basin Masterplan

Comment and Response Tracking
Draft Conceptual Design Report

No.	YOUR NAME (last name, first name)	SECTION #	PAGE	LINE	COMMENT	S, R, E (Substantive, Requested, Editorial)	A, R, C (Accepted, Rejected with explanation, Needs Clarification)	RESPONSE (by consultant)
1	Fisher, Andrew	TOC	iii		Wiedeman misspelled on Table 7-15	E	**A**	**Report revised**
2	Fisher, Andrew	ES	1	Tab ES1	Should we included Joel in here? HE had more impact on the study than Heather certainly, and had some definite impact on the final alternatives	S	**A**	**Report revised**
3	Fisher, Andrew	ES	1		See pdf. Misspellings of Wiedeman, Greeley and Bluffs.	E	**A**	**Report revised**
4	Fisher, Andrew	ES	2		Can we please change the color of the existing roads so they stand out more	R	**A**	**Figure has been revised**
5	Fisher, Andrew	ES	3		There are many areas that are shades of red or purple, so it's really difficult to differentiate between River Run and Promontory Heights. Please update colors and/or label the major developments	R	**A**	**Figure has been revised**
6	Fisher, Andrew	ES	4	ES 5.2	In the first paragraph, it states that it was discussed prevfiously that no records were found regarding the dam/basin. This is actually the first mention of this location in the report	E	**A**	**Report was revised to remove the reference**
7	Fisher, Andrew	ES	5	ES 5.3	Is it the Promontory Heights development or Lake Bluff that Hertzke Draw watershed impacts?	S	**A**	**The reference to the Lake Bluff development was made before the development was separated. The reference has been revised to Promontory Heights**
8	Fisher, Andrew	ES	6	ES 5.5	See pdf. There is a statement that dictates a point in time but it is unclear what this refers to. Please clarify	R	**A**	**Report revised**
9	Fisher, Andrew	ES	7	5.7	Add "from" for clarity	R	**A**	**Report revised**
10	Fisher, Andrew	ES	7	5.7.4	Change "Amour Drive" to "Amour Hill Drive"	E	**A**	**Report revised**
11	Fisher, Andrew	ES	7	5.7.4	"relying" should bwe "relaying"	E	**A**	**Report revised**
12	Fisher, Andrew	ES	8	5.10	Revise 71st Street to 71st Avenue throughout report.	E	**A**	**Report revised**
13	Fisher, Andrew	ES	8	5.10	Can you speak to the proposed conveyance of flows across the basin boundary from Sharktooth to Sheep Draw?	S	**A**	**The report was revised to explain the existing RCP culverts discharge into a wetland channel on the east side of 71st Ave. The wetland channel is within the Poudre 100-yr floodplain and outfall just upstream of the main stem of Sheep Draw**
14	Fisher, Andrew	ES	8	5.10	Can you speak to the proposed conveyance of flows across the basin boundary from Sharktooth to Sheep Draw?	S	**A**	**See comment 13**
15	Fisher, Andrew	ES	9	5.12	Change Armor to Amour	E	**A**	**Report revised**
16	Fisher, Andrew	ES	9	5.12	Are we planning on a fully fleshed out BCA in the final report per the RFP, including a more fleshed out prioritization?	S	**R**	**The BCA developed in the alternative analysis was carried forward into the Conceptual Design and Exective Summary sections. The majority of alternatives do not have benefits to develop a BCA but rather increase the conveyance capacity to meet current City criteria**
17	Fisher, Andrew	ES	10	Table ES 3	Typo in title	E	**A**	**Report revised**
18	Fisher, Andrew	1	13	Table 1-1	Text is cut off in first column	E	**A**	**Report revised**
19	Fisher, Andrew	1	13	Table 1-1	Promontory Heights?	E	**A**	**Report revised**
20	Fisher, Andrew	1	14	Table 1-2	Same comment as No 2	E	**A**	**Report revised**
21	Fisher, Andrew	2	20	Fig 2.1	Same as Comment No 4	R	**A**	**Report revised**
22	Fisher, Andrew	2	21	Fig 2.2	Same as Comment No 5	R	**A**	**Report revised**
23	Fisher, Andrew	2	22	Fig 2.3	What are the blue squares inscribed in circles with a 0? Existing ponds? Are these intended to be shown?	E	**A**	**Yes, existing detention basins were shown on the figure. The figure has been revised to include the detention basin names**
24	Fisher, Andrew	3	23	3.1	How many instances was a pipeline in SWMM conveyed across subbasin boundaries?	R	**A**	**The report was revised to include a reference to sixteen locations where this occurred**

Sharktooth Bluffs Basin Masterplan

Comment and Response Tracking
Draft Conceptual Design Report

No.	YOUR NAME (last name, first name)	SECTION #	PAGE	LINE	COMMENT	S, R, E (Substantive, Requested, Editorial)	A, R, C (Accepted, Rejected with explanation, Needs Clarification)	RESPONSE (by consultant)
25	Fisher, Andrew	3	23	3.2	You may know phasing more than I, but with the rebrand of UDFCD to MHFD, is reissuance of the UDFCD manuals forthcoming such that it would behoove us to change references of UDFCD to MHFD? Assuming that is not clearcut, it may be worth a short passage mentioning the connection.	S	**A**	**Reference to the MHFD has been included in the report**
26	Fisher, Andrew	3	24	3.4.5	Beginning of paragraph got lost in the header	E	**A**	**Report revised**
27	Fisher, Andrew	4	30	4.1	Is there anything to note from the previous Sheep Draw study that informed this study?	S	**A**	**The previous study did not include information for these areas. The previous study focused on the main stem of Sheep Draw**
28	Fisher, Andrew	4	30	4.2.1	Please specify pipes 30" and up	R	**A**	**Report revised**
29	Fisher, Andrew	4	37-38	Fig 4.5/4.6	High hazard designations at end of Spur Draw, Missile, Hertzke and near 71st Ave. I presume this is a result of boundary condition and that there isn't specifically a high hazard adjacent to the river? Can this be edited out?	R	**A**	**High hazard designations have been revised**
30	Fisher, Andrew	5	48	5.7	Why is a BCA completed for 81st Avenue alone?	S	**A**	**See comment 16. No other projects provided mitigation benefits to justify a BCA being completed**
31	Fisher, Andrew	5	49	5.8.3	It may be helpful to have an exhibit showing the extent of the drainageway reaches	R	**A**	**Figure 7.3 has been added to the report**
32	Fisher, Andrew	6	54	6.1	As development continues, stream buffer width needs decrease. Do you have recommendations for how to manage the decreased needs with increased development?	S	**A**	**A recommendation threshold of 80 percent has been included in the report. Once the threshold is exceeded the buffer widths could be reduced**
33	Fisher, Andrew	6	55	Table 6-1	78th Avneue has No Action and minimum Criteria Alternatives selected. Please clarify.	E	**A**	**Table has been revised**
34	Fisher, Andrew	6	58	Figure 6-1	Figure reflects recommendations from initial Alt Analysis. Please update with final recommended plans	S	**A**	**Figure has been revised**
35	Fisher, Andrew	7	60	7.1.1	Typo	E	**A**	**Report revised**
36	Fisher, Andrew	7	78	7.2.7.4	Please ensure all mentions of street are "Amour Hill Drive"	E	**A**	**Report revised**
37	Fisher, Andrew	7	78	7.2.7.4	"relying" should bwe "relaying"	E	**A**	**Report revised**
38	Fisher, Andrew	7	78	7.2.7.4	What is the existing slope of the 30" RCP?	R	**A**	**The existing pipe at 0% slope was determined from survey which was verified.**
39	Fisher, Andrew	7	78	Table 7-15	Wiedeman misspelled on Table 7-15	E	**A**	**Report revised**
40	Fisher, Andrew	7	87		As development continues, stream buffer width needs decrease. Do you have recommendations for how to manage the decreased needs with increased development?	S	**A**	**See comment 32**
41	Fisher, Andrew	App A	A-13		Do we have meeting minutes after February 6?	R	**A**	**Informal communication followed the Feb. 6 meeting. The memo supplements the meeting minutes to summarize this communication**
42	Fisher, Andrew	App D	C St / 71st		Change all mentions of 71st St to 71st Ave	E	**A**	**References have been changed**
43	Fisher, Andrew	App D	C St / 71st		"Type D" Inlet is intended to capture all 71 cfs? Can you clarify? This would require many inlets, and this location is not currently a detention pond. It seems more infrastructure would be required to route 71 cfs to an inlet point here.	S	**A**	**The label has been revised to include further description of the extent of the proposed improvements**
44	Fisher, Andrew	App D	C St / 71st		Design proposed to remove use of an existing detention facility while creating a 100-year storm drain? I may have missed this discussion, but why is this storm drain so large?	S	**A**	**Design has been revised to continue low flows through the detention facility**
45	Fisher, Andrew	App D	C St/71st		Typical channel section?	R	**A**	**Typical Channel section has been added**
46	Fisher, Andrew	App D	C St / 71st		Please label existing storm drains and indicate they are proposed to remain	R	**A**	**Revised**
47	Fisher, Andrew	App D	C St/71st		How are we addressing proption of flows conveyed to a different drainage basin?	S	**A**	**Existing drainage patterns into Sheep Draw to Poudre has been clarified in text**
48	Fisher, Andrew	App D	C St/71st		Profile indicates receiving channel has adverse slope. Is this real, or is the alignment working its way up the channel embankment?	S	**A**	**Profile has been revised**

Sharktooth Bluffs Basin Masterplan

Comment and Response Tracking
Draft Conceptual Design Report

No.	YOUR NAME (last name, first name)	SECTION #	PAGE	LINE	COMMENT	S, R, E (Substantive, Requested, Editorial)	A, R, C (Accepted, Rejected with explanation, Needs Clarification)	RESPONSE (by consultant)
49	Fisher, Andrew	App D	SD Outfall		Why is HERCP pipe proposed instead of 48"?	R	**A**	**The proposed design transitions to 48" once adequate cover is available**
50	Fisher, Andrew	App D	SD Outfall		Profile slope switches from 0.30% to -0.30%	E	**A**	**Pipe slope label has been revised**
51	Fisher, Andrew	App D	SD Outfall		What is the required boundary for easement and/or ROW acquisition for the channel and pond?	R	**A**	**Proposed easement and acquisiton limits have been added**
52	Fisher, Andrew	App D	Wied	1	Amour Hill Dr misspelled	E	**A**	**Revised**
53	Fisher, Andrew	App D	Wied	1	83rd Ave is incorrectly labeled as 95th Ave	R	**A**	**Revised**
54	Fisher, Andrew	App D	Wied	2	What is the required boundary for easement and/or ROW acquisition for the channel and pond?	R	**A**	**Proposed easement and acquisiton limits have been added**
55	Fisher, Andrew	App D	Wied	3	What is the required boundary for easement and/or ROW acquisition for the channel and pond?	R	**A**	**Proposed easement and acquisiton limits have been added**
56	Fisher, Andrew	App D	Wied	4	How is depth estimated on water and sewer? Existing pipe being dead flat is suspicious. Dropping 0.4ft shouldn't conflict with sanitary but it might, which would invalidate this alt.	S	**A**	**The existing pipe at 0% slope was determined from survey which was verified.**
57	Fisher, Andrew	Appd D	CR 62 E		Roads are mislabeled and the north arrow is the wrong direction.	S	**A**	**Report revised**
58	Fisher, Andrew	App D	Jones	6	Does this detail provide enough freeboard?	S	**A**	**The detail was revised to show 1 ft of depth of flow over the spillway and the 1 ft of freeboard**

APPENDIX B - HYDROLOGIC ANALYSIS

Sharktooth Bluff Basin - Interactive Map

Interactive Figures (Select Below)

Study Area Map

Existing Soils Map

Future Soils Map

Existing Land Use

Future Land Use	1-ft Contours	ON	OFF
Existing SWMM Routing	10-ft Contours & Labels	ON	OFF
Future SWMM Routing	Subwatershed Labels	ON	OFF

Sub-basin Label

Subbasin Name
Area (Ac.) | Imperv. Ex % Fut %

- SWMM Junction
- SWMM Dividers
- SWMM Outfall
- SWMM Storage
- SWMM Conduit
- Subwatershed
- Study Area
- Drainageway

Soil Type

- A
- B
- C
- D
- Water

Land Use

- 5 - 10%
- 10 - 20%
- 20 - 30%
- 30 - 40%
- 40 - 50%
- 50 - 60%
- 60 -70%
- 70 - 80%
- 80 - 90%
- 90 - 100%

Watersheds

- Fairway Tributary
- Hertzke Draw
- Missile Park Draw
- Northridge Draw
- Orr Gulch
- Poudre Learning Center
- Poudre River
- Poudre River Ranch
- Sharktooth Bluffs
- Spur Draw
- Wiedeman Creek

N W E S

0 0.25 0.5 1 Miles

CUHP Rainfall Distribution

2-Year 1-hr Point Rainfall = 0.85 in		5-Year 1-hr Point Rainfall = 1.12 in		10-Year 1-hr Point Rainfall = 1.41 in		50-Year 1-hr Point Rainfall = 2.29 in		100-Year 1-hr Point Rainfall = 2.77 in	
Time (min)	Depth (in)	Time (min)	Depth (in)	Time (min)	Depth (in)	Time (min)	Depth (in)	Time (min)	Depth (in)
00:05	0.02	00:05	0.02	00:05	0.03	00:05	0.03	00:05	0.03
00:10	0.03	00:10	0.04	00:10	0.05	00:10	0.08	00:10	0.08
00:15	0.07	00:15	0.10	00:15	0.12	00:15	0.11	00:15	0.13
00:20	0.14	00:20	0.17	00:20	0.21	00:20	0.18	00:20	0.22
00:25	0.21	00:25	0.28	00:25	0.35	00:25	0.34	00:25	0.39
00:30	0.12	00:30	0.15	00:30	0.17	00:30	0.57	00:30	0.69
00:35	0.05	00:35	0.06	00:35	0.08	00:35	0.27	00:35	0.39
00:40	0.04	00:40	0.05	00:40	0.06	00:40	0.18	00:40	0.22
00:45	0.03	00:45	0.04	00:45	0.05	00:45	0.11	00:45	0.17
00:50	0.03	00:50	0.04	00:50	0.05	00:50	0.11	00:50	0.14
00:55	0.03	00:55	0.03	00:55	0.05	00:55	0.07	00:55	0.11
01:00	0.03	01:00	0.03	01:00	0.05	01:00	0.07	01:00	0.11
01:05	0.03	01:05	0.03	01:05	0.05	01:05	0.07	01:05	0.11
01:10	0.02	01:10	0.03	01:10	0.05	01:10	0.05	01:10	0.06
01:15	0.02	01:15	0.03	01:15	0.05	01:15	0.05	01:15	0.06
01:20	0.02	01:20	0.02	01:20	0.04	01:20	0.04	01:20	0.03
01:25	0.02	01:25	0.02	01:25	0.03	01:25	0.04	01:25	0.03
01:30	0.02	01:30	0.02	01:30	0.03	01:30	0.03	01:30	0.03
01:35	0.02	01:35	0.02	01:35	0.03	01:35	0.03	01:35	0.03
01:40	0.02	01:40	0.02	01:40	0.03	01:40	0.03	01:40	0.03
01:45	0.02	01:45	0.02	01:45	0.03	01:45	0.03	01:45	0.03
01:50	0.02	01:50	0.02	01:50	0.03	01:50	0.03	01:50	0.03
01:55	0.01	01:55	0.02	01:55	0.02	01:55	0.03	01:55	0.03
02:00	0.01	02:00	0.01	02:00	0.02	02:00	0.03	02:00	0.03

CUHP Input Parameters

								Depression Storage (in)		Horton's Infiltration Paramaters		
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
FT_100	FT_B100	Sharktooth Bluffs	0.007087	0.101268939	0.23786	0.0029	31.8	0.35	0.1	3.05	0.0018	0.51
FT_101	FT_B101	Sharktooth Bluffs	0.030624	0.098087121	0.295795	0.0057	27.5	0.35	0.1	4.82	0.0008	0.96
FT_105	FT_B105	Sharktooth Bluffs	0.012618	0.106477273	0.19928	0.0425	43.2	0.35	0.1	4.84	0.0008	0.96
FT_110	FT_B110	Sharktooth Bluffs	0.002841	0.032784091	0.096591	0.0283	8.6	0.35	0.1	5	0.0007	1.00
FT_115	FT_B115	Sharktooth Bluffs	0.005095	0.051647727	0.104754	0.0275	21.7	0.35	0.1	5	0.0007	1.00
FT_120	FT_B120	Sharktooth Bluffs	0.053347	0.222518939	0.377405	0.0138	36.6	0.35	0.1	4.65	0.0007	0.93
FT_125	FT_B125	Sharktooth Bluffs	0.029471	0.133106061	0.32214	0.0229	5.7	0.4	0.1	3.19	0.0017	0.55
FT_130	FT_B130	Sharktooth Bluffs	0.083929	0.382537879	0.604716	0.0175	34.3	0.35	0.1	4.86	0.0009	0.92
HD_100	HD_B100	Sharktooth Bluffs	0.062669	0.197594697	0.400038	0.0188	5	0.4	0.1	3.57	0.0017	0.52
HD_105	HD_B105	Sharktooth Bluffs	0.113026	0.326136364	0.804451	0.0448	5.5	0.4	0.1	3.52	0.0015	0.63
HD_110	HD_B110	Sharktooth Bluffs	0.2449	0.502253788	1.085038	0.0315	5.8	0.4	0.1	3.1	0.0017	0.52
MPD_100	MPD_B100	Sharktooth Bluffs	0.12456	0.183371212	0.559489	0.0192	5.4	0.4	0.1	3.68	0.0013	0.68
MPD_105	MPD_B105	Sharktooth Bluffs	0.304375	0.418731061	0.974072	0.0315	6.7	0.4	0.1	3.47	0.0016	0.58
ND_100	ND_B100	Sharktooth Bluffs	0.035205	0.11967803	0.303125	0.035	12.1	0.35	0.1	4.83	0.0008	0.96
ND_105	ND_B105	Sharktooth Bluffs	0.051102	0.179943182	0.406061	0.0237	20.5	0.35	0.1	4.96	0.0007	0.99
ND_110	ND_B110	Sharktooth Bluffs	0.00163	0.057651515	0.086648	0.022	45.8	0.35	0.1	5	0.0007	1.00
ND_115	ND_B115	Sharktooth Bluffs	0.001861	0.046306818	0.085758	0.0295	16.2	0.35	0.1	5	0.0007	1.00
ND_120	ND_B120	Sharktooth Bluffs	0.000614	0.028011364	0.061837	0.0348	69.2	0.35	0.1	5	0.0007	1.00
ND_130	ND_B130	Sharktooth Bluffs	0.046312	0.135094697	0.41697	0.0125	25	0.35	0.1	5	0.0007	1.00
ND_135	ND_B135	Sharktooth Bluffs	0.007525	0.082234848	0.175341	0.0187	5.3	0.35	0.1	5	0.0007	1.00
ND_140	ND_B140	Sharktooth Bluffs	0.008558	0.060587121	0.128352	0.0207	59.1	0.35	0.1	5	0.0007	1.00
OG_100	OG_B100	Sharktooth Bluffs	0.293962	0.502367424	0.94125	0.0167	6.1	0.4	0.1	3.87	0.0012	0.72
OG_105	OG_B105	Sharktooth Bluffs	0.069535	0.329772727	0.570758	0.042	5.3	0.4	0.1	3.26	0.0017	0.57
OG_110	OG_B110	Sharktooth Bluffs	0.063768	0.20155303	0.419261	0.042	6.4	0.4	0.1	3.08	0.0018	0.52
PLC_100	PLC_B100	Sharktooth Bluffs	0.014299	0.064090909	0.315227	0.0081	18.9	0.4	0.1	3.31	0.0018	0.52
PLC_105	PLC_B105	Sharktooth Bluffs	0.251714	0.507594697	1.249337	0.0043	41.2	0.4	0.1	2.56	0.0011	0.38
PLC_110	PLC_B110	Sharktooth Bluffs	0.208985	0.324393939	0.716383	0.0253	7.1	0.4	0.1	3.99	0.0015	0.67
PLC_115	PLC_B115	Sharktooth Bluffs	0.196614	0.362026515	0.653636	0.0129	5.9	0.4	0.1	4.31	0.0012	0.79
PLC_120	PLC_B120	Sharktooth Bluffs	0.190338	0.263920455	0.520057	0.0013	6.4	0.4	0.1	4.02	0.0018	0.58
PLC_121	PLC_B121	Sharktooth Bluffs	0.086158	0.231666667	0.517008	0.0237	5.6	0.4	0.1	3.47	0.0018	0.54
PR_100	PR_B100	Sharktooth Bluffs	0.011813	0.090208333	0.163428	0.0599	5	0.4	0.1	2.73	0.0016	0.45
PR_105	PR_B105	Sharktooth Bluffs	0.042886	0.162992424	0.28572	0.0281	5.4	0.4	0.1	3.88	0.0015	0.63
PR_110	PR_B110	Sharktooth Bluffs	0.058249	0.148617424	0.350511	0.0531	5.4	0.4	0.1	2.91	0.0016	0.49
PR_115	PR_B115	Sharktooth Bluffs	0.016751	0.103806818	0.210095	0.0034	5.3	0.4	0.1	3.18	0.0015	0.53
PR_120	PR_B120	Sharktooth Bluffs	0.054683	0.19219697	0.528996	0.0362	5.7	0.4	0.1	3.36	0.0017	0.54
PR_125	PR_B125	Sharktooth Bluffs	0.021478	0.126723485	0.217197	0.0315	5.3	0.4	0.1	3.02	0.0016	0.46
PR_130	PR_B130	Sharktooth Bluffs	0.04892	0.068219697	0.250947	0.0576	7	0.4	0.1	3.32	0.0015	0.56
PR_135	PR_B135	Sharktooth Bluffs	0.222832	0.256325758	0.662898	0.0042	65.8	0.4	0.1	1.2	0.0006	0.20
PR_150	PR_B150	Sharktooth Bluffs	0.135777	0.314507576	0.606345	0.0021	17	0.4	0.1	2.5	0.0014	0.42
PR_155	PR_B155	Sharktooth Bluffs	0.014449	0.112935606	0.246023	0.0215	41.1	0.35	0.1	3.16	0.0017	0.54
PR_160	PR_B160	Sharktooth Bluffs	0.010397	0.096174242	0.143485	0.0249	21.7	0.35	0.1	4.19	0.0011	0.80
PRR_100	PRR_B100	Sharktooth Bluffs	0.030097	0.176212121	0.30428	0.0226	46.7	0.35	0.1	4.76	0.0008	0.94

CUHP Input Parameters

								Depression Storage (in)		Horton's Infiltration Paramaters		
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
PRR_105	PRR_B105	Sharktooth Bluffs	0.008214	0.068674242	0.161383	0.0179	5.1	0.4	0.1	3.01	0.0018	0.50
SD_100	SD_B100	Sharktooth Bluffs	0.10412	0.296174242	0.604205	0.0295	5.5	0.4	0.1	3.47	0.0016	0.59
SD_105	SD_B105	Sharktooth Bluffs	0.104729	0.234280303	0.520928	0.0356	5.3	0.4	0.1	4.59	0.0013	0.77
SD_110	SD_B110	Sharktooth Bluffs	0.056662	0.19217803	0.438466	0.0449	5.6	0.4	0.1	3.79	0.0015	0.66
SD_115	SD_B115	Sharktooth Bluffs	0.064756	0.238125	0.575341	0.0286	5.1	0.4	0.1	4.36	0.0018	0.60
SD_120	SD_B120	Sharktooth Bluffs	0.18846	0.432518939	0.815341	0.0305	7.3	0.4	0.1	4.39	0.0015	0.68
SKD_100	SKD_B100	Sharktooth Bluffs	0.07954	0.179772727	0.339053	0.002	6.7	0.4	0.1	3.17	0.0017	0.54
SKD_105	SKD_B105	Sharktooth Bluffs	0.034963	0.164318182	0.320682	0.0042	7.2	0.4	0.1	3.74	0.0014	0.68
SKD_106	SKD_B106	Sharktooth Bluffs	0.0045	0.140965909	0.258049	0.0213	16.1	0.4	0.1	4.66	0.0009	0.92
SKD_110	SKD_B110	Sharktooth Bluffs	0.059574	0.260852273	0.530303	0.043	6.2	0.4	0.1	4.5	0.0012	0.81
SKD_115	SKD_B115	Sharktooth Bluffs	0.051916	0.171060606	0.422443	0.026	6.9	0.4	0.1	4.08	0.0014	0.71
SKD_120	SKD_B120	Sharktooth Bluffs	0.080488	0.204109848	0.734508	0.0237	5.5	0.4	0.1	3.19	0.0017	0.53
SKD_125	SKD_B125	Sharktooth Bluffs	0.044067	0.169299242	0.294962	0.016	5	0.4	0.1	3.07	0.0018	0.50
SKD_126	SKD_B126	Sharktooth Bluffs	0.139805	0.348598485	0.691307	0.0278	7.8	0.4	0.1	3.27	0.0018	0.52
SKD_130	SKD_B130	Sharktooth Bluffs	0.09865	0.361022727	0.743674	0.0236	5.4	0.4	0.1	3.38	0.0018	0.54
SKD_135	SKD_B135	Sharktooth Bluffs	0.101898	0.185511364	0.376723	0.018	5.7	0.4	0.1	3.51	0.0016	0.61
SKD_136	SKD_B136	Sharktooth Bluffs	0.090337	0.263712121	0.512481	0.0237	7.8	0.4	0.1	3.17	0.0018	0.52
SKD_137	SKD_B137	Sharktooth Bluffs	0.082834	0.356950758	0.69197	0.0215	8.2	0.4	0.1	3.43	0.0017	0.55
SKD_140	SKD_B140	Sharktooth Bluffs	0.141376	0.256969697	0.660568	0.0224	5.4	0.4	0.1	3.07	0.0018	0.52
SKD_141	SKD_B141	Sharktooth Bluffs	0.02627	0.085075758	0.265511	0.0259	5.1	0.4	0.1	3.4	0.0016	0.60
SKD_145	SKD_B145	Sharktooth Bluffs	0.217092	0.335094697	0.769659	0.0196	6.3	0.4	0.1	3.04	0.0018	0.51
SKD_150	SKD_B150	Sharktooth Bluffs	0.175452	0.473598485	0.880739	0.0105	6.3	0.4	0.1	3.07	0.0018	0.52
SKD_155	SKD_B155	Sharktooth Bluffs	0.137107	0.429431818	0.674697	0.0169	8.1	0.4	0.1	4.05	0.0014	0.69
SKD_160	SKD_B160	Sharktooth Bluffs	0.002978	0.028219697	0.075871	0.0164	24.4	0.4	0.1	4.5	0.0018	0.60
SKD_165	SKD_B165	Sharktooth Bluffs	0.041927	0.237897727	0.469659	0.0148	16.5	0.4	0.1	3.83	0.0016	0.61
SKD_170	SKD_B170	Sharktooth Bluffs	0.052826	0.188295455	0.358864	0.0118	17	0.4	0.1	3.86	0.0017	0.59
SKD_175	SKD_B175	Sharktooth Bluffs	0.050648	0.253541667	0.418958	0.0088	11.9	0.4	0.1	3.35	0.0017	0.54
SKD_180	SKD_B180	Sharktooth Bluffs	0.047986	0.286969697	0.687898	0.0159	22.1	0.35	0.1	4.78	0.0012	0.82
SKD_185	SKD_B185	Sharktooth Bluffs	0.068374	0.278352273	0.543636	0.0146	23.2	0.35	0.1	4.71	0.0013	0.77
SKD_190	SKD_B190	Sharktooth Bluffs	0.038657	0.232045455	0.329186	0.0205	13.7	0.35	0.1	4.63	0.0015	0.70
SKD_195	SKD_B195	Sharktooth Bluffs	0.060824	0.231458333	0.440511	0.0163	16.3	0.35	0.1	4.8	0.0011	0.84
WC_100	WC_B100	Sharktooth Bluffs	0.005163	0.024981061	0.119375	0.0044	24.6	0.35	0.1	4.49	0.0018	0.60
WC_101	WC_B101	Sharktooth Bluffs	0.011879	0.064356061	0.151023	0.0177	64.2	0.35	0.1	4.94	0.0008	0.96
WC_102	WC_B102	Sharktooth Bluffs	0.010288	0.105208333	0.30661	0.0313	39.7	0.35	0.1	4.12	0.0015	0.69
WC_103	WC_B103	Sharktooth Bluffs	0.006006	0.086212121	0.170436	0.0426	59.8	0.35	0.1	3.44	0.0016	0.61
WC_105	WC_B105	Sharktooth Bluffs	0.017401	0.093143939	0.30608	0.0124	54.5	0.35	0.1	4.5	0.0013	0.77
WC_105.1	WC_B105.1	Sharktooth Bluffs	0.003206	0.036912879	0.106174	0.0441	60.7	0.35	0.1	3.23	0.0017	0.56
WC_105.2	WC_B105.2	Sharktooth Bluffs	0.00344	0.066363636	0.154148	0.0321	62.1	0.35	0.1	3.75	0.0014	0.69
WC_106	WC_B106	Sharktooth Bluffs	0.023522	0.213238636	0.332348	0.0242	36.8	0.35	0.1	3.83	0.0013	0.71
WC_107	WC_B107	Sharktooth Bluffs	0.014284	0.065738636	0.183144	0.0404	26.7	0.35	0.1	4.12	0.0014	0.71
WC_108	WC_B108	Sharktooth Bluffs	0.003947	0.093011364	0.182311	0.0309	56.9	0.35	0.1	4.92	0.0008	0.96
WC_109	WC_B109	Sharktooth Bluffs	0.004449	0.071325758	0.128277	0.019	43.3	0.35	0.1	4.28	0.0011	0.81

CUHP Input Parameters

Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness	Depression Storage (in)		Horton's Infiltration Paramaters		
								Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
WC_110	WC_B110	Sharktooth Bluffs	0.027039	0.153276515	0.305	0.0309	36.4	0.35	0.1	4.69	0.0011	0.84
WC_111	WC_B111	Sharktooth Bluffs	0.010801	0.07	0.224697	0.0191	37.9	0.35	0.1	3.11	0.0018	0.51
WC_112	WC_B112	Sharktooth Bluffs	0.003977	0.067140152	0.128674	0.0344	22.4	0.35	0.1	5	0.0007	1.00
WC_112.5	WC_B112.5	Sharktooth Bluffs	0.005305	0.047234848	0.120492	0.0244	32.5	0.35	0.1	4.87	0.0008	0.97
WC_113	WC_B113	Sharktooth Bluffs	0.04514	0.158958333	0.351477	0.0196	5.4	0.4	0.1	3	0.0018	0.50
WC_114	WC_B114	Sharktooth Bluffs	0.042074	0.141287879	0.337955	0.0176	5.6	0.4	0.1	3.12	0.0017	0.53
WC_115	WC_B115	Sharktooth Bluffs	0.025658	0.115795455	0.240739	0.0158	9.7	0.4	0.1	4.84	0.001	0.89
WC_120	WC_B120	Sharktooth Bluffs	0.311137	0.297253788	0.739167	0.0162	6.9	0.4	0.1	3.36	0.0017	0.58
WC_130	WC_B130	Sharktooth Bluffs	0.031627	0.166515152	0.309318	0.0042	19.1	0.4	0.1	4.85	0.001	0.88
WC_135	WC_B135	Sharktooth Bluffs	0.175939	0.276647727	0.640284	0.017	19.3	0.4	0.1	4.37	0.0011	0.76
WC_140	WC_B140	Sharktooth Bluffs	0.266844	0.336931818	0.802633	0.0139	10.8	0.4	0.1	4.29	0.0015	0.69
WC_145	WC_B145	Sharktooth Bluffs	0.004284	0.013712121	0.076629	0.0143	30.3	0.4	0.1	4.28	0.0018	0.59
WC_146	WC_B146	Sharktooth Bluffs	0.041462	0.126174242	0.308883	0.0185	7.4	0.4	0.1	4.64	0.0015	0.71
WC_150	WC_B150	Sharktooth Bluffs	0.181991	0.29467803	0.876875	0.0138	6.5	0.4	0.1	3.15	0.0018	0.51
WC_155	WC_B155	Sharktooth Bluffs	0.008148	0.241969697	0.497064	0.0151	52.9	0.4	0.1	4.73	0.0013	0.78
WC_160	WC_B160	Sharktooth Bluffs	0.052767	0.094412879	0.295814	0.0088	17	0.4	0.1	4.29	0.0018	0.59
WC_165	WC_B165	Sharktooth Bluffs	0.008387	0.242594697	0.496572	0.0153	52.4	0.4	0.1	4.74	0.0013	0.79
WC_170	WC_B170	Sharktooth Bluffs	0.005682	0.112859848	0.233561	0.0093	18.3	0.4	0.1	4.5	0.0018	0.60
WC_171	WC_B171	Sharktooth Bluffs	0.004063	0.021003788	0.081989	0.009	63.4	0.35	0.1	4.5	0.0018	0.60
WC_172	WC_B172	Sharktooth Bluffs	0.006514	0.030587121	0.106761	0.0089	55.4	0.35	0.1	4.55	0.0017	0.64
WC_173	WC_B173	Sharktooth Bluffs	0.006277	0.060454545	0.162481	0.0069	47.3	0.35	0.1	4.47	0.0018	0.60

Future CUHP Input Parameters

								Depression Storage (in)		Horton's Infiltration Paramaters		
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
FT_100	FT_B100	Sharktooth Bluffs	0.007087	0.101268939	0.23786	0.0029	45	0.35	0.1	2.76	0.0016	0.46
FT_101	FT_B101	Sharktooth Bluffs	0.030624	0.098087121	0.295795	0.0057	60	0.35	0.1	5.51	0.0009	1.09
FT_105	FT_B105	Sharktooth Bluffs	0.012618	0.106477273	0.19928	0.0425	66	0.35	0.1	4.61	0.0008	0.91
FT_110	FT_B110	Sharktooth Bluffs	0.002841	0.032784091	0.096591	0.0283	54	0.35	0.1	5.5	0.0008	1.1
FT_115	FT_B115	Sharktooth Bluffs	0.005095	0.051647727	0.104754	0.0275	50	0.35	0.1	4.6	0.0006	0.92
FT_120	FT_B120	Sharktooth Bluffs	0.053347	0.222518939	0.377405	0.0138	50	0.35	0.1	4.98	0.0007	1
FT_125	FT_B125	Sharktooth Bluffs	0.029471	0.133106061	0.32214	0.0229	67	0.35	0.1	6.18	0.0009	1.24
FT_130	FT_B130	Sharktooth Bluffs	0.083929	0.382537879	0.604716	0.0175	55	0.35	0.1	4.39	0.0008	0.83
HD_100	HD_B100	Sharktooth Bluffs	0.062669	0.197594697	0.400038	0.0188	6.999993	0.4	0.1	3.74	0.0018	0.55
HD_105	HD_B105	Sharktooth Bluffs	0.113026	0.326136364	0.804451	0.0448	7.000004	0.4	0.1	3.3	0.0014	0.58
HD_110	HD_B110	Sharktooth Bluffs	0.2449	0.502253788	1.085038	0.0315	19	0.4	0.1	3.29	0.0016	0.53
MPD_100	MPD_B100	Sharktooth Bluffs	0.12456	0.183371212	0.559489	0.0192	6.999999	0.4	0.1	3.59	0.0013	0.66
MPD_105	MPD_B105	Sharktooth Bluffs	0.304375	0.418731061	0.974072	0.0315	7.000001	0.4	0.1	3.16	0.0013	0.53
ND_100	ND_B100	Sharktooth Bluffs	0.035205	0.11967803	0.303125	0.035	57	0.35	0.1	5.37	0.0009	1.07
ND_105	ND_B105	Sharktooth Bluffs	0.051102	0.179943182	0.406061	0.0237	51	0.35	0.1	5.56	0.0008	1.11
ND_110	ND_B110	Sharktooth Bluffs	0.00163	0.057651515	0.086648	0.022	79	0.35	0.1	5.3	0.0007	1.06
ND_115	ND_B115	Sharktooth Bluffs	0.001861	0.046306818	0.085758	0.0295	80	0.35	0.1	4.2	0.0006	0.84
ND_120	ND_B120	Sharktooth Bluffs	0.000614	0.028011364	0.061837	0.0348	80	0.35	0.1	5.09	0.0007	1.02
ND_130	ND_B130	Sharktooth Bluffs	0.046312	0.135094697	0.41697	0.0125	80	0.35	0.1	5.23	0.0007	1.05
ND_135	ND_B135	Sharktooth Bluffs	0.007525	0.082234848	0.175341	0.0187	80	0.35	0.1	5.27	0.0007	1.05
ND_140	ND_B140	Sharktooth Bluffs	0.008558	0.060587121	0.128352	0.0207	80	0.35	0.1	4.56	0.0006	0.91
OG_100	OG_B100	Sharktooth Bluffs	0.293962	0.502367424	0.94125	0.0167	7.118841	0.4	0.1	3.8	0.0012	0.7
OG_105	OG_B105	Sharktooth Bluffs	0.069535	0.329772727	0.570758	0.042	47	0.4	0.1	3.46	0.0015	0.61
OG_110	OG_B110	Sharktooth Bluffs	0.063768	0.20155303	0.419261	0.042	44	0.4	0.1	3.15	0.0018	0.53
PLC_100	PLC_B100	Sharktooth Bluffs	0.014299	0.064090909	0.315227	0.0081	22	0.4	0.1	3.41	0.0019	0.54
PLC_105	PLC_B105	Sharktooth Bluffs	0.251714	0.507594697	1.249337	0.0043	44	0.4	0.1	2.46	0.0011	0.36
PLC_110	PLC_B110	Sharktooth Bluffs	0.208985	0.324393939	0.716383	0.0253	30	0.35	0.1	3.72	0.0013	0.63
PLC_115	PLC_B115	Sharktooth Bluffs	0.196614	0.362026515	0.653636	0.0129	34	0.35	0.1	4.47	0.0013	0.81
PLC_120	PLC_B120	Sharktooth Bluffs	0.190338	0.263920455	0.520057	0.0013	46	0.35	0.1	4.3	0.0017	0.61
PLC_121	PLC_B121	Sharktooth Bluffs	0.086158	0.231666667	0.517008	0.0237	67	0.35	0.1	4.64	0.0017	0.64
PR_100	PR_B100	Sharktooth Bluffs	0.011813	0.090208333	0.163428	0.0599	7.000013	0.4	0.1	2.78	0.0017	0.46
PR_105	PR_B105	Sharktooth Bluffs	0.042886	0.162992424	0.28572	0.0281	6.999996	0.4	0.1	3.83	0.0015	0.62
PR_110	PR_B110	Sharktooth Bluffs	0.058249	0.148617424	0.350511	0.0531	6.999995	0.4	0.1	2.73	0.0015	0.46
PR_115	PR_B115	Sharktooth Bluffs	0.016751	0.103806818	0.210095	0.0034	6.999981	0.4	0.1	3.12	0.0015	0.52
PR_120	PR_B120	Sharktooth Bluffs	0.054683	0.19219697	0.528996	0.0362	7.000006	0.4	0.1	3.56	0.0019	0.57
PR_125	PR_B125	Sharktooth Bluffs	0.021478	0.126723485	0.217197	0.0315	6.999986	0.4	0.1	3.27	0.0017	0.5
PR_130	PR_B130	Sharktooth Bluffs	0.04892	0.068219697	0.250947	0.0576	7	0.4	0.1	3.29	0.0015	0.56
PR_135	PR_B135	Sharktooth Bluffs	0.222832	0.256325758	0.662898	0.0042	67	0.4	0.1	1.14	0.0005	0.19
PR_150	PR_B150	Sharktooth Bluffs	0.135777	0.314507576	0.606345	0.0021	17	0.4	0.1	2.65	0.0015	0.45
PR_155	PR_B155	Sharktooth Bluffs	0.014449	0.112935606	0.246023	0.0215	61	0.35	0.1	2.97	0.0016	0.51
PR_160	PR_B160	Sharktooth Bluffs	0.010397	0.096174242	0.143485	0.0249	54	0.35	0.1	4.36	0.0012	0.83
PRR_100	PRR_B100	Sharktooth Bluffs	0.030097	0.176212121	0.30428	0.0226	70	0.35	0.1	5.9	0.0008	1.18

Future CUHP Input Parameters

								Depression Storage (in)		Horton's Infiltration Paramaters		
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
PRR_105	PRR_B105	Sharktooth Bluffs	0.008214	0.068674242	0.161383	0.0179	75	0.35	0.1	5.52	0.0008	1.1
SD_100	SD_B100	Sharktooth Bluffs	0.10412	0.296174242	0.604205	0.0295	7.000005	0.4	0.1	3.56	0.0016	0.61
SD_105	SD_B105	Sharktooth Bluffs	0.104729	0.234280303	0.520928	0.0356	6.999999	0.4	0.1	4.74	0.0013	0.79
SD_110	SD_B110	Sharktooth Bluffs	0.056662	0.19217803	0.438466	0.0449	6.999997	0.4	0.1	3.67	0.0014	0.63
SD_115	SD_B115	Sharktooth Bluffs	0.064756	0.238125	0.575341	0.0286	6.999995	0.4	0.1	4.74	0.0019	0.63
SD_120	SD_B120	Sharktooth Bluffs	0.18846	0.432518939	0.815341	0.0305	14	0.4	0.1	4.33	0.0014	0.67
SKD_100	SKD_B100	Sharktooth Bluffs	0.07954	0.179772727	0.339053	0.002	9.524667	0.4	0.1	3.35	0.0018	0.57
SKD_105	SKD_B105	Sharktooth Bluffs	0.034963	0.164318182	0.320682	0.0042	23	0.4	0.1	3.18	0.0011	0.58
SKD_106	SKD_B106	Sharktooth Bluffs	0.0045	0.140965909	0.258049	0.0213	49	0.4	0.1	3.99	0.0008	0.78
SKD_110	SKD_B110	Sharktooth Bluffs	0.059574	0.260852273	0.530303	0.043	37	0.4	0.1	5.04	0.0012	0.92
SKD_115	SKD_B115	Sharktooth Bluffs	0.051916	0.171060606	0.422443	0.026	29	0.4	0.1	3.82	0.0012	0.67
SKD_120	SKD_B120	Sharktooth Bluffs	0.080488	0.204109848	0.734508	0.0237	51	0.4	0.1	3.15	0.0017	0.53
SKD_125	SKD_B125	Sharktooth Bluffs	0.044067	0.169299242	0.294962	0.016	51	0.35	0.1	3.44	0.0019	0.54
SKD_126	SKD_B126	Sharktooth Bluffs	0.139805	0.348598485	0.691307	0.0278	53	0.35	0.1	4.58	0.0018	0.6
SKD_130	SKD_B130	Sharktooth Bluffs	0.09865	0.361022727	0.743674	0.0236	51	0.35	0.1	3.52	0.0016	0.53
SKD_135	SKD_B135	Sharktooth Bluffs	0.101898	0.185511364	0.376723	0.018	51	0.35	0.1	3.66	0.0016	0.62
SKD_136	SKD_B136	Sharktooth Bluffs	0.090337	0.263712121	0.512481	0.0237	53	0.35	0.1	4.24	0.0016	0.63
SKD_137	SKD_B137	Sharktooth Bluffs	0.082834	0.356950758	0.69197	0.0215	55	0.35	0.1	4.67	0.0016	0.72
SKD_140	SKD_B140	Sharktooth Bluffs	0.141376	0.256969697	0.660568	0.0224	51	0.35	0.1	4.77	0.0013	0.78
SKD_141	SKD_B141	Sharktooth Bluffs	0.02627	0.085075758	0.265511	0.0259	51	0.35	0.1	3.7	0.0009	0.72
SKD_145	SKD_B145	Sharktooth Bluffs	0.217092	0.335094697	0.769659	0.0196	54	0.35	0.1	4.88	0.0011	0.87
SKD_150	SKD_B150	Sharktooth Bluffs	0.175452	0.473598485	0.880739	0.0105	47	0.35	0.1	4.69	0.0007	0.92
SKD_155	SKD_B155	Sharktooth Bluffs	0.137107	0.429431818	0.674697	0.0169	65	0.35	0.1	5.23	0.0012	0.91
SKD_160	SKD_B160	Sharktooth Bluffs	0.002978	0.028219697	0.075871	0.0164	63	0.4	0.1	4.72	0.0019	0.63
SKD_165	SKD_B165	Sharktooth Bluffs	0.041927	0.237897727	0.469659	0.0148	25	0.4	0.1	4.1	0.0014	0.6
SKD_170	SKD_B170	Sharktooth Bluffs	0.052826	0.188295455	0.358864	0.0118	26	0.4	0.1	5.02	0.0015	0.79
SKD_175	SKD_B175	Sharktooth Bluffs	0.050648	0.253541667	0.418958	0.0088	14	0.4	0.1	3.61	0.0012	0.54
SKD_180	SKD_B180	Sharktooth Bluffs	0.047986	0.286969697	0.687898	0.0159	79	0.35	0.1	4.14	0.0011	0.69
SKD_185	SKD_B185	Sharktooth Bluffs	0.068374	0.278352273	0.543636	0.0146	75	0.35	0.1	5.27	0.0015	0.86
SKD_190	SKD_B190	Sharktooth Bluffs	0.038657	0.232045455	0.329186	0.0205	75	0.35	0.1	3.76	0.0012	0.58
SKD_195	SKD_B195	Sharktooth Bluffs	0.060824	0.231458333	0.440511	0.0163	78	0.35	0.1	5.11	0.0011	0.92
WC_100	WC_B100	Sharktooth Bluffs	0.005163	0.024981061	0.119375	0.0044	36	0.35	0.1	4.25	0.0016	0.55
WC_101	WC_B101	Sharktooth Bluffs	0.011879	0.064356061	0.151023	0.0177	70	0.35	0.1	5.04	0.0008	0.98
WC_102	WC_B102	Sharktooth Bluffs	0.010288	0.105208333	0.30661	0.0313	70	0.35	0.1	3.8	0.0013	0.64
WC_103	WC_B103	Sharktooth Bluffs	0.006006	0.086212121	0.170436	0.0426	70	0.35	0.1	3.55	0.0016	0.63
WC_105	WC_B105	Sharktooth Bluffs	0.017401	0.093143939	0.30608	0.0124	70	0.35	0.1	4.22	0.0012	0.73
WC_105.1	WC_B105.1	Sharktooth Bluffs	0.003206	0.036912879	0.106174	0.0441	70	0.35	0.1	3.41	0.0018	0.59
WC_105.2	WC_B105.2	Sharktooth Bluffs	0.00344	0.066363636	0.154148	0.0321	70	0.35	0.1	3.27	0.0011	0.61
WC_106	WC_B106	Sharktooth Bluffs	0.023522	0.213238636	0.332348	0.0242	70	0.35	0.1	3.82	0.0013	0.71
WC_107	WC_B107	Sharktooth Bluffs	0.014284	0.065738636	0.183144	0.0404	56	0.35	0.1	4.16	0.0013	0.73
WC_108	WC_B108	Sharktooth Bluffs	0.003947	0.093011364	0.182311	0.0309	70	0.35	0.1	3.92	0.0006	0.76
WC_109	WC_B109	Sharktooth Bluffs	0.004449	0.071325758	0.128277	0.019	70	0.35	0.1	4.79	0.0012	0.91

Future CUHP Input Parameters

								Depression Storage (in)		Horton's Infiltration Paramaters		
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
WC_110	WC_B110	Sharktooth Bluffs	0.027039	0.153276515	0.305	0.0309	70	0.35	0.1	4.42	0.001	0.79
WC_111	WC_B111	Sharktooth Bluffs	0.010801	0.07	0.224697	0.0191	70	0.35	0.1	2.91	0.0017	0.48
WC_112	WC_B112	Sharktooth Bluffs	0.003977	0.067140152	0.128674	0.0344	70	0.35	0.1	4.52	0.0006	0.9
WC_112.5	WC_B112.5	Sharktooth Bluffs	0.005305	0.047234848	0.120492	0.0244	70	0.35	0.1	4.42	0.0006	0.88
WC_113	WC_B113	Sharktooth Bluffs	0.04514	0.158958333	0.351477	0.0196	75	0.35	0.1	3.98	0.0006	0.8
WC_114	WC_B114	Sharktooth Bluffs	0.042074	0.141287879	0.337955	0.0176	74	0.35	0.1	5.24	0.0007	1.05
WC_115	WC_B115	Sharktooth Bluffs	0.025658	0.115795455	0.240739	0.0158	52	0.35	0.1	4.23	0.0009	0.77
WC_120	WC_B120	Sharktooth Bluffs	0.311137	0.297253788	0.739167	0.0162	74	0.35	0.1	4.78	0.0009	0.93
WC_130	WC_B130	Sharktooth Bluffs	0.031627	0.166515152	0.309318	0.0042	52	0.35	0.1	3.8	0.0009	0.67
WC_135	WC_B135	Sharktooth Bluffs	0.175939	0.276647727	0.640284	0.017	52	0.4	0.1	4.46	0.0011	0.78
WC_140	WC_B140	Sharktooth Bluffs	0.266844	0.336931818	0.802633	0.0139	73	0.35	0.1	4.74	0.0015	0.74
WC_145	WC_B145	Sharktooth Bluffs	0.004284	0.013712121	0.076629	0.0143	80	0.4	0.1	3.72	0.0016	0.51
WC_146	WC_B146	Sharktooth Bluffs	0.041462	0.126174242	0.308883	0.0185	54	0.35	0.1	5.22	0.0017	0.78
WC_150	WC_B150	Sharktooth Bluffs	0.181991	0.29467803	0.876875	0.0138	73	0.35	0.1	4.69	0.0018	0.64
WC_155	WC_B155	Sharktooth Bluffs	0.008148	0.241969697	0.497064	0.0151	88	0.4	0.1	3.64	0.001	0.61
WC_160	WC_B160	Sharktooth Bluffs	0.052767	0.094412879	0.295814	0.0088	92	0.35	0.1	4.75	0.002	0.64
WC_165	WC_B165	Sharktooth Bluffs	0.008387	0.242594697	0.496572	0.0153	85	0.4	0.1	5.31	0.0014	0.89
WC_170	WC_B170	Sharktooth Bluffs	0.005682	0.112859848	0.233561	0.0093	73	0.4	0.1	4.95	0.002	0.66
WC_171	WC_B171	Sharktooth Bluffs	0.004063	0.021003788	0.081989	0.009	70	0.35	0.1	5.38	0.0021	0.69
WC_172	WC_B172	Sharktooth Bluffs	0.006514	0.030587121	0.106761	0.0089	70	0.35	0.1	4.8	0.0018	0.67
WC_173	WC_B173	Sharktooth Bluffs	0.006277	0.060454545	0.162481	0.0069	70	0.35	0.1	4.54	0.0018	0.61

Existing Node Peak Flows (cfs)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
FT_B100	JUNCTION	0.5	0.8	1.3	3.6	4.9
FT_B101	JUNCTION	1.6	2.8	4.0	14.6	22.0
FT_B105	JUNCTION	2.5	3.4	4.6	12.1	16.9
FT_B110	JUNCTION	0.0	0.1	0.1	1.0	1.7
FT_B115	JUNCTION	0.2	0.4	0.6	2.5	4.0
FT_B120	JUNCTION	5.8	8.2	11.4	34.0	49.2
FT_B125	JUNCTION	0.5	0.8	4.1	18.4	26.4
FT_B130	JUNCTION	6.5	9.9	13.8	45.0	66.0
FT_J110	JUNCTION	0.5	0.8	4.2	19.3	28.0
FT_J130	JUNCTION	3.0	3.1	3.1	3.5	3.8
FT_J150	JUNCTION	2.7	4.0	8.2	24.8	24.8
FT_J201	JUNCTION	1.6	2.8	7.2	53.2	85.3
FT_J210	JUNCTION	0.5	0.8	4.2	19.3	28.0
FT_J215	JUNCTION	6.7	10.2	14.1	45.7	66.9
FT_J305	JUNCTION	2.7	4.0	8.2	24.8	24.8
FT_J310	JUNCTION	0.5	0.8	4.1	18.4	26.4
FT_J405	JUNCTION	2.7	4.0	8.2	24.8	24.8
FT_J505	JUNCTION	2.7	4.0	8.2	24.8	24.8
FT_J605	JUNCTION	2.7	4.0	8.2	24.8	24.8
FT_J705	JUNCTION	0.5	0.8	4.1	18.4	26.4
HD_B100	JUNCTION	0.8	1.5	8.4	39.3	56.3
HD_B105	JUNCTION	1.3	2.5	9.3	60.9	89.4
HD_B110	JUNCTION	3.2	7.2	31.0	134.6	192.3
HD_J110	JUNCTION	4.3	9.6	40.2	195.1	280.9
HD_Outlet	JUNCTION	4.9	10.8	47.7	232.4	334.9
MPD_B100	JUNCTION	1.4	3.0	7.5	77.2	115.0
MPD_B105	JUNCTION	4.9	9.2	36.0	185.5	267.4
ND_B100	JUNCTION	0.4	1.3	2.2	15.8	25.9
ND_B105	JUNCTION	1.6	3.1	4.7	20.3	32.8
ND_B110	JUNCTION	0.3	0.4	0.5	1.2	1.7
ND_B115	JUNCTION	0.0	0.1	0.1	0.6	1.0
ND_B120	JUNCTION	0.2	0.3	0.4	0.8	1.1
ND_B130	JUNCTION	2.1	3.6	5.3	19.4	30.6
ND_B135	JUNCTION	0.0	0.1	0.1	1.6	3.1
ND_B140	JUNCTION	3.3	4.3	5.6	12.0	16.2
ND_J100	JUNCTION	0.4	1.3	2.2	28.3	53.5
ND_J105	JUNCTION	5.6	8.4	8.8	13.1	14.2
ND_J130	JUNCTION	0.0	0.1	0.1	0.6	1.0
ND_J135	JUNCTION	3.3	4.3	5.6	12.0	16.2
ND_J205	JUNCTION	2.5	3.4	4.1	8.4	9.5
ND_J230	JUNCTION	0.3	0.4	0.5	1.2	1.7
ND_J235	JUNCTION	3.3	4.3	5.6	12.0	16.2
ND_J305	JUNCTION	3.4	5.1	5.1	5.1	5.1
ND_J330	JUNCTION	0.9	1.4	2.0	5.1	8.4

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
ND_J430	JUNCTION	0.9	1.5	2.0	5.1	8.5
OG_B100	JUNCTION	2.1	4.9	8.2	120.8	187.5
OG_B105	JUNCTION	0.8	1.5	7.9	37.9	54.6
OG_B110	JUNCTION	1.3	3.4	12.1	47.5	66.7
OG_J100	JUNCTION	1.6	3.8	16.5	78.7	113.8
OG_Outlet	JUNCTION	2.1	4.9	17.8	154.2	253.6
PLC_B100	JUNCTION	0.7	1.2	2.7	8.9	12.4
PLC_B105	JUNCTION	28.0	40.7	64.6	172.1	231.2
PLC_B110	JUNCTION	3.2	6.4	17.6	126.1	185.5
PLC_B115	JUNCTION	1.2	3.2	5.5	83.5	132.6
PLC_B120	JUNCTION	2.1	4.0	16.6	86.0	125.4
PLC_B121	JUNCTION	1.3	2.5	12.5	55.0	78.5
PLC_J100	JUNCTION	30.7	47.2	97.7	127.0	127.4
PLC_J110	JUNCTION	3.2	6.4	17.6	126.1	185.5
PLC_J115	JUNCTION	3.1	7.3	45.6	496.6	790.0
PLC_J120	JUNCTION	2.3	4.8	24.0	134.7	198.3
PLC_J215	JUNCTION	2.5	6.4	42.8	445.2	688.9
PR_B100	JUNCTION	0.2	0.8	2.6	9.9	13.8
PR_B105	JUNCTION	0.6	1.1	4.0	27.8	40.5
PR_B110	JUNCTION	1.2	3.0	12.7	51.3	71.5
PR_B115	JUNCTION	0.2	0.3	1.5	7.6	11.0
PR_B120	JUNCTION	0.8	1.5	7.4	33.7	48.3
PR_B125	JUNCTION	0.4	1.0	3.8	15.5	21.8
PR_B130	JUNCTION	1.7	3.1	11.9	55.6	79.2
PR_B135	JUNCTION	85.8	124.0	169.4	340.5	432.9
PR_B150	JUNCTION	4.6	9.0	19.6	64.6	90.7
PR_B155	JUNCTION	2.6	4.1	6.4	15.6	20.5
PR_B160	JUNCTION	0.6	1.0	1.4	6.7	9.7
PR_J355	JUNCTION	6.2	9.5	11.1	11.6	11.6
PRR_B100	JUNCTION	5.9	8.1	10.9	27.7	38.3
PRR_B105	JUNCTION	0.1	0.4	1.4	5.4	7.6
PRR_J100	JUNCTION	5.9	8.1	11.5	31.7	44.1
SD_B100	JUNCTION	1.3	2.5	11.1	60.5	87.7
SD_B105	JUNCTION	0.8	2.1	3.5	57.1	88.6
SD_B110	JUNCTION	0.7	1.5	4.9	35.2	51.6
SD_B115	JUNCTION	0.7	1.3	6.0	34.6	50.2
SD_B120	JUNCTION	2.3	4.9	11.4	96.4	143.6
SD_J100	JUNCTION	3.9	9.6	31.1	274.6	411.6
SD_J110	JUNCTION	3.2	7.1	21.1	163.7	242.6
SD_J200	JUNCTION	3.8	8.6	24.1	217.5	327.3
SD_J210	JUNCTION	3.0	6.2	17.4	130.9	193.8
SKD_B100	JUNCTION	1.1	2.1	9.2	40.6	58.1
SKD_B105	JUNCTION	0.3	0.7	1.7	13.8	20.6
SKD_B106	JUNCTION	0.1	0.1	0.2	0.9	1.6

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
SKD_B110	JUNCTION	0.4	1.0	1.7	24.7	39.7
SKD_B115	JUNCTION	0.6	1.4	2.9	28.4	42.6
SKD_B120	JUNCTION	1.1	2.1	10.4	46.4	66.4
SKD_B125	JUNCTION	0.7	2.1	7.4	29.3	41.4
SKD_B126	JUNCTION	2.9	6.4	22.0	88.0	124.4
SKD_B130	JUNCTION	1.1	2.3	10.9	49.3	70.8
SKD_B135	JUNCTION	1.7	3.2	13.8	74.7	107.1
SKD_B136	JUNCTION	2.0	4.5	14.9	58.4	82.6
SKD_B137	JUNCTION	1.3	2.3	8.7	39.5	56.7
SKD_B140	JUNCTION	2.3	6.2	23.8	96.3	136.2
SKD_B141	JUNCTION	0.4	0.8	3.7	19.4	27.6
SKD_B145	JUNCTION	3.9	10.7	36.4	143.0	201.8
SKD_B150	JUNCTION	2.1	5.5	19.5	81.1	116.6
SKD_B155	JUNCTION	1.6	3.3	7.0	60.3	90.4
SKD_B160	JUNCTION	0.3	0.5	0.8	2.8	3.8
SKD_B165	JUNCTION	1.4	2.3	4.7	20.4	29.0
SKD_B170	JUNCTION	2.4	3.9	8.4	32.9	46.5
SKD_B175	JUNCTION	1.2	2.1	6.1	24.6	34.9
SKD_B180	JUNCTION	1.6	2.6	3.8	17.8	26.6
SKD_B185	JUNCTION	3.2	5.2	7.6	34.2	49.6
SKD_B190	JUNCTION	1.1	1.9	4.1	20.4	29.6
SKD_B195	JUNCTION	1.6	3.0	4.6	27.0	41.8
SKD_J100	JUNCTION	12.4	33.9	117.6	420.6	626.4
SKD_J105	JUNCTION	12.4	33.6	116.6	410.9	610.8
SKD_J106	JUNCTION	12.1	33.1	114.8	391.2	578.3
SKD_J110	JUNCTION	12.3	33.4	115.5	391.5	579.5
SKD_J120	JUNCTION	13.6	37.0	142.5	709.8	1063.6
SKD_J125	JUNCTION	3.1	7.8	28.4	116.2	164.6
SKD_J126	JUNCTION	2.9	6.5	22.0	88.0	124.5
SKD_J136	JUNCTION	3.7	7.7	22.3	102.6	150.6
SKD_J140	JUNCTION	5.9	17.4	65.2	326.7	489.2
SKD_J145	JUNCTION	4.5	13.6	48.3	250.3	374.1
SKD_J150	JUNCTION	2.8	7.6	24.2	137.7	203.9
SKD_J160	JUNCTION	1.4	2.3	4.7	20.4	29.0
SKD_J175	JUNCTION	1.2	2.1	6.1	24.6	34.9
SKD_J180	JUNCTION	2.7	4.8	8.6	47.4	71.2
SKD_J220	JUNCTION	13.2	35.8	135.4	671.4	1006.0
SKD_J226	JUNCTION	0.3	0.5	1.0	9.2	18.9
SKD_J235	JUNCTION	10.4	27.4	96.8	477.7	713.3
SKD_J250	JUNCTION	0.5	0.6	0.9	8.5	8.5
SKD_J265	JUNCTION	0.0	0.0	0.0	0.0	0.0
SKD_J275	JUNCTION	0.0	0.0	0.0	1.8	14.8
SKD_J280	JUNCTION	2.7	4.9	8.7	47.4	71.3
SKD_J290	JUNCTION	2.7	4.9	8.7	47.4	64.8

Existing Node Peak Flows (cfs)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
SKD_J320	JUNCTION	11.3	30.3	112.9	572.4	859.5
SKD_J335	JUNCTION	10.2	27.0	94.6	464.0	691.9
SKD_J336	JUNCTION	3.1	5.4	13.6	55.9	79.4
SKD_J380	JUNCTION	2.7	4.9	8.7	47.4	65.0
SKD_J420	JUNCTION	10.9	28.8	104.3	528.3	793.2
SKD_J436	JUNCTION	3.1	5.5	13.6	55.9	79.4
SKD_J536	JUNCTION	3.1	5.5	13.6	55.9	79.4
SKD_J636	JUNCTION	3.2	5.5	13.6	55.9	79.4
WC_B100	JUNCTION	0.5	0.7	1.4	4.3	5.8
WC_B101	JUNCTION	5.2	6.8	9.0	18.7	24.8
WC_B102	JUNCTION	1.5	2.1	3.3	9.1	12.2
WC_B103	JUNCTION	2.1	2.9	4.1	8.7	11.3
WC_B105	JUNCTION	4.4	6.3	8.4	20.2	26.6
WC_B105.1	JUNCTION	1.5	2.1	2.9	5.9	7.6
WC_B105.2	JUNCTION	1.1	1.6	2.1	4.5	5.9
WC_B106	JUNCTION	2.7	4.0	6.0	18.0	24.6
WC_B107	JUNCTION	1.6	2.5	4.2	14.1	19.3
WC_B108	JUNCTION	0.9	1.2	1.6	3.7	4.9
WC_B109	JUNCTION	0.7	1.1	1.5	4.1	5.6
WC_B110	JUNCTION	3.4	5.2	7.2	23.0	32.1
WC_B111	JUNCTION	1.9	3.1	4.9	12.0	15.7
WC_B112	JUNCTION	0.1	0.3	0.4	1.6	2.5
WC_B112.5	JUNCTION	0.5	0.9	1.2	3.9	5.7
WC_B113	JUNCTION	0.7	2.3	7.8	30.3	42.8
WC_B114	JUNCTION	0.7	1.4	6.5	27.7	39.5
WC_B115	JUNCTION	0.2	0.6	1.1	10.3	17.2
WC_B120	JUNCTION	6.2	11.2	46.7	215.7	308.1
WC_B130	JUNCTION	0.7	1.3	2.0	10.2	16.4
WC_B140	JUNCTION	5.6	10.9	22.2	147.4	216.9
WC_B145	JUNCTION	0.8	1.2	2.2	6.3	8.6
WC_B146	JUNCTION	0.6	1.3	2.6	24.8	36.9
WC_B150	JUNCTION	3.0	7.7	26.9	108.2	153.1
WC_B155	JUNCTION	0.9	1.3	1.7	4.4	5.9
WC_B160	JUNCTION	3.2	5.1	11.2	42.9	59.5
WC_B165	JUNCTION	0.9	1.3	1.7	4.5	6.1
WC_B170	JUNCTION	0.2	0.3	0.5	2.2	3.2
WC_B171	JUNCTION	2.1	2.9	4.0	8.0	10.4
WC_B172	JUNCTION	2.5	3.6	5.1	11.1	14.6
WC_B173	JUNCTION	1.2	1.8	2.7	6.6	8.6
WC_J100	JUNCTION	19.4	39.3	104.3	198.7	218.6
WC_J101	JUNCTION	5.2	6.8	9.0	21.9	29.9
WC_J102	JUNCTION	3.4	4.9	6.7	12.6	15.7
WC_J105	JUNCTION	1.1	1.5	2.1	358.2	590.0
WC_J106	JUNCTION	12.2	28.2	85.6	479.5	703.5
WC_J107	JUNCTION	7.3	11.5	20.5	74.6	107.6
WC_J108	JUNCTION	7.3	11.5	20.5	74.6	107.6
WC_J109	JUNCTION	1.6	2.3	3.0	7.8	14.6
WC_J112	JUNCTION	1.2	3.0	8.8	33.8	48.0
WC_J112.5	JUNCTION	1.2	3.0	8.8	13.4	13.4
WC_J113.5	JUNCTION	0.7	2.3	7.8	10.4	10.4
WC_J114	JUNCTION	0.7	1.7	7.1	36.6	55.1
WC_J120	JUNCTION	11.9	27.7	84.6	476.8	699.7
WC_J135	JUNCTION	0.2	0.3	0.5	2.2	3.2
WC_J140	JUNCTION	8.0	17.6	47.7	194.6	264.1
WC_J145	JUNCTION	0.9	1.3	1.7	4.4	5.9
WC_J146	JUNCTION	0.6	1.3	2.6	84.2	141.0
WC_J165	JUNCTION	0.9	1.4	2.0	5.9	8.4
WC_J170	JUNCTION	9.7	13.1	17.9	40.3	53.9
WC_J171	JUNCTION	9.7	13.1	17.9	40.3	54.0
WC_J172	JUNCTION	7.7	10.3	14.0	32.7	44.0
WC_J173	JUNCTION	4.3	6.2	9.0	18.6	23.8
WC_J200	JUNCTION	14.0	31.0	90.2	140.0	140.0
WC_J201	JUNCTION	15.8	34.4	96.1	178.5	192.9
WC_J202	JUNCTION	2.1	2.9	3.8	3.8	3.8
WC_J205	JUNCTION	14.0	31.0	90.2	140.0	140.0
WC_J206	JUNCTION	12.2	28.2	85.6	479.5	703.5
WC_J207	JUNCTION	8.6	14.5	29.7	109.7	157.8
WC_J212.5	JUNCTION	0.7	2.3	7.8	10.4	10.4
WC_J220	JUNCTION	8.6	19.6	51.3	277.9	404.1
WC_J240	JUNCTION	0.6	0.8	1.2	13.3	35.1
WC_J245	JUNCTION	3.8	6.0	12.5	46.4	64.7
WC_J272	JUNCTION	5.2	6.8	9.0	21.9	29.9
WC_J273	JUNCTION	3.4	4.9	6.7	12.6	15.7
WC_J305	JUNCTION	5.1	7.2	9.7	372.0	609.8
WC_J306	JUNCTION	0.0	0.0	0.0	0.0	0.0
WC_J307	JUNCTION	1.4	3.3	9.2	35.3	50.4
WC_J312.5	JUNCTION	0.7	2.3	7.8	10.4	10.4
WC_J320	JUNCTION	8.4	18.5	49.6	275.6	401.8
WC_J340	JUNCTION	3.0	7.7	26.9	50.8	50.8
WC_J405	JUNCTION	1.1	1.5	2.1	358.1	590.0
WC_J420	JUNCTION	1.8	3.3	3.3	3.0	3.0
WC_J505	JUNCTION	1.1	1.6	2.1	4.5	6.9
WC_J506	JUNCTION	1.4	2.1	2.9	5.9	7.1
WC_J706	JUNCTION	11.9	27.7	84.6	476.8	699.6
FT_OUTLET	OUTFALL	2.2	3.3	7.3	25.0	25.2
FT_OUTLET2	OUTFALL	2.1	3.6	8.2	56.8	90.2
MPD_OUTLET	OUTFALL	4.8	9.9	38.0	246.3	364.6
PLC_OUTLET	OUTFALL	31.2	48.3	99.1	135.9	139.4
PR_OUTLET	OUTFALL	7.0	10.9	14.5	26.3	31.2
PRR_OUTLET	OUTFALL	5.9	8.1	11.5	31.7	44.1
SKD_OUTLET	OUTFALL	12.7	34.7	122.4	449.6	670.0
WC_OUTLET	OUTFALL	19.4	39.3	104.3	198.7	218.6
WC_OUTLET2	OUTFALL	5.1	7.2	9.7	372.0	609.8
WC_OUTLET3	OUTFALL	9.5	16.1	32.5	121.3	173.9
FT_OUTLET3	OUTFALL	0.0	0.0	0.0	5.4	18.6
PLC_OUTLET2	OUTFALL	0.0	0.0	0.0	554.6	951.6
SD_Outlet	OUTFALL	3.9	9.6	31.1	274.6	411.6
FT_D101	DIVIDER	1.6	2.8	7.2	53.2	85.3
FT_D105	DIVIDER	2.7	4.0	8.2	30.2	43.4
FT_D125	DIVIDER	0.5	0.8	4.1	18.4	26.4
FT_D130	DIVIDER	6.5	9.9	13.8	45.0	66.0
FT_D205	DIVIDER	2.7	4.0	8.2	30.2	43.4
FT_D305	DIVIDER	0.5	0.8	4.1	18.4	26.4
FT_J115	DIVIDER	3.4	6.0	10.2	49.5	70.4
ND_D105	DIVIDER	6.2	9.5	11.4	27.4	41.6
ND_D110	DIVIDER	0.3	0.4	0.5	1.2	1.7
ND_D115	DIVIDER	0.0	0.1	0.1	0.6	1.0
ND_D120	DIVIDER	0.2	0.3	0.4	0.8	1.1
ND_D140	DIVIDER	3.3	4.3	5.6	12.0	16.2
PLC_D115	DIVIDER	2.3	4.8	24.0	134.6	198.3
PLC_J105	DIVIDER	30.7	47.2	97.7	690.0	1094.3
SKD_D110	DIVIDER	13.6	36.9	142.3	709.5	1063.2
SKD_D135	DIVIDER	10.9	28.8	104.3	528.3	793.3
SKD_D165	DIVIDER	1.4	2.3	4.7	20.4	29.0
SKD_D170	DIVIDER	3.2	5.5	13.6	55.9	79.4
SKD_D190	DIVIDER	2.7	4.9	8.7	47.4	71.4
SKD_D270	DIVIDER	0.0	0.0	0.0	0.0	0.0
SKD_D580	DIVIDER	2.7	4.9	8.7	47.4	71.4
SKD_S180	DIVIDER	0.5	0.6	0.9	9.7	22.6
WC_D101	DIVIDER	0.0	0.0	0.5	4.9	7.3
WC_D103	DIVIDER	2.1	2.9	4.1	8.7	11.3
WC_D105	DIVIDER	5.1	7.2	9.7	372.0	609.8
WC_D105.1	DIVIDER	1.5	2.1	2.9	5.9	7.6
WC_D105.2	DIVIDER	1.1	1.6	2.1	4.5	5.9
WC_D106	DIVIDER	14.0	31.0	90.2	494.8	725.5
WC_D109	DIVIDER	1.6	2.3	3.0	7.8	14.6
WC_D110	DIVIDER	5.7	9.2	17.7	67.5	98.0
WC_D111	DIVIDER	1.9	3.1	4.9	12.0	15.7
WC_D112	DIVIDER	1.4	3.3	9.2	35.3	50.4
WC_D112.5	DIVIDER	0.5	0.9	1.2	23.4	37.6
WC_D113	DIVIDER	0.7	2.3	7.8	30.3	42.8
WC_D150	DIVIDER	3.0	7.7	26.9	108.2	153.1

Existing Node Peak Flows (cfs)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
WC_D155	DIVIDER	0.9	1.3	1.7	4.4	5.9
WC_D172	DIVIDER	2.5	3.6	5.1	11.1	14.6
WC_D205	DIVIDER	14.0	31.0	90.2	140.0	140.0
WC_D210	DIVIDER	2.5	4.4	11.3	47.0	69.1
WC_D272	DIVIDER	2.1	2.9	4.0	8.0	10.4
WC_D310	DIVIDER	0.7	1.7	7.1	36.5	55.0
WC_D806	DIVIDER	11.9	27.7	84.6	476.8	699.7
WC_D160	DIVIDER	3.8	6.0	12.5	46.4	64.7
FT_Melbourne	STORAGE	6.9	10.5	14.7	48.0	70.6
FT_Melbourne	STORAGE	4.9	8.2	12.9	47.8	70.4
FT_S120	STORAGE	5.8	8.2	11.4	34.0	49.2
ND_Northridg	STORAGE	3.1	4.1	5.4	13.2	18.8
ND_Winograd	STORAGE	2.8	4.3	6.2	22.5	35.8
PR_PoudreRiv	STORAGE	7.0	10.9	14.4	26.3	31.2
SKD_CDOT_st	STORAGE	1.6	2.7	5.4	22.8	32.4
SKD_Promont	STORAGE	7.4	12.5	19.9	99.2	147.1
WC_B135	STORAGE	7.7	13.5	20.0	102.3	153.4
WC_CDOT_stl	STORAGE	5.3	8.2	15.9	56.0	77.5

Future Node Peak Flows (cfs)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
FT_B100	JUNCTION	0.9	1.4	2.1	4.9	6.5
FT_B101	JUNCTION	9.5	12.6	16.4	35.7	47.8
FT_B105	JUNCTION	5.3	7.1	9.2	19.1	25.2
FT_B110	JUNCTION	0.9	1.2	1.6	3.6	5.0
FT_B115	JUNCTION	1.4	1.9	2.6	5.9	8.3
FT_B120	JUNCTION	11.4	15.0	20.1	47.9	66.4
FT_B125	JUNCTION	11.9	15.7	20.1	40.8	54.1
FT_B130	JUNCTION	18.4	25.0	33.2	78.9	106.0
FT_D101	DIVIDER	0.2	0.2	0.2	0.2	0.2
FT_D105	DIVIDER	0.5	0.5	0.5	0.5	0.5
FT_D125	DIVIDER	0.1	0.1	0.1	0.1	0.1
FT_D130	DIVIDER	0.6	0.6	0.6	0.6	0.6
FT_D205	DIVIDER	0.5	0.5	0.5	0.5	0.5
FT_D305	DIVIDER	0.1	0.1	0.1	0.1	0.1
FT_J110	JUNCTION	0.4	0.4	0.4	0.4	0.4
FT_J115	DIVIDER	0.8	0.9	1.0	1.1	1.1
FT_J130	JUNCTION	0.6	0.6	0.7	0.7	0.7
FT_J150	JUNCTION	0.5	0.5	0.5	0.5	0.5
FT_J201	JUNCTION	0.2	0.2	0.2	0.2	0.2
FT_J210	JUNCTION	0.4	0.4	0.4	0.4	0.4
FT_J215	JUNCTION	0.6	0.6	0.7	0.7	0.7
FT_J305	JUNCTION	0.5	0.5	0.5	0.5	0.5
FT_J310	JUNCTION	0.1	0.1	0.1	0.1	0.1
FT_J405	JUNCTION	0.5	0.5	0.5	0.5	0.5
FT_J505	JUNCTION	0.5	0.5	0.5	0.5	0.5
FT_J605	JUNCTION	0.5	0.5	0.5	0.5	0.5
FT_J705	JUNCTION	0.1	0.1	0.1	0.1	0.1
FT_Melbourn	STORAGE	0.8	0.9	1.1	1.1	1.1
FT_Melbourn	STORAGE	0.8	0.9	1.0	1.1	1.1
FT_OUTLET	OUTFALL	0.5	0.5	0.5	0.5	0.5
FT_OUTLET2	OUTFALL	0.4	0.4	0.4	0.4	0.4
Future_FT_B1	STORAGE	0.9	1.4	2.1	4.9	6.5
Future_FT_B1	STORAGE	9.5	12.6	16.4	35.7	47.8
Future_FT_B1	STORAGE	5.3	7.1	9.2	19.1	25.2
Future_FT_B1	STORAGE	0.9	1.2	1.6	3.6	5.0
Future_FT_B1	STORAGE	1.4	1.9	2.6	5.9	8.3
Future_FT_B1	STORAGE	11.4	15.0	20.1	47.9	66.4
Future_FT_B1	STORAGE	11.9	15.7	20.1	40.8	54.1
Future_FT_B1	STORAGE	18.4	25.0	33.2	78.9	106.0
Future_HD_B:	STORAGE	1.2	2.1	8.9	39.7	56.7
Future_HD_B:	STORAGE	1.7	3.2	10.8	62.8	91.4
Future_HD_B:	STORAGE	12.2	19.1	42.3	150.2	209.7
Future_MPD_	STORAGE	1.9	4.0	9.8	79.8	117.6
Future_MPD_	STORAGE	4.9	9.3	32.3	182.2	264.0

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
Future_ND_B100	STORAGE	12.8	16.9	22.4	49.8	67.4
Future_ND_B105	STORAGE	12.8	17.0	22.5	52.3	72.5
Future_ND_B110	STORAGE	0.7	0.9	1.2	2.2	2.9
Future_ND_B115	STORAGE	1.0	1.3	1.6	3.1	3.9
Future_ND_B120	STORAGE	0.3	0.4	0.5	1.0	1.2
Future_ND_B130	STORAGE	23.7	31.2	40.0	75.0	96.2
Future_ND_B135	STORAGE	3.6	4.8	6.2	11.6	14.8
Future_ND_B140	STORAGE	5.2	6.9	8.8	16.2	21.0
Future_OG_B100	STORAGE	2.6	5.9	9.7	124.6	191.3
Future_OG_B105	STORAGE	14.4	20.9	30.5	77.1	101.6
Future_OG_B110	STORAGE	15.8	23.2	36.8	87.5	115.3
Future_PLC_B100	STORAGE	0.9	1.4	2.9	9.3	12.8
Future_PLC_B105	STORAGE	31.8	45.9	72.1	183.9	245.1
Future_PLC_B110	STORAGE	22.3	34.7	58.0	186.2	254.9
Future_PLC_B115	STORAGE	21.5	32.7	46.7	157.6	219.3
Future_PLC_B120	STORAGE	33.3	47.7	72.9	181.6	240.0
Future_PLC_B121	STORAGE	36.8	50.9	69.2	141.4	181.3
Future_PRR_B100	STORAGE	12.2	16.1	20.6	40.9	53.7
Future_PRR_B105	STORAGE	4.0	5.2	6.7	13.0	16.9
Future_SD_B100	STORAGE	1.7	3.1	11.2	60.4	87.6
Future_SD_B105	STORAGE	1.0	2.7	4.5	57.1	88.6
Future_SD_B110	STORAGE	0.9	1.8	5.3	35.6	52.1
Future_SD_B115	STORAGE	0.9	1.8	6.3	34.8	50.4
Future_SD_B120	STORAGE	5.4	9.8	16.6	102.7	150.7
Future_SKD_B100	STORAGE	1.6	2.8	9.8	41.3	58.9
Future_SKD_B105	STORAGE	1.6	2.6	4.1	17.3	24.7
Future_SKD_B110	STORAGE	7.1	10.7	14.9	46.7	66.2
Future_SKD_B115	STORAGE	4.6	7.3	10.3	40.1	56.2
Future_SKD_B120	STORAGE	20.5	29.3	43.9	101.2	131.8
Future_SKD_B125	STORAGE	12.9	19.5	28.5	62.3	80.9
Future_SKD_B126	STORAGE	39.6	56.3	82.8	187.4	243.6
Future_SKD_B130	STORAGE	22.3	32.6	47.9	110.4	143.3
Future_SKD_B135	STORAGE	34.0	48.6	72.3	163.3	213.6
Future_SKD_B136	STORAGE	25.8	36.8	53.3	121.8	158.9
Future_SKD_B137	STORAGE	19.2	27.2	38.0	89.6	116.9
Future_SKD_B140	STORAGE	37.5	54.3	72.3	182.4	243.0
Future_SKD_B141	STORAGE	7.9	11.5	15.3	37.9	51.0
Future_SKD_B145	STORAGE	60.5	84.6	112.2	269.7	361.0
Future_SKD_B150	STORAGE	27.4	36.3	48.9	124.0	173.3
Future_SKD_B155	STORAGE	44.1	60.2	78.4	170.7	222.8
Future_SKD_B165	STORAGE	2.3	3.5	5.7	22.2	31.3
Future_SKD_B170	STORAGE	3.5	5.5	7.7	32.4	46.6
Future_SKD_B175	STORAGE	1.2	2.1	4.0	22.5	32.8
Future_SKD_B190	STORAGE	17.2	23.5	30.7	60.5	77.0

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
Future_SKD_B195	STORAGE	28.2	16.9	22.4	49.8	67.4
Future_WC_B100	STORAGE	0.8	17.0	22.5	52.3	72.5
Future_WC_B101	STORAGE	5.9	0.9	1.2	2.2	2.9
Future_WC_B102	STORAGE	3.8	1.3	1.6	3.1	3.9
Future_WC_B103	STORAGE	2.6	0.4	0.5	1.0	1.2
Future_WC_B105	STORAGE	6.7	31.2	40.0	75.0	96.2
Future_WC_B105.1	STORAGE	1.8	4.8	6.2	11.6	14.8
Future_WC_B106	STORAGE	8.4	6.9	8.8	16.2	21.0
Future_WC_B107	STORAGE	5.7	5.9	9.7	124.6	191.3
Future_WC_B109	STORAGE	1.7	20.9	30.5	77.1	101.6
Future_WC_B110	STORAGE	11.7	23.2	36.8	87.5	115.3
Future_WC_B111	STORAGE	5.0	1.4	2.9	9.3	12.8
Future_WC_B112	STORAGE	1.7	45.9	72.1	183.9	245.1
Future_WC_B112.5	STORAGE	2.6	34.7	58.0	186.2	254.9
Future_WC_B113	STORAGE	22.3	32.7	46.7	157.6	219.3
Future_WC_B114	STORAGE	20.5	47.7	72.9	181.6	240.0
Future_WC_B115	STORAGE	6.9	50.9	69.2	141.4	181.3
Future_WC_B120	STORAGE	160.8	16.1	20.6	40.9	53.7
Future_WC_B130	STORAGE	5.9	5.2	6.7	13.0	16.9
Future_WC_B135	STORAGE	48.2	3.1	11.2	60.4	87.6
Future_WC_B140	STORAGE	123.3	2.7	4.5	57.1	88.6
Future_WC_B146	STORAGE	13.4	1.8	5.3	35.6	52.1
Future_WC_B150	STORAGE	80.9	1.8	6.3	34.8	50.4
Future_WC_B160	STORAGE	41.0	9.8	16.6	102.7	150.7
Future_WC_B170	STORAGE	1.6	2.8	9.8	41.3	58.9
Future_WC_B171	STORAGE	2.4	2.6	4.1	17.3	24.7
Future_WC_B172	STORAGE	3.6	10.7	14.9	46.7	66.2
Future_WC_B173	STORAGE	2.4	7.3	10.3	40.1	56.2
HD_B100	JUNCTION	1.2	29.3	43.9	101.2	131.8
HD_B105	JUNCTION	1.7	19.5	28.5	62.3	80.9
HD_B110	JUNCTION	12.2	56.3	82.8	187.4	243.6
HD_J105	JUNCTION	0.1	32.6	47.9	110.4	143.3
HD_J110	JUNCTION	4.9	48.6	72.3	163.3	213.6
HD_Outlet	JUNCTION	5.2	36.8	53.3	121.8	158.9
MPD_B100	JUNCTION	1.9	27.2	38.0	89.6	116.9
MPD_B105	JUNCTION	4.9	54.3	72.3	182.4	243.0
MPD_J105	JUNCTION	0.5	11.5	15.3	37.9	51.0
MPD_OUTLET	OUTFALL	0.8	84.6	112.2	269.7	361.0
ND_B100	JUNCTION	12.8	36.3	48.9	124.0	173.3
ND_B105	JUNCTION	12.8	60.2	78.4	170.7	222.8
ND_B110	JUNCTION	0.7	3.5	5.7	22.2	31.3
ND_B115	JUNCTION	1.0	5.5	7.7	32.4	46.6
ND_B120	JUNCTION	0.3	2.1	4.0	22.5	32.8
ND_B130	JUNCTION	23.7	23.5	30.7	60.5	77.0

Future Node Peak Flows (cfs)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
ND_B135	JUNCTION	3.6	4.8	6.2	11.6	14.8
ND_B140	JUNCTION	5.2	6.9	8.8	16.2	21.0
ND_D105	DIVIDER	1.4	1.5	1.6	1.7	1.7
ND_D110	DIVIDER	0.1	0.1	0.1	0.1	0.1
ND_D115	DIVIDER	0.1	0.1	0.1	0.1	0.1
ND_D120	DIVIDER	0.0	0.0	0.1	0.1	0.1
ND_D140	DIVIDER	0.1	0.1	0.1	0.1	0.1
ND_J100	JUNCTION	0.3	0.3	0.3	0.3	0.3
ND_J105	JUNCTION	1.2	1.3	1.4	1.5	1.5
ND_J130	JUNCTION	0.1	0.1	0.1	0.1	0.1
ND_J135	JUNCTION	0.1	0.1	0.1	0.1	0.1
ND_J205	JUNCTION	0.4	0.4	0.4	0.4	0.4
ND_J230	JUNCTION	0.1	0.1	0.1	0.1	0.1
ND_J235	JUNCTION	0.1	0.1	0.1	0.1	0.1
ND_J305	JUNCTION	0.8	0.9	1.0	1.1	1.1
ND_J330	JUNCTION	0.0	0.0	0.0	0.0	0.0
ND_J430	JUNCTION	0.0	0.0	0.0	0.0	0.0
ND_NorthridgeHigh	STORAGE	0.2	0.2	0.2	0.2	0.2
ND_Pond_inflow	JUNCTION	0.1	0.1	0.1	0.1	0.1
ND_Winograd	STORAGE	0.4	0.4	0.4	0.4	0.4
OG_B100	JUNCTION	2.6	5.9	9.7	124.6	191.3
OG_B105	JUNCTION	14.4	20.9	30.5	77.1	101.6
OG_B110	JUNCTION	15.8	23.2	36.8	87.5	115.3
OG_J100	JUNCTION	2.8	2.8	2.8	2.8	2.8
OG_J105	JUNCTION	1.3	1.3	1.3	1.3	1.3
OG_J110	JUNCTION	1.6	1.6	1.6	1.6	1.6
OG_Outlet	JUNCTION	3.1	3.9	6.7	6.9	6.9
PLC_B100	JUNCTION	0.9	1.4	2.9	9.3	12.8
PLC_B105	JUNCTION	31.8	45.9	72.1	183.9	245.1
PLC_B110	JUNCTION	22.3	34.7	58.0	186.2	254.9
PLC_B115	JUNCTION	21.5	32.7	46.7	157.6	219.3
PLC_B120	JUNCTION	33.3	47.7	72.9	181.6	240.0
PLC_B121	JUNCTION	36.8	50.9	69.2	141.4	181.3
PLC_D115	DIVIDER	7.6	5.5	5.5	5.5	5.5
PLC_J100	JUNCTION	18.5	18.6	18.9	19.7	20.2
PLC_J105	DIVIDER	18.5	18.6	18.9	19.7	20.2
PLC_J110	JUNCTION	4.4	4.4	4.4	4.4	4.4
PLC_J115	JUNCTION	10.1	10.3	10.6	11.4	12.0
PLC_J120	JUNCTION	5.5	5.5	5.5	5.5	5.5
PLC_J121	JUNCTION	1.6	1.6	1.6	1.6	1.6
PLC_J215	JUNCTION	8.0	7.5	7.8	8.6	9.2
PLC_OUTLET	OUTFALL	18.6	18.9	19.3	20.1	20.6
PR_B100	JUNCTION	0.3	1.0	2.8	10.2	14.0
PR_B105	JUNCTION	0.8	1.5	4.6	28.4	41.1
PR_B110	JUNCTION	1.6	3.9	13.6	52.3	72.6
PR_B115	JUNCTION	0.2	0.4	1.6	7.8	11.2
PR_B120	JUNCTION	1.0	1.8	8.0	34.2	48.9
PR_B125	JUNCTION	0.5	1.0	3.8	15.5	21.8
PR_B130	JUNCTION	1.7	3.1	12.0	55.7	79.3
PR_B135	JUNCTION	87.8	125.8	171.7	343.3	436.2
PR_B150	JUNCTION	4.6	8.7	19.1	64.0	90.1
PR_B155	JUNCTION	5.0	7.2	10.1	20.8	26.7
PR_B160	JUNCTION	3.1	4.4	5.9	14.1	18.8
PR_J355	JUNCTION	1.4	1.5	1.6	1.7	1.7
PR_OUTLET	OUTFALL	5.2	7.4	10.3	21.0	26.9
PR_PoudreRiv	STORAGE	5.2	7.4	10.3	21.0	26.9
PRR_B100	JUNCTION	12.2	16.1	20.6	40.9	53.7
PRR_B105	JUNCTION	4.0	5.2	6.7	13.0	16.9
PRR_J100	JUNCTION	1.1	1.2	1.4	1.9	1.9
PRR_J105	JUNCTION	0.2	0.3	0.5	1.0	1.0
PRR_OUTLET	OUTFALL	1.1	1.2	1.4	1.9	1.9
SD_B100	JUNCTION	1.7	3.1	11.2	60.4	87.6
SD_B105	JUNCTION	1.0	2.7	4.5	57.1	88.6
SD_B110	JUNCTION	0.9	1.8	5.3	35.6	52.1
SD_B115	JUNCTION	0.9	1.8	6.3	34.8	50.4
SD_B120	JUNCTION	5.4	9.8	16.6	102.7	150.7
SD_J100	JUNCTION	4.5	7.4	10.0	9.9	9.9
SD_J110	JUNCTION	3.7	4.7	5.8	5.8	5.8
SD_J200	JUNCTION	4.0	5.9	7.7	7.7	7.7
SD_J210	JUNCTION	3.4	4.0	4.5	4.5	4.5
SD_Outlet	OUTFALL	4.5	7.4	10.0	9.9	9.9
SKD_B100	JUNCTION	1.6	2.8	9.8	41.3	58.9
SKD_B105	JUNCTION	1.6	2.6	4.1	17.3	24.7
SKD_B106	JUNCTION	0.6	0.8	1.1	2.7	3.8
SKD_B110	JUNCTION	7.1	10.7	14.9	46.7	66.2
SKD_B115	JUNCTION	4.6	7.3	10.3	40.1	56.2
SKD_B120	JUNCTION	20.5	29.3	43.9	101.2	131.8
SKD_B125	JUNCTION	12.9	19.5	28.5	62.3	80.9
SKD_B126	JUNCTION	39.6	56.3	82.8	187.4	243.6
SKD_B130	JUNCTION	22.3	32.6	47.9	110.4	143.3
SKD_B135	JUNCTION	34.0	48.6	72.3	163.3	213.6
SKD_B136	JUNCTION	25.8	36.8	53.3	121.8	158.9
SKD_B137	JUNCTION	19.2	27.2	38.0	89.6	116.9
SKD_B140	JUNCTION	37.5	54.3	72.3	182.4	243.0
SKD_B141	JUNCTION	7.9	11.5	15.3	37.9	51.0
SKD_B145	JUNCTION	60.5	84.6	112.2	269.7	361.0
SKD_B150	JUNCTION	27.4	36.3	48.9	124.0	173.3
SKD_B155	JUNCTION	44.1	60.2	78.4	170.7	222.8
SKD_B160	JUNCTION	1.4	1.9	2.6	5.5	7.2
SKD_B165	JUNCTION	2.3	3.5	5.7	22.2	31.3
SKD_B170	JUNCTION	3.5	5.5	7.7	32.4	46.6
SKD_B175	JUNCTION	1.2	2.1	4.0	22.5	32.8
SKD_B180	JUNCTION	17.0	23.1	29.6	59.1	74.7
SKD_B185	JUNCTION	27.0	37.1	47.6	96.0	122.4
SKD_B190	JUNCTION	17.2	23.5	30.7	60.5	77.0
SKD_B195	JUNCTION	28.2	38.2	48.9	94.9	121.3
SKD_CDOT_stb3	STORAGE	1.7	2.8	3.7	7.7	9.5
SKD_D110	DIVIDER	24.9	26.2	30.6	40.3	48.1
SKD_D135	DIVIDER	16.2	18.3	22.6	32.1	40.0
SKD_D165	DIVIDER	1.5	2.3	2.3	2.3	2.3
SKD_D170	DIVIDER	2.4	4.5	6.0	11.4	19.2
SKD_D190	DIVIDER	0.7	0.7	0.7	0.7	0.7
SKD_D270	DIVIDER	0.0	0.0	0.0	0.0	0.0
SKD_D580	DIVIDER	0.7	0.7	0.7	0.7	0.7
SKD_J100	JUNCTION	23.3	25.7	29.7	38.7	45.8
SKD_J105	JUNCTION	22.8	25.2	29.2	38.2	45.3
SKD_J106	JUNCTION	22.3	24.2	28.2	37.2	44.3
SKD_J110	JUNCTION	22.3	24.2	28.2	37.2	44.4
SKD_J115	JUNCTION	0.5	1.0	1.0	1.0	1.0
SKD_J120	JUNCTION	25.6	26.2	30.6	40.3	48.1
SKD_J125	JUNCTION	4.5	4.7	4.9	5.7	5.7
SKD_J126	JUNCTION	3.0	3.2	3.4	4.2	4.2
SKD_J130	JUNCTION	1.6	1.6	1.6	1.5	1.6
SKD_J136	JUNCTION	4.1	6.1	8.0	13.0	20.9
SKD_J137	JUNCTION	1.1	1.1	1.1	1.1	1.1
SKD_J140	JUNCTION	8.2	8.5	10.5	14.8	14.8
SKD_J141	JUNCTION	0.5	0.5	0.5	0.5	0.5
SKD_J145	JUNCTION	6.0	6.3	8.3	12.7	12.7
SKD_J150	JUNCTION	3.4	3.8	5.7	10.1	10.1
SKD_J155	JUNCTION	1.3	1.3	1.3	1.3	1.3
SKD_J160	JUNCTION	1.5	2.3	2.3	2.3	2.3
SKD_J175	JUNCTION	0.5	1.3	2.1	7.5	15.3
SKD_J180	JUNCTION	0.7	0.7	0.7	0.7	0.7
SKD_J220	JUNCTION	22.1	24.2	28.6	38.3	46.1
SKD_J226	JUNCTION	0.1	0.3	0.5	1.3	1.3
SKD_J235	JUNCTION	13.4	15.5	19.8	29.3	37.2
SKD_J250	JUNCTION	1.3	1.7	3.6	8.5	8.5
SKD_J265	JUNCTION	0.0	0.0	0.0	0.0	0.0
SKD_J275	JUNCTION	0.0	0.0	0.0	5.6	13.4
SKD_J280	JUNCTION	0.7	0.7	0.7	0.7	0.7
SKD_J290	JUNCTION	0.7	0.7	0.7	0.7	0.7
SKD_J320	JUNCTION	17.7	19.7	24.0	33.6	41.4

Future Node Peak Flows (cfs)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
SKD_J335	JUNCTION	12.9	15.0	19.3	28.8	36.7
SKD_J336	JUNCTION	2.4	4.5	6.1	11.3	19.2
SKD_J380	JUNCTION	0.7	0.7	0.7	0.7	0.7
SKD_J420	JUNCTION	16.2	18.3	22.6	32.1	40.0
SKD_J436	JUNCTION	2.4	4.5	6.1	11.3	19.2
SKD_J536	JUNCTION	2.4	4.5	6.1	11.3	19.2
SKD_J636	JUNCTION	2.4	4.5	6.0	11.4	19.2
SKD_OUTLET	OUTFALL	23.6	26.3	31.2	40.2	47.3
SKD_Promont	STORAGE	44.3	60.5	77.5	155.2	197.2
SKD_S180	DIVIDER	1.3	1.7	3.6	13.4	21.2
WC_B100	JUNCTION	0.8	1.2	2.1	5.6	7.5
WC_B101	JUNCTION	5.9	7.8	10.1	20.2	26.5
WC_B102	JUNCTION	3.8	5.3	7.1	14.4	18.4
WC_B103	JUNCTION	2.6	3.6	4.9	9.7	12.4
WC_B105	JUNCTION	6.7	9.3	12.1	25.0	32.2
WC_B105.1	JUNCTION	1.8	2.5	3.3	6.4	8.2
WC_B105.2	JUNCTION	1.3	1.9	2.5	5.0	6.4
WC_B106	JUNCTION	8.4	11.6	15.3	31.5	40.3
WC_B107	JUNCTION	5.7	8.1	11.0	24.9	32.9
WC_B108	JUNCTION	1.3	1.7	2.3	4.6	6.0
WC_B109	JUNCTION	1.7	2.4	3.1	6.3	8.2
WC_B110	JUNCTION	11.7	16.0	20.7	42.4	55.0
WC_B111	JUNCTION	5.0	7.1	9.5	18.4	23.4
WC_B112	JUNCTION	1.7	2.2	2.9	5.7	7.5
WC_B112.5	JUNCTION	2.6	3.4	4.4	8.8	11.5
WC_B113	JUNCTION	22.3	29.7	38.2	74.3	96.1
WC_B114	JUNCTION	20.5	27.0	34.6	66.8	87.2
WC_B115	JUNCTION	6.9	9.8	13.0	31.6	42.6
WC_B120	JUNCTION	160.8	215.7	279.4	548.4	706.0
WC_B130	JUNCTION	5.9	8.4	11.2	28.6	38.2
WC_B135	JUNCTION	48.2	67.9	90.6	223.0	300.4
WC_B140	JUNCTION	123.3	169.8	221.8	445.1	567.1
WC_B145	JUNCTION	3.5	4.8	6.3	11.9	14.5
WC_B146	JUNCTION	13.4	19.1	26.5	61.3	80.6
WC_B150	JUNCTION	80.9	111.0	148.3	292.7	371.4
WC_B155	JUNCTION	2.2	2.9	3.7	7.2	9.1
WC_B160	JUNCTION	41.0	54.3	68.7	120.6	149.1
WC_B165	JUNCTION	2.2	2.9	3.7	7.2	9.2
WC_B170	JUNCTION	1.6	2.2	2.9	6.1	7.7
WC_B171	JUNCTION	2.4	3.2	4.4	8.5	10.9
WC_B172	JUNCTION	3.6	4.9	6.6	12.9	16.6
WC_B173	JUNCTION	2.4	3.3	4.4	8.8	11.2
WC_CDOT_stl	STORAGE	7.3	9.5	12.0	22.2	27.6
WC_D101	DIVIDER	0.0	0.0	0.0	0.0	0.0
WC_D103	DIVIDER	0.1	0.1	0.1	0.1	0.1
WC_D105	DIVIDER	1.5	2.0	2.5	5.1	6.4
WC_D105.1	DIVIDER	0.1	0.1	0.1	0.1	0.1
WC_D105.2	DIVIDER	1.3	1.9	2.5	5.0	6.4
WC_D106	DIVIDER	15.2	15.4	15.5	15.7	15.9
WC_D109	DIVIDER	1.4	1.8	2.4	4.7	6.1
WC_D110	DIVIDER	1.3	1.3	1.3	1.3	1.3
WC_D111	DIVIDER	0.5	0.5	0.5	0.5	0.5
WC_D112	DIVIDER	0.6	0.6	0.6	0.6	0.6
WC_D112.5	DIVIDER	0.1	0.1	0.1	0.1	0.1
WC_D113	DIVIDER	0.4	0.4	0.4	0.4	0.4
WC_D150	DIVIDER	3.4	3.4	3.4	3.4	3.4
WC_D155	DIVIDER	2.2	2.9	3.7	7.2	9.1
WC_D160	DIVIDER	3.5	4.3	5.1	8.7	10.6
WC_D172	DIVIDER	0.2	0.2	0.2	0.2	0.2
WC_D205	DIVIDER	15.2	15.4	15.5	15.7	15.9
WC_D210	DIVIDER	1.0	1.0	1.0	1.0	1.0
WC_D272	DIVIDER	0.0	0.1	0.1	0.1	0.1
WC_D310	DIVIDER	0.5	0.5	0.5	0.5	0.5
WC_D806	DIVIDER	14.9	15.0	15.1	15.3	15.5
WC_J100	JUNCTION	15.8	16.0	16.3	16.6	16.8
WC_J101	JUNCTION	0.1	0.1	0.1	0.1	0.1
WC_J102	JUNCTION	0.3	0.3	0.3	0.3	0.3
WC_J105	JUNCTION	1.3	1.8	2.4	4.9	6.3
WC_J106	JUNCTION	14.9	15.1	15.2	15.4	15.6
WC_J107	JUNCTION	2.3	2.8	3.3	5.7	7.1
WC_J108	JUNCTION	2.3	2.8	3.3	5.7	7.1
WC_J109	JUNCTION	1.4	1.8	2.4	4.7	6.1
WC_J112	JUNCTION	0.5	0.5	0.5	0.5	0.5
WC_J112.5	JUNCTION	0.5	0.5	0.5	0.5	0.5
WC_J113.5	JUNCTION	0.4	0.4	0.4	0.4	0.4
WC_J114	JUNCTION	0.5	0.5	0.5	0.5	0.5
WC_J115	JUNCTION	0.3	0.3	0.3	0.3	0.3
WC_J120	JUNCTION	14.9	15.0	15.1	15.3	15.5
WC_J130	JUNCTION	0.3	0.3	0.3	0.3	0.3
WC_J135	JUNCTION	0.3	0.3	0.3	0.3	0.3
WC_J140	JUNCTION	9.0	9.2	9.2	9.5	9.6
WC_J145	JUNCTION	2.2	2.9	3.7	7.2	9.1
WC_J146	JUNCTION	0.9	0.9	0.9	0.9	0.9
WC_J165	JUNCTION	2.2	2.9	3.7	7.3	9.3
WC_J170	JUNCTION	0.3	0.4	0.4	0.4	0.4
WC_J171	JUNCTION	0.3	0.4	0.4	0.4	0.4
WC_J172	JUNCTION	0.3	0.3	0.3	0.3	0.3
WC_J173	JUNCTION	0.4	0.4	0.4	0.4	0.4
WC_J200	JUNCTION	15.2	15.4	15.5	15.7	15.9
WC_J201	JUNCTION	15.4	15.6	15.8	16.1	16.3
WC_J202	JUNCTION	0.1	0.1	0.1	0.1	0.1
WC_J205	JUNCTION	15.2	15.4	15.5	15.7	15.9
WC_J206	JUNCTION	14.9	15.1	15.2	15.4	15.6
WC_J207	JUNCTION	2.9	3.3	3.8	6.3	7.7
WC_J212.5	JUNCTION	0.4	0.4	0.4	0.4	0.4
WC_J220	JUNCTION	11.4	11.5	11.6	11.8	12.0
WC_J235	STORAGE	1.6	1.6	1.6	1.6	1.6
WC_J240	JUNCTION	1.2	1.3	1.4	1.6	1.7
WC_J245	JUNCTION	3.5	4.3	5.1	8.7	10.6
WC_J272	JUNCTION	0.1	0.1	0.1	0.1	0.1
WC_J273	JUNCTION	0.3	0.3	0.3	0.3	0.3
WC_J305	JUNCTION	1.5	2.0	2.5	5.1	6.4
WC_J306	JUNCTION	0.0	0.0	0.0	0.0	0.0
WC_J307	JUNCTION	0.6	0.6	0.6	0.6	0.6
WC_J312.5	JUNCTION	0.4	0.4	0.4	0.4	0.4
WC_J320	JUNCTION	10.0	10.1	10.1	10.4	10.5
WC_J340	JUNCTION	3.4	3.4	3.4	3.4	3.4
WC_J405	JUNCTION	1.3	1.8	2.4	4.9	6.3
WC_J420	JUNCTION	1.4	1.4	1.4	1.4	1.4
WC_J505	JUNCTION	1.3	1.9	2.5	5.0	6.4
WC_J506	JUNCTION	0.1	0.1	0.1	0.1	0.1
WC_J706	JUNCTION	14.9	15.0	15.1	15.3	15.5
WC_OUTLET	OUTFALL	15.8	16.0	16.3	16.6	16.8
WC_OUTLET2	OUTFALL	1.5	2.0	2.5	5.1	6.4
WC_OUTLET3	OUTFALL	3.1	3.5	4.0	6.4	7.9
1	OUTFALL	0.0	0.0	0.0	0.0	0.0
2	OUTFALL	0.0	0.0	0.0	0.0	0.0

Existing Node Total Inflow (Ac-ft)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
FT_B100	JUNCTION	0.9	1.5	2.4	6.0	8.0
FT_B101	JUNCTION	2.1	3.3	4.7	14.3	21.9
FT_B105	JUNCTION	2.0	2.7	3.7	8.1	11.4
FT_B110	JUNCTION	0.0	0.0	0.1	0.7	1.2
FT_B115	JUNCTION	0.2	0.4	0.5	1.8	3.0
FT_B120	JUNCTION	6.4	9.0	12.3	29.6	42.7
FT_B125	JUNCTION	0.4	0.8	3.7	18.1	26.9
FT_B130	JUNCTION	8.8	13.2	18.0	47.9	70.3
FT_J110	JUNCTION	0.4	0.8	3.8	18.7	28.1
FT_J130	JUNCTION	5.9	6.5	6.9	7.5	7.8
FT_J150	JUNCTION	2.4	3.6	7.4	25.6	31.6
FT_J201	JUNCTION	2.1	3.9	8.9	49.1	80.4
FT_J210	JUNCTION	0.4	0.8	3.8	18.7	28.1
FT_J215	JUNCTION	9.0	13.4	18.3	48.5	71.2
FT_J305	JUNCTION	2.4	3.6	7.4	25.6	31.6
FT_J310	JUNCTION	0.4	0.8	3.7	18.1	26.9
FT_J405	JUNCTION	2.4	3.6	7.4	25.6	31.6
FT_J505	JUNCTION	2.4	3.6	7.4	25.6	31.6
FT_J605	JUNCTION	2.4	3.6	7.4	25.6	31.6
FT_J705	JUNCTION	0.4	0.8	3.7	18.1	26.9
HD_B100	JUNCTION	0.7	1.5	7.7	38.7	57.1
HD_B105	JUNCTION	1.2	2.5	8.9	61.4	94.5
HD_B110	JUNCTION	3.6	8.4	34.4	155.0	228.0
HD_J110	JUNCTION	4.8	11.0	43.3	216.4	322.2
HD_Outlet	JUNCTION	5.6	12.6	51.3	255.0	380.6
MPD_B100	JUNCTION	1.1	2.3	5.9	60.8	97.3
MPD_B105	JUNCTION	4.4	9.1	32.8	179.2	268.8
ND_B100	JUNCTION	0.5	1.0	1.7	10.9	19.2
ND_B105	JUNCTION	1.9	3.3	4.9	18.0	29.3
ND_B110	JUNCTION	0.3	0.4	0.5	1.0	1.4
ND_B115	JUNCTION	0.0	0.1	0.1	0.6	1.0
ND_B120	JUNCTION	0.2	0.2	0.3	0.6	0.7
ND_B130	JUNCTION	2.6	4.1	5.9	18.4	28.8
ND_B135	JUNCTION	0.0	0.1	0.1	1.5	3.0
ND_B140	JUNCTION	2.0	2.7	3.6	6.8	9.0
ND_J100	JUNCTION	0.5	1.0	1.8	30.7	54.6
ND_J105	JUNCTION	14.1	20.7	24.9	45.1	60.5
ND_J130	JUNCTION	0.0	0.1	0.1	0.6	1.0
ND_J135	JUNCTION	2.0	2.7	3.6	6.8	9.0
ND_J205	JUNCTION	4.9	7.3	10.2	28.3	43.3
ND_J230	JUNCTION	0.3	0.4	0.5	1.0	1.4
ND_J235	JUNCTION	2.0	2.7	3.6	6.8	9.0
ND_J305	JUNCTION	9.2	13.3	14.7	16.7	17.2
ND_J330	JUNCTION	2.1	2.8	3.7	8.3	12.1
ND_J430	JUNCTION	2.1	2.8	3.7	8.3	12.0
OG_B100	JUNCTION	2.4	5.5	10.2	132.9	218.8
OG_B105	JUNCTION	0.8	1.7	8.0	41.7	62.3
OG_B110	JUNCTION	1.1	2.8	9.7	41.1	60.2
OG_J100	JUNCTION	2.2	4.9	18.9	85.6	125.8
OG_Outlet	JUNCTION	5.1	11.4	31.6	224.3	352.9
PLC_B100	JUNCTION	0.9	1.6	3.3	10.3	14.6
PLC_B105	JUNCTION	40.8	61.1	97.3	225.3	298.0
PLC_B110	JUNCTION	2.7	5.6	15.0	109.6	170.3
PLC_B115	JUNCTION	1.3	3.1	5.9	79.8	137.2
PLC_B120	JUNCTION	2.7	5.5	21.2	112.9	169.1
PLC_B121	JUNCTION	1.2	2.5	11.1	53.4	79.2
PLC_J100	JUNCTION	51.9	84.1	179.2	349.9	383.6
PLC_J110	JUNCTION	2.7	5.6	15.0	109.6	170.3
PLC_J115	JUNCTION	8.0	17.1	66.3	589.2	972.9
PLC_J120	JUNCTION	4.3	8.7	33.8	169.1	251.4
PLC_J215	JUNCTION	6.7	14.0	60.2	509.5	834.8
PR_B100	JUNCTION	0.2	0.6	2.1	7.9	11.4
PR_B105	JUNCTION	0.4	0.9	3.0	22.9	35.3
PR_B110	JUNCTION	0.8	2.1	8.7	37.4	54.9
PR_B115	JUNCTION	0.2	0.4	1.9	10.1	15.0
PR_B120	JUNCTION	0.7	1.5	6.8	33.8	49.7
PR_B125	JUNCTION	0.3	0.9	3.5	14.1	20.5
PR_B130	JUNCTION	0.7	1.5	5.3	29.1	43.6
PR_B135	JUNCTION	63.8	95.1	132.9	248.3	313.0
PR_B150	JUNCTION	7.7	15.3	34.1	102.2	141.8
PR_B155	JUNCTION	2.4	3.7	5.5	12.7	16.9
PR_B160	JUNCTION	0.6	0.9	1.4	5.6	8.7
PR_J355	JUNCTION	16.1	24.0	29.8	43.3	54.6
PRR_B100	JUNCTION	5.2	7.2	9.6	20.7	28.6
PRR_B105	JUNCTION	0.1	0.4	1.3	5.3	7.8
PRR_J100	JUNCTION	5.3	7.5	10.9	26.1	36.5
SD_B100	JUNCTION	1.2	2.5	10.2	59.8	90.5
SD_B105	JUNCTION	0.6	1.5	2.9	44.2	74.6
SD_B110	JUNCTION	0.6	1.2	3.9	29.6	46.0
SD_B115	JUNCTION	0.7	1.4	6.0	36.8	55.9
SD_B120	JUNCTION	2.4	5.0	11.8	96.4	151.3
SD_J100	JUNCTION	5.8	12.2	35.3	268.5	420.5
SD_J110	JUNCTION	3.7	7.8	21.9	163.3	253.8
SD_J200	JUNCTION	4.4	9.3	24.8	207.2	328.4
SD_J210	JUNCTION	3.0	6.4	17.8	133.2	207.2
SKD_B100	JUNCTION	1.3	2.7	10.7	49.7	73.3
SKD_B105	JUNCTION	0.4	0.9	2.3	18.0	28.2
SKD_B106	JUNCTION	0.1	0.2	0.3	1.7	2.9
SKD_B110	JUNCTION	0.4	1.0	1.8	23.4	40.8
SKD_B115	JUNCTION	0.6	1.2	2.7	25.4	40.5
SKD_B120	JUNCTION	1.1	2.3	10.6	50.0	74.0
SKD_B125	JUNCTION	0.6	1.9	6.8	28.5	41.7
SKD_B126	JUNCTION	2.8	6.7	21.8	90.8	132.3
SKD_B130	JUNCTION	1.3	2.9	12.8	61.4	90.5
SKD_B135	JUNCTION	1.2	2.5	9.5	57.7	87.8
SKD_B136	JUNCTION	1.8	4.5	14.3	58.9	85.9
SKD_B137	JUNCTION	1.6	3.3	11.2	51.9	76.1
SKD_B140	JUNCTION	2.0	5.6	20.7	90.2	132.6
SKD_B141	JUNCTION	0.3	0.6	2.5	14.9	22.7
SKD_B145	JUNCTION	3.6	10.1	34.4	141.5	205.9
SKD_B150	JUNCTION	2.9	7.7	26.7	113.2	165.4
SKD_B155	JUNCTION	1.9	4.0	8.7	69.7	109.6
SKD_B160	JUNCTION	0.2	0.4	0.7	2.1	3.0
SKD_B165	JUNCTION	1.9	3.3	6.6	26.7	39.0
SKD_B170	JUNCTION	2.6	4.5	9.1	34.7	50.3
SKD_B175	JUNCTION	1.6	3.0	8.3	33.1	48.2
SKD_B180	JUNCTION	2.7	4.3	6.6	25.9	39.6
SKD_B185	JUNCTION	4.4	7.0	10.6	40.2	60.2
SKD_B190	JUNCTION	1.3	2.2	4.6	22.0	33.1
SKD_B195	JUNCTION	2.0	3.4	5.5	27.9	45.1
SKD_J100	JUNCTION	29.2	65.1	193.0	705.9	997.4
SKD_J105	JUNCTION	28.9	64.4	190.9	687.5	969.8
SKD_J106	JUNCTION	28.3	63.2	188.1	659.8	926.8
SKD_J110	JUNCTION	28.4	63.2	188.1	659.8	926.8
SKD_J120	JUNCTION	30.7	67.5	211.8	972.9	1463.9
SKD_J125	JUNCTION	5.5	11.6	34.4	140.6	208.4
SKD_J126	JUNCTION	4.9	9.8	27.6	112.0	166.6
SKD_J136	JUNCTION	6.4	12.4	32.5	130.7	228.6
SKD_J140	JUNCTION	13.9	32.5	98.5	466.5	678.2
SKD_J145	JUNCTION	12.0	27.1	78.0	377.5	546.3
SKD_J150	JUNCTION	8.4	17.1	43.3	235.1	340.7
SKD_J160	JUNCTION	1.9	3.3	6.6	26.7	39.0
SKD_J175	JUNCTION	1.6	3.0	8.3	35.6	90.5
SKD_J180	JUNCTION	3.3	5.7	10.2	50.0	78.6
SKD_J220	JUNCTION	29.7	65.4	201.3	920.7	1390.3
SKD_J226	JUNCTION	2.1	3.3	6.0	21.8	34.7
SKD_J235	JUNCTION	22.0	48.8	144.5	662.9	1003.6
SKD_J250	JUNCTION	3.7	5.3	7.7	51.6	63.8
SKD_J265	JUNCTION	0.0	0.0	0.0	0.0	0.0
SKD_J275	JUNCTION	0.0	0.0	0.0	2.1	42.0
SKD_J280	JUNCTION	3.3	5.6	10.1	50.0	78.6
SKD_J290	JUNCTION	3.3	5.6	10.1	50.0	77.0

Existing Node Total Inflow (Ac-ft)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
SKD_J320	JUNCTION	24.3	53.7	167.0	782.6	1181.6
SKD_J335	JUNCTION	21.8	48.2	142.4	647.6	982.1
SKD_J336	JUNCTION	4.3	7.6	17.6	70.3	140.9
SKD_J380	JUNCTION	3.3	5.6	10.1	50.0	77.3
SKD_J420	JUNCTION	23.1	51.3	154.1	721.2	1092.6
SKD_J436	JUNCTION	4.2	7.5	17.5	70.3	140.9
SKD_J536	JUNCTION	4.2	7.5	17.5	70.3	140.9
SKD_J636	JUNCTION	4.2	7.5	17.5	70.3	140.9
WC_B100	JUNCTION	0.4	0.7	1.2	3.7	5.2
WC_B101	JUNCTION	3.1	4.2	5.5	10.4	13.6
WC_B102	JUNCTION	1.5	2.2	3.3	8.2	11.1
WC_B103	JUNCTION	1.5	2.1	2.9	5.9	7.6
WC_B105	JUNCTION	3.7	5.3	7.1	15.2	20.2
WC_B105.1	JUNCTION	0.8	1.2	1.6	3.2	4.1
WC_B105.2	JUNCTION	0.9	1.2	1.7	3.3	4.3
WC_B106	JUNCTION	3.1	4.5	6.7	17.6	24.4
WC_B107	JUNCTION	1.2	1.9	3.0	9.5	13.7
WC_B108	JUNCTION	0.9	1.2	1.6	3.1	4.2
WC_B109	JUNCTION	0.7	1.0	1.4	3.3	4.6
WC_B110	JUNCTION	3.3	4.8	6.6	17.7	25.4
WC_B111	JUNCTION	1.6	2.6	4.1	9.5	12.6
WC_B112	JUNCTION	0.2	0.3	0.4	1.5	2.4
WC_B112.5	JUNCTION	0.5	0.7	1.0	2.7	4.1
WC_B113	JUNCTION	0.6	2.1	7.2	29.4	43.0
WC_B114	JUNCTION	0.6	1.3	5.6	26.3	39.0
WC_B115	JUNCTION	0.2	0.6	1.0	8.6	15.6
WC_B120	JUNCTION	4.9	9.9	37.1	187.2	279.3
WC_B130	JUNCTION	1.2	2.1	3.2	13.5	22.2
WC_B140	JUNCTION	5.6	11.0	22.8	143.0	220.7
WC_B145	JUNCTION	0.4	0.7	1.1	3.2	4.5
WC_B146	JUNCTION	0.5	1.1	2.2	20.5	32.5
WC_B150	JUNCTION	3.1	8.3	28.5	118.2	172.5
WC_B155	JUNCTION	1.7	2.4	3.1	6.8	9.2
WC_B160	JUNCTION	2.6	4.5	9.2	34.7	50.3
WC_B165	JUNCTION	1.7	2.4	3.2	7.0	9.4
WC_B170	JUNCTION	0.3	0.5	1.0	3.7	5.4
WC_B171	JUNCTION	1.1	1.5	2.1	4.1	5.3
WC_B172	JUNCTION	1.5	2.1	2.9	6.1	8.0
WC_B173	JUNCTION	1.2	1.7	2.5	5.6	7.4
WC_J100	JUNCTION	39.6	69.4	149.5	365.2	414.3
WC_J101	JUNCTION	3.1	4.2	5.6	12.4	17.1
WC_J102	JUNCTION	3.1	4.4	6.2	12.2	15.4
WC_J105	JUNCTION	0.9	1.2	1.7	241.8	484.9
WC_J106	JUNCTION	26.4	50.6	122.8	543.2	813.3
WC_J107	JUNCTION	7.3	11.5	20.2	68.7	101.6
WC_J108	JUNCTION	7.3	11.5	20.3	68.7	101.6
WC_J109	JUNCTION	1.6	2.2	2.9	6.4	9.4
WC_J112	JUNCTION	1.1	2.8	8.2	32.2	47.0
WC_J112.5	JUNCTION	1.1	2.8	8.2	20.5	23.2
WC_J113.5	JUNCTION	0.6	2.1	7.2	16.9	19.0
WC_J114	JUNCTION	0.8	1.9	6.7	35.3	54.6
WC_J120	JUNCTION	25.7	49.4	121.2	540.1	810.2
WC_J135	JUNCTION	0.3	0.5	1.0	3.7	5.4
WC_J140	JUNCTION	13.0	25.3	60.2	253.2	365.2
WC_J145	JUNCTION	1.7	2.4	3.1	6.8	9.2
WC_J146	JUNCTION	0.5	1.1	2.2	57.4	112.0
WC_J165	JUNCTION	2.1	3.0	4.3	11.0	15.1
WC_J170	JUNCTION	5.6	7.8	10.6	22.5	30.2
WC_J171	JUNCTION	5.6	7.8	10.6	22.6	30.2
WC_J172	JUNCTION	4.6	6.3	8.5	18.5	25.0
WC_J173	JUNCTION	4.3	6.1	8.7	17.8	22.8
WC_J200	JUNCTION	29.4	54.9	129.2	322.2	359.1
WC_J201	JUNCTION	35.0	62.6	139.6	343.7	386.7
WC_J202	JUNCTION	1.5	2.1	2.9	4.0	4.2
WC_J205	JUNCTION	29.4	54.9	129.2	322.2	359.1
WC_J206	JUNCTION	26.5	50.6	122.8	543.2	813.3
WC_J207	JUNCTION	8.6	14.6	28.9	102.2	151.0
WC_J212.5	JUNCTION	0.6	2.1	7.2	16.9	19.0
WC_J220	JUNCTION	19.6	37.4	80.4	337.6	506.4
WC_J240	JUNCTION	4.7	6.4	9.6	30.1	52.8
WC_J245	JUNCTION	4.6	7.4	13.5	45.7	65.4
WC_J272	JUNCTION	3.1	4.2	5.6	12.4	17.1
WC_J273	JUNCTION	3.1	4.4	6.2	12.2	15.4
WC_J305	JUNCTION	4.6	6.5	8.7	256.9	503.3
WC_J306	JUNCTION	0.0	0.0	0.0	0.0	0.0
WC_J307	JUNCTION	1.3	3.1	8.7	33.8	49.4
WC_J312.5	JUNCTION	0.6	2.1	7.2	16.9	19.0
WC_J320	JUNCTION	13.5	26.3	62.3	310.0	478.8
WC_J340	JUNCTION	3.1	8.3	28.5	81.3	93.0
WC_J405	JUNCTION	0.9	1.2	1.7	241.8	484.9
WC_J420	JUNCTION	6.2	11.3	18.2	28.3	28.4
WC_J505	JUNCTION	0.9	1.2	1.7	3.3	4.5
WC_J506	JUNCTION	0.8	1.2	1.6	3.2	4.1
WC_J706	JUNCTION	25.7	49.4	121.2	540.1	810.2
FT_OUTLET	OUTFALL	2.6	3.8	7.7	26.0	31.9
FT_OUTLET2	OUTFALL	3.0	5.4	11.3	55.2	88.4
MPD_OUTLET	OUTFALL	5.8	11.9	39.6	242.1	368.3
PLC_OUTLET	OUTFALL	52.8	85.9	182.3	362.1	399.0
PR_OUTLET	OUTFALL	18.5	27.7	35.3	55.9	71.5
PRR_OUTLET	OUTFALL	5.3	7.5	10.9	26.1	36.5
SKD_OUTLET	OUTFALL	30.5	67.8	203.8	755.0	1071.1
WC_OUTLET	OUTFALL	39.6	69.4	149.5	365.2	414.3
WC_OUTLET2	OUTFALL	4.6	6.5	8.7	256.9	503.3
WC_OUTLET3	OUTFALL	10.0	16.7	31.9	112.0	164.8
FT_OUTLET3	OUTFALL	0.0	0.0	0.0	1.2	7.9
PLC_OUTLET2	OUTFALL	0.0	0.0	0.0	580.0	1068.0
SD_Outlet	OUTFALL	5.8	12.2	35.3	268.5	420.5
FT_D101	DIVIDER	2.1	3.9	8.9	49.1	80.1
FT_D105	DIVIDER	2.4	3.6	7.4	26.9	39.6
FT_D125	DIVIDER	0.4	0.8	3.7	18.1	26.9
FT_D130	DIVIDER	8.8	13.2	18.0	47.9	70.3
FT_D205	DIVIDER	2.4	3.6	7.4	26.9	39.6
FT_D305	DIVIDER	0.4	0.8	3.7	18.1	26.9
FT_J115	DIVIDER	9.2	13.8	18.8	50.3	74.0
ND_D105	DIVIDER	16.1	24.0	29.8	62.9	89.6
ND_D110	DIVIDER	0.3	0.4	0.5	1.0	1.4
ND_D115	DIVIDER	0.0	0.1	0.1	0.6	1.0
ND_D120	DIVIDER	0.2	0.2	0.3	0.6	0.7
ND_D140	DIVIDER	2.0	2.7	3.6	6.8	9.0
PLC_D115	DIVIDER	4.3	8.7	33.8	169.1	251.4
PLC_J105	DIVIDER	51.9	84.1	179.2	926.8	1445.5
SKD_D110	DIVIDER	30.6	67.5	211.8	972.9	1463.9
SKD_D135	DIVIDER	23.1	51.3	154.1	721.2	1092.6
SKD_D165	DIVIDER	1.9	3.3	6.6	26.7	39.0
SKD_D170	DIVIDER	4.2	7.5	17.5	70.3	140.9
SKD_D190	DIVIDER	3.3	5.7	10.1	50.0	78.6
SKD_D270	DIVIDER	0.0	0.0	0.0	0.0	0.0
SKD_D580	DIVIDER	3.3	5.6	10.1	50.0	78.6
SKD_S180	DIVIDER	3.7	5.3	7.7	53.7	105.9
WC_D101	DIVIDER	0.0	0.0	0.1	2.0	3.5
WC_D103	DIVIDER	1.5	2.1	2.9	5.9	7.6
WC_D105	DIVIDER	4.6	6.5	8.7	256.9	503.3
WC_D105.1	DIVIDER	0.8	1.2	1.6	3.2	4.1
WC_D105.2	DIVIDER	0.9	1.2	1.7	3.3	4.3
WC_D106	DIVIDER	29.5	55.2	129.2	561.6	837.8
WC_D109	DIVIDER	1.6	2.2	2.9	6.4	9.4
WC_D110	DIVIDER	5.7	9.3	17.3	62.3	93.0
WC_D111	DIVIDER	1.6	2.6	4.1	9.5	12.6
WC_D112	DIVIDER	1.3	3.1	8.7	33.8	49.4
WC_D112.5	DIVIDER	0.5	0.7	1.0	15.2	28.0
WC_D113	DIVIDER	0.6	2.1	7.2	29.4	43.0
WC_D150	DIVIDER	3.1	8.3	28.5	118.2	172.5

Existing Node Total Inflow (Ac-ft)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
WC_D155	DIVIDER	1.7	2.4	3.1	6.8	9.2
WC_D172	DIVIDER	1.5	2.1	2.9	6.1	8.0
WC_D205	DIVIDER	29.4	54.9	129.2	322.2	359.1
WC_D210	DIVIDER	2.4	4.5	10.7	44.5	67.5
WC_D272	DIVIDER	1.1	1.5	2.1	4.1	5.3
WC_D310	DIVIDER	0.8	1.9	6.7	35.3	54.6
WC_D806	DIVIDER	25.7	49.4	121.2	540.1	810.2
WC_D160	DIVIDER	4.6	7.4	13.5	45.7	65.4
FT_Melbourne	STORAGE	9.2	13.8	18.8	50.3	74.0
FT_Melbourne	STORAGE	9.2	13.8	18.8	50.3	74.0
FT_S120	STORAGE	6.4	9.0	12.3	29.6	42.7
ND_Northridg	STORAGE	2.1	2.8	3.7	8.3	12.1
ND_Winograd	STORAGE	5.0	7.4	10.3	28.4	43.3
PR_PoudreRiv	STORAGE	18.5	27.7	35.3	55.9	71.5
SKD_CDOT_st	STORAGE	2.1	3.7	7.3	28.8	42.0
SKD_Promont	STORAGE	10.4	17.0	27.3	116.0	178.3
WC_B135	STORAGE	7.7	13.0	20.4	89.0	140.3
WC_CDOT_stl	STORAGE	6.8	10.5	17.7	55.9	78.9

Future Node Total Inflow (Ac-ft)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
FT_B100	JUNCTION	1.3	2.1	3.1	6.7	8.6
FT_B101	JUNCTION	7.4	10.0	13.1	25.2	33.1
FT_B105	JUNCTION	3.4	4.6	6.0	11.4	14.9
FT_B110	JUNCTION	0.6	0.8	1.1	2.1	2.8
FT_B115	JUNCTION	1.0	1.3	1.7	3.5	4.8
FT_B120	JUNCTION	10.2	13.7	18.2	36.8	50.0
FT_B125	JUNCTION	8.1	10.9	14.2	26.0	33.8
FT_B130	JUNCTION	18.1	24.9	32.8	67.5	90.5
FT_D101	DIVIDER	1.9	1.9	1.9	1.9	1.9
FT_D105	DIVIDER	4.3	4.5	4.7	4.8	4.8
FT_D125	DIVIDER	1.0	1.0	1.0	1.0	1.0
FT_D130	DIVIDER	5.7	5.8	5.8	5.8	5.8
FT_D205	DIVIDER	4.3	4.5	4.7	4.8	4.8
FT_D305	DIVIDER	1.0	1.0	1.0	1.0	1.0
FT_J110	JUNCTION	3.4	3.6	3.8	3.8	3.8
FT_J115	DIVIDER	6.4	6.8	7.3	9.1	9.9
FT_J130	JUNCTION	5.8	5.9	6.0	6.2	6.4
FT_J150	JUNCTION	4.3	4.5	4.7	4.8	4.8
FT_J201	JUNCTION	1.9	1.9	1.9	1.9	1.9
FT_J210	JUNCTION	3.4	3.6	3.8	3.8	3.8
FT_J215	JUNCTION	5.8	5.9	6.0	6.2	6.4
FT_J305	JUNCTION	4.3	4.5	4.7	4.8	4.8
FT_J310	JUNCTION	0.9	1.0	1.0	1.0	1.0
FT_J405	JUNCTION	4.3	4.5	4.7	4.8	4.8
FT_J505	JUNCTION	4.3	4.5	4.7	4.8	4.8
FT_J605	JUNCTION	4.3	4.5	4.7	4.8	4.8
FT_J705	JUNCTION	1.0	1.0	1.0	1.0	1.0
FT_Melbourn	STORAGE	6.5	6.9	7.4	9.2	10.1
FT_Melbourn	STORAGE	6.5	6.9	7.4	9.2	10.1
FT_OUTLET	OUTFALL	4.1	4.3	4.5	4.5	4.5
FT_OUTLET2	OUTFALL	3.0	3.7	3.8	3.8	3.8
Future_FT_B1	STORAGE	1.3	2.1	3.1	6.7	8.6
Future_FT_B1	STORAGE	7.4	10.0	13.1	25.2	33.1
Future_FT_B1	STORAGE	3.4	4.6	6.0	11.4	14.9
Future_FT_B1	STORAGE	0.6	0.8	1.1	2.1	2.8
Future_FT_B1	STORAGE	1.0	1.3	1.7	3.5	4.8
Future_FT_B1	STORAGE	10.2	13.7	18.2	36.8	50.0
Future_FT_B1	STORAGE	8.1	10.9	14.2	26.0	33.8
Future_FT_B1	STORAGE	18.1	24.9	32.8	67.5	90.5
Future_HD_B:	STORAGE	1.0	2.1	8.1	38.7	57.4
Future_HD_B:	STORAGE	1.6	3.4	10.7	64.8	97.9
Future_HD_B:	STORAGE	14.6	24.6	50.9	172.5	243.4
Future_MPD_	STORAGE	1.5	3.2	7.8	63.8	100.0
Future_MPD_	STORAGE	4.5	9.6	30.4	179.2	268.5

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
Future_ND_B100	STORAGE	7.9	10.7	14.2	27.9	37.1
Future_ND_B105	STORAGE	10.0	13.5	17.8	35.6	48.5
Future_ND_B110	STORAGE	0.5	0.7	0.9	1.7	2.1
Future_ND_B115	STORAGE	0.6	0.9	1.1	2.0	2.5
Future_ND_B120	STORAGE	0.2	0.3	0.4	0.6	0.8
Future_ND_B130	STORAGE	15.6	21.1	27.4	48.2	60.5
Future_ND_B135	STORAGE	2.5	3.4	4.5	7.8	9.8
Future_ND_B140	STORAGE	2.9	3.9	5.1	8.9	11.2
Future_OG_B100	STORAGE	3.0	6.7	12.2	138.4	221.6
Future_OG_B105	STORAGE	12.8	18.4	26.4	60.5	80.4
Future_OG_B110	STORAGE	11.2	16.6	25.0	57.1	75.8
Future_PLC_B100	STORAGE	1.1	1.8	3.5	10.6	14.8
Future_PLC_B105	STORAGE	44.5	66.3	104.7	233.2	303.2
Future_PLC_B110	STORAGE	21.0	32.2	51.6	151.0	211.5
Future_PLC_B115	STORAGE	22.3	32.8	46.6	133.2	190.0
Future_PLC_B120	STORAGE	35.0	50.0	73.7	167.0	221.9
Future_PLC_B121	STORAGE	24.2	33.8	45.7	88.7	113.2
Future_PRR_B100	STORAGE	8.7	11.8	15.2	27.5	35.3
Future_PRR_B105	STORAGE	2.6	3.5	4.5	8.1	10.3
Future_SD_B100	STORAGE	1.5	3.2	10.4	59.5	90.2
Future_SD_B105	STORAGE	0.9	2.0	3.8	44.2	74.6
Future_SD_B110	STORAGE	0.7	1.6	4.3	30.4	47.0
Future_SD_B115	STORAGE	1.0	1.9	6.4	36.8	55.5
Future_SD_B120	STORAGE	5.9	10.8	18.8	104.7	159.3
Future_SKD_B100	STORAGE	1.9	3.7	11.6	50.3	72.7
Future_SKD_B105	STORAGE	2.3	3.9	6.3	22.9	32.2
Future_SKD_B110	STORAGE	7.3	10.7	14.5	38.1	54.6
Future_SKD_B115	STORAGE	4.7	7.2	10.5	34.4	49.4
Future_SKD_B120	STORAGE	16.7	24.1	35.0	75.8	99.1
Future_SKD_B125	STORAGE	9.3	13.8	19.9	42.0	54.9
Future_SKD_B126	STORAGE	30.3	43.0	61.4	130.7	170.9
Future_SKD_B130	STORAGE	20.6	30.0	43.3	93.0	121.5
Future_SKD_B135	STORAGE	21.1	29.9	43.0	93.3	122.5
Future_SKD_B136	STORAGE	19.4	27.4	38.7	83.2	108.9
Future_SKD_B137	STORAGE	18.3	25.8	35.6	75.5	99.1
Future_SKD_B140	STORAGE	27.8	39.6	52.8	118.2	158.7
Future_SKD_B141	STORAGE	5.1	7.3	9.7	21.5	29.0
Future_SKD_B145	STORAGE	45.7	63.8	84.1	178.6	239.7
Future_SKD_B150	STORAGE	30.7	42.0	56.2	118.2	162.7
Future_SKD_B155	STORAGE	36.2	50.0	65.4	128.0	166.6
Future_SKD_B165	STORAGE	3.2	5.2	8.3	28.5	39.9
Future_SKD_B170	STORAGE	4.0	6.2	9.1	31.9	47.3
Future_SKD_B175	STORAGE	1.7	3.2	6.0	30.6	43.9
Future_SKD_B190	STORAGE	12.3	17.0	22.5	42.0	53.1

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
Future_SKD_B195	STORAGE	19.9	27.3	35.3	64.1	81.3
Future_WC_B100	STORAGE	0.7	1.0	1.7	4.2	5.7
Future_WC_B101	STORAGE	3.4	4.6	6.0	11.1	14.3
Future_WC_B102	STORAGE	3.0	4.2	5.6	10.7	13.6
Future_WC_B103	STORAGE	1.8	2.5	3.3	6.4	8.1
Future_WC_B105	STORAGE	5.0	7.0	9.2	17.7	22.6
Future_WC_B105.1	STORAGE	1.0	1.3	1.8	3.4	4.4
Future_WC_B106	STORAGE	6.9	9.5	12.7	24.2	31.0
Future_WC_B107	STORAGE	3.2	4.5	6.1	12.9	17.0
Future_WC_B109	STORAGE	1.3	1.8	2.3	4.4	5.6
Future_WC_B110	STORAGE	7.8	10.7	14.0	26.7	34.4
Future_WC_B111	STORAGE	3.3	4.7	6.3	11.8	14.9
Future_WC_B112	STORAGE	1.1	1.5	2.0	3.7	4.7
Future_WC_B112.5	STORAGE	1.5	2.1	2.7	4.9	6.3
Future_WC_B113	STORAGE	14.1	19.2	25.0	45.1	57.4
Future_WC_B114	STORAGE	12.9	17.5	22.7	40.5	51.9
Future_WC_B115	STORAGE	5.1	7.2	9.5	20.6	27.9
Future_WC_B120	STORAGE	95.8	130.7	170.0	313.0	399.0
Future_WC_B130	STORAGE	6.3	9.0	11.9	26.4	35.3
Future_WC_B135	STORAGE	35.3	49.4	65.4	143.0	193.7
Future_WC_B140	STORAGE	81.6	112.9	149.5	281.1	356.0
Future_WC_B146	STORAGE	8.9	12.6	17.2	36.8	48.8
Future_WC_B150	STORAGE	56.5	78.3	105.0	196.1	247.7
Future_WC_B160	STORAGE	21.4	29.2	37.7	64.8	79.8
Future_WC_B170	STORAGE	1.8	2.4	3.3	6.1	7.7
Future_WC_B171	STORAGE	1.2	1.7	2.2	4.3	5.4
Future_WC_B172	STORAGE	1.9	2.7	3.6	6.8	8.7
Future_WC_B173	STORAGE	1.9	2.6	3.5	6.7	8.4
HD_B100	JUNCTION	1.0	2.1	8.1	38.7	57.4
HD_B105	JUNCTION	1.6	3.4	10.7	64.8	97.9
HD_B110	JUNCTION	14.6	24.6	50.9	172.5	243.4
HD_J105	JUNCTION	0.5	1.6	7.7	13.7	13.8
HD_J110	JUNCTION	14.9	26.0	53.1	59.2	59.2
HD_Outlet	JUNCTION	15.8	28.0	60.5	72.7	72.7
MPD_B100	JUNCTION	1.5	3.2	7.8	63.8	100.0
MPD_B105	JUNCTION	4.5	9.6	30.4	179.2	268.5
MPD_J105	JUNCTION	2.4	6.7	13.7	13.8	13.8
MPD_OUTLET	OUTFALL	3.7	9.6	20.7	40.8	40.8
ND_B100	JUNCTION	7.9	10.7	14.2	27.9	37.1
ND_B105	JUNCTION	10.0	13.5	17.8	35.6	48.5
ND_B110	JUNCTION	0.5	0.7	0.9	1.7	2.1
ND_B115	JUNCTION	0.6	0.9	1.1	2.0	2.5
ND_B120	JUNCTION	0.2	0.3	0.4	0.6	0.8
ND_B130	JUNCTION	15.6	21.1	27.4	48.2	60.5

Future Node Total Inflow (Ac-ft)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
ND_B135	JUNCTION	2.5	3.4	4.5	7.8	9.8
ND_B140	JUNCTION	2.9	3.9	5.1	8.9	11.2
ND_D105	DIVIDER	10.6	11.4	12.2	14.2	14.9
ND_D110	DIVIDER	0.4	0.6	0.8	0.9	0.9
ND_D115	DIVIDER	0.5	0.7	0.9	1.0	1.0
ND_D120	DIVIDER	0.1	0.2	0.2	0.5	0.6
ND_D140	DIVIDER	1.0	1.0	1.0	1.0	1.0
ND_J100	JUNCTION	2.9	2.9	2.9	2.9	2.9
ND_J105	JUNCTION	8.8	9.5	10.4	12.4	13.1
ND_J130	JUNCTION	0.5	0.7	0.9	0.9	0.9
ND_J135	JUNCTION	1.0	1.0	1.0	1.0	1.0
ND_J205	JUNCTION	2.5	2.9	3.2	3.4	3.4
ND_J230	JUNCTION	0.4	0.6	0.8	0.9	0.9
ND_J235	JUNCTION	1.0	1.0	1.0	1.0	1.0
ND_J305	JUNCTION	6.4	6.8	7.3	9.1	9.9
ND_J330	JUNCTION	0.0	0.0	0.0	0.0	0.0
ND_J430	JUNCTION	0.0	0.0	0.0	0.0	0.0
ND_NorthridgeHigh	STORAGE	1.9	1.9	1.9	1.9	1.9
ND_Pond_inflow	JUNCTION	1.0	1.0	1.0	1.0	1.0
ND_Winograd	#N/A	2.8	3.2	3.6	3.8	3.8
OG_B100	JUNCTION	3.0	6.7	12.2	138.4	221.6
OG_B105	JUNCTION	12.8	18.4	26.4	60.5	80.4
OG_B110	JUNCTION	11.2	16.6	25.0	57.1	75.8
OG_J100	JUNCTION	17.1	23.4	25.0	25.2	25.3
OG_J105	JUNCTION	9.3	12.1	12.3	12.3	12.3
OG_J110	JUNCTION	8.2	12.1	13.8	13.9	13.9
OG_Outlet	JUNCTION	18.9	27.7	34.4	61.1	61.4
PLC_B100	JUNCTION	1.1	1.8	3.5	10.6	14.8
PLC_B105	JUNCTION	44.5	66.3	104.7	233.2	303.2
PLC_B110	JUNCTION	21.0	32.2	51.6	151.0	211.5
PLC_B115	JUNCTION	22.3	32.8	46.6	133.2	190.0
PLC_B120	JUNCTION	35.0	50.0	73.7	167.0	221.9
PLC_B121	JUNCTION	24.2	33.8	45.7	88.7	113.2
PLC_D115	DIVIDER	47.6	51.3	51.6	51.6	51.6
PLC_J100	JUNCTION	138.7	156.8	168.2	174.0	176.2
PLC_J105	DIVIDER	138.7	156.8	168.2	174.0	176.5
PLC_J110	JUNCTION	20.4	31.3	41.7	42.0	42.0
PLC_J115	JUNCTION	82.6	92.1	93.6	99.4	101.9
PLC_J120	JUNCTION	47.6	51.6	51.6	51.9	51.9
PLC_J121	JUNCTION	13.9	13.9	14.0	14.0	14.0
PLC_J215	JUNCTION	61.4	66.3	67.8	73.7	75.8
PLC_OUTLET	OUTFALL	138.7	156.8	169.7	176.2	178.3
PR_B100	JUNCTION	0.2	0.7	2.2	8.1	11.6
PR_B105	JUNCTION	0.6	1.2	3.6	23.6	36.2
PR_B110	JUNCTION	1.1	2.8	10.0	39.0	56.2
PR_B115	JUNCTION	0.3	0.6	2.1	10.4	14.9
PR_B120	JUNCTION	0.9	1.9	7.3	33.8	50.0
PR_B125	JUNCTION	0.4	0.9	3.3	13.9	20.3
PR_B130	JUNCTION	0.7	1.6	5.4	29.1	43.6
PR_B135	JUNCTION	64.8	95.1	132.6	248.3	313.0
PR_B150	JUNCTION	7.6	14.7	32.8	100.7	130.1
PR_B155	JUNCTION	3.7	5.4	7.5	14.8	19.0
PR_B160	JUNCTION	2.2	3.1	4.1	8.8	11.8
PR_J355	JUNCTION	10.6	11.4	12.2	14.2	14.9
PR_OUTLET	OUTFALL	14.3	16.7	19.6	28.9	33.8
PR_PoudreRiv	STORAGE	14.3	16.8	19.7	29.0	33.8
PRR_B100	JUNCTION	8.7	11.8	15.2	27.5	35.3
PRR_B105	JUNCTION	2.6	3.5	4.5	8.1	10.3
PRR_J100	JUNCTION	9.3	10.3	11.2	14.1	15.8
PRR_J105	JUNCTION	1.1	1.7	2.5	5.5	7.2
PRR_OUTLET	OUTFALL	9.3	10.3	11.2	14.1	15.8
SD_B100	JUNCTION	1.5	3.2	10.4	59.5	90.2
SD_B105	JUNCTION	0.9	2.0	3.8	44.2	74.6
SD_B110	JUNCTION	0.7	1.6	4.3	30.4	47.0
SD_B115	JUNCTION	1.0	1.9	6.4	36.8	55.5
SD_B120	JUNCTION	5.9	10.8	18.8	104.7	159.3
SD_J100	JUNCTION	9.5	19.0	43.0	91.1	91.1
SD_J110	JUNCTION	7.2	13.9	28.9	54.3	54.3
SD_J200	JUNCTION	7.9	15.8	32.5	72.1	72.4
SD_J210	JUNCTION	6.5	12.4	24.7	42.7	42.7
SD_Outlet	OUTFALL	9.5	19.0	43.0	91.1	91.1
SKD_B100	JUNCTION	1.9	3.7	11.6	50.3	72.7
SKD_B105	JUNCTION	2.3	3.9	6.3	22.9	32.2
SKD_B106	JUNCTION	0.8	1.2	1.5	3.3	4.6
SKD_B110	JUNCTION	7.3	10.7	14.5	38.1	54.6
SKD_B115	JUNCTION	4.7	7.2	10.5	34.4	49.4
SKD_B120	JUNCTION	16.7	24.1	35.0	75.8	99.1
SKD_B125	JUNCTION	9.3	13.8	19.9	42.0	54.9
SKD_B126	JUNCTION	30.3	43.0	61.4	130.7	170.9
SKD_B130	JUNCTION	20.6	30.0	43.3	93.0	121.5
SKD_B135	JUNCTION	21.1	29.9	43.0	93.3	122.5
SKD_B136	JUNCTION	19.4	27.4	38.7	83.2	108.9
SKD_B137	JUNCTION	18.3	25.8	35.6	75.5	99.1
SKD_B140	JUNCTION	27.8	39.6	52.8	118.2	158.7
SKD_B141	JUNCTION	5.1	7.3	9.7	21.5	29.0
SKD_B145	JUNCTION	45.7	63.8	84.1	178.6	239.7
SKD_B150	JUNCTION	30.7	42.0	56.2	118.2	162.7
SKD_B155	JUNCTION	36.2	50.0	65.4	128.0	166.6
SKD_B160	JUNCTION	0.8	1.1	1.5	3.0	3.8
SKD_B165	JUNCTION	3.2	5.2	8.3	28.5	39.9
SKD_B170	JUNCTION	4.0	6.2	9.1	31.9	47.3
SKD_B175	JUNCTION	1.7	3.2	6.0	30.6	43.9
SKD_B180	JUNCTION	16.0	22.1	28.8	52.5	66.3
SKD_B185	JUNCTION	21.5	29.6	38.7	72.1	91.5
SKD_B190	JUNCTION	12.3	17.0	22.5	42.0	53.1
SKD_B195	JUNCTION	19.9	27.3	35.3	64.1	81.3
SKD_CDOT_stb3	STORAGE	3.9	6.2	9.7	24.7	25.6
SKD_D110	DIVIDER	188.4	209.9	226.8	303.8	334.5
SKD_D135	DIVIDER	127.1	141.5	156.8	232.0	263.0
SKD_D165	DIVIDER	3.1	5.1	8.2	21.8	21.8
SKD_D170	DIVIDER	5.4	9.2	14.9	60.2	87.5
SKD_D190	DIVIDER	6.8	6.8	6.8	6.8	6.8
SKD_D270	DIVIDER	0.0	0.0	0.0	0.0	0.0
SKD_D580	DIVIDER	6.7	6.8	6.8	6.8	6.8
SKD_J100	JUNCTION	171.3	192.4	211.5	284.2	313.0
SKD_J105	JUNCTION	170.6	190.6	208.7	281.4	310.0
SKD_J106	JUNCTION	168.5	186.9	202.2	273.4	301.7
SKD_J110	JUNCTION	170.6	189.4	204.7	274.7	302.3
SKD_J115	JUNCTION	2.6	4.8	7.2	9.4	9.5
SKD_J120	JUNCTION	189.7	211.5	228.6	306.0	337.6
SKD_J125	JUNCTION	37.1	42.4	44.5	48.2	48.8
SKD_J126	JUNCTION	28.6	29.5	30.6	34.7	35.0
SKD_J130	JUNCTION	13.6	13.8	13.9	13.9	13.9
SKD_J136	JUNCTION	22.7	26.6	32.5	76.1	101.9
SKD_J137	JUNCTION	10.3	10.4	10.4	10.4	10.5
SKD_J140	JUNCTION	74.0	77.0	86.2	118.5	124.3
SKD_J141	JUNCTION	3.0	4.3	4.7	4.8	4.8
SKD_J145	JUNCTION	53.7	56.5	66.0	98.2	104.0
SKD_J150	JUNCTION	30.1	32.8	42.4	75.2	81.3
SKD_J155	JUNCTION	12.3	12.4	12.4	12.4	12.4
SKD_J160	JUNCTION	3.1	5.1	8.2	21.7	21.8
SKD_J175	JUNCTION	1.5	3.1	5.9	28.7	50.9
SKD_J180	JUNCTION	6.6	6.6	6.6	6.6	6.7
SKD_J220	JUNCTION	174.3	193.3	210.8	288.8	319.2
SKD_J226	JUNCTION	1.0	1.9	3.1	7.4	7.9
SKD_J235	JUNCTION	107.7	116.0	131.4	206.9	238.2
SKD_J250	JUNCTION	11.2	14.1	23.4	56.8	62.9
SKD_J265	JUNCTION	0.0	0.0	0.0	0.0	0.0
SKD_J275	JUNCTION	0.0	0.0	0.0	8.7	30.6
SKD_J280	JUNCTION	6.7	6.7	6.8	6.8	6.8
SKD_J290	JUNCTION	6.8	6.8	6.8	6.8	6.8
SKD_J320	JUNCTION	138.1	152.2	167.6	241.8	272.5

Future Node Total Inflow (Ac-ft)

Node	Node Type	2-yr	5-yr	10-yr	50-yr	100-yr
SKD_J335	JUNCTION	105.6	112.6	127.7	203.2	234.8
SKD_J336	JUNCTION	5.4	9.1	14.9	59.5	86.5
SKD_J380	JUNCTION	6.7	6.8	6.8	6.8	6.8
SKD_J420	JUNCTION	127.1	141.5	156.8	232.0	263.0
SKD_J436	JUNCTION	5.4	9.2	14.9	59.8	86.9
SKD_J536	JUNCTION	5.4	9.2	14.9	59.8	86.9
SKD_J636	JUNCTION	5.4	9.2	14.9	60.2	87.5
SKD_OUTLET	OUTFALL	172.2	194.9	221.9	297.4	325.3
SKD_Promont	STORAGE	44.2	58.3	74.0	131.0	164.2
SKD_S180	DIVIDER	11.2	14.1	23.4	65.7	93.6
WC_B100	JUNCTION	0.7	1.0	1.7	4.2	5.7
WC_B101	JUNCTION	3.4	4.6	6.0	11.1	14.3
WC_B102	JUNCTION	3.0	4.2	5.6	10.7	13.6
WC_B103	JUNCTION	1.8	2.5	3.3	6.4	8.1
WC_B105	JUNCTION	5.0	7.0	9.2	17.7	22.6
WC_B105.1	JUNCTION	1.0	1.3	1.8	3.4	4.4
WC_B105.2	JUNCTION	1.0	1.4	1.9	3.6	4.5
WC_B106	JUNCTION	6.9	9.5	12.7	24.2	31.0
WC_B107	JUNCTION	3.2	4.5	6.1	12.9	17.0
WC_B108	JUNCTION	1.1	1.5	2.0	3.7	4.8
WC_B109	JUNCTION	1.3	1.8	2.3	4.4	5.6
WC_B110	JUNCTION	7.8	10.7	14.0	26.7	34.4
WC_B111	JUNCTION	3.3	4.7	6.3	11.8	14.9
WC_B112	JUNCTION	1.1	1.5	2.0	3.7	4.7
WC_B112.5	JUNCTION	1.5	2.1	2.7	4.9	6.3
WC_B113	JUNCTION	14.1	19.2	25.0	45.1	57.4
WC_B114	JUNCTION	12.9	17.5	22.7	40.5	51.9
WC_B115	JUNCTION	5.1	7.2	9.5	20.6	27.9
WC_B120	JUNCTION	95.8	130.7	170.0	313.0	399.0
WC_B130	JUNCTION	6.3	9.0	11.9	26.4	35.3
WC_B135	JUNCTION	35.3	49.4	65.4	143.0	193.7
WC_B140	JUNCTION	81.6	112.9	149.5	281.1	356.0
WC_B145	JUNCTION	1.5	2.0	2.7	4.8	6.0
WC_B146	JUNCTION	8.9	12.6	17.2	36.8	48.8
WC_B150	JUNCTION	56.5	78.3	105.0	196.1	247.7
WC_B155	JUNCTION	3.1	4.2	5.5	9.6	11.8
WC_B160	JUNCTION	21.4	29.2	37.7	64.8	79.8
WC_B165	JUNCTION	3.0	4.2	5.4	9.5	11.8
WC_B170	JUNCTION	1.8	2.4	3.3	6.1	7.7
WC_B171	JUNCTION	1.2	1.7	2.2	4.3	5.4
WC_B172	JUNCTION	1.9	2.7	3.6	6.8	8.7
WC_B173	JUNCTION	1.9	2.6	3.5	6.7	8.4
WC_CDOT_stl	STORAGE	22.7	26.2	29.6	40.2	45.7
WC_D101	DIVIDER	0.0	0.0	0.0	0.0	0.0
WC_D103	DIVIDER	1.0	1.0	1.0	1.0	1.0
WC_D105	DIVIDER	2.9	3.3	3.8	5.5	6.5
WC_D105.1	DIVIDER	0.8	1.0	1.0	1.0	1.0
WC_D105.2	DIVIDER	1.0	1.4	1.9	3.6	4.5
WC_D106	DIVIDER	132.9	134.7	136.3	139.0	140.3
WC_D109	DIVIDER	2.1	2.5	3.0	4.7	5.8
WC_D110	DIVIDER	10.3	11.7	12.3	12.3	12.3
WC_D111	DIVIDER	3.0	4.2	4.8	4.8	4.8
WC_D112	DIVIDER	5.6	5.7	5.7	5.7	5.7
WC_D112.5	DIVIDER	0.9	0.9	1.0	1.0	1.0
WC_D113	DIVIDER	3.8	3.9	3.9	3.9	3.9
WC_D150	DIVIDER	32.5	32.8	32.8	32.8	32.8
WC_D155	DIVIDER	3.1	4.2	5.5	9.6	11.8
WC_D160	DIVIDER	18.2	19.9	21.5	25.7	28.0
WC_D172	DIVIDER	1.1	1.6	1.9	1.9	1.9
WC_D205	DIVIDER	132.6	134.4	135.6	138.4	139.9
WC_D210	DIVIDER	7.4	8.8	9.4	9.4	9.5
WC_D272	DIVIDER	0.3	0.5	0.8	0.9	0.9
WC_D310	DIVIDER	4.5	4.6	4.6	4.7	4.7
WC_D806	DIVIDER	130.4	132.0	133.2	136.3	137.5
WC_J100	JUNCTION	137.8	140.6	142.7	145.5	147.0
WC_J101	JUNCTION	1.0	1.0	1.0	1.0	1.0
WC_J102	JUNCTION	2.8	2.8	2.8	2.8	2.8
WC_J105	JUNCTION	1.0	1.4	1.9	3.6	4.5
WC_J106	JUNCTION	130.7	132.6	133.8	136.6	138.1
WC_J107	JUNCTION	12.4	14.1	15.2	17.0	18.1
WC_J108	JUNCTION	12.4	14.2	15.3	17.0	18.1
WC_J109	JUNCTION	2.1	2.5	3.0	4.7	5.8
WC_J112	JUNCTION	4.8	4.8	4.8	4.8	4.8
WC_J112.5	JUNCTION	4.8	4.8	4.8	4.8	4.8
WC_J113.5	JUNCTION	3.8	3.9	3.9	3.9	3.9
WC_J114	JUNCTION	4.5	4.6	4.7	4.7	4.7
WC_J115	JUNCTION	2.6	2.8	2.8	2.8	2.9
WC_J120	JUNCTION	130.4	132.0	133.2	136.3	137.5
WC_J130	JUNCTION	2.8	2.8	2.8	2.8	2.8
WC_J135	JUNCTION	1.7	2.3	2.9	2.9	2.9
WC_J140	JUNCTION	83.5	85.0	86.2	89.0	90.5
WC_J145	JUNCTION	3.1	4.2	5.5	9.6	11.8
WC_J146	JUNCTION	8.3	8.6	8.7	8.7	8.7
WC_J165	JUNCTION	4.8	6.5	8.0	12.2	14.5
WC_J170	JUNCTION	2.4	3.1	3.7	3.8	3.8
WC_J171	JUNCTION	2.4	3.1	3.7	3.8	3.8
WC_J172	JUNCTION	2.1	2.6	2.9	2.9	2.9
WC_J173	JUNCTION	3.7	3.7	3.7	3.7	3.7
WC_J200	JUNCTION	132.3	134.1	135.3	138.4	139.6
WC_J201	JUNCTION	134.1	136.6	138.4	141.5	142.7
WC_J202	JUNCTION	0.9	1.0	1.0	1.0	1.0
WC_J205	JUNCTION	132.6	134.4	136.0	138.7	139.9
WC_J206	JUNCTION	130.7	132.6	133.8	136.9	138.1
WC_J207	JUNCTION	18.0	19.9	20.9	22.7	23.8
WC_J212.5	JUNCTION	3.8	3.8	3.9	3.9	3.9
WC_J220	JUNCTION	98.5	100.4	101.6	104.3	105.6
WC_J235	STORAGE	13.9	14.0	14.0	14.0	14.0
WC_J240	JUNCTION	9.1	10.4	11.4	14.4	15.7
WC_J245	JUNCTION	18.2	19.9	21.5	25.6	27.9
WC_J272	JUNCTION	1.0	1.0	1.0	1.0	1.0
WC_J273	JUNCTION	2.8	2.8	2.8	2.8	2.8
WC_J305	JUNCTION	2.9	3.3	3.8	5.5	6.5
WC_J306	JUNCTION	0.0	0.0	0.0	0.0	0.0
WC_J307	JUNCTION	5.6	5.7	5.7	5.7	5.7
WC_J312.5	JUNCTION	3.8	3.8	3.9	3.9	3.9
WC_J320	JUNCTION	91.1	92.7	93.9	96.7	97.9
WC_J340	JUNCTION	32.5	32.8	32.8	32.8	32.8
WC_J405	JUNCTION	1.0	1.4	1.9	3.6	4.5
WC_J420	JUNCTION	9.0	9.0	9.1	9.1	9.1
WC_J505	JUNCTION	1.0	1.4	1.9	3.6	4.5
WC_J506	JUNCTION	0.8	1.0	1.0	1.0	1.0
WC_J706	JUNCTION	130.1	132.0	133.2	136.3	137.5
WC_OUTLET	OUTFALL	137.8	140.6	142.7	145.5	147.0
WC_OUTLET2	OUTFALL	2.9	3.3	3.8	5.5	6.5
WC_OUTLET3	OUTFALL	20.5	23.3	24.4	26.1	27.2
1.0	OUTFALL	0.0	0.0	0.0	0.0	0.0
2.0	OUTFALL	0.0	0.0	0.0	0.0	0.0

Detention Rating Curves

Promontory Pond			
Stage (ft)	Surface Area (ft^2)	Storage (Ac-ft)	Discharge (cfs)
4905.6	--	--	--
4906	41,312	0.1	0.1
4907	103,496	1.7	0.7
4908	169,486	4.8	1.6
4909	200,585	9.1	9.9
4910	218,867	13.9	26.9
4911	218,867	18.9	31.6
4911.9*	218,867	23.4	34.7
4912	218,867	23.9	37.0
4913	218,867	29.0	341.4
*Overtopping Elevation			

Orr Pond - CDOT			
Stage (ft)	Surface Area (ft^2)	Storage (Ac-ft)	Discharge (cfs)
4864.5	--	--	--
4865	363	0.0	0.1
4866	14,217	0.1	0.3
4867	24,137	0.6	1.1
4868	33,250	1.2	1.6
4869	37,086	2.0	14.1
4870	37,086	2.9	37.0
4870.8*	37,086	3.6	45.5
4871	37,086	3.7	67.5
4872	37,086	4.6	351.7
*Overtopping Elevation			

83rd Ave Pond - CDOT			
Stage (ft)	Surface Area (ft^2)	Storage (Ac-ft)	Discharge (cfs)
4817.6	--	--	--
4818	6,636	0.5	0.1
4819	36,183	1.4	0.6
4820	43,152	2.4	1.2
4821	48,271	3.5	1.6
4822	48,271	4.6	1.9
4822.1*	48,271	4.8	1.9
4823	48,271	5.7	66.2
4824	48,271	5.8	226.7
*Overtopping Elevation			

Northridge Pond			
Stage (ft)	Surface Area (ft^2)	Storage (Ac-ft)	Discharge (cfs)
4774.72	--	--	--
4776	7,219	0.1	1.0
4777	15,488	0.3	4.6
4778	22,752	0.8	13.6
4778.9*	22,752	1.2	15.8
4779	22,752	1.3	18.2
4780	22,752	1.8	126.4
*Overtopping Elevation			

C Street Pond			
Stage (ft)	Surface Area (ft^2)	Storage (Ac-ft)	Discharge (cfs)
4752.4	0	--	--
4754	3,374	0.0	2.4
4755	17,578	0.3	4.3
4756	31,809	0.8	7.8
4757	46,022	1.7	8.9
4758	56,484	2.9	9.8
4759	56,484	4.2	10.7
4759.8*	56,484	5.2	11.3
4760	56,484	5.5	17.9
4761	56,484	6.8	119.0
4762	56,484	8.1	336.8
*Overtopping Elevation			

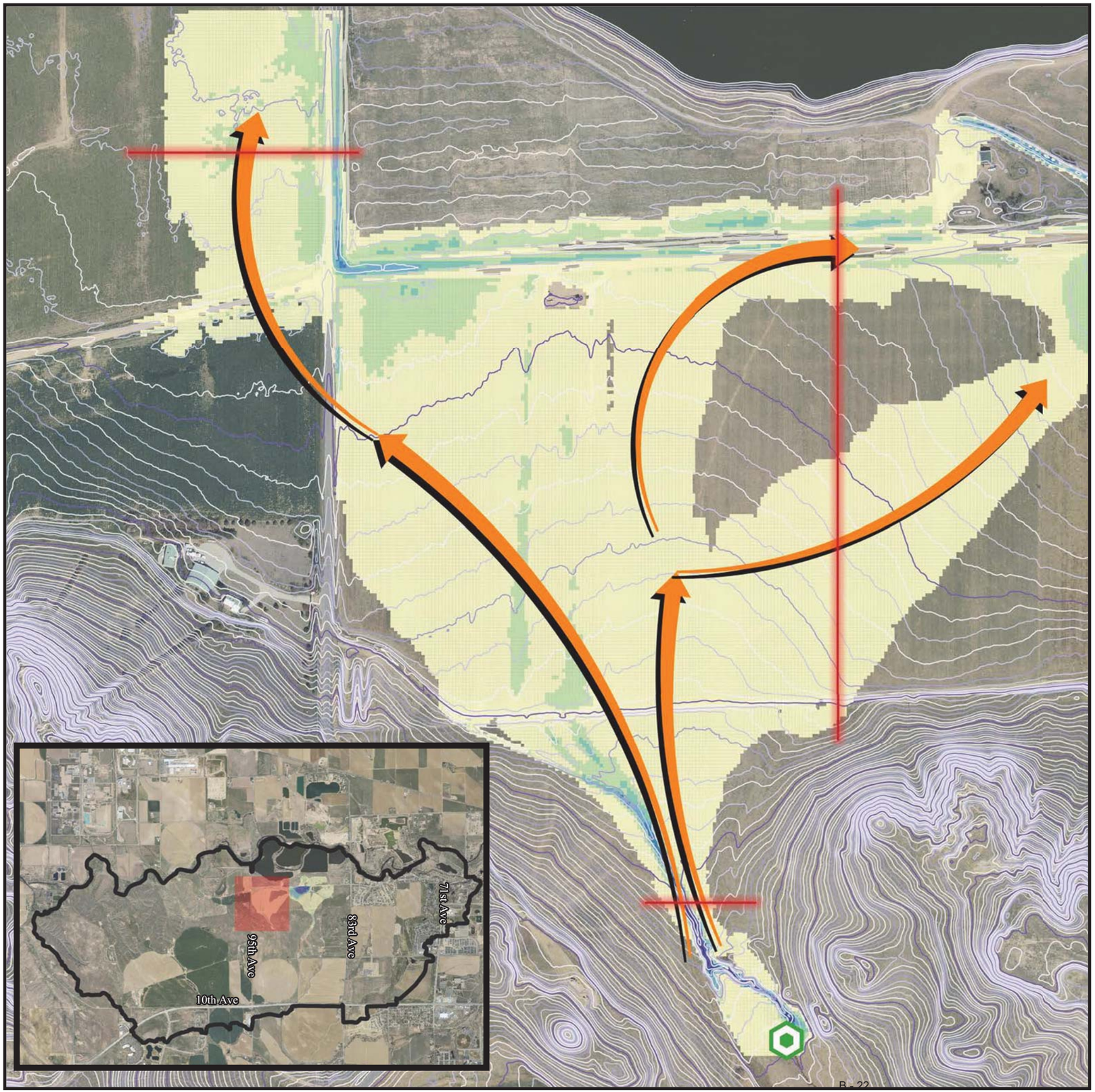
Melbourne St Pond - 1			
Stage (ft)	Surface Area (ft^2)	Storage (Ac-ft)	Discharge (cfs)
4756.9	0	--	--
4758	419	0.0	0.3
4759	2,189	0.1	1.0
4760	4,059	0.2	1.4
4761	6,047	0.4	1.7
4761.4*	6,047	0.4	2.0
4762	6,047	0.5	10.0
4763	6,047	0.6	70.7
4764	6,047	0.6	390.0
*Overtopping Elevation			

Melbourne St Pond - 2			
Stage (ft)	Surface Area (ft^2)	Storage (Ac-ft)	Discharge (cfs)
4750.2	0	--	--
4751	700	0.0	0.7
4752	1,488	0.1	1.2
4753	2,158	0.1	1.5
4754	2,816	0.2	1.8
4755	3,573	0.3	3.2
4756	3,573	0.4	4.3
4757	3,573	0.4	5.1
4757.6*	3,573	0.5	5.5
4758	3,573	0.5	16.9
4759	3,573	0.5	588.9
*Overtopping Elevation			

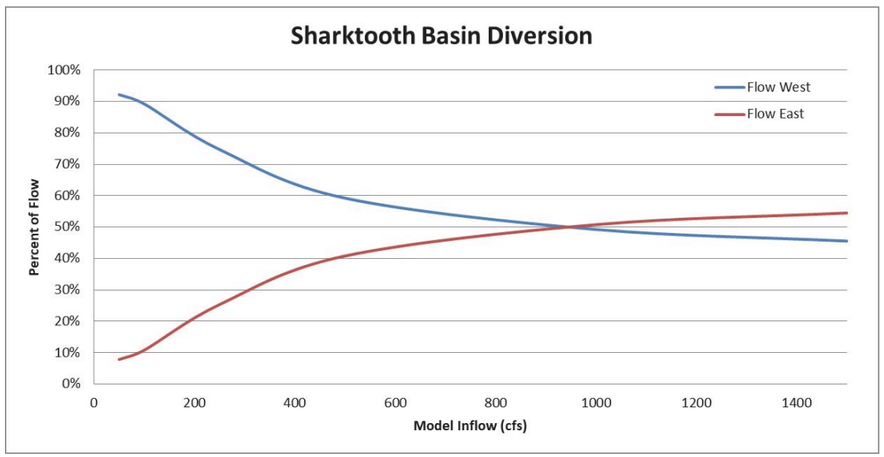
Poudre River Ranch			
Stage (ft)	Surface Area (ft^2)	Storage (Ac-ft)	Discharge (cfs)
4700	0	--	--
4701	625	0.00	1.5
4702	625	0.02	27.4
4702.2*	625	0.02	51.1
4703	625	0.03	205.4
*Overtopping Elevation			

Sharktooth Bluffs
Storm Drainage Master Plan

FLO-2D Diversion Curve
SWMM Element: SKD_D110

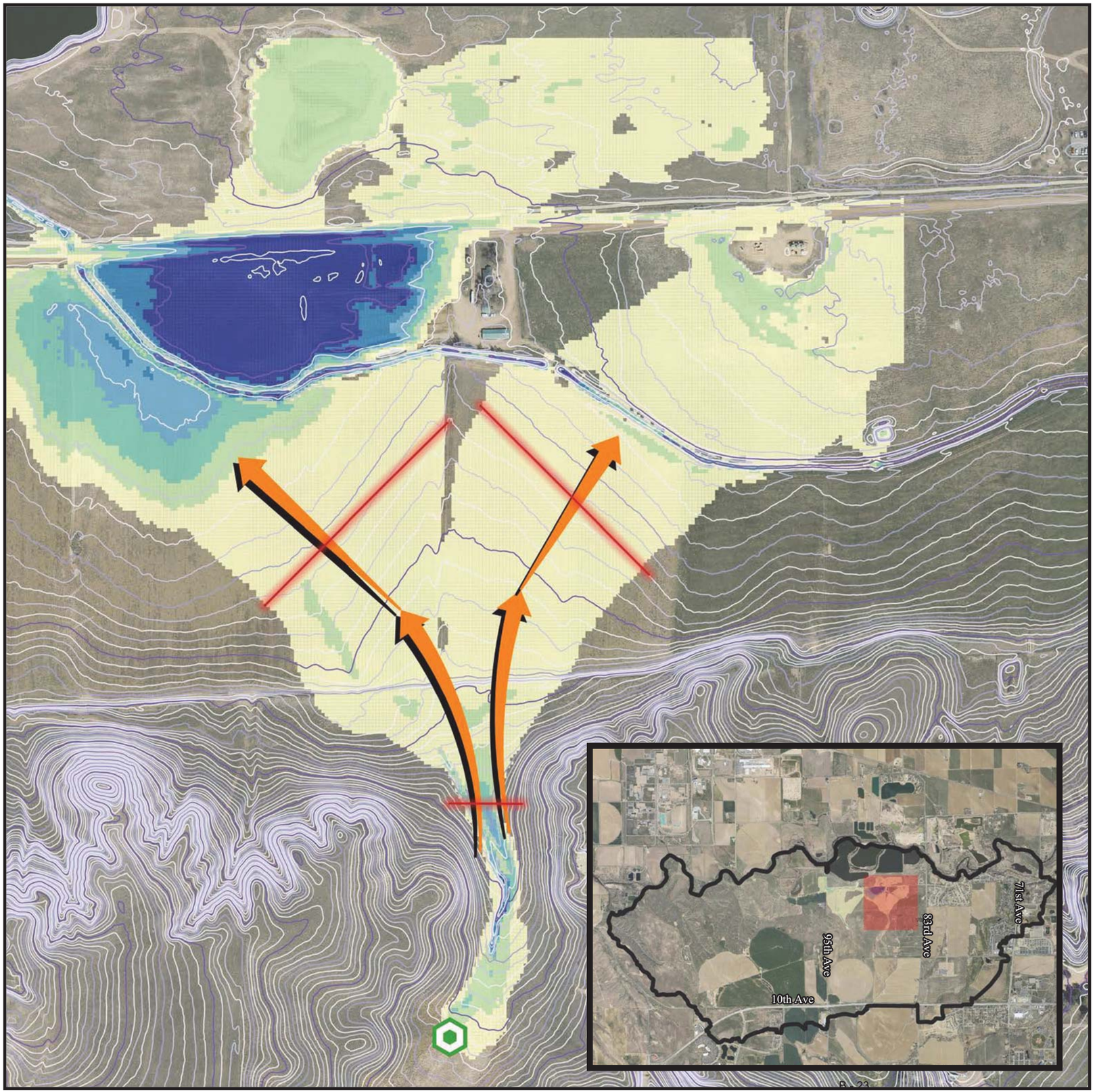


Sharktooth Diversion				
	Diversion to the West		Diversion to the East	
Model Inflow	Percent (%)	Discharge (cfs)	Percent (%)	Discharge (cfs)
50	92%	46.1	8%	3.9
100	89%	89.2	11%	10.8
250	75%	186.7	25%	63.3
500	59%	296.0	41%	204.0
1000	49%	492.3	51%	507.7
1500	46%	682.9	54%	817.1

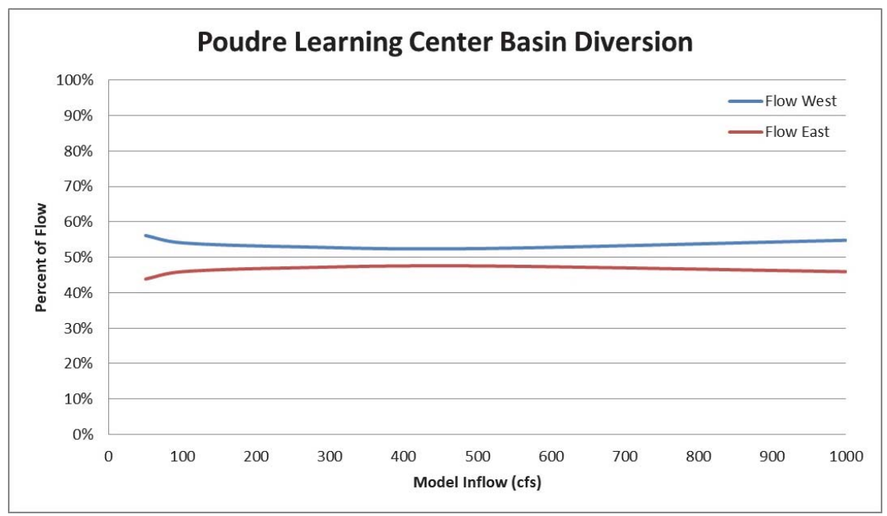


Sharktooth Bluffs
Storm Drainage Master Plan

FLO-2D Diversion Curve
SWMM Element: PLC_D115



Poudre Learning Center				
	Diversion to the West		Diversion to the East	
Model Inflow	Percent (%)	Discharge (cfs)	Percent (%)	Discharge (cfs)
50	56%	28.1	44%	21.9
100	54%	54.1	46%	45.9
250	53%	132.5	47%	117.5
500	52%	262.3	48%	237.7
1000	55%	548.0	46%	452.0



APPENDIX C - ALTERNATIVE ANALYSIS

UD MP-Cost Unit Costs

Item	Unit	Unit Cost 2012 Q1	Adjusted Unit Cost 2018 Q3
Circular Pipes			
12-inch	L.F.	$36.00	$48.00
18-inch	L.F.	$54.00	$72.00
24-inch	L.F.	$72.00	$96.00
30-inch	L.F.	$90.00	$121.00
36-inch	L.F.	$108.00	$145.00
42-inch	L.F.	$126.00	$169.00
48-inch	L.F.	$144.00	$193.00
54-inch	L.F.	$216.00	$289.00
60-inch	L.F.	$240.00	$322.00
66-inch	L.F.	$264.00	$354.00
72-inch	L.F.	$360.00	$482.00
78-inch	L.F.	$390.00	$523.00
84-inch	L.F.	$420.00	$563.00
90-inch	L.F.	$450.00	$603.00
96-inch	L.F.	$480.00	$643.00
102-inch	L.F.	$714.00	$957.00
108-inch	L.F.	$756.00	$1,013.00
120-inch	L.F.	$840.00	$1,126.00
Flared End Sections			
12-inch	EA	$710.00	$951.00
18-inch	EA	$920.00	$1,233.00
24-inch	EA	$970.00	$1,300.00
30-inch	EA	$1,570.00	$2,104.00
36-inch	EA	$1,610.00	$2,157.00
42-inch	EA	$1,700.00	$2,278.00
48-inch	EA	$2,060.00	$2,760.00
Manholes and Inlets			
Manhole, 4' Dia. (Pipe Dia. < 36"), Depth > 15-feet)	EA	$2,900.00	$3,886.00
Manhole, 5' Dia. (Pipe Dia. 36" - 42"), Depth > 15-feet)	EA	$3,900.00	$5,226.00
Manhole, 6' Dia. (Pipe Dia. , Depth > 15-feet)	EA	$4,300.00	$5,762.00
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)	EA	$12,000.00	$16,080.00
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)	EA	$15,000.00	$20,100.00
Storm Inlet, Type R/Type 14, 5-foot, 10-foot deep avg.	EA	$4,600.00	$6,164.00

Item	Unit	Unit Cost 2012 Q1	Adjusted Unit Cost 2018 Q3
Hydraulic Structures			
Grouted Boulders, 36-inch	C.Y.	$190.00	$255.00
Soil Riprap, Type M	C.Y.	$70.00	$94.00
Excavation, Complete-in-Place	C.Y.	$11.00	$15.00
Bedding, Granular Type II	C.Y.	$58.00	$78.00
Grout	C.Y.	$240.00	$322.00
Check Structure, Concrete	L.F.	$270.00	$362.00
Channel Improvements			
Boulder Edging, 12" High	L.F.	$60.00	$80.00
Boulder Edging, 24" High	L.F.	$75.00	$101.00
Boulder Edging, 36" High	L.F.	$90.00	$121.00
Concrete Low Flow Channel	L.F.	$40.00	$54.00
Grouted Boulders, 12"	S.Y.	$130.00	$174.00
Grouted Boulders, 18"	S.Y.	$150.00	$201.00
Grouted Boulders, 24"	S.Y.	$170.00	$228.00
Grouted Boulders, 36"	S.Y.	$190.00	$255.00
Grouted Boulders, 48"	S.Y.	$200.00	$268.00
6-inch Riprap, Type VL	C.Y.	$45.00	$60.00
9-inch Riprap, Type L	C.Y.	$55.00	$74.00
12-inch Riprap, Type M	C.Y.	$60.00	$80.00
18-inch Riprap, Type H	C.Y.	$80.00	$107.00
24-inch Riprap, Type VH	C.Y.	$85.00	$114.00
Soil Riprap, Type VL	C.Y.	$50.00	$67.00
Soil Riprap, Type L	C.Y.	$60.00	$80.00
Soil Riprap, Type M	C.Y.	$70.00	$94.00
Soil Riprap, Type H	C.Y.	$80.00	$107.00
Soil Riprap, Type VH	C.Y.	$90.00	$121.00
Excavation, Low Range	C.Y.	$11.00	$15.00
Excavation, Mid Range	C.Y.	$24.00	$32.00
Excavation, High Range	C.Y.	$31.00	$42.00
Concrete and Steel			
Concrete	C.Y.	$600.00	$771.00
Steel	LB.	$0.90	$1.00

Item	Unit	Unit Cost 2012 Q1	Adjusted Unit Cost 2018 Q3
Landscaping and Recreation Improvements			
Wetlands Plantings	ACRE	$25,000.00	$33,500.00
Reclamation & seeding (native grasses)	ACRE	$1,000.00	$1,340.00
Trail/Path, Concrete (10' Width)	L.F.	$44.00	$59.00
Trail/Path, Crusher Fines (10' Width)	L.F.	$11.00	$15.00
Operation and Maintenance			
Culvert Maintenance	L.F.	$1.00	$1.00
Manhole and Inlet Maintenance	EA	$50.00	$67.00
Hydraulic Structure Maintenance	EA	$500.00	$670.00
Channel Maintenance	L.F.	$2.00	$3.00
Detention/WQ Maintenance	ACRE	$1,500.00	$2,010.00
Mowing	ACRE	$50.00	$67.00
Trail Maintenance	L.F.	$5.00	$7.00
Removals			
Removal of culvert pipe (D<48")	L.F.	$20.00	$27.00
Removal of culvert pipe (48"<D<84")	L.F.	$50.00	$67.00
Removal of culvert pipe (D>84")	L.F.	$75.00	$101.00
Concrete Box Culvert	L.F./CELL	$100.00	$134.00
Land Acquisition			
Temporary Easements	EA	User Defined	User Defined
Easement/ROW Acquisition	ACRE	User Defined	User Defined
Detention/Water Quality Facilities			
Excavation, Low Range	C.Y.	$11.00	$15.00
Excavation, Mid Range	C.Y.	$24.00	$32.00
Excavation, High Range	C.Y.	$31.00	$42.00
Outlet Works	EA	User Defined	User Defined
Water Quality Appurtenances	EA	User Defined	User Defined
Detention (Complete-in-Place)	AC-FT	$45,600.00	$61,104.00
Headwalls for Circular Pipes			
See Headwall Table			See Headwall Table
Wingwalls for Circular Pipes			
See Wingwall Table			See Wingwall Table
Box Culverts			
See Box Culvert Table			See Box Culvert Table

UD-MP Cost Unit Costs

Box Culvert (CDOT M-601-1)

Span (feet)	Cost $/LF								
	Rise (feet)								
	2	3	4	5	6	7	8	9	10
4	$475.29	$485.47	$547.45	$661.03	$722.88	$784.73	$847.58	$908.62	$970.47
5	$537.14	$598.99	$661.03	$722.88	$784.73	$847.58	$898.49	$989.79	$1,081.50
6	$598.99	$661.03	$722.88	$784.73	$804.13	$823.54	$949.41	$1,070.97	$1,192.52
7	$661.03	$722.88	$784.73	$847.58	$884.49	$921.40	$1,019.26	$1,136.36	$1,253.47
8	$722.88	$784.73	$847.58	$898.49	$949.41	$1,019.26	$1,089.10	$1,159.08	$1,229.06
9	ERROR	$847.58	$908.62	$989.79	$1,070.97	$1,136.36	$1,201.76	$1,266.09	$1,330.42
10	ERROR	$908.62	$970.47	$1,081.50	$1,192.52	$1,253.47	$1,314.42	$1,373.10	$1,431.78
11	ERROR	$970.47	$1,033.32	$1,160.83	$1,288.34	$1,354.79	$1,421.24	$1,486.19	$1,551.15
12	ERROR	ERROR	$1,095.16	$1,239.66	$1,384.16	$1,456.11	$1,528.06	$1,599.29	$1,670.52
13	ERROR	ERROR	ERROR	ERROR	$1,539.54	$1,606.23	$1,672.93	$1,745.54	$1,818.16
14	ERROR	ERROR	ERROR	ERROR	$1,694.91	$1,756.36	$1,817.80	$1,891.80	$1,965.80
15	ERROR	ERROR	ERROR	ERROR	$1,905.87	$1,977.88	$2,049.88	$2,127.74	$2,205.60
16	ERROR	ERROR	ERROR	ERROR	$2,116.83	$2,199.39	$2,281.96	$2,363.68	$2,445.40
17	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	$2,453.80	$2,537.84	$2,621.88
18	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	$2,625.65	$2,712.00	$2,798.35
19	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	$2,951.87	$3,028.58	$3,105.29
20	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	$3,278.09	$3,345.16	$3,412.24

Headwall/Toewall (CDOT M-601-2)

Span (feet)	Steel (lbs/lf)
4	18.9
6	22.1
8	22.5
10	28.2
12	27.6
14	34
16	32.3
18	39
20	38.6

Notes: Concrete quantity estimated as 0.085 CY/LF per standard detail.
Weight of steel for span of 4 feet was linearly extrapolated.

Minimum Criteria Alternatives

C-4: Northridge Draw – 71st Avenue Crossing

C-4: Northridge Draw – C Street

C-5: Poudre Learning Center – 83rd Avenue

C-5: Poudre Learning Center – County Road 62 Central

C-6: Poudre Learning Center – County Road 62 Eastern

C-6: Poudre Learning Center – County Road 62 Western

C-7: Sharktooth Draw – 4th Street Central

C-7: Sharktooth Draw – 4th Street Eastern

C-8: Sharktooth Draw – 4th Street Western

C-8: Sharktooth Draw – 95th Avenue

C-9: Sharktooth Draw – County Road 62

C-9: Wiedeman Creek – 4th Street

C-10: Wiedeman Creek – 78th Avenue

C-10: Wiedeman Creek – 81st Avenue

C-11: Wiedeman Creek – Skyview Street

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	ND
REACH :	1
JURISDICTION :	City of Greeley
REACH ID:	71stAveCrossing-Reach1

Enter Estimator Name on Project Info | DATE : 12/19/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
7	3	1	65	L.F.	$722.88	$46,987.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
7	1	9.00	2	EA	$813.96	$1,628.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
7	3	1	2	EA	$6,827.66	$13,655.30	
Channel Improvements							
Excavation, Mid Range			250	C.Y.	$32.00	$8,000.00	Trench Excavation
12-inch Riprap, Type M			10	C.Y.	$80.00	$800.00	
Removals							
Removal of culvert pipe (D<48")			50	L.F.	$27.00	$1,350.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		24	TON	$150.00	$3,600.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$62,270.00
Hydraulic Structures				$0.00
Channel Improvements				$8,800.00
Detention/Water Quality Facilities				$0.00
Removals				$1,350.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$3,600.00
Subtotal Capital Improvement Costs				**$76,020.00**
Additional Capital Improvement Costs				
Dewatering	$760.20	L.S.		$760.00
Mobilization	5%			$3,801.00
Traffic Control	$3,801.00	L.S.		$3,801.00
Utility Coordination/Relocation	$3,801.00	L.S.		$3,801.00
Stormwater Management/Erosion Control	5%			$3,801.00
Subtotal Additional Capital Improvement Costs				**$15,964.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$13,798.00
Legal/Administrative	5%			$4,599.00
Contract Admin/Construction Management	10%			$9,198.00
Contingency	25%			$22,996.00
Subtotal Other Costs				**$50,591.00**
Total Capital Improvement Costs				**$142,575.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	65	L.F.	$1.00	$65.00
Total Annual Operation and Maintenance Cost				**$65.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$2,043.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	ND
REACH :	1
JURISDICTION :	City of Greeley
REACH ID:	Cstreet

JKD | DATE : 12/19/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		1720	C.Y.	$32.00	$55,040.00	Channel Excavation
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		3	AC-FT	$61,104.00	$183,312.00	Reconfigure existing retention
Landscaping and Maintenance Improvements						
Wetlands Plantings		2	ACRE	$33,500.00	$67,000.00	
Reclamation & seeding (native grasses)		1	ACRE	$1,340.00	$1,340.00	
Land Acquisition						
Easement/ROW Acquisition		5.00	ACRE	$43,337.77	$216,689.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$55,040.00
Detention/Water Quality Facilities				$183,312.00
Removals				$0.00
Landscaping and Maintenance Improvements				$68,340.00
Special Items (User Defined)				$0.00
Subtotal Capital Improvement Costs				**$306,692.00**
Additional Capital Improvement Costs				
Dewatering	$3,066.92	L.S.		$3,067.00
Mobilization	5%			$15,335.00
Traffic Control	$15,334.60	L.S.		$15,335.00
Utility Coordination/Relocation	$15,334.60	L.S.		$15,335.00
Stormwater Management/Erosion Control	5%			$15,335.00
Subtotal Additional Capital Improvement Costs				**$64,407.00**
Land Acquisition Costs				
ROW/Easements				$216,689.00
Subtotal Land Acquisition Costs				**$216,689.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$55,665.00
Legal/Administrative	5%			$18,555.00
Contract Admin/Construction Management	10%			$37,110.00
Contingency	25%			$92,775.00
Subtotal Other Costs				**$204,105.00**
Total Capital Improvement Costs				**$791,893.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	1600	L.F.	$3.00	$4,800.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, s	1	ACRE	$2,010.00	$2,010.00
Total Annual Operation and Maintenance Cost				**$6,810.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$213,995.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	PLC
REACH :	2
JURISDICTION :	City of Greeley
REACH ID:	83rd Ave JKD
DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
13	6	2	80	L.F.	$3,079.08	$246,326.00	
Channel Improvements							
Excavation, Mid Range			1043	C.Y.	$32.00	$33,376.00	
12-inch Riprap, Type M			33	C.Y.	$80.00	$2,607.00	
Removals							
Removal of culvert pipe (D<48")			70	L.F.	$27.00	$1,890.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		58	TON	$250.00	$14,500.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$246,326.00
Hydraulic Structures				$0.00
Channel Improvements				$35,983.00
Detention/Water Quality Facilities				$0.00
Removals				$1,890.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$14,500.00
Subtotal Capital Improvement Costs				**$300,039.00**
Additional Capital Improvement Costs				
Dewatering	$3,000.39	L.S.		$3,000.00
Mobilization	5%			$15,002.00
Traffic Control	$15,001.95	L.S.		$15,002.00
Utility Coordination/Relocation	$15,001.95	L.S.		$15,002.00
Stormwater Management/Erosion Control	5%			$15,002.00
Subtotal Additional Capital Improvement Costs				**$63,008.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$54,457.00
Legal/Administrative	5%			$18,152.00
Contract Admin/Construction Management	10%			$36,305.00
Contingency	25%			$90,762.00
Subtotal Other Costs				**$199,676.00**
Total Capital Improvement Costs				**$562,723.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	80	L.F.	$1.00	$160.00
Total Annual Operation and Maintenance Cost				**$160.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$5,028.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	PLC
REACH :	3
JURISDICTION :	City of Greeley
REACH ID:	CR 62 Central Crossing JKD
DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
36-inch	50	1	50	L.F.	$145.00	$7,250.00	
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
36-inch	Yes	1	2	EA	$2,157.00	$4,314.00	
Channel Improvements							
Excavation, Mid Range			133	C.Y.	$32.00	$4,256.00	
12-inch Riprap, Type M			7	C.Y.	$80.00	$560.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		16	TON	$250.00	$4,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$11,564.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$4,816.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$4,000.00
Subtotal Capital Improvement Costs				**$21,720.00**
Additional Capital Improvement Costs				
Dewatering	$217.20	L.S.		$217.00
Mobilization	5%			$1,086.00
Traffic Control	$1,086.00	L.S.		$1,086.00
Utility Coordination/Relocation	$1,086.00	L.S.		$1,086.00
Stormwater Management/Erosion Control	5%			$1,086.00
Subtotal Additional Capital Improvement Costs				**$4,561.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$3,942.00
Legal/Administrative	5%			$1,314.00
Contract Admin/Construction Management	10%			$2,628.00
Contingency	25%			$6,570.00
Subtotal Other Costs				**$14,454.00**
Total Capital Improvement Costs				**$40,735.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	50	L.F.	$1.00	$50.00
Total Annual Operation and Maintenance Cost				**$50.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$1,571.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	PLC
REACH :	3
JURISDICTION :	City of Greeley
REACH ID:	CR 62 East Crossing JKD
DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
12	4	1	100	L.F.	$1,095.16	$109,516.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
12	1	14.00	2	EA	$1,343.16	$2,686.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
12	4	1	2	EA	$9,735.48	$19,471.00	
Channel Improvements							
Excavation, Mid Range			600	C.Y.	$32.00	$19,200.00	Culvert
12-inch Riprap, Type M			16	C.Y.	$80.00	$1,303.00	Culvert
Excavation, Mid Range			2300	C.Y.	$32.00	$73,600.00	675 ft channel downstream of CR 62 to PLC
12-inch Riprap, Type M			16	C.Y.	$80.00	$1,280.00	Downstream confluence
Removals							
Removal of culvert pipe (D<48")			50	L.F.	$27.00	$1,350.00	
Landscaping and Maintenance Improvements							
Wetlands Plantings			2	ACRE	$33,500.00	$71,522.00	
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Trail/Path, Concrete (10' Width)			50	L.F.	$59.00	$2,950.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		33	TON	$250.00	$8,250.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$131,673.00
Hydraulic Structures				$0.00
Channel Improvements				$95,383.00
Detention/Water Quality Facilities				$0.00
Removals				$1,350.00
Landscaping and Maintenance Improvements				$75,812.00
Special Items (User Defined)				$8,250.00
Subtotal Capital Improvement Costs				**$312,468.00**
Additional Capital Improvement Costs				
Dewatering	$3,124.68	L.S.		$3,125.00
Mobilization	5%			$15,623.00
Traffic Control	$15,623.40	L.S.		$15,623.00
Utility Coordination/Relocation	$15,623.40	L.S.		$15,623.00
Stormwater Management/Erosion Control	5%			$15,623.00
Subtotal Additional Capital Improvement Costs				**$65,617.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$56,713.00
Legal/Administrative	5%			$18,904.00
Contract Admin/Construction Management	10%			$37,809.00
Contingency	25%			$94,521.00
Subtotal Other Costs				**$207,947.00**
Total Capital Improvement Costs				**$586,032.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	100	L.F.	$1.00	$100.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	675	L.F.	$3.00	$2,025.00
Total Annual Operation and Maintenance Cost				**$2,125.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$66,775.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	PLC
REACH :	3
JURISDICTION :	City of Greeley
REACH ID:	CR 62 West Crossing Enter Estimator Name on Project Info
DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
12	4	1	100	L.F.	$1,095.16	$109,516.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
12	1	14.00	2	EA	$1,343.16	$2,686.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
12	4	1	2	EA	$9,735.48	$19,471.00	
Channel Improvements							
Excavation, Mid Range			630	C.Y.	$32.00	$20,160.00	
12-inch Riprap, Type M			16	C.Y.	$80.00	$1,303.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Trail/Path, Concrete (10' Width)			50	L.F.	$59.00	$2,950.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		18	TON	$250.00	$4,500.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$131,673.00
Hydraulic Structures				$0.00
Channel Improvements				$21,463.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$4,290.00
Special Items (User Defined)				$4,500.00
Subtotal Capital Improvement Costs				**$161,926.00**
Additional Capital Improvement Costs				
Dewatering	$1,619.26	L.S.		$1,619.00
Mobilization	5%			$8,096.00
Traffic Control	$8,096.30	L.S.		$8,096.00
Utility Coordination/Relocation	$8,096.30	L.S.		$8,096.00
Stormwater Management/Erosion Control	5%			$8,096.00
Subtotal Additional Capital Improvement Costs				**$34,003.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$29,389.00
Legal/Administrative	5%			$9,796.00
Contract Admin/Construction Management	10%			$19,593.00
Contingency	25%			$48,982.00
Subtotal Other Costs				**$107,760.00**
Total Capital Improvement Costs				**$303,689.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	100	L.F.	$1.00	$100.00
Total Annual Operation and Maintenance Cost				**$100.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$3,142.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD
REACH :	3
JURISDICTION :	City of Greeley
REACH ID:	4th St Central - Minimum Criteria JKD DATE : 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
48-inch	50	1	50	L.F.	$193.00	$9,650.00	
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
48-inch	Yes	1	2	EA	$2,760.00	$5,520.00	
Channel Improvements							
Excavation, Mid Range			167	C.Y.	$32.00	$5,344.00	
12-inch Riprap, Type M			13	C.Y.	$80.00	$1,040.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		18	TON	$250.00	$4,500.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$15,170.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$6,384.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$4,500.00
Subtotal Capital Improvement Costs				**$27,394.00**
Additional Capital Improvement Costs				
Dewatering	$273.94	L.S.		$274.00
Mobilization	5%			$1,370.00
Traffic Control	$1,369.70	L.S.		$1,370.00
Utility Coordination/Relocation	$1,369.70	L.S.		$1,370.00
Stormwater Management/Erosion Control	5%			$1,370.00
Subtotal Additional Capital Improvement Costs				**$5,754.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$4,972.00
Legal/Administrative	5%			$1,657.00
Contract Admin/Construction Management	10%			$3,315.00
Contingency	25%			$8,287.00
Subtotal Other Costs				**$18,231.00**
Total Capital Improvement Costs				**$51,379.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	50	L.F.	$1.00	$100.00	
Total Annual Operation and Maintenance Cost				**$100.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$3,142.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD
REACH :	3
JURISDICTION :	City of Greeley
REACH ID:	4th Street Eastern - Min Criteria JKD DATE : 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
48-inch	50	1	50	L.F.	$193.00	$9,650.00	
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
48-inch	Yes	1	2	EA	$2,760.00	$5,520.00	
Channel Improvements							
Excavation, Mid Range			167	C.Y.	$32.00	$5,344.00	
12-inch Riprap, Type M			13	C.Y.	$80.00	$1,040.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		18	TON	$250.00	$4,500.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$15,170.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$6,384.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$4,500.00
Subtotal Capital Improvement Costs				**$27,394.00**
Additional Capital Improvement Costs				
Dewatering	$273.94	L.S.		$274.00
Mobilization	5%			$1,370.00
Traffic Control	$1,369.70	L.S.		$1,370.00
Utility Coordination/Relocation	$1,369.70	L.S.		$1,370.00
Stormwater Management/Erosion Control	5%			$1,370.00
Subtotal Additional Capital Improvement Costs				**$5,754.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$4,972.00
Legal/Administrative	5%			$1,657.00
Contract Admin/Construction Management	10%			$3,315.00
Contingency	25%			$8,287.00
Subtotal Other Costs				**$18,231.00**
Total Capital Improvement Costs				**$51,379.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	50	L.F.	$1.00	$50.00	
Total Annual Operation and Maintenance Cost				**$50.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$1,571.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD
REACH :	3
JURISDICTION :	City of Greeley
REACH ID:	4th Street Western - Min Criteria

Enter Estimator Name on Project Info | DATE : | 12/26/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
10	5	1	50	L.F.	$1,081.50	$54,075.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
10	1	12.00	2	EA	$1,158.48	$2,317.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
10	5	1	2	EA	$12,054.14	$24,108.30	
Channel Improvements							
Excavation, Mid Range			296	C.Y.	$32.00	$9,472.00	
12-inch Riprap, Type M			22	C.Y.	$80.00	$1,778.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		29	TON	$250.00	$7,250.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$80,500.00
Hydraulic Structures				$0.00
Channel Improvements				$11,250.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$7,250.00
Subtotal Capital Improvement Costs				**$100,340.00**
Additional Capital Improvement Costs				
Dewatering	$1,003.40	L.S.		$1,003.00
Mobilization	5%			$5,017.00
Traffic Control	$5,017.00	L.S.		$5,017.00
Utility Coordination/Relocation	$5,017.00	L.S.		$5,017.00
Stormwater Management/Erosion Control	5%			$5,017.00
Subtotal Additional Capital Improvement Costs				**$21,071.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$18,212.00
Legal/Administrative	5%			$6,071.00
Contract Admin/Construction Management	10%			$12,141.00
Contingency	25%			$30,353.00
Subtotal Other Costs				**$66,777.00**
Total Capital Improvement Costs				**$188,188.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	50	L.F.	$1.00	$100.00	
Total Annual Operation and Maintenance Cost				**$100.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$3,142.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD
REACH :	3
JURISDICTION :	City of Greeley
REACH ID:	95th Ave - Min Criteria

JKD | DATE : | 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
8	5	2	60	L.F.	$1,796.98	$107,819.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
8	2	19.00	2	EA	$1,725.96	$3,452.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
8	5	2	2	EA	$13,884.19	$27,768.40	
Channel Improvements							
Excavation, Mid Range			490	C.Y.	$32.00	$15,680.00	
12-inch Riprap, Type M			36	C.Y.	$80.00	$2,880.00	
Removals							
Removal of culvert pipe (D<48")			120	L.F.	$27.00	$3,240.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		48	TON	$250.00	$12,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$139,039.00
Hydraulic Structures				$0.00
Channel Improvements				$18,560.00
Detention/Water Quality Facilities				$0.00
Removals				$3,240.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$12,000.00
Subtotal Capital Improvement Costs				**$174,179.00**
Additional Capital Improvement Costs				
Dewatering	$1,741.79	L.S.		$1,742.00
Mobilization	5%			$8,709.00
Traffic Control	$8,708.95	L.S.		$8,709.00
Utility Coordination/Relocation	$8,708.95	L.S.		$8,709.00
Stormwater Management/Erosion Control	5%			$8,709.00
Subtotal Additional Capital Improvement Costs				**$36,578.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$31,614.00
Legal/Administrative	5%			$10,538.00
Contract Admin/Construction Management	10%			$21,076.00
Contingency	25%			$52,689.00
Subtotal Other Costs				**$115,917.00**
Total Capital Improvement Costs				**$326,674.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	120	L.F.	$1.00	$120.00	
Total Annual Operation and Maintenance Cost				**$120.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$3,771.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD
REACH :	3
JURISDICTION :	City of Greeley
REACH ID:	County Road 62 - Min Criteria JKD
DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
10	6	2	50	L.F.	$2,385.05	$119,252.00	
Channel Improvements							
Excavation, Mid Range			530	C.Y.	$32.00	$16,960.00	Culvert
12-inch Riprap, Type M			44	C.Y.	$80.00	$3,555.00	Culvert
Excavation, Mid Range			35625	C.Y.	$32.00	$1,140,000.00	Channel Excavation (1800 ft downstream, 3000 ft upstream
9-inch Riprap, Type L			1944	C.Y.	$74.00	$143,889.00	Channel Stabilization
Removals							
Removal of culvert pipe (D<48")			50	L.F.	$27.00	$1,350.00	
Landscaping and Maintenance Improvements							
Wetlands Plantings			1	ACRE	$33,500.00	$33,500.00	
Reclamation & seeding (native grasses)			6	ACRE	$1,340.00	$8,308.00	
Trail/Path, Crusher Fines (10' Width)			3500	L.F.	$15.00	$52,500.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		47	TON	$250.00	$11,750.00	
Riffle Drop	<----User Defined Items		18	EA	$19,500.00	$351,000.00	Riffle Drop ~200 ft.
Land Acquisition							
Easement/ROW Acquisition			10.83	ACRE	$88,000.00	$953,040.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$119,252.00
Hydraulic Structures				$0.00
Channel Improvements				$1,304,404.00
Detention/Water Quality Facilities				$0.00
Removals				$1,350.00
Landscaping and Maintenance Improvements				$94,308.00
Special Items (User Defined)				$362,750.00
Subtotal Capital Improvement Costs				**$1,882,064.00**
Additional Capital Improvement Costs				
Dewatering	$18,820.64	L.S.		$18,821.00
Mobilization	5%			$94,103.00
Traffic Control	$94,103.20	L.S.		$94,103.00
Utility Coordination/Relocation	$94,103.20	L.S.		$94,103.00
Stormwater Management/Erosion Control	5%			$94,103.00
Subtotal Additional Capital Improvement Costs				**$395,233.00**
Land Acquisition Costs				
ROW/Easements				$953,040.00
Subtotal Land Acquisition Costs				**$953,040.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$341,595.00
Legal/Administrative	5%			$113,865.00
Contract Admin/Construction Management	10%			$227,730.00
Contingency	25%			$569,324.00
Subtotal Other Costs				**$1,252,514.00**
Total Capital Improvement Costs				**$4,482,851.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	50	L.F.	$1.00	$50.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	3500	L.F.	$3.00	$10,500.00	
Total Annual Operation and Maintenance Cost				**$10,550.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$331,519.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	WC
REACH :	3
JURISDICTION :	City of Greeley
REACH ID:	4th Street - Min Criteria JKD
DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
6	4	1	50	L.F.	$722.88	$36,144.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
6	1	8.00	2	EA	$723.52	$1,447.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
6	4	1	2	EA	$8,330.86	$16,661.70	
Channel Improvements							
Excavation, Mid Range			200	C.Y.	$32.00	$6,400.00	
12-inch Riprap, Type M			13	C.Y.	$80.00	$1,066.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		22	TON	$250.00	$5,500.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$54,253.00
Hydraulic Structures				$0.00
Channel Improvements				$7,466.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$5,500.00
Subtotal Capital Improvement Costs				**$68,559.00**
Additional Capital Improvement Costs				
Dewatering	$685.59	L.S.		$686.00
Mobilization	5%			$3,428.00
Traffic Control	$3,427.95	L.S.		$3,428.00
Utility Coordination/Relocation	$3,427.95	L.S.		$3,428.00
Stormwater Management/Erosion Control	5%			$3,428.00
Subtotal Additional Capital Improvement Costs				**$14,398.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$12,444.00
Legal/Administrative	5%			$4,148.00
Contract Admin/Construction Management	10%			$8,296.00
Contingency	25%			$20,739.00
Subtotal Other Costs				**$45,627.00**
Total Capital Improvement Costs				**$128,584.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	50	L.F.	$1.00	$100.00	
Total Annual Operation and Maintenance Cost				**$100.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$3,142.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Enter Project Name on Project Info Tab
DRAINAGEWAY : WC-78thAve
REACH : 2
JURISDICTION : City of Greeley
REACH ID: Min-Reach2 — Enter Estimator Name on Project Info — DATE : Enter Date on Project Info Tab.

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
60-inch	220	1	220	L.F.	$322.00	$70,840.00	
Manholes and Inlets							
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			1	EA	$16,080.00	$16,080.00	
Channel Improvements							
Excavation, Mid Range			900	C.Y.	$32.00	$28,800.00	Trench Excavation
Special Items (User Defined)							
Curb and Gutter	<----User Defined Items		25	LF	$10,000.00	$250,000.00	
Asphalt	<----User Defined Items		12	TON	$150.00	$1,800.00	

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$86,920.00
Concrete Box Culverts			$0.00
Hydraulic Structures			$0.00
Channel Improvements			$28,800.00
Detention/Water Quality Facilities			$0.00
Removals			$0.00
Landscaping and Maintenance Improvements			$0.00
Special Items (User Defined)			$251,800.00
Subtotal Capital Improvement Costs			**$367,520.00**
Additional Capital Improvement Costs			
Dewatering	$3,675.20	L.S.	$3,675.00
Mobilization	5%		$18,376.00
Traffic Control	$18,376.00	L.S.	$18,376.00
Utility Coordination/Relocation	$18,376.00	L.S.	$18,376.00
Stormwater Management/Erosion Control	5%		$18,376.00
Subtotal Additional Capital Improvement Costs			**$77,179.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$66,705.00
Legal/Administrative	5%		$22,235.00
Contract Admin/Construction Management	10%		$44,470.00
Contingency	25%		$111,175.00
Subtotal Other Costs			**$244,585.00**
Total Capital Improvement Costs			**$689,284.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	220	L.F.	$1.00	$220.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	4	EA	$67.00	$268.00
Total Annual Operation and Maintenance Cost				**$488.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$15,335.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluffs
DRAINAGEWAY : WC
REACH : 1
JURISDICTION : City of Greeley
REACH ID: 81st Ave - Min Criteria — Monica Ramirez — DATE : 12/19/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
18-inch	50	3	150	L.F.	$72.00	$10,800.00	Inlet replacement
Manholes and Inlets							
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			2	EA	$16,080.00	$32,160.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			1	EA	$20,100.00	$20,100.00	
Storm Inlet, Type R/Type 14, 5-foot			3	EA	$6,164.00	$18,492.00	
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
9	4	1	565	L.F.	$908.62	$513,370.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
9	1	11.00	1	EA	$999.24	$999.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
9	4	1	1	EA	$9,033.17	$9,033.20	
Channel Improvements							
Excavation, Mid Range			2825	C.Y.	$32.00	$90,400.00	
Removals							
Concrete Box Culvert			565	L.F./CELL	$134.00	$75,710.00	
Special Items (User Defined)							
Curb and Gutter	<----User Defined Items		50	LF	$50.00	$2,500.00	
Asphalt	<----User Defined Items		300	TON	$250.00	$75,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$81,552.00
Concrete Box Culverts				$523,402.00
Hydraulic Structures				$0.00
Channel Improvements				$90,400.00
Detention/Water Quality Facilities				$0.00
Removals				$75,710.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$77,500.00
Subtotal Capital Improvement Costs				**$848,564.00**
Additional Capital Improvement Costs				
Dewatering	$8,485.64	L.S.		$8,486.00
Mobilization	5%			$42,428.00
Traffic Control	$42,428.20	L.S.		$42,428.00
Utility Coordination/Relocation	$42,428.20	L.S.		$42,428.00
Stormwater Management/Erosion Control	5%			$42,428.00
Subtotal Additional Capital Improvement Costs				**$178,198.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$154,014.00
Legal/Administrative	5%			$51,338.00
Contract Admin/Construction Management	10%			$102,676.00
Contingency	25%			$256,691.00
Subtotal Other Costs				**$564,719.00**
Total Capital Improvement Costs				**$1,591,481.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	1100	L.F.	$1.00	$1,100.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	6	EA	$67.00	$402.00
Total Annual Operation and Maintenance Cost				**$1,502.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$47,198.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	WC
REACH :	3
JURISDICTION :	City of Greeley
REACH ID:	Skyview Street - Min Criteria JKD
DATE :	12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
18-inch	50	2	100	L.F.	$72.00	$7,200.00	Reset inlets on Skyview Street
Manholes and Inlets							
Storm Inlet, Type R/Type 14, 5-foot			2	EA	$6,164.00	$12,328.00	
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
12	5	1	150	L.F.	$1,239.66	$185,950.00	
Headwall and Trowalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
12	1	14.00	2	EA	$1,343.16	$2,686.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
12	5	1	2	EA	$12,577.01	$25,154.00	
Channel Improvements							
Excavation, Mid Range			1000	C.Y.	$32.00	$32,000.00	
12-inch Riprap, Type M			22	C.Y.	$80.00	$1,776.00	
Removals							
Removal of culvert pipe (D>84")			150	L.F.	$101.00	$15,150.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		26	TON	$250.00	$6,500.00	
Curb and Gutter	<----User Defined Items		75	LF	$50.00	$3,750.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$19,528.00
Concrete Box Culverts				$213,790.00
Hydraulic Structures				$0.00
Channel Improvements				$33,776.00
Detention/Water Quality Facilities				$0.00
Removals				$15,150.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$10,250.00
Subtotal Capital Improvement Costs				**$293,834.00**
Additional Capital Improvement Costs				
Dewatering	$2,938.34	L.S.		$2,938.00
Mobilization	5%			$14,692.00
Traffic Control	$14,691.70	L.S.		$14,692.00
Utility Coordination/Relocation	$14,691.70	L.S.		$14,692.00
Stormwater Management/Erosion Control	5%			$14,692.00
Subtotal Additional Capital Improvement Costs				**$61,706.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$53,331.00
Legal/Administrative	5%			$17,777.00
Contract Admin/Construction Management	10%			$35,554.00
Contingency	25%			$88,885.00
Subtotal Other Costs				**$195,547.00**
Total Capital Improvement Costs				**$551,087.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	150	L.F.	$1.00	$300.00	
Total Annual Operation and Maintenance Cost				**$300.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$9,427.00**	

Flood Hazard Mitigation Alternatives

C-13: Foothills Tributary – Melbourne Street Option 1

C-13: Foothills Tributary – Melbourne Street Option 2

C-14: Foothills Tributary – North of Melbourne Street

C-14: Northridge Draw – C Street

C-14: Poudre Learning Center – County Road 62 Eastern

C-15: Poudre Learning Center – County Road 62 Western

C-15: Sharktooth Draw – 4th Street Central

C-16: Sharktooth Draw – 4th Street Eastern

C-16: Sharktooth Draw – 4th Street Western

C-17: Sharktooth Draw – 95th Avenue

C-17: Sharktooth Draw – County Road 62

C-18: Sharktooth Draw – Downstream Option 1

C-18: Sharktooth Draw – Downstream Option 2

C-19: Wiedeman Creek – 4th Street

C-19: Wiedeman Creek – 78th Avenue

C-20: Wiedeman Creek – 81st Avenue: 100-yr Storm Drain

C-20: Wiedeman Creek – 81st Avenue: Detention (8 Ac-ft.)

C-21: Wiedeman Creek – 81st Avenue: Detention (22 Ac-ft.)

C-21: Wiedeman Creek – 81st Avenue: Detention (44 Ac-ft.)

C-22: Wiedeman Creek – Armor Hill Road

C-22: Wiedeman Creek – Skyview Street

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : NofMelbourneSt
REACH : 1
JURISDICTION : City of Greeley
REACH ID: FM (Option 1)-Reach1 | Enter Estimator Name on Project Info | DATE : 12/19/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
42-inch	50	1	50	L.F.	$169.00	$8,450.00	
18-inch	50	2	100	L.F.	$72.00	$7,200.00	Reset inlet laterals
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
42-inch	Yes	1	1	EA	$2,278.00	$2,278.00	
Manholes and Inlets							
Storm Inlet, Type R/Type 14, 5-foot			2	EA	$6,164.00	$12,328.00	
Channel Improvements							
Excavation, Mid Range			150	C.Y.	$32.00	$4,800.00	
Removals							
Removal of culvert pipe (D<48")			100	L.F.	$27.00	$2,700.00	
Special Items (User Defined)							
Curb and Gutter	<----User Defined Items		50	LF	$50.00	$2,500.00	
Asphalt	<----User Defined Items		9	TON	$250.00	$2,250.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$30,256.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$4,800.00
Detention/Water Quality Facilities				$0.00
Removals				$2,700.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$4,750.00
Subtotal Capital Improvement Costs				**$42,506.00**
Additional Capital Improvement Costs				
Dewatering	$425.06	L.S.		$425.00
Mobilization	5%			$2,125.00
Traffic Control	$2,125.30	L.S.		$2,125.00
Utility Coordination/Relocation	$2,125.30	L.S.		$2,125.00
Stormwater Management/Erosion Control	5%			$2,125.00
Subtotal Additional Capital Improvement Costs				**$8,925.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$7,715.00
Legal/Administrative	5%			$2,572.00
Contract Admin/Construction Management	10%			$5,143.00
Contingency	25%			$12,858.00
Subtotal Other Costs				**$28,288.00**
Total Capital Improvement Costs				**$79,719.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	50	L.F.	$1.00	$50.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	3	EA	$67.00	$201.00
Total Annual Operation and Maintenance Cost				**$251.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$7,887.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : NofMelbourneSt
REACH : 2
JURISDICTION : City of Greeley
REACH ID: FM (Option 2)-Reach2 | Enter Estimator Name on Project Info | DATE : 12/19/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
42-inch	785	1	785	L.F.	$169.00	$132,665.00	
18-inch	50	2	100	L.F.	$72.00	$7,200.00	Reset inlet laterals
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
42-inch	Yes	1	2	EA	$2,278.00	$4,556.00	
Manholes and Inlets							
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			4	EA	$5,226.00	$20,904.00	
Storm Inlet, Type R/Type 14, 5-foot			2	EA	$6,164.00	$12,328.00	
Channel Improvements							
Excavation, Mid Range			2350	C.Y.	$32.00	$75,200.00	Trench Excavation
Special Items (User Defined)							
Asphalt	<----User Defined Items		260	TON	$150.00	$39,000.00	
Curb and Gutter	<----User Defined Items		50	LF	$50.00	$2,500.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$177,653.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$75,200.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$41,500.00
Subtotal Capital Improvement Costs				**$294,353.00**
Additional Capital Improvement Costs				
Dewatering	$2,943.53	L.S.		$2,944.00
Mobilization	5%			$14,718.00
Traffic Control	$14,717.65	L.S.		$14,718.00
Utility Coordination/Relocation	$14,717.65	L.S.		$14,718.00
Stormwater Management/Erosion Control	5%			$14,718.00
Subtotal Additional Capital Improvement Costs				**$61,816.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$53,425.00
Legal/Administrative	5%			$17,808.00
Contract Admin/Construction Management	10%			$35,617.00
Contingency	25%			$89,042.00
Subtotal Other Costs				**$195,892.00**
Total Capital Improvement Costs				**$552,061.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	785	L.F.	$1.00	$785.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	6	EA	$67.00	$402.00
Total Annual Operation and Maintenance Cost				**$1,187.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$37,300.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : NofMelbourneSt
REACH : 1
JURISDICTION : City of Greeley
REACH ID: FM-Reach1 Enter Estimator Name on Project Info DATE : 12/19/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
18-inch	50	1	50	L.F.	$72.00	$3,600.00	
Channel Improvements							
Excavation, Mid Range			90	C.Y.	$32.00	$2,880.00	Excavation
Detention/Water Quality Facilities							
Detention (User Entered Quantities)							
Outlet Works			1	EA	$5,000.00	$5,000.00	Modify existin outlet strucutre with new outlet pipe
Special Items (User Defined)							
Asphalt	<----User Defined Items		7	TON	$250.00	$1,775.00	

Master Plan Capital Improvement Cost Summary		
Capital Improvement Costs		
Pipe Culverts and Storm Drains	$3,600.00	
Concrete Box Culverts	$0.00	
Hydraulic Structures	$0.00	
Channel Improvements	$2,880.00	
Detention/Water Quality Facilities	$5,000.00	
Removals	$0.00	
Landscaping and Maintenance Improvements	$0.00	
Special Items (User Defined)	$1,775.00	
Subtotal Capital Improvement Costs	**$13,255.00**	
Additional Capital Improvement Costs		
Dewatering	$133.00	
Mobilization	$663.00	
Traffic Control	$663.00	
Utility Coordination/Relocation	$663.00	
Stormwater Management/Erosion Control	$663.00	
Subtotal Additional Capital Improvement Costs	**$2,785.00**	
Land Acquisition Costs		
ROW/Easements	$0.00	
Subtotal Land Acquisition Costs	**$0.00**	
Other Costs (percentage of Capital Improvement Costs)		
Engineering	$2,406.00	
Legal/Administrative	$802.00	
Contract Admin/Construction Management	$1,604.00	
Contingency	$4,010.00	
Subtotal Other Costs	**$8,822.00**	
Total Capital Improvement Costs	**$24,862.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	50	L.F.	$1.00	$100.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, s	0.2	ACRE	$2,010.00	$402.00	
Total Annual Operation and Maintenance Cost				**$502.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$15,775.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : ND
REACH : 2
JURISDICTION : City of Greeley
REACH ID: C Street JKD DATE : 12/19/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
18-inch	700	1	700	L.F.	$72.00	$50,400.00	
42-inch	1550	1	1550	L.F.	$169.00	$261,950.00	
Flare End Sections							
Diameter (in)	Applicable	No. of Barrels					
42-inch	Yes	1	1	EA	$2,278.00	$2,278.00	
Manholes and Inlets							
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			7	EA	$5,226.00	$36,582.00	
Channel Improvements							
Excavation, Mid Range			3880	C.Y.	$32.00	$124,160.00	Trench Excavation (Shallow to Mid) & Roadside Swale
Excavation, High Range			5000	C.Y.	$42.00	$210,000.00	Trench Excavation (Deep)
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		775	TON	$50.00	$38,750.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains			$351,210.00	
Concrete Box Culverts			$0.00	
Hydraulic Structures			$0.00	
Channel Improvements			$334,160.00	
Detention/Water Quality Facilities			$0.00	
Removals			$0.00	
Landscaping and Maintenance Improvements			$1,340.00	
Special Items (User Defined)			$38,750.00	
Subtotal Capital Improvement Costs			**$725,460.00**	
Additional Capital Improvement Costs				
Dewatering	$7,254.60	L.S.	$7,255.00	
Mobilization	5%		$36,273.00	
Traffic Control	$36,273.00	L.S.	$36,273.00	
Utility Coordination/Relocation	$36,273.00	L.S.	$36,273.00	
Stormwater Management/Erosion Control	5%		$36,273.00	
Subtotal Additional Capital Improvement Costs			**$152,347.00**	
Land Acquisition Costs				
ROW/Easements			$0.00	
Subtotal Land Acquisition Costs			**$0.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$131,671.00	
Legal/Administrative	5%		$43,890.00	
Contract Admin/Construction Management	10%		$87,781.00	
Contingency	25%		$219,452.00	
Subtotal Other Costs			**$482,794.00**	
Total Capital Improvement Costs			**$1,360,601.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	2200	L.F.	$1.00	$2,200.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	7	EA	$67.00	$469.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	200	L.F.	$3.00	$600.00	
Total Annual Operation and Maintenance Cost				**$3,269.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$102,724.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	PLC
REACH :	2
JURISDICTION :	City of Greeley
REACH ID:	CR 62 East - FHMA

Enter Estimator Name on Project Info | DATE : | 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**				
12	5	1	100	L.F.	$1,239.66	$123,966.00	
Headwall and Toewalls							
Individual Box Span (ft)	**No. of Barrels**	**Total Span (ft)**					
12	1	14.00	2	EA	$1,343.16	$2,686.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	**Box Rise (ft)**	**No. of Barrels**					
12	5	1	2	EA	$12,577.01	$25,154.00	
Channel Improvements							
Excavation, Mid Range			670	C.Y.	$32.00	$21,440.00	Culvert
12-inch Riprap, Type M			18	C.Y.	$80.00	$1,440.00	Culvert
Excavation, Mid Range			2300	C.Y.	$32.00	$73,600.00	675 ft channel DS of CR 62 to PLC
12-inch Riprap, Type M			16	C.Y.	$80.00	$1,280.00	Downstream
Removals							
Removal of culvert pipe (D<48")			50	L.F.	$27.00	$1,350.00	
Landscaping and Maintenance Improvements							
Wetlands Plantings			2	ACRE	$33,500.00	$67,000.00	
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Trail/Path, Concrete (10' Width)			50	L.F.	$59.00	$2,950.00	
Special Items (User Defined)							
Asphalt	**<----User Defined Items**		33	TON	$250.00	$8,250.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$151,806.00
Hydraulic Structures				$0.00
Channel Improvements				$97,760.00
Detention/Water Quality Facilities				$0.00
Removals				$1,350.00
Landscaping and Maintenance Improvements				$71,290.00
Special Items (User Defined)				$8,250.00
Subtotal Capital Improvement Costs				**$330,456.00**
Additional Capital Improvement Costs				
Dewatering	$3,304.56	L.S.		$3,305.00
Mobilization	5%			$16,523.00
Traffic Control	$16,522.80	L.S.		$16,523.00
Utility Coordination/Relocation	$16,522.80	L.S.		$16,523.00
Stormwater Management/Erosion Control	5%			$16,523.00
Subtotal Additional Capital Improvement Costs				**$69,397.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$59,978.00
Legal/Administrative	5%			$19,993.00
Contract Admin/Construction Management	10%			$39,985.00
Contingency	25%			$99,963.00
Subtotal Other Costs				**$219,919.00**
Total Capital Improvement Costs				**$619,772.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	100	L.F.	$1.00	$100.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	675	L.F.	$3.00	$2,025.00
Total Annual Operation and Maintenance Cost				**$2,125.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$66,775.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	PLC
REACH :	2
JURISDICTION :	City of Greeley
REACH ID:	CR 62 West - FHMA

Enter Estimator Name on Project Info | DATE : | 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**				
12	5	1	100	L.F.	$1,239.66	$123,966.00	
Headwall and Toewalls							
Individual Box Span (ft)	**No. of Barrels**	**Total Span (ft)**					
12	1	14.00	2	EA	$1,343.16	$2,686.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	**Box Rise (ft)**	**No. of Barrels**					
12	5	1	2	EA	$12,577.01	$25,154.00	
Channel Improvements							
Excavation, Mid Range			693	C.Y.	$32.00	$22,176.00	
12-inch Riprap, Type M			16	C.Y.	$80.00	$1,303.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Trail/Path, Concrete (10' Width)			50	L.F.	$59.00	$2,950.00	
Special Items (User Defined)							
Asphalt	**<----User Defined Items**		20	TON	$250.00	$5,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$151,806.00
Hydraulic Structures				$0.00
Channel Improvements				$23,479.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$4,290.00
Special Items (User Defined)				$5,000.00
Subtotal Capital Improvement Costs				**$184,575.00**
Additional Capital Improvement Costs				
Dewatering	$1,845.75	L.S.		$1,846.00
Mobilization	5%			$9,229.00
Traffic Control	$9,228.75	L.S.		$9,229.00
Utility Coordination/Relocation	$9,228.75	L.S.		$9,229.00
Stormwater Management/Erosion Control	5%			$9,229.00
Subtotal Additional Capital Improvement Costs				**$38,762.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$33,501.00
Legal/Administrative	5%			$11,167.00
Contract Admin/Construction Management	10%			$22,334.00
Contingency	25%			$55,834.00
Subtotal Other Costs				**$122,836.00**
Total Capital Improvement Costs				**$346,173.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	100	L.F.	$1.00	$100.00
Total Annual Operation and Maintenance Cost				**$100.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$3,142.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD
REACH :	2
JURISDICTION :	City of Greeley
REACH ID:	4th Street Central - FHMA

Enter Estimator Name on Project Info | DATE : 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
6	3	1	50	L.F.	$661.03	$33,052.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
6	1	8.00	2	EA	$723.52	$1,447.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
6	3	1	2	EA	$6,607.22	$13,214.40	
Channel Improvements							
Excavation, Mid Range			178	C.Y.	$32.00	$5,696.00	
12-inch Riprap, Type M			22	C.Y.	$80.00	$1,778.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		22	TON	$250.00	$5,500.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$47,713.00
Hydraulic Structures				$0.00
Channel Improvements				$7,474.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$5,500.00
Subtotal Capital Improvement Costs				**$62,027.00**
Additional Capital Improvement Costs				
Dewatering	$620.27	L.S.		$620.00
Mobilization	5%			$3,101.00
Traffic Control	$3,101.35	L.S.		$3,101.00
Utility Coordination/Relocation	$3,101.35	L.S.		$3,101.00
Stormwater Management/Erosion Control	5%			$3,101.00
Subtotal Additional Capital Improvement Costs				**$13,024.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$11,258.00
Legal/Administrative	5%			$3,753.00
Contract Admin/Construction Management	10%			$7,505.00
Contingency	25%			$18,763.00
Subtotal Other Costs				**$41,279.00**
Total Capital Improvement Costs				**$116,330.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	50	L.F.	$1.00	$100.00	
Total Annual Operation and Maintenance Cost				**$100.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$3,142.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD
REACH :	2
JURISDICTION :	City of Greeley
REACH ID:	4th Street Eastern - FHMA

Enter Estimator Name on Project Info | DATE : 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
6	3	1	50	L.F.	$661.03	$33,052.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
6	1	8.00	2	EA	$723.52	$1,447.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
6	3	1	2	EA	$6,607.22	$13,214.40	
Channel Improvements							
Excavation, Mid Range			278	C.Y.	$32.00	$8,889.00	
12-inch Riprap, Type M			22	C.Y.	$80.00	$1,778.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		33	TON	$250.00	$8,250.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$47,713.00
Hydraulic Structures				$0.00
Channel Improvements				$10,667.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$8,250.00
Subtotal Capital Improvement Costs				**$67,970.00**
Additional Capital Improvement Costs				
Dewatering	$679.70	L.S.		$680.00
Mobilization	5%			$3,399.00
Traffic Control	$3,398.50	L.S.		$3,399.00
Utility Coordination/Relocation	$3,398.50	L.S.		$3,399.00
Stormwater Management/Erosion Control	5%			$3,399.00
Subtotal Additional Capital Improvement Costs				**$14,276.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$12,337.00
Legal/Administrative	5%			$4,112.00
Contract Admin/Construction Management	10%			$8,225.00
Contingency	25%			$20,562.00
Subtotal Other Costs				**$45,236.00**
Total Capital Improvement Costs				**$127,482.00**

Master Plan Operation and Maintenance Cost Summary					
Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	50	L.F.	$1.00	$50.00	
Total Annual Operation and Maintenance Cost				**$50.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$1,571.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD
REACH :	2
JURISDICTION :	City of Greeley
REACH ID:	4th Street West - FHMA

Enter Estimator Name on Project Info | DATE : 12/26/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
12	5	1	50	L.F.	$1,239.66	$61,983.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
12	1	14.00	2	EA	$1,343.16	$2,686.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
12	5	1	2	EA	$12,577.01	$25,154.00	
Channel Improvements							
Excavation, Mid Range			333	C.Y.	$32.00	$10,656.00	
12-inch Riprap, Type M			27	C.Y.	$80.00	$2,133.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		33	TON	$250.00	$8,250.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$89,823.00
Hydraulic Structures				$0.00
Channel Improvements				$12,789.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$8,250.00
Subtotal Capital Improvement Costs				**$112,202.00**
Additional Capital Improvement Costs				
Dewatering	$1,122.02	L.S.		$1,122.00
Mobilization	5%			$5,610.00
Traffic Control	$5,610.10	L.S.		$5,610.00
Utility Coordination/Relocation	$5,610.10	L.S.		$5,610.00
Stormwater Management/Erosion Control	5%			$5,610.00
Subtotal Additional Capital Improvement Costs				**$23,562.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$20,365.00
Legal/Administrative	5%			$6,788.00
Contract Admin/Construction Management	10%			$13,576.00
Contingency	25%			$33,941.00
Subtotal Other Costs				**$74,670.00**
Total Capital Improvement Costs				**$210,434.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	50	L.F.	$1.00	$100.00
Total Annual Operation and Maintenance Cost				**$100.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$3,142.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD
REACH :	2
JURISDICTION :	City of Greeley
REACH ID:	95th Ave - FHMA

Enter Estimator Name on Project Info | DATE : 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
10	5	2	60	L.F.	$2,162.99	$129,780.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
10	2	23.00	2	EA	$2,220.42	$4,441.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
10	5	2	2	EA	$14,929.93	$29,859.90	
Channel Improvements							
Excavation, Mid Range			578	C.Y.	$32.00	$18,496.00	
12-inch Riprap, Type M			44	C.Y.	$80.00	$3,520.00	
Removals							
Removal of culvert pipe (D<48")			120	L.F.	$27.00	$3,240.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		57	TON	$250.00	$14,250.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$164,081.00
Hydraulic Structures				$0.00
Channel Improvements				$22,016.00
Detention/Water Quality Facilities				$0.00
Removals				$3,240.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$14,250.00
Subtotal Capital Improvement Costs				**$204,927.00**
Additional Capital Improvement Costs				
Dewatering	$2,049.27	L.S.		$2,049.00
Mobilization	5%			$10,246.00
Traffic Control	$10,246.35	L.S.		$10,246.00
Utility Coordination/Relocation	$10,246.35	L.S.		$10,246.00
Stormwater Management/Erosion Control	5%			$10,246.00
Subtotal Additional Capital Improvement Costs				**$43,033.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$37,194.00
Legal/Administrative	5%			$12,398.00
Contract Admin/Construction Management	10%			$24,796.00
Contingency	25%			$61,990.00
Subtotal Other Costs				**$136,378.00**
Total Capital Improvement Costs				**$384,338.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	120	L.F.	$1.00	$120.00
Total Annual Operation and Maintenance Cost				**$120.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$3,771.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD
REACH :	2
JURISDICTION :	City of Greeley
REACH ID:	CR 62 - FHMA

Enter Estimator Name on Project Info | DATE : 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
10	7	2	50	L.F.	$2,506.94	$125,347.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
10	2	23.00	2	EA	$2,220.42	$4,441.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
10	7	2	2	EA	$20,616.17	$41,232.30	
Channel Improvements							
Excavation, Mid Range			600	C.Y.	$32.00	$19,200.00	Culvert
12-inch Riprap, Type M			44	C.Y.	$80.00	$3,555.00	Culvert
Excavation, Mid Range			35625	C.Y.	$32.00	$1,140,000.00	Channel Excavation
9-inch Riprap, Type L			1944	C.Y.	$74.00	$143,889.00	Channel Stabilization
Removals							
Removal of culvert pipe (D<48")			50	L.F.	$27.00	$1,350.00	
Landscaping and Maintenance Improvements							
Wetlands Plantings			1	ACRE	$33,500.00	$33,500.00	
Reclamation & seeding (native grasses)			6	ACRE	$1,340.00	$8,308.00	
Trail/Path, Crusher Fines (10' Width)			3500	L.F.	$15.00	$52,500.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		47	TON	$250.00	$11,750.00	
Riffle Drop	<----User Defined Items		18	EA	$19,500.00	$351,000.00	~Riffle every 200 ft
Land Acquisition							
Easement/ROW Acquisition			10.83	ACRE	$88,000.00	$953,040.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$171,020.00
Hydraulic Structures					$0.00
Channel Improvements					$1,306,644.00
Detention/Water Quality Facilities					$0.00
Removals					$1,350.00
Landscaping and Maintenance Improvements					$94,308.00
Special Items (User Defined)					$362,750.00
Subtotal Capital Improvement Costs					**$1,936,072.00**
Additional Capital Improvement Costs					
Dewatering	$19,360.72	L.S.			$19,361.00
Mobilization	5%				$96,804.00
Traffic Control	$96,803.60	L.S.			$96,804.00
Utility Coordination/Relocation	$96,803.60	L.S.			$96,804.00
Stormwater Management/Erosion Control	5%				$96,804.00
Subtotal Additional Capital Improvement Costs					**$406,577.00**
Land Acquisition Costs					
ROW/Easements					$953,040.00
Subtotal Land Acquisition Costs					**$953,040.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering	15%				$351,397.00
Legal/Administrative	5%				$117,132.00
Contract Admin/Construction Management	10%				$234,265.00
Contingency	25%				$585,662.00
Subtotal Other Costs					**$1,288,456.00**
Total Capital Improvement Costs					**$4,584,145.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	50	L.F.	$1.00	$50.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	3500	L.F.	$3.00	$10,500.00
Total Annual Operation and Maintenance Cost				**$10,550.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$331,519.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluff
DRAINAGEWAY :	SKD at CR 62
REACH :	1
JURISDICTION :	City of Greeley
REACH ID:	DSCh_Option1-Reach1

Enter Estimator Name on Project Info | DATE : 12/21/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		21375	C.Y.	$32.00	$684,000.00	Excavation downstream (1800 ft)
9-inch Riprap, Type L		2000	C.Y.	$74.00	$148,000.00	Channel stabilization (1800 ft)
Landscaping and Maintenance Improvements						
Trail/Path, Crusher Fines (10' Width)		1800	L.F.	$15.00	$27,000.00	
Special Items (User Defined)						
Riffle Drop	<----User Defined Items	9	EA	$19,500.00	$175,500.00	~Every 200 ft
William R Jones Ditch Separation Structure	<----User Defined Items	1	EA	$50,000.00	$50,000.00	
Land Acquisition						
Easement/ROW Acquisition		4.02	ACRE	$88,000.00	$353,760.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$0.00
Concrete Box Culverts					$0.00
Hydraulic Structures					$0.00
Channel Improvements					$832,000.00
Detention/Water Quality Facilities					$0.00
Removals					$0.00
Landscaping and Maintenance Improvements					$27,000.00
Special Items (User Defined)					$225,500.00
Subtotal Capital Improvement Costs					**$1,084,500.00**
Additional Capital Improvement Costs					
Dewatering		$10,845.00	L.S.		$10,845.00
Mobilization		5%			$54,225.00
Traffic Control		$54,225.00	L.S.		$54,225.00
Utility Coordination/Relocation		$54,225.00	L.S.		$54,225.00
Stormwater Management/Erosion Control		5%			$54,225.00
Subtotal Additional Capital Improvement Costs					**$227,745.00**
Land Acquisition Costs					
ROW/Easements					$353,760.00
Subtotal Land Acquisition Costs					**$353,760.00**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%			$196,837.00
Legal/Administrative		5%			$65,612.00
Contract Admin/Construction Management		10%			$131,225.00
Contingency		25%			$328,061.00
Subtotal Other Costs					**$721,735.00**
Total Capital Improvement Costs					**$2,387,740.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	1800	L.F.	$3.00	$5,400.00
Total Annual Operation and Maintenance Cost				**$5,400.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$169,687.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : SKD at CR 62
REACH : 2
JURISDICTION : City of Greeley
REACH ID: DSCh_Option2-Reach2 — Enter Estimator Name on Project Info — DATE : 12/21/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
9-inch Riprap, Type L		1111	C.Y.	$74.00	$82,222.00	Bank stabilization (1000 ft)
Excavation, Mid Range		13250	C.Y.	$32.00	$424,000.00	Channel excavation (1000 ft)
Landscaping and Maintenance Improvements						
Trail/Path, Crusher Fines (10' Width)		800	L.F.	$15.00	$12,000.00	
Special Items (User Defined)						
Riffle Drop	<----User Defined Items	5	EA	$19,500.00	$97,500.00	Every ~200 ft
Land Acquisition						
Easement/ROW Acquisition		2.50	ACRE	$88,000.00	$220,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$306,222.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$12,000.00
Special Items (User Defined)				$97,500.00
Subtotal Capital Improvement Costs				**$615,722.00**
Additional Capital Improvement Costs				
Dewatering	$6,157.22	L.S.		$6,157.00
Mobilization	5%			$30,786.00
Traffic Control	$30,786.10	L.S.		$30,786.00
Utility Coordination/Relocation	$30,786.10	L.S.		$30,786.00
Stormwater Management/Erosion Control	5%			$30,786.00
Subtotal Additional Capital Improvement Costs				**$129,301.00**
Land Acquisition Costs				
ROW/Easements				$220,000.00
Subtotal Land Acquisition Costs				**$220,000.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$111,753.00
Legal/Administrative	5%			$37,251.00
Contract Admin/Construction Management	10%			$74,502.00
Contingency	25%			$186,256.00
Subtotal Other Costs				**$409,762.00**
Total Capital Improvement Costs				**$1,374,785.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	1000	L.F.	$3.00	$3,000.00
Total Annual Operation and Maintenance Cost				**$3,000.00**
Effective Interest Rate				2.00%
Total Operation and Maintenance Costs Over 50 Years				**$94,271.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : WC
REACH : 2
JURISDICTION : City of Greeley
REACH ID: 4th St - FHMA — Enter Estimator Name on Project Info — DATE : 12/21/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**				
7	4	1	50	L.F.	$784.73	$39,236.00	
Headwall and Toewalls							
Individual Box Span (ft)	**No. of Barrels**	**Total Span (ft)**					
7	1	9.00	2	EA	$813.96	$1,628.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	**Box Rise (ft)**	**No. of Barrels**					
7	4	1	2	EA	$8,564.96	$17,129.90	
Channel Improvements							
Excavation, Mid Range			217	C.Y.	$32.00	$6,944.00	
12-inch Riprap, Type M			16	C.Y.	$80.00	$1,303.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,340.00	$1,340.00	
Special Items (User Defined)							
Asphalt	<----User Defined Items		24	TON	$250.00	$6,000.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$57,994.00
Hydraulic Structures				$0.00
Channel Improvements				$8,247.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$1,340.00
Special Items (User Defined)				$6,000.00
Subtotal Capital Improvement Costs				**$73,581.00**
Additional Capital Improvement Costs				
Dewatering	$735.81	L.S.		$736.00
Mobilization	5%			$3,679.00
Traffic Control	$3,679.05	L.S.		$3,679.00
Utility Coordination/Relocation	$3,679.05	L.S.		$3,679.00
Stormwater Management/Erosion Control	5%			$3,679.00
Subtotal Additional Capital Improvement Costs				**$15,452.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$13,355.00
Legal/Administrative	5%			$4,452.00
Contract Admin/Construction Management	10%			$8,903.00
Contingency	25%			$22,258.00
Subtotal Other Costs				**$48,968.00**
Total Capital Improvement Costs				**$138,001.00**

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	50	L.F.	$1.00	$100.00	
Total Annual Operation and Maintenance Cost				**$100.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$3,142.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Enter Project Name on Project Info Tab
DRAINAGEWAY : WC-78thAve
REACH : 3
JURISDICTION : City of Greeley
REACH ID: FM-Reach3 Enter Estimator Name on Project Info DATE : Enter Date on Project Info Tab.

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		1000	C.Y.	$32.00	$32,000.00	
12-inch Riprap, Type M		10	C.Y.	$80.00	$800.00	
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		1	ACRE	$1,340.00	$1,340.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs	
Pipe Culverts and Storm Drains	$0.00
Concrete Box Culverts	$0.00
Hydraulic Structures	$0.00
Channel Improvements	$32,800.00
Detention/Water Quality Facilities	$0.00
Removals	$0.00
Landscaping and Maintenance Improvements	$1,340.00
Special Items (User Defined)	$0.00
Subtotal Capital Improvement Costs	**$34,140.00**
Additional Capital Improvement Costs	
Dewatering $341.40 L.S.	$341.00
Mobilization 5%	$1,707.00
Traffic Control $1,707.00 L.S.	$1,707.00
Utility Coordination/Relocation $1,707.00 L.S.	$1,707.00
Stormwater Management/Erosion Control 5%	$1,707.00
Subtotal Additional Capital Improvement Costs	**$7,169.00**
Land Acquisition Costs	
ROW/Easements	$0.00
Subtotal Land Acquisition Costs	**$0.00**
Other Costs (percentage of Capital Improvement Costs)	
Engineering 15%	$6,196.00
Legal/Administrative 5%	$2,065.00
Contract Admin/Construction Management 10%	$4,131.00
Contingency 25%	$10,327.00
Subtotal Other Costs	**$22,719.00**
Total Capital Improvement Costs	**$64,028.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	250	L.F.	$3.00	$750.00	
Total Annual Operation and Maintenance Cost				**$750.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$23,568.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluffs
DRAINAGEWAY : SKD
REACH : 81stAve
JURISDICTION : City of Greeley
REACH ID: 81st Ave - FHMA 100-yr storm Monica Ramirez DATE : 12/19/2018

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
18-inch	50	3	150	L.F.	$72.00	$10,800.00	Replace Inlet Laterals
Manholes and Inlets							
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			3	EA	$20,100.00	$60,300.00	
Storm Inlet, Type R/Type 14, 5-foot			3	EA	$6,164.00	$18,492.00	
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)				
8	4	2	500	L.F.	$1,695.15	$847,576.00	
11	4	2	565	L.F.	$2,066.63	$1,167,647.00	
Headwall and Toewalls							
Individual Box Span (ft)	No. of Barrels	Total Span (ft)					
8	2	19.00	1	EA	$1,725.96	$1,726.00	
11	2	25.00	1	EA	$2,413.50	$2,414.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)							
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels					
8	4	2	1	EA	$10,906.01	$10,906.00	
11	4	2	1	EA	$12,310.64	$12,310.60	
Channel Improvements							
Excavation, Mid Range			5535	C.Y.	$32.00	$177,120.00	Excavation
Removals							
Concrete Box Culvert			1065	L.F./CELL	$134.00	$142,710.00	
Landscaping and Maintenance Improvements							
Trail/Path, Concrete (10' Width)			50	L.F.	$59.00	$2,950.00	
Special Items (User Defined)							
Curb and Gutter	<----User Defined Items		100	L.F.	$50.00	$5,000.00	
Asphalt	<----User Defined Items		553	TON	$250.00	$138,250.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs	
Pipe Culverts and Storm Drains	$89,592.00
Concrete Box Culverts	$2,042,580.00
Hydraulic Structures	$0.00
Channel Improvements	$177,120.00
Detention/Water Quality Facilities	$0.00
Removals	$142,710.00
Landscaping and Maintenance Improvements	$2,950.00
Special Items (User Defined)	$143,250.00
Subtotal Capital Improvement Costs	**$2,598,202.00**
Additional Capital Improvement Costs	
Dewatering $25,982.02 L.S.	$25,982.00
Mobilization 5%	$129,910.00
Traffic Control $129,910.10 L.S.	$129,910.00
Utility Coordination/Relocation $129,910.10 L.S.	$129,910.00
Stormwater Management/Erosion Control 5%	$129,910.00
Subtotal Additional Capital Improvement Costs	**$545,622.00**
Land Acquisition Costs	
ROW/Easements	$0.00
Subtotal Land Acquisition Costs	**$0.00**
Other Costs (percentage of Capital Improvement Costs)	
Engineering 15%	$471,574.00
Legal/Administrative 5%	$157,191.00
Contract Admin/Construction Management 10%	$314,382.00
Contingency 25%	$785,956.00
Subtotal Other Costs	**$1,729,103.00**
Total Capital Improvement Costs	**$4,872,927.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	2200	L.F.	$1.00	$2,200.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	6	EA	$67.00	$402.00	
Total Annual Operation and Maintenance Cost				**$2,602.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$81,764.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs
DRAINAGEWAY :	WC
REACH :	1
JURISDICTION :	City of Greeley
REACH ID:	81st Ave - FHMA - 22 Ac.ft

Monica Ramirez | DATE : 12/19/2018

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities					
Detention (Complete-in-Place)					
Detention Facility 1 (Complete-in-Place)	22	AC-FT	$61,104.00	$1,313,736.00	
Landscaping and Maintenance Improvements					
Trail/Path, Crusher Fines (10' Width)	900	L.F.	$15.00	$13,500.00	
Land Acquisition					
Easement/ROW Acquisition	10.00	ACRE	$88,000.00	$880,000.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$1,313,736.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$13,500.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$1,327,236.00**	
Additional Capital Improvement Costs					
Dewatering	$13,272.36	L.S.		$13,272.00	
Mobilization	5%			$66,362.00	
Traffic Control	$66,361.80	L.S.		$66,362.00	
Utility Coordination/Relocation	$66,361.80	L.S.		$66,362.00	
Stormwater Management/Erosion Control	5%			$66,362.00	
Subtotal Additional Capital Improvement Costs				**$278,720.00**	
Land Acquisition Costs					
ROW/Easements				$880,000.00	
Subtotal Land Acquisition Costs				**$880,000.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering	15%			$240,893.00	
Legal/Administrative	5%			$80,298.00	
Contract Admin/Construction Management	10%			$160,596.00	
Contingency	25%			$401,489.00	
Subtotal Other Costs				**$883,276.00**	
Total Capital Improvement Costs				**$3,369,232.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	1100	L.F.	$1.00	$1,100.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	6	EA	$67.00	$402.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, s	10	ACRE	$2,010.00	$20,100.00	
Total Annual Operation and Maintenance Cost				**$21,602.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$678,813.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs
DRAINAGEWAY :	WC
REACH :	1
JURISDICTION :	City of Greeley
REACH ID:	81st Ave - FHMA - 44 Ac.ft

Monica Ramirez | DATE : 12/19/2018

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities					
Detention (Complete-in-Place)					
Detention Facility 1 (Complete-in-Place)	44	AC-FT	$61,104.00	$2,688,576.00	
Landscaping and Maintenance Improvements					
Wetlands Plantings	3	ACRE	$33,500.00	$83,750.00	
Reclamation & seeding (native grasses)	14	ACRE	$1,340.00	$18,760.00	
Trail/Path, Crusher Fines (10' Width)	1200	L.F.	$15.00	$18,000.00	Maintenance Road
Land Acquisition					
Easement/ROW Acquisition	16.00	ACRE	$88,000.00	$1,408,000.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$2,688,576.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$120,510.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$2,809,086.00**	
Additional Capital Improvement Costs					
Dewatering	$28,090.86	L.S.		$28,091.00	
Mobilization	5%			$140,454.00	
Traffic Control	$140,454.30	L.S.		$140,454.00	
Utility Coordination/Relocation	$140,454.30	L.S.		$140,454.00	
Stormwater Management/Erosion Control	5%			$140,454.00	
Subtotal Additional Capital Improvement Costs				**$589,907.00**	
Land Acquisition Costs					
ROW/Easements				$1,408,000.00	
Subtotal Land Acquisition Costs				**$1,408,000.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering	15%			$509,849.00	
Legal/Administrative	5%			$169,950.00	
Contract Admin/Construction Management	10%			$339,899.00	
Contingency	25%			$849,748.00	
Subtotal Other Costs				**$1,869,446.00**	
Total Capital Improvement Costs				**$6,676,439.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	1100	L.F.	$1.00	$1,100.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	6	EA	$67.00	$402.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, s	16.5	ACRE	$2,010.00	$33,165.00	
Total Annual Operation and Maintenance Cost				**$34,667.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$1,089,362.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Sharktooth Bluffs
DRAINAGEWAY :	WC
REACH :	2
JURISDICTION :	City of Greeley
REACH ID:	81st Ave - FHMA 8 Ac.ft

Monica Ramirez | DATE : | 12/19/2018

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities					
Detention (Complete-in-Place)					
Detention Facility 1 (Complete-in-Place)	8	AC-FT	$61,104.00	$458,280.00	
Landscaping and Maintenance Improvements					
Wetlands Plantings	1	ACRE	$33,500.00	$33,500.00	
Reclamation & seeding (native grasses)	6	ACRE	$1,340.00	$7,370.00	
Trail/Path, Crusher Fines (10' Width)	700	L.F.	$15.00	$10,500.00	Maintenance Road
Land Acquisition					
Easement/ROW Acquisition	6.00	ACRE	$88,000.00	$528,000.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$458,280.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$51,370.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$509,650.00**	
Additional Capital Improvement Costs					
Dewatering	$5,096.50	L.S.		$5,097.00	
Mobilization	5%			$25,483.00	
Traffic Control	$25,482.50	L.S.		$25,483.00	
Utility Coordination/Relocation	$25,482.50	L.S.		$25,483.00	
Stormwater Management/Erosion Control	5%			$25,483.00	
Subtotal Additional Capital Improvement Costs				**$107,029.00**	
Land Acquisition Costs					
ROW/Easements				$528,000.00	
Subtotal Land Acquisition Costs				**$528,000.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering	15%			$92,502.00	
Legal/Administrative	5%			$30,834.00	
Contract Admin/Construction Management	10%			$61,668.00	
Contingency	25%			$154,170.00	
Subtotal Other Costs				**$339,174.00**	
Total Capital Improvement Costs				**$1,483,853.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	1100	L.F.	$1.00	$1,100.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	6	EA	$67.00	$402.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, s	6	ACRE	$2,010.00	$12,060.00	
Total Annual Operation and Maintenance Cost				**$13,562.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$426,167.00**	

Canal Base Flow Separation Alternatives

C-24: Northridge Draw – Poudre River Ranch

C-24: Poudre Learning Center – Jones Ditch

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : ND
REACH : 1
JURISDICTION : City of Greeley
REACH ID: PRR - Baseflow Separation | Enter Estimator Name on Project Info | DATE : 12/19/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains						
Manholes and Inlets						
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)		2	EA	$16,080.00	$32,160.00	
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)			
7	3	1	70	L.F.	$722.88	$50,602.00	Flume over Greeley No. 3 Canal
Headwall and Toewalls						
Individual Box Span (ft)	No. of Barrels	Total Span (ft)				
7	1	9.00	2	EA	$813.96	$1,628.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft)	Box Rise (ft)	No. of Barrels				
7	3	1	2	EA	$6,827.66	$13,655.30	
Channel Improvements						
Excavation, Mid Range		900	C.Y.	$32.00	$28,800.00	Channel Excavation
18-inch Riprap, Type H		5	C.Y.	$107.00	$535.00	Outlet Protection
Landscaping and Maintenance Improvements						
Trail/Path, Concrete (10' Width)		75	L.F.	$59.00	$4,425.00	Maintenance Road north of Greeley No. 3
Land Acquisition						
Easement/ROW Acquisition		0.70	ACRE	$8,471.71	$5,930.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$32,160.00
Concrete Box Culverts				$65,885.00
Hydraulic Structures				$0.00
Channel Improvements				$29,335.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$4,425.00
Special Items (User Defined)				$0.00
Subtotal Capital Improvement Costs				**$131,805.00**
Additional Capital Improvement Costs				
Dewatering	$1,318.05	L.S.		$1,318.00
Mobilization	5%			$6,590.00
Traffic Control	$6,590.25	L.S.		$6,590.00
Utility Coordination/Relocation	$6,590.25	L.S.		$6,590.00
Stormwater Management/Erosion Control	5%			$6,590.00
Subtotal Additional Capital Improvement Costs				**$27,678.00**
Land Acquisition Costs				
ROW/Easements				$5,930.00
Subtotal Land Acquisition Costs				**$5,930.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$23,922.00
Legal/Administrative	5%			$7,974.00
Contract Admin/Construction Management	10%			$15,948.00
Contingency	25%			$39,871.00
Subtotal Other Costs				**$87,715.00**
Total Capital Improvement Costs				**$253,128.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, c	75	L.F.	$1.00	$75.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, s	0.5	ACRE	$2,010.00	$1,005.00	
Total Annual Operation and Maintenance Cost				**$1,080.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$33,937.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : PLC
REACH : 1
JURISDICTION : City of Greeley
REACH ID: Jones Ditch - Baseflow Separation | Enter Estimator Name on Project Info | DATE : 12/21/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Channel Improvements						
Excavation, Mid Range		890	C.Y.	$32.00	$28,480.00	600 LF overflow channel
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		1	ACRE	$1,340.00	$769.00	
Special Items (User Defined)						
Concrete Spillway	<----User Defined Items	50	C.Y.	$804.00	$40,200.00	Concrete for canal separation spillway

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$28,480.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$769.00
Special Items (User Defined)				$40,200.00
Subtotal Capital Improvement Costs				**$69,449.00**
Additional Capital Improvement Costs				
Dewatering	$694.49	L.S.		$694.00
Mobilization	5%			$3,472.00
Traffic Control	$3,472.45	L.S.		$3,472.00
Utility Coordination/Relocation	$3,472.45	L.S.		$3,472.00
Stormwater Management/Erosion Control	5%			$3,472.00
Subtotal Additional Capital Improvement Costs				**$14,582.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$12,605.00
Legal/Administrative	5%			$4,202.00
Contract Admin/Construction Management	10%			$8,403.00
Contingency	25%			$21,008.00
Subtotal Other Costs				**$46,218.00**
Total Capital Improvement Costs				**$130,249.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	1	EA	$670.00	$134.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	600	L.F.	$3.00	$900.00	
Total Annual Operation and Maintenance Cost				**$1,034.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$32,492.00**	

No Action Alternatives

C-26: Foothills Tributary – North of Melbourne

C-26: Poudre Learning Center – 83rd Avenue

C-27: Poudre River Ranch – East

C-27: Wiedeman Creek – 4th Street

C-28: Wiedeman Creek – 78th Avenue

C-28: Wiedeman Creek – 81st Avenue

C-29: Wiedeman Creek – Armour Hill Road

C-29: Wiedeman Creek – Skyview Street

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : NofMelbourneSt
REACH : 1
JURISDICTION : City of Greeley
REACH ID: NoAction-Reach1 — Enter Estimator Name on Project Info — DATE : 12/19/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering			L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control			L.S.		$0.00	
Utility Coordination/Relocation			L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$0.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	150	L.F.	$1.00	$300.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, s	0.2	ACRE	$2,010.00	$402.00	
Total Annual Operation and Maintenance Cost				**$702.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$22,059.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : 83rd Ave
REACH : 5
JURISDICTION : City of Greeley
REACH ID: No Action-Reach5 — Enter Estimator Name on Project Info — DATE : 12/21/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering			L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control			L.S.		$0.00	
Utility Coordination/Relocation			L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$0.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	77	L.F.	$1.00	$77.00	
Total Annual Operation and Maintenance Cost				**$77.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$2,420.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : East Poudre River Rd
REACH : 1
JURISDICTION : City of Greeley
REACH ID: EPRR-Reach1 Monica Ramirez DATE : 12/19/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering		$0.00	L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control		$0.00	L.S.		$0.00	
Utility Coordination/Relocation		$0.00	L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$0.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	275	L.F.	$1.00	$550.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	2	EA	$67.00	$268.00	
Total Annual Operation and Maintenance Cost				**$818.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$25,705.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluff
DRAINAGEWAY : Wiedeman Creek - 4th Street
REACH : 1
JURISDICTION : City of Greeley
REACH ID: No Action-Reach1 Enter Estimator Name on Project Info DATE : 12/21/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering			L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control			L.S.		$0.00	
Utility Coordination/Relocation			L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$0.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	50	L.F.	$1.00	$100.00	
Total Annual Operation and Maintenance Cost				**$100.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$3,142.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Enter Project Name on Project Info Tab
DRAINAGEWAY : WC-78thAve
REACH : 1
JURISDICTION : City of Greeley
REACH ID: No Action-Reach1 | Enter Estimator Name on Project Info | DATE : | Enter Date on Project Info Tab.

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering			L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control			L.S.		$0.00	
Utility Coordination/Relocation			L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$0.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	220	L.F.	$1.00	$220.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	1	EA	$67.00	$67.00	
Total Annual Operation and Maintenance Cost				**$287.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$9,019.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Sharktooth Bluffs
DRAINAGEWAY : WC
REACH : 5
JURISDICTION : City of Greeley
REACH ID: NoAction-Reach5 | Monica Ramirez | DATE : | 12/19/2018

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering			L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control			L.S.		$0.00	
Utility Coordination/Relocation			L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land Acquisition Costs						
ROW/Easements					$0.00	
Subtotal Land Acquisition Costs					**$0.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$0.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs,	1100	L.F.	$1.00	$1,100.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	6	EA	$67.00	$402.00	
Total Annual Operation and Maintenance Cost				**$1,502.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$47,198.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT : Enter Project Name on Project Info Tab
DRAINAGEWAY : Wiedeman Creek - Armour Hill Dr
REACH : 1
JURISDICTION : City of Greeley
REACH ID: No Action-Reach1 Enter Estimator Name on Project Info **DATE :** Enter Date on Project Info Tab.

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Land Acquisition						
Easement/ROW Acquisition		0.30	ACRE	$132,618.00	$39,785.00	

Master Plan Capital Improvement Cost Summary						
Capital Improvement Costs						
Pipe Culverts and Storm Drains					$0.00	
Concrete Box Culverts					$0.00	
Hydraulic Structures					$0.00	
Channel Improvements					$0.00	
Detention/Water Quality Facilities					$0.00	
Removals					$0.00	
Landscaping and Maintenance Improvements					$0.00	
Special Items (User Defined)					$0.00	
Subtotal Capital Improvement Costs					**$0.00**	
Additional Capital Improvement Costs						
Dewatering			L.S.		$0.00	
Mobilization		5%			$0.00	
Traffic Control			L.S.		$0.00	
Utility Coordination/Relocation			L.S.		$0.00	
Stormwater Management/Erosion Control		5%			$0.00	
Subtotal Additional Capital Improvement Costs					**$0.00**	
Land Acquisition Costs						
ROW/Easements					$39,785.00	
Subtotal Land Acquisition Costs					**$39,785.00**	
Other Costs (percentage of Capital Improvement Costs)						
Engineering		15%			$0.00	
Legal/Administrative		5%			$0.00	
Contract Admin/Construction Management		10%			$0.00	
Contingency		25%			$0.00	
Subtotal Other Costs					**$0.00**	
Total Capital Improvement Costs					**$39,785.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	420	L.F.	$1.00	$840.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	5	EA	$67.00	$670.00	
Total Annual Operation and Maintenance Cost				**$1,510.00**	
Effective Interest Rate				2.00%	
Total Operation and Maintenance Costs Over 50 Years				**$47,450.00**	

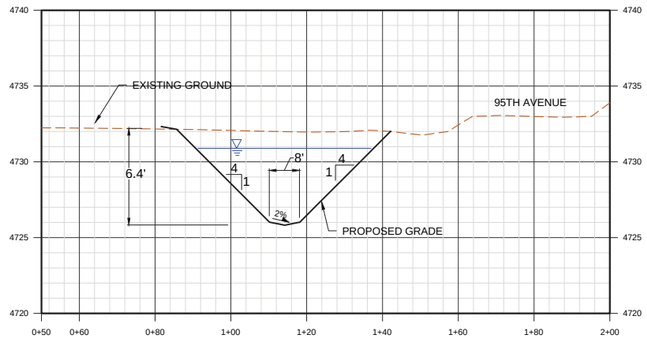
Benefit - Cost Ratio Calculations

BCA Assumptions		
Discount Rate		7.0%
Project Life		50 years
EAD Before Migitation	$	12,728
EAD After Mitigation	$	-
EAB	$	12,728
Project Benefits	$	175,656

Building Information				Existing Conditions FFE Flooding Depths (ft.)					Existing Conditions Structure Percent Damaged					Existing Conditions Content Percent Damages				
Parcel No.	Address	Structure Value	Contents Value	2-yr	5-yr	10-yr	50-yr	100-yr	2-yr	5-yr	10-yr	50-yr	100-yr	2-yr	5-yr	10-yr	50-yr	100-yr
80532331003	7907 RIVER RUN DR	$ 346,465	$ 173,233	0.00	0.00	0.00	0.00	0.48	0.0%	0.0%	0.0%	0.0%	7.2%	0.0%	0.0%	0.0%	0.0%	4.1%
80532331002	7911 RIVER RUN DR	$ 298,312	$ 149,156	0.00	0.00	0.00	0.00	1.37	0.0%	0.0%	0.0%	0.0%	17.3%	0.0%	0.0%	0.0%	0.0%	10.0%
80532331001	7915 RIVER RUN DR	$ 302,555	$ 151,278	0.00	0.33	0.30	0.31	0.39	0.0%	5.0%	4.6%	4.7%	5.9%	0.0%	2.9%	2.6%	2.7%	3.4%
80532332013	604 N 81ST AVE	$ 279,742	$ 139,871	0.00	0.00	0.00	0.00	0.19	0.0%	0.0%	0.0%	0.0%	2.9%	0.0%	0.0%	0.0%	0.0%	1.7%
80532332014	600 N 81ST AVE	$ 365,666	$ 182,833	0.00	0.00	0.00	0.00	1.12	0.0%	0.0%	0.0%	0.0%	15.9%	0.0%	0.0%	0.0%	0.0%	9.1%
80532330005	8101 RIVER RUN DR	$ 296,998	$ 148,499	0.00	0.00	0.00	0.00	1.11	0.0%	0.0%	0.0%	0.0%	15.8%	0.0%	0.0%	0.0%	0.0%	9.1%
80532306001	441 HORIZON CIR	$ 501,078	$ 250,539	0.00	0.00	0.00	0.00	0.85	0.0%	0.0%	0.0%	0.0%	13.0%	0.0%	0.0%	0.0%	0.0%	7.4%
80532329038	520 DEVILLE DR	$ 318,259	$ 159,130	0.00	0.00	0.00	0.00	0.65	0.0%	0.0%	0.0%	0.0%	9.9%	0.0%	0.0%	0.0%	0.0%	5.7%
80532329037	516 DEVILLE DR	$ 301,865	$ 150,933	0.00	0.00	0.00	0.00	0.62	0.0%	0.0%	0.0%	0.0%	9.4%	0.0%	0.0%	0.0%	0.0%	5.4%

Building Information				Existing Conditions Damages					Expected Annualized			
Parcel No.	Address	Structure Value	Contents Value	2-yr	5-yr	10-yr	50-yr	100-yr	Before Mitigation	After Mitigation	Benefit	Project Benefits
80532331003	7907 RIVER RUN DR	$ 346,465	$ 173,233	$ -	$ -	$ -	$ -	$ 32,241	$ 484	$ -	$ 484	$ 6,674
80532331002	7911 RIVER RUN DR	$ 298,312	$ 149,156	$ -	$ -	$ -	$ -	$ 66,454	$ 997	$ -	$ 997	$ 13,757
80532331001	7915 RIVER RUN DR	$ 302,555	$ 151,278	$ -	$ 19,401	$ 17,745	$ 18,455	$ 22,891	$ 6,651	$ -	$ 6,651	$ 91,790
80532332013	604 N 81ST AVE	$ 279,742	$ 139,871	$ -	$ -	$ -	$ -	$ 10,446	$ 157	$ -	$ 157	$ 2,162
80532332014	600 N 81ST AVE	$ 365,666	$ 182,833	$ -	$ -	$ -	$ -	$ 74,811	$ 1,122	$ -	$ 1,122	$ 15,487
80532330005	8101 RIVER RUN DR	$ 296,998	$ 148,499	$ -	$ -	$ -	$ -	$ 60,475	$ 907	$ -	$ 907	$ 12,519
80532306001	441 HORIZON CIR	$ 501,078	$ 250,539	$ -	$ -	$ -	$ -	$ 83,658	$ 1,255	$ -	$ 1,255	$ 17,318
80532329038	520 DEVILLE DR	$ 318,259	$ 159,130	$ -	$ -	$ -	$ -	$ 40,629	$ 609	$ -	$ 609	$ 8,411
80532329037	516 DEVILLE DR	$ 301,865	$ 150,933	$ -	$ -	$ -	$ -	$ 36,412	$ 546	$ -	$ 546	$ 7,538

APPENDIX D - CONCEPTUAL DESIGN INFORMATION



DRAINAGE CHANNEL
TYPICAL CROSS SECTION

GEOMORPHIC RECOMMENDATIONS FROM MASTER PLAN TO BE USED DURING FINAL DESIGN

NORTH

0 100' 200' 400'
SCALE: 1" = 200'

BELLEVUE PIPELINE STABILIZATION

PROPOSED DETENTION FACILITY
100-YEAR WSEL = 4749.44 FT
SURFACE AREA = 14 ACRES
VOLUME AT 100YR = 88 AF
DEPTH AT 100-YEAR = 9.84 FT

EXISTING 100-YEAR FLOODPLAIN

PROPOSED DRAINAGE EASEMENT

PROPOSED PROPERTY ACQUISITION

PROPOSED 4FT X 5FT RCBC POND OUTLET

PROPOSED DRAINAGE CHANNEL (SEE TYPICAL CROSS SECTION, THIS SHEET)

EXISTING BELLVUE WATER TREATMENT PLANT WATER MAINS

PROPOSED STORM DRAIN OUTFALL
38"X60" HERCP

RESIDUAL EXISTING 100-YEAR FLOODPLAIN (LIGHT BLUE)

1060 cfs
229 cfs
75 cfs
158 cfs

XS
XS

ORR ED
SIEBRING RESERVOIR
COUNTY RD 62
SHARKTOOTH DRAW
95TH AVENUE
MARTIN MARIETTA MATERIALS INC.
CACHE LA POUDRE RIVER
GREELEY - ROTHE LLC
ERBY PHILIP H.

No.	DATE	REVISIONS	APPR.

811 Know what's below. Call before you dig.

PREPARED FOR: City of Greeley Colorado

PREPARED BY: ICON ENGINEERING, INC.

PLAN
DRAWN JYM
DESIGNED JD
CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN
SHARKTOOTH DRAW CONCEPTUAL DESIGN
OVERALL LAYOUT

ICON PROJECT No. 18-019-SBB

DATE
JULY 2019

SHEET
1 OF 9

PROPOSED DRAINAGE CHANNEL

PROPOSED DRAINAGE EASEMENT

TOP OF BERM = 4750.44 FT

4FT X 5FT RCBC @ 0.2%

133.81 LF OF 200FT

PROPOSED 4FTX 5FT RCBC POND OUTLET INV. OUT = 4739.60 FT

200ft SPILLWAY ELEV = 4749.44FT

PROPOSED PROPERTY ACQUISITION

PROPOSED DETENTION POND TO LIMIT FLOWS

100-YEAR WSEL = 4749.44 FT
SURFACE AREA = 14 ACRES
VOLUME = 88 AC-FT
QIN = 1060 CFS
QOUT = 230 CFS

100-YR WSEL = 4749.44 FT

EXISTING BELLEVUE WATER TREATMENT PLANT WATER MAINS

DROP STRUCTURE

95TH AVENUE

NORTH

0 60' 120' 180'
SCALE: 1" = 60'

No.	DATE	REVISIONS	APPR.

Know what's below. Call before you dig.

PREPARED FOR: City of Greeley Colorado

PREPARED BY: ICON ENGINEERING, INC.

PLAN
DRAWN JYM
DESIGNED JD
CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN
SHARKTOOTH DRAW CONCEPTUAL DESIGN
DETENTION FACILITY DETAIL

ICON PROJECT No. 18-019-SBB

DATE JULY 2019

SHEET 2 OF 9

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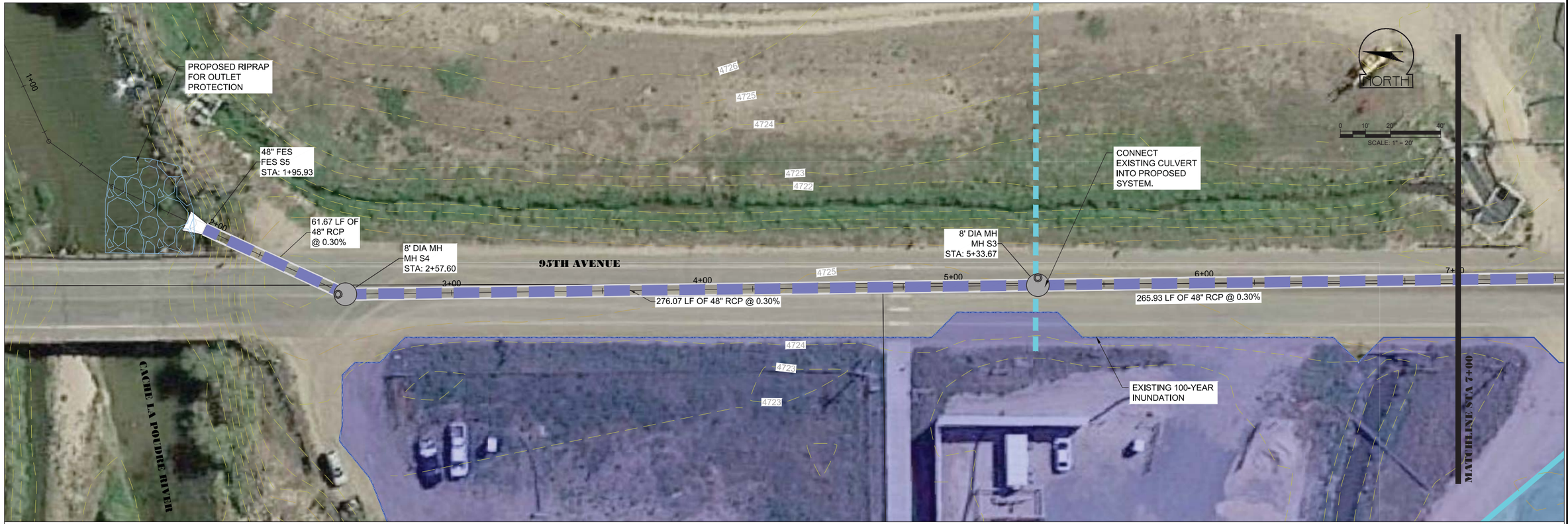

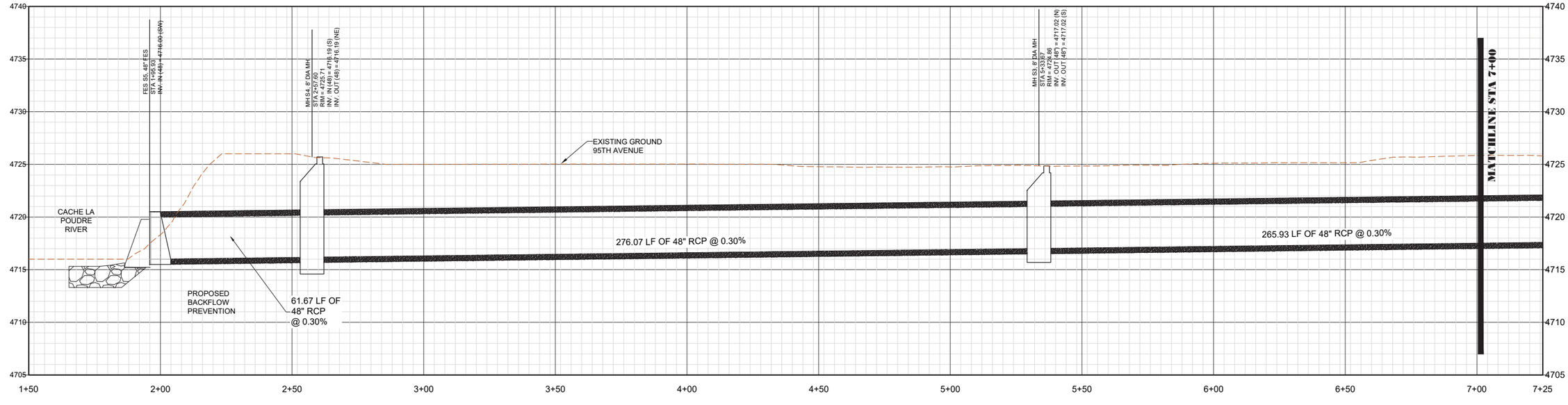

No.	DATE	REVISIONS	APPR.

Know what's below. Call before you dig.

PREPARED FOR: City of Greeley, Colorado

PREPARED BY: ICON ENGINEERING, INC.

PLAN
DRAWN JYM
DESIGNED JD
CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

SHARKTOOTH DRAW CONCEPTUAL DESIGN

OUTFALL PROFILE

ICON PROJECT No. 18-019-SBB

DATE
JULY 2019

SHEET
3 OF 9

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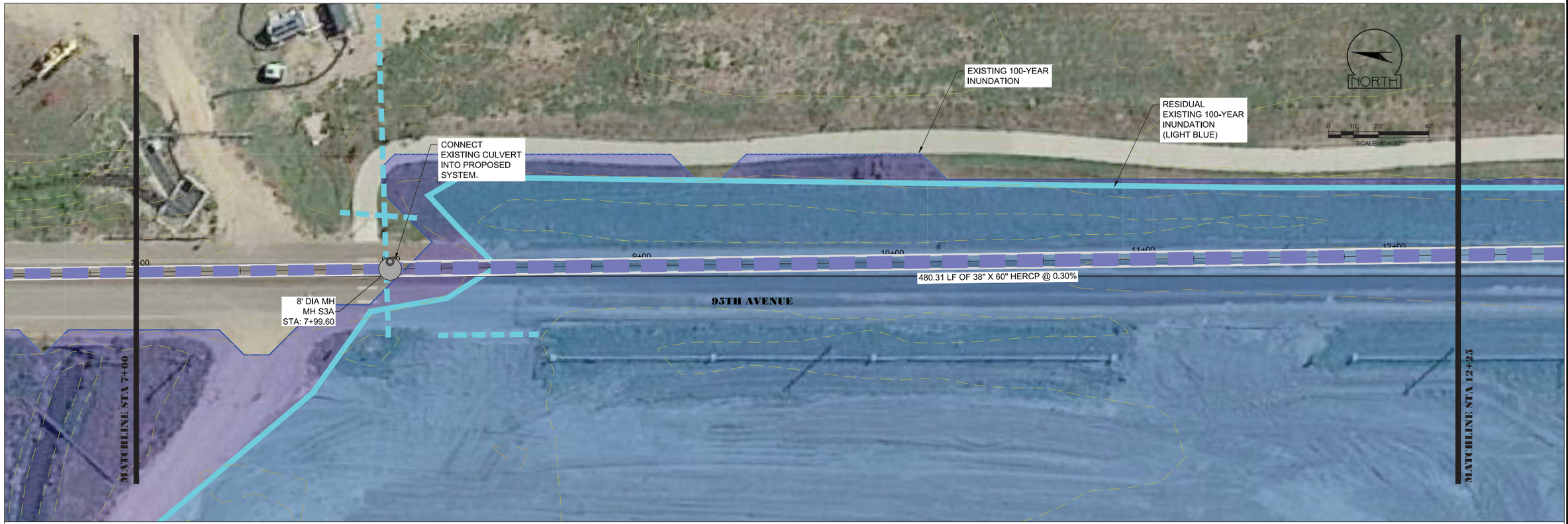

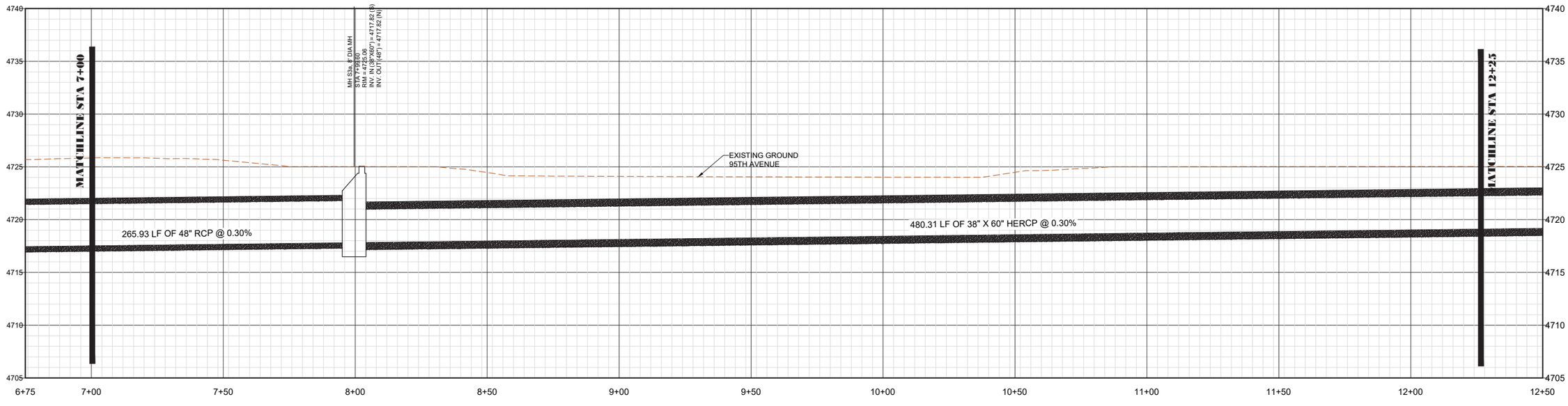

No.	DATE	REVISIONS	APPR.

Know what's below. Call before you dig.

PREPARED FOR: City of Greeley, Colorado

PREPARED BY: ICON ENGINEERING, INC.

PLAN
DRAWN JYM
DESIGNED JD
CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

SHARKTOOTH DRAW CONCEPTUAL DESIGN

OUTFALL PROFILE

ICON PROJECT No. 18-019-SBB

DATE
JULY 2019

SHEET
4 OF 9

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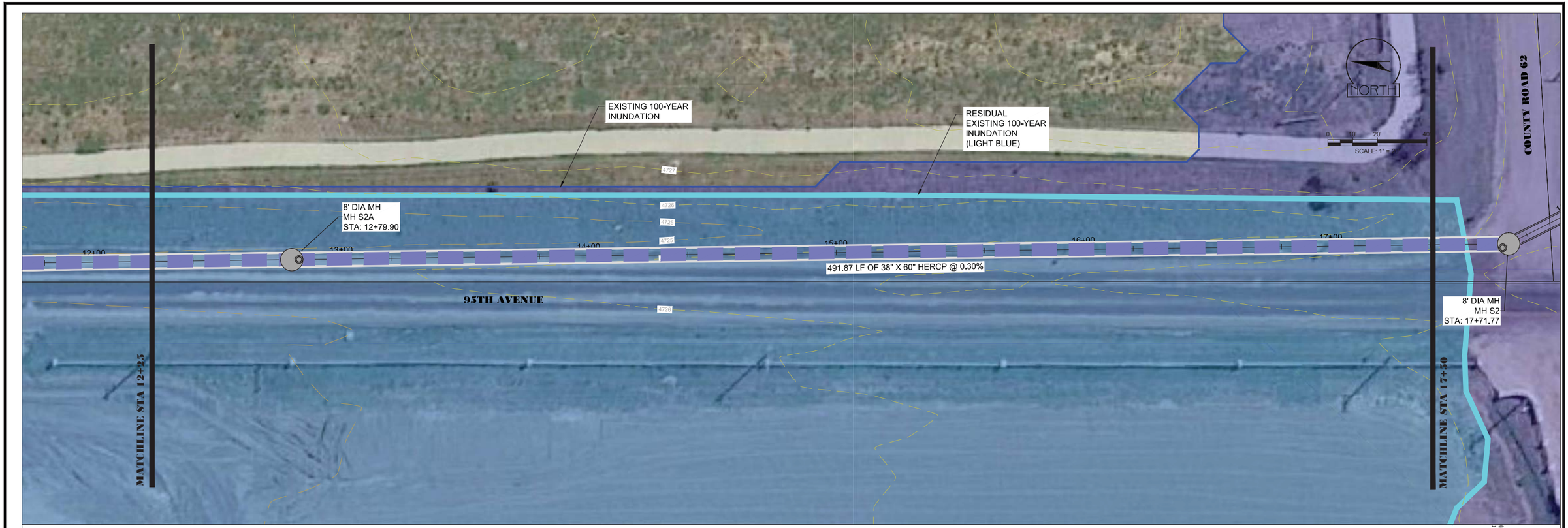

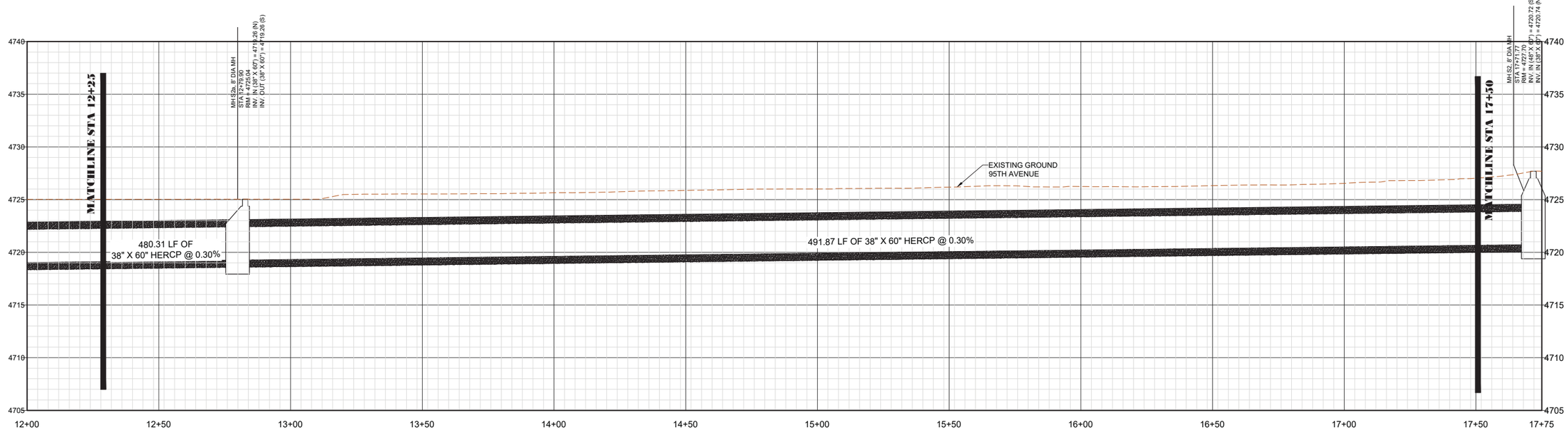

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No.	DATE	REVISIONS	APPR.

Know what's below. Call before you dig.

PREPARED FOR: City of Greeley Colorado

PREPARED BY: ICON ENGINEERING, INC.

PLAN
DRAWN JYM
DESIGNED JD
CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

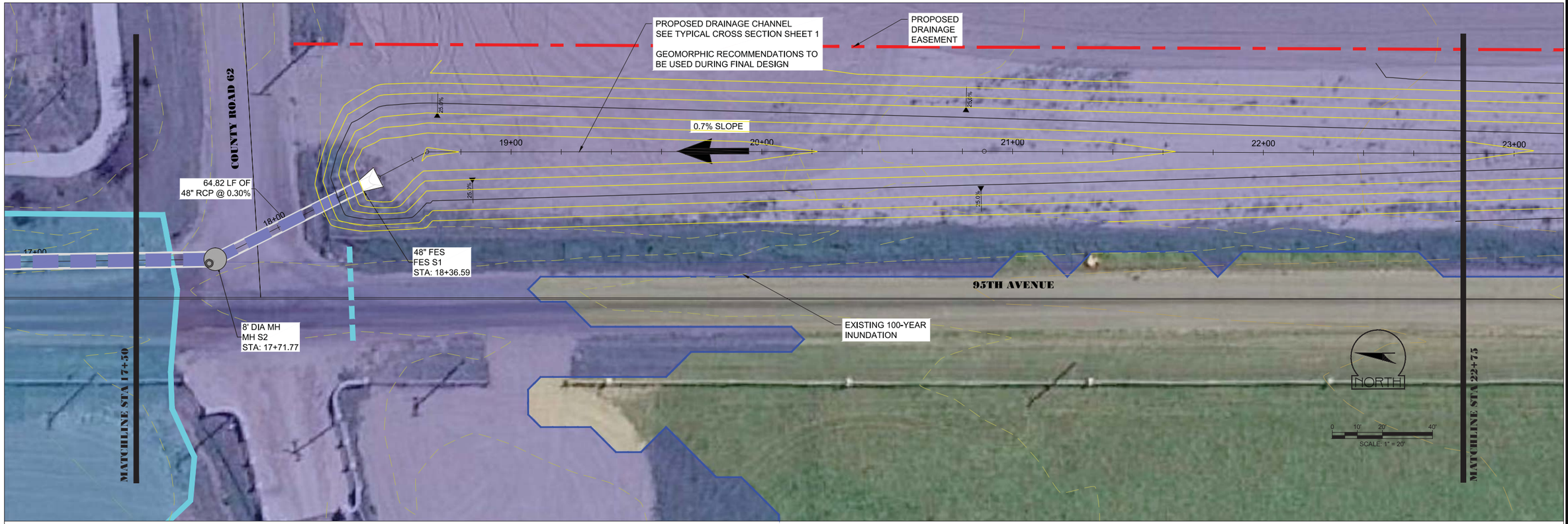
SHARKTOOTH DRAW CONCEPTUAL DESIGN

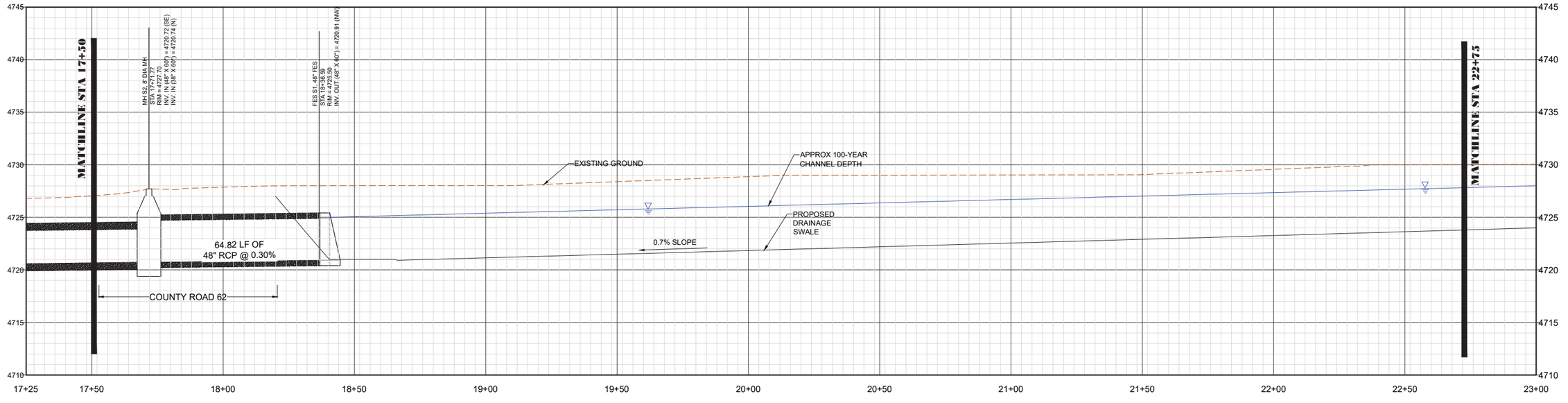
OUTFALL PROFILE

ICON PROJECT No. 18-019-SBB

DATE
JULY 2019

SHEET
5 OF 9





No.	DATE	REVISIONS	APPR.

Know what's below. Call before you dig.

PREPARED FOR: City of Greeley, Colorado

PREPARED BY: ICON ENGINEERING, INC.

PLAN
DRAWN JYM
DESIGNED JD
CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

SHARKTOOTH DRAW CONCEPTUAL DESIGN

OUTFALL PROFILE

ICON PROJECT No. 18-019-SBB

DATE
JULY 2019

SHEET
6 OF 9

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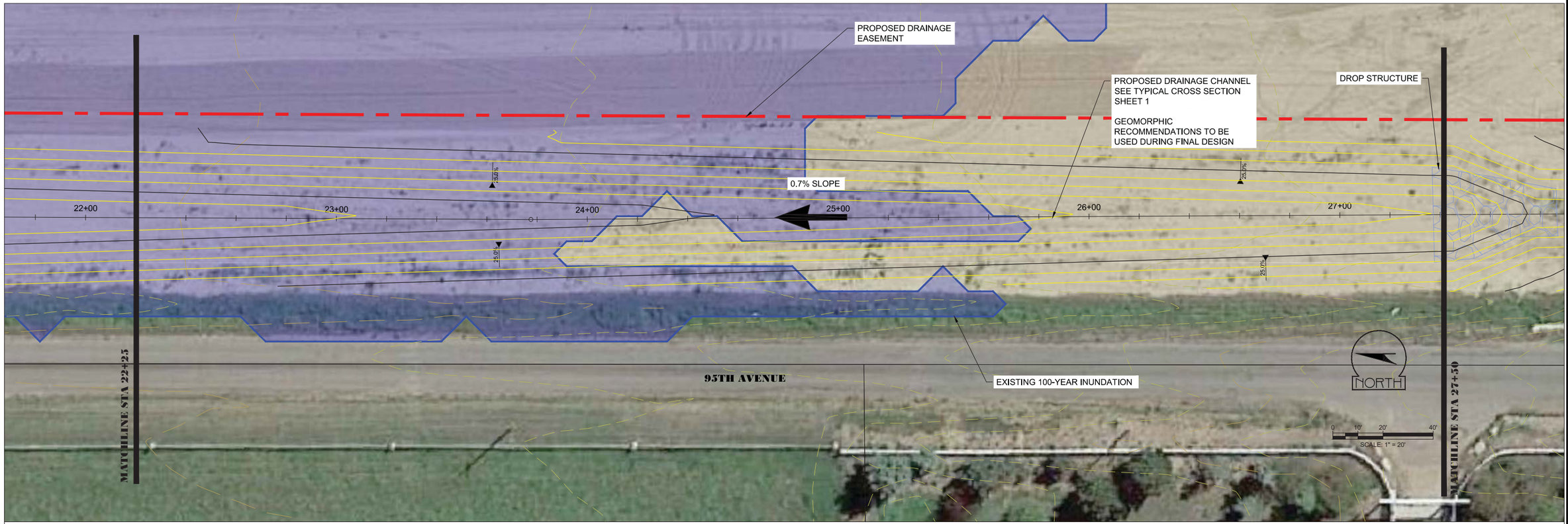

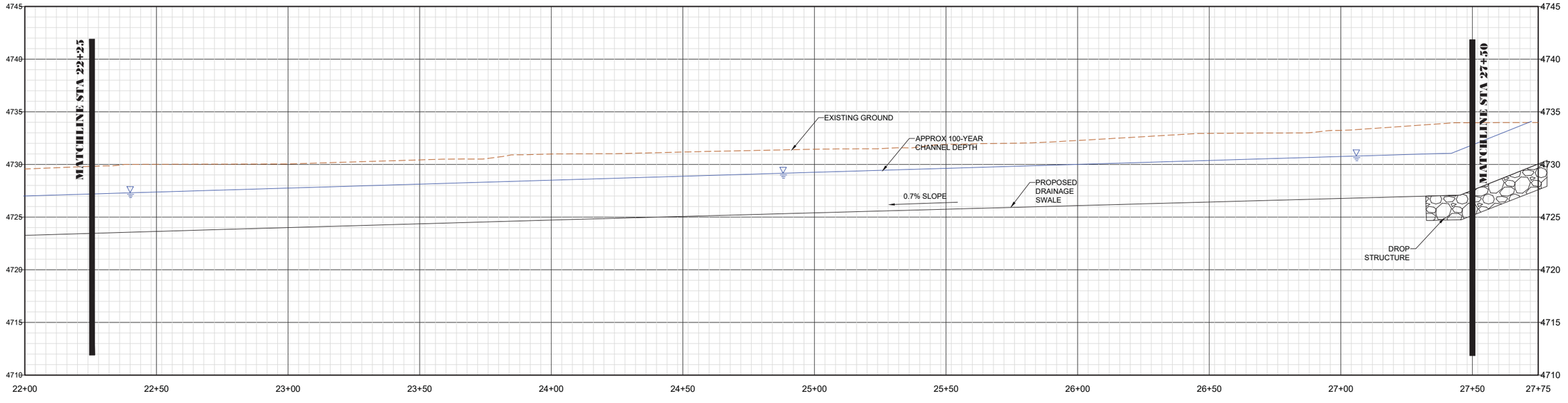

No.	DATE	REVISIONS	APPR.

Know what's below. Call before you dig.

PREPARED FOR: City of Greeley Colorado

PREPARED BY: ICON ENGINEERING, INC.

PLAN
DRAWN JYM
DESIGNED JD
CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

SHARKTOOTH DRAW CONCEPTUAL DESIGN

OUTFALL PROFILE

ICON PROJECT No. 18-019-SBB

DATE JULY 2019

SHEET 7 OF 9

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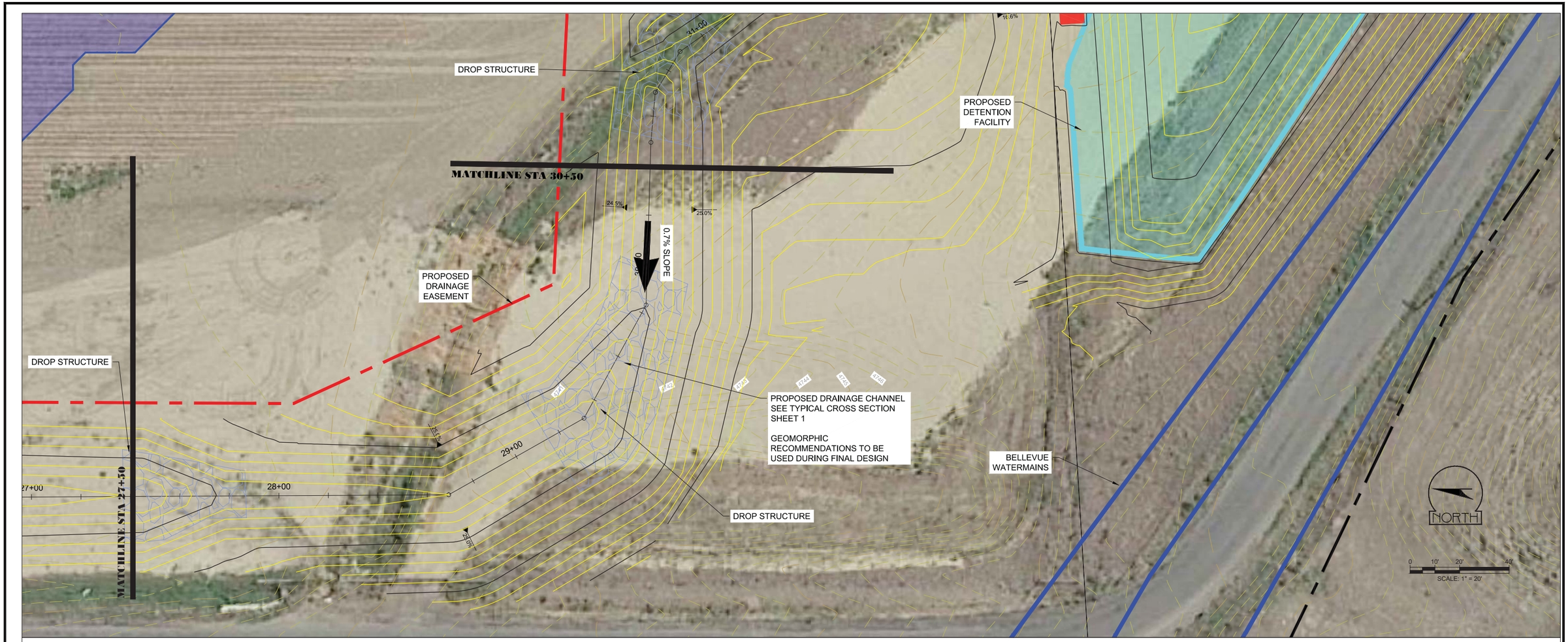

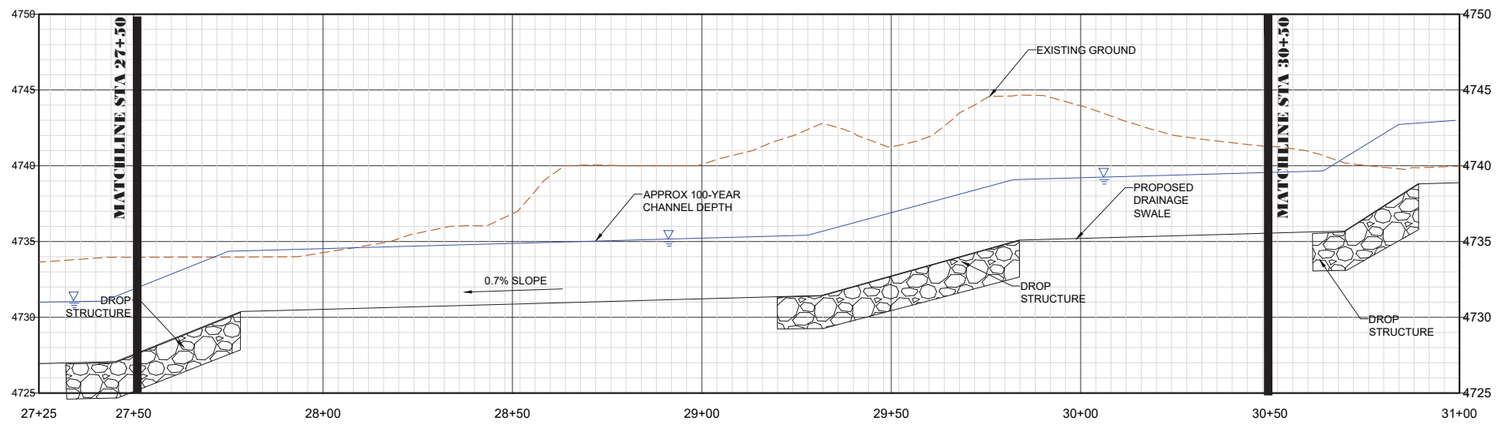

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DATE JULY 2019

SHEET 8 OF 9

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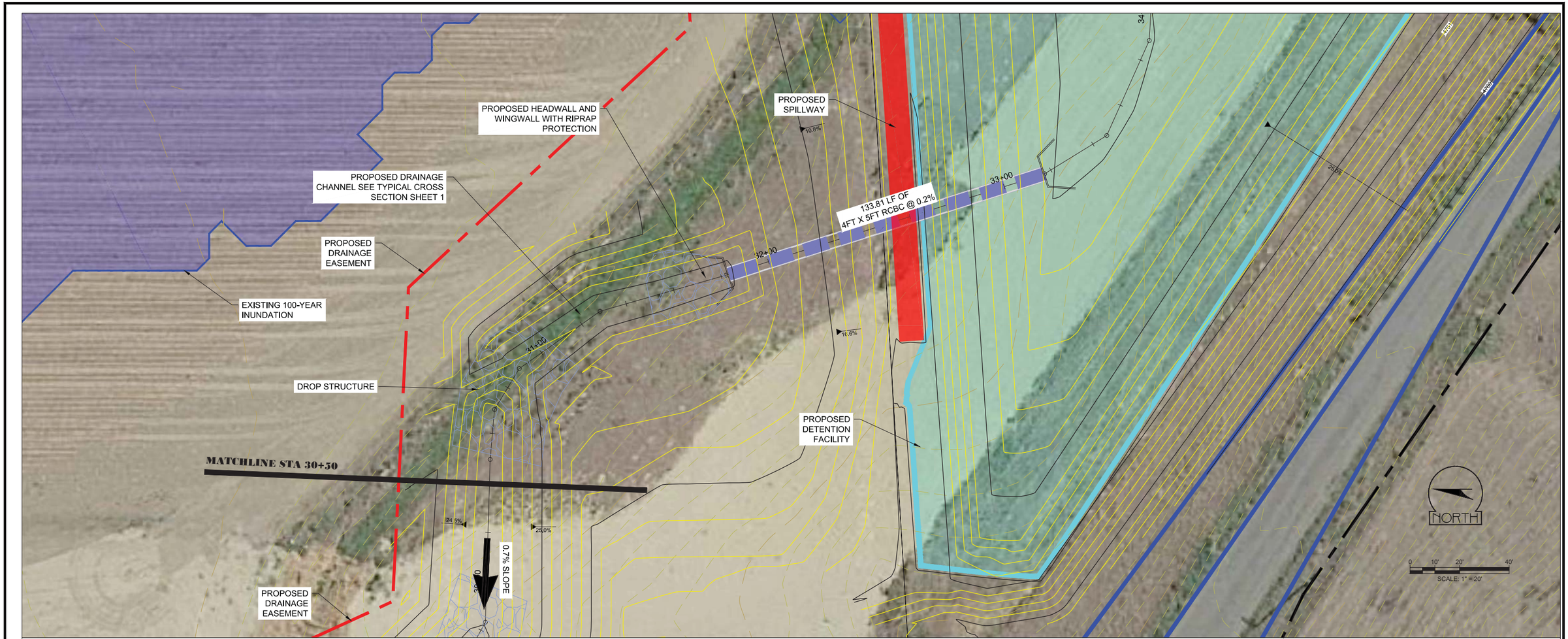

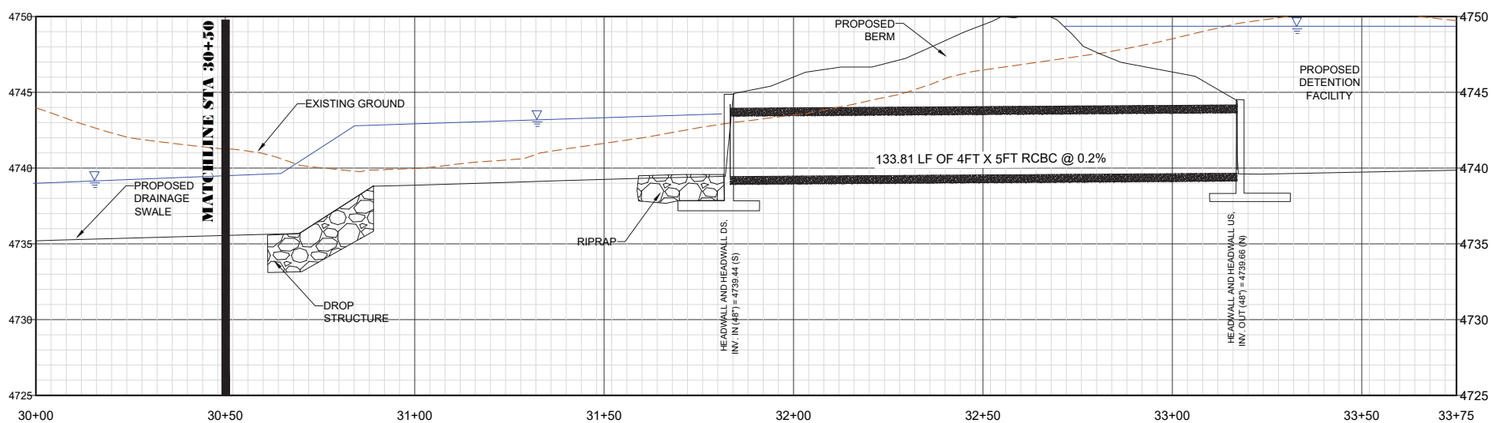

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OUTFALL PROFILE

ICON PROJECT No. 18-019-SBB

DATE
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SHEET
9 OF 9

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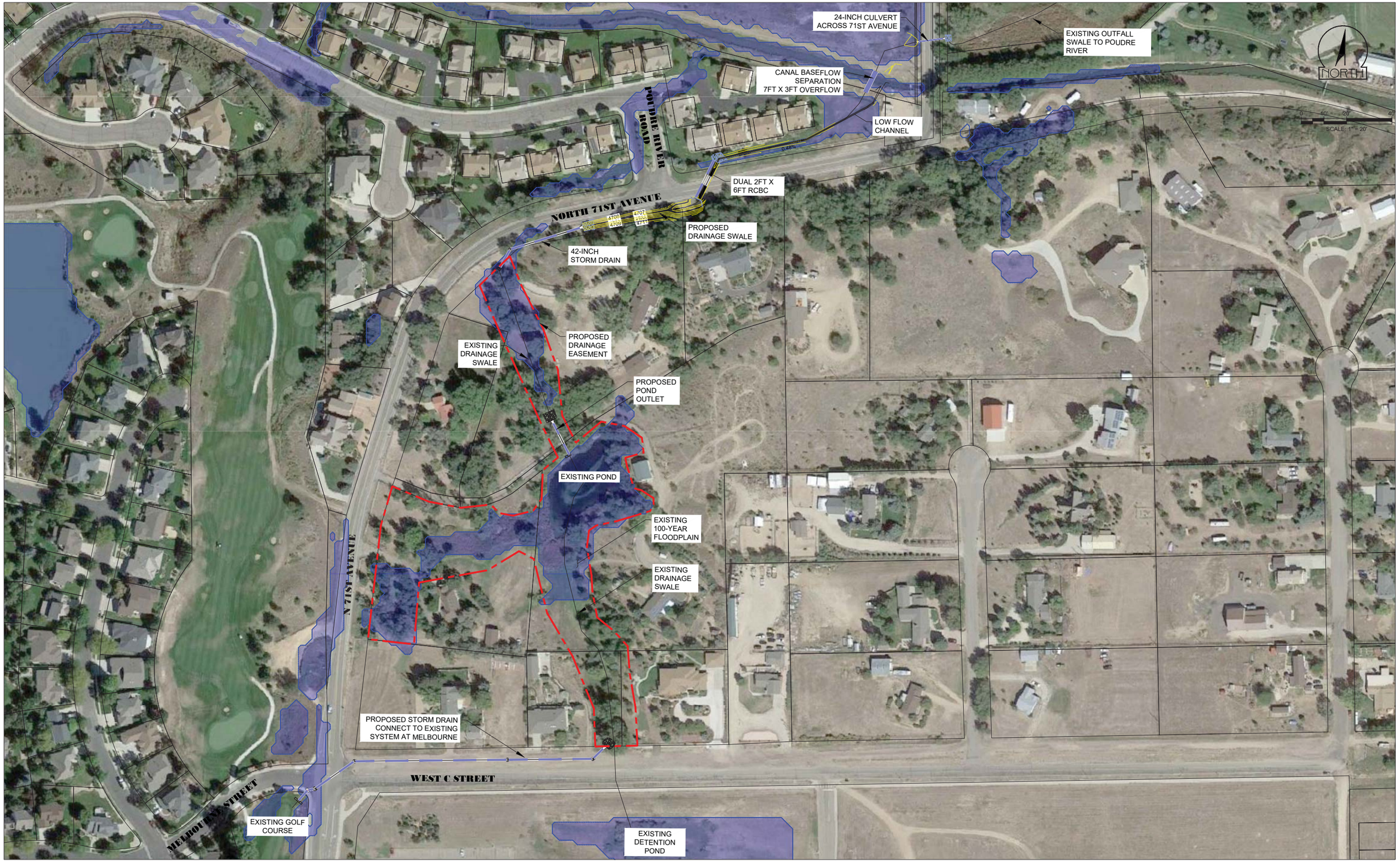

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PLAN
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SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

NORTHRIDGE DRAW CONCEPTUAL DESIGN

WEST C STREET AND 71ST AVENUE STORM DRAIN SYSTEM

ICON PROJECT No. 18-019-SBB

DATE
JULY 2019

SHEET
1 OF 9

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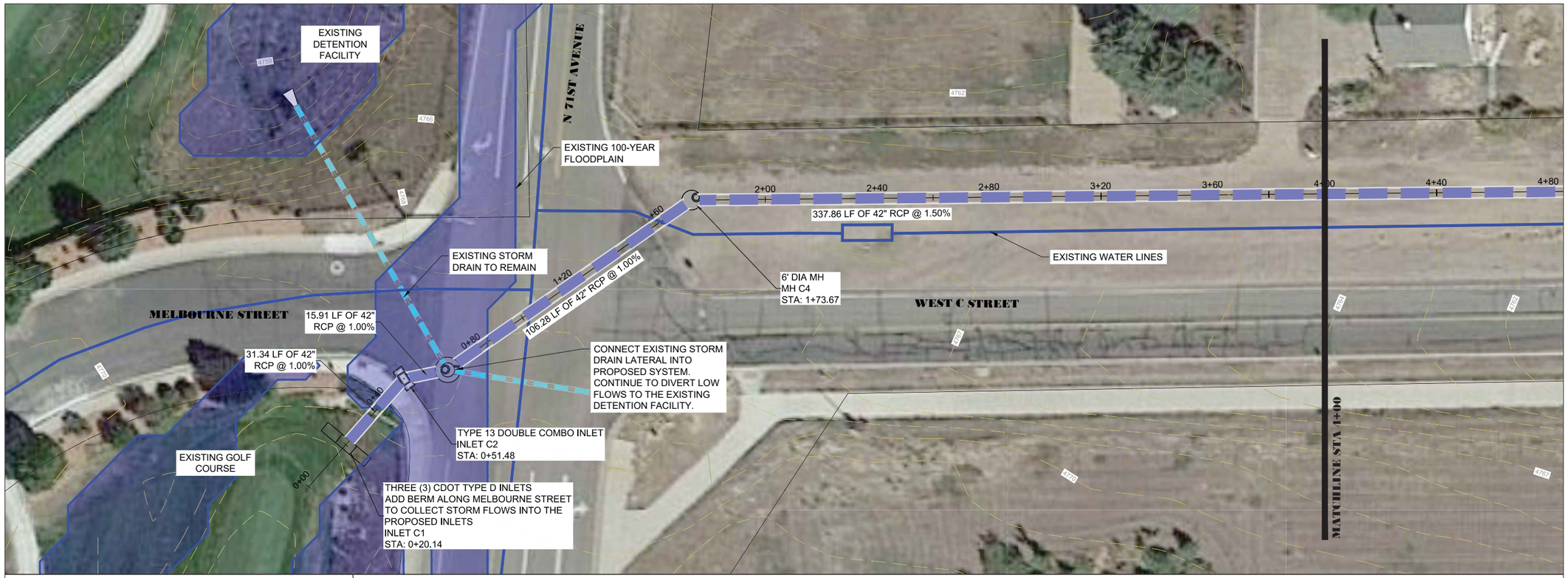

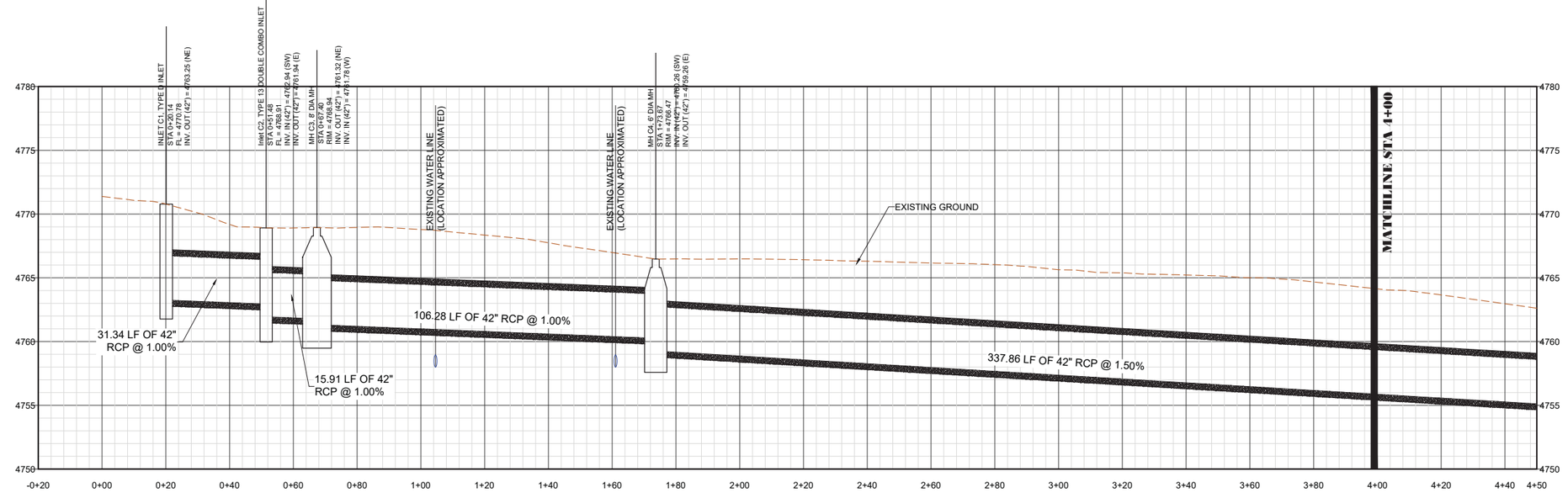

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WEST C STREET AND 71ST AVENUE STORM DRAIN SYSTEM

ICON PROJECT No. 18-019-SBB

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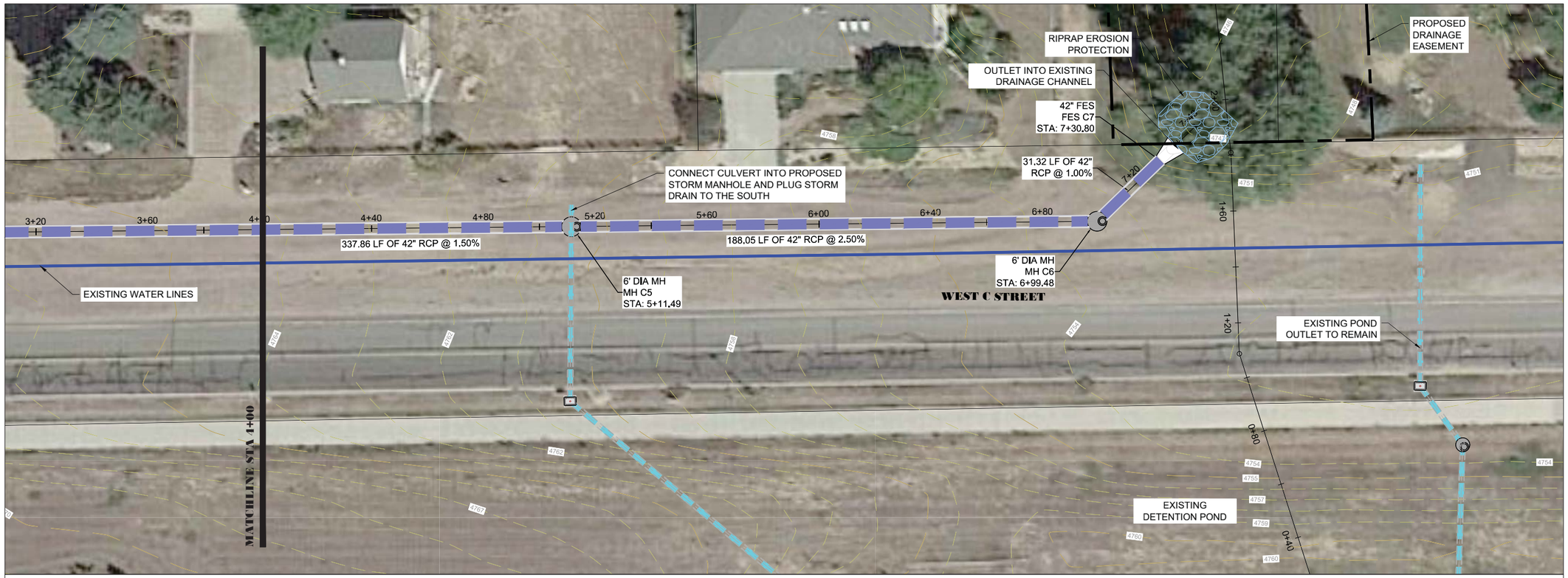
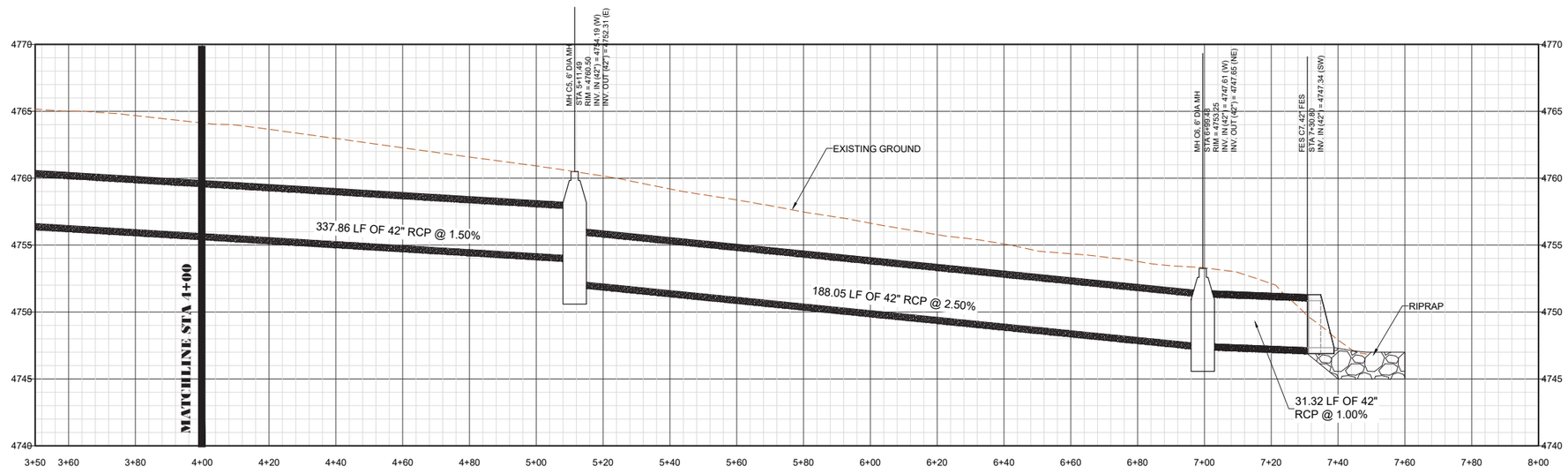
SHEET 2 OF 9





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WEST C STREET AND 71ST AVENUE STORM DRAIN SYSTEM

ICON PROJECT No. 18-019-SBB

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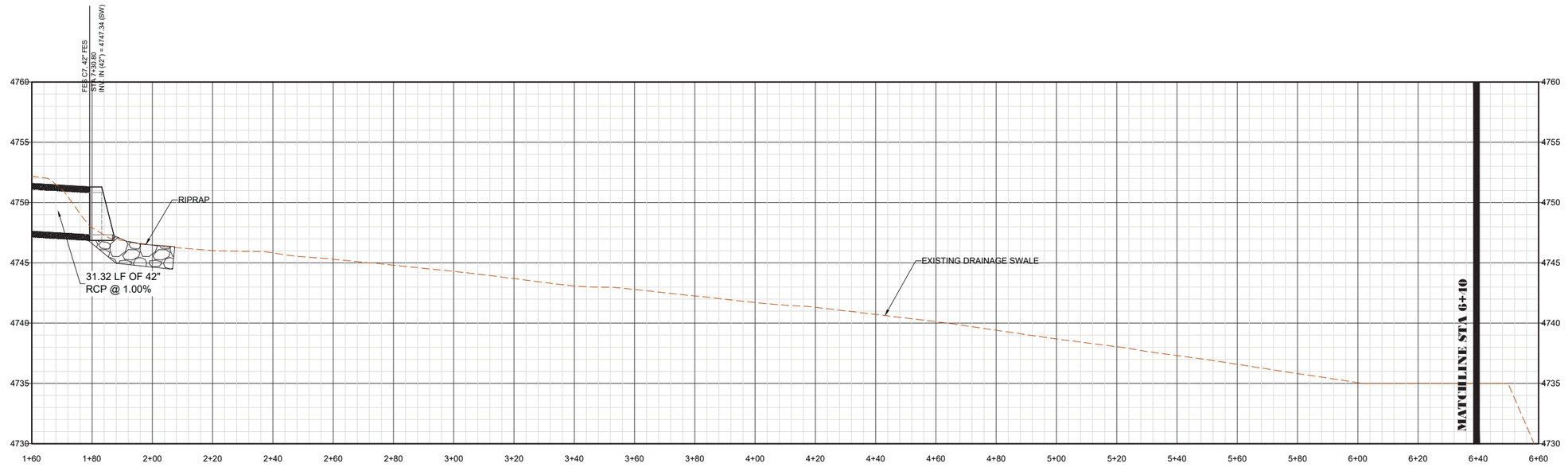
SHEET
3 OF 9



NORTH

0 10' 20' 40'
SCALE: 1" = 20'

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WEST C STREET AND 71ST AVENUE STORM DRAIN SYSTEM

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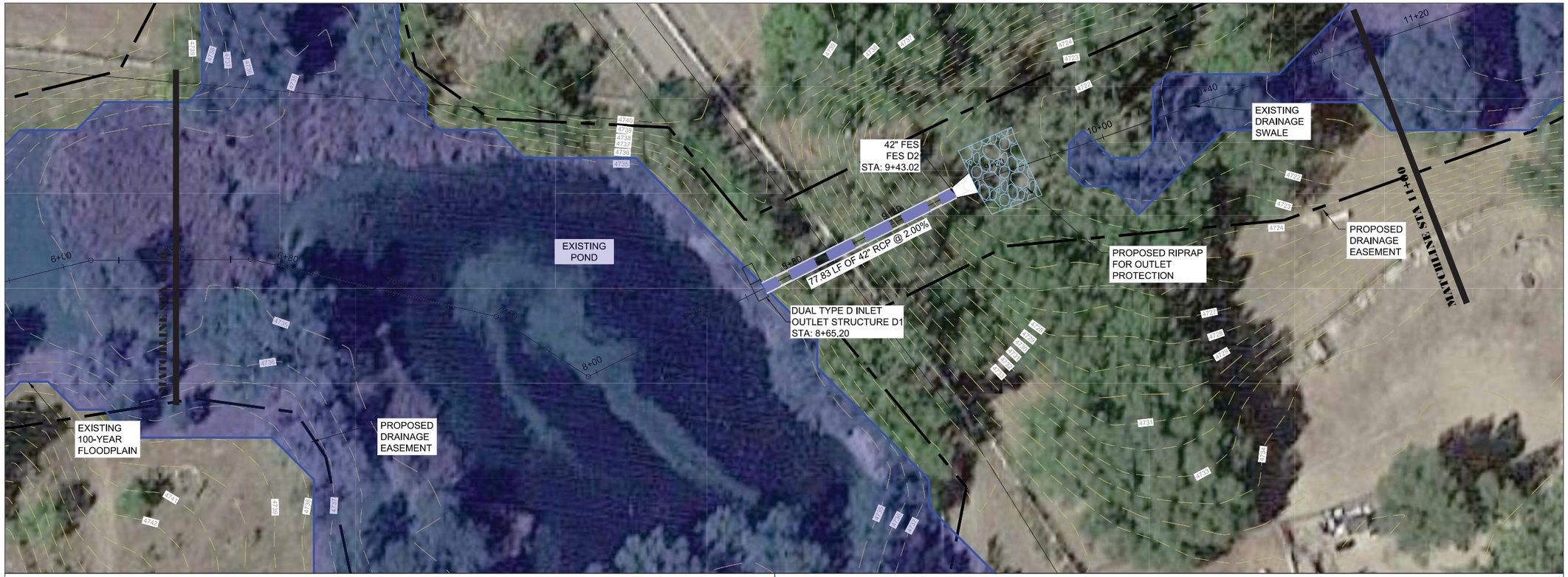
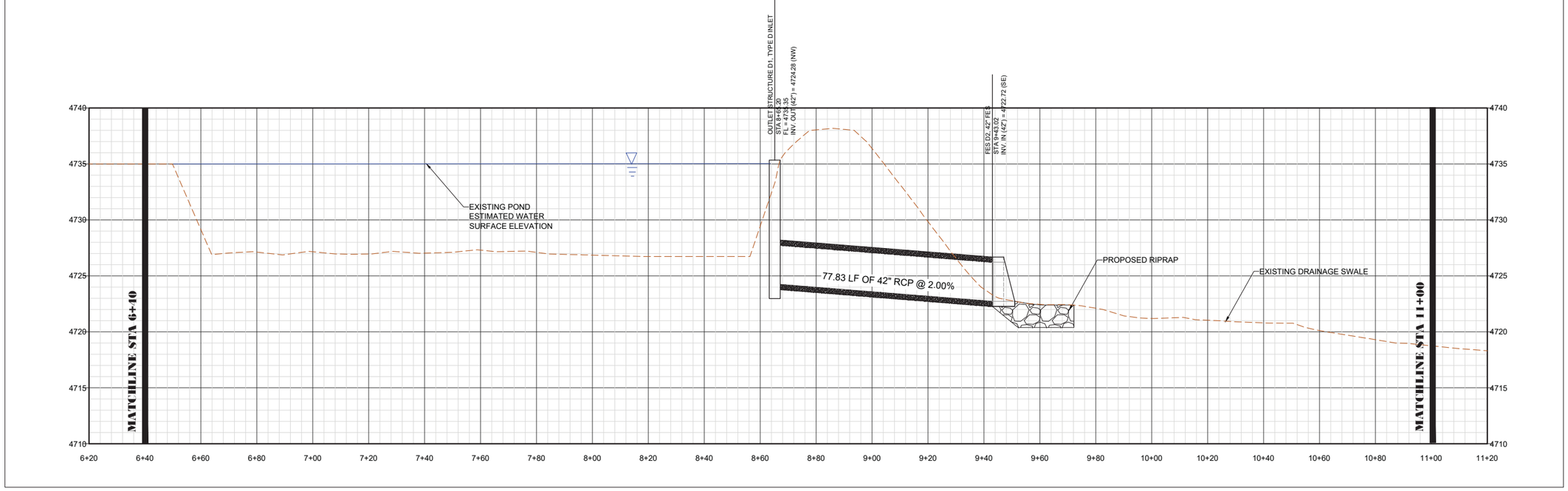
4 OF 9





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WEST C STREET AND 71ST AVENUE STORM DRAIN SYSTEM

ICON PROJECT No. 18-019-SBB

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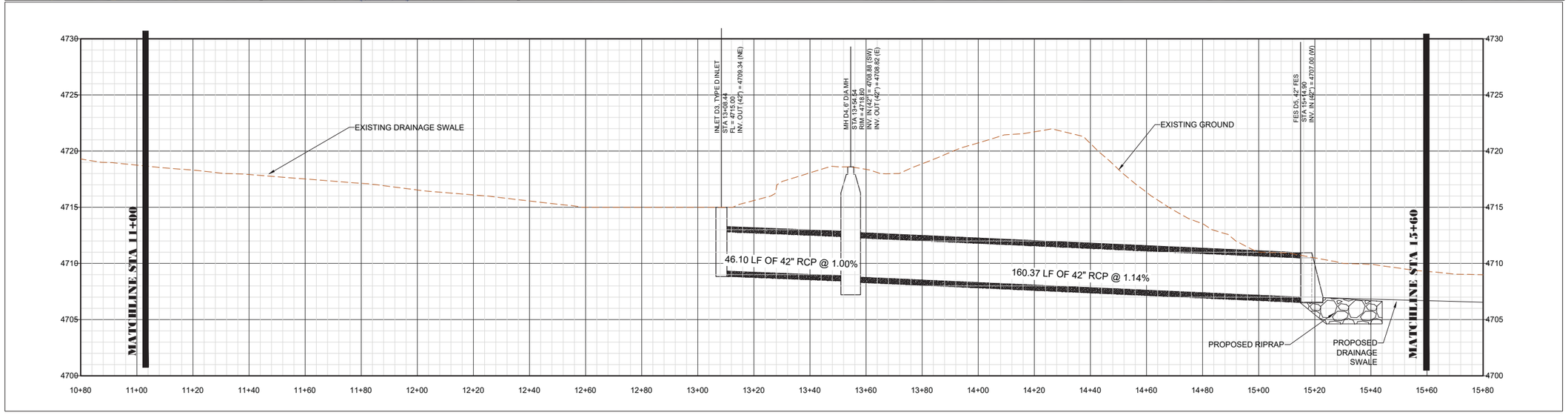

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WEST C STREET AND 71ST AVENUE STORM DRAIN SYSTEM

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6 OF 9

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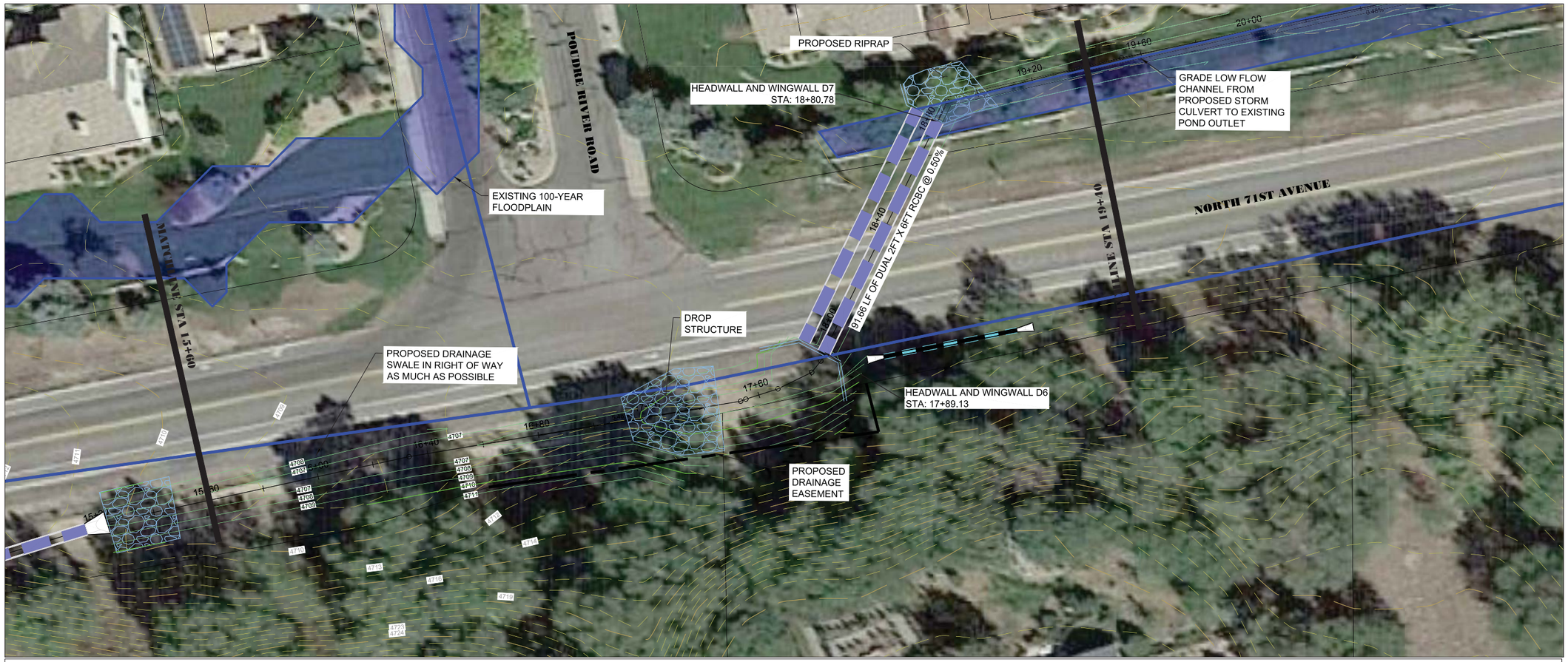

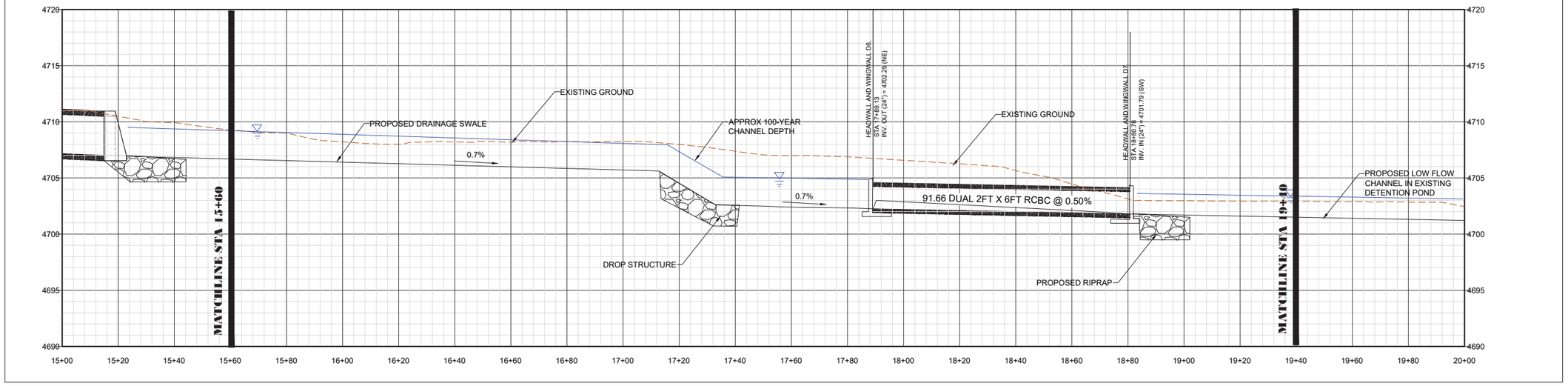

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WEST C STREET AND 71ST AVENUE STORM DRAIN SYSTEM

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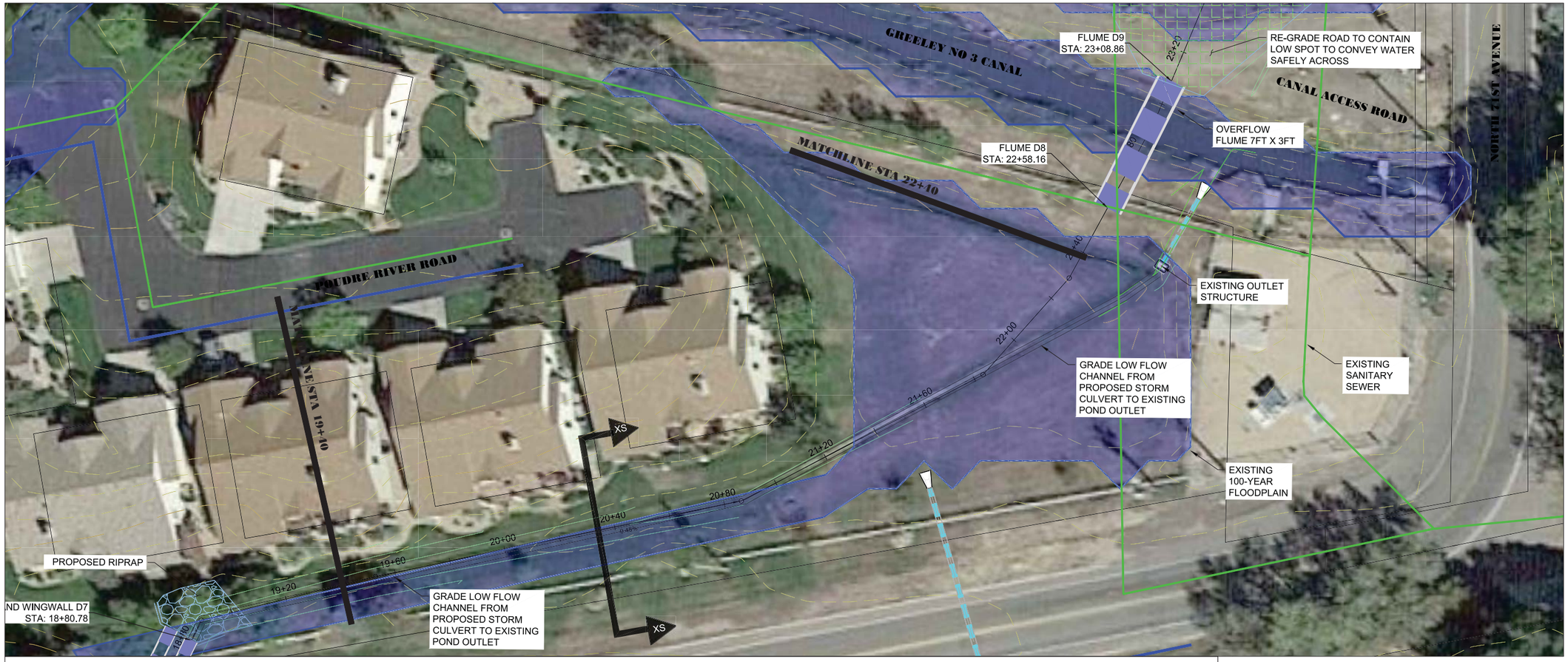
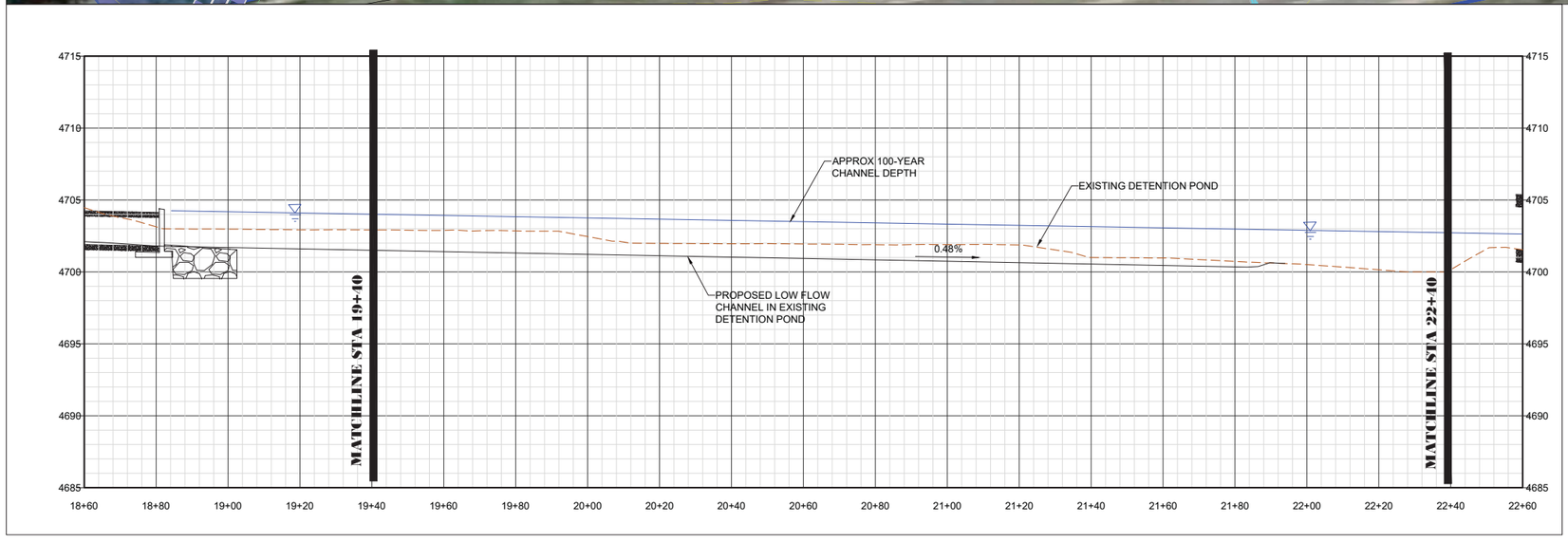
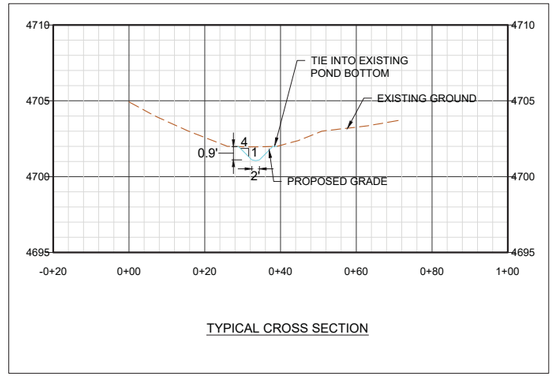
DATE
JULY 2019

SHEET
7 OF 9







TYPICAL CROSS SECTION

NORTH

0 10' 20' 40'
SCALE: 1" = 20'

No.	DATE	REVISIONS	APPR.

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SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

NORTHRIDGE DRAW CONCEPTUAL DESIGN

WEST C STREET AND 71ST AVENUE STORM DRAIN SYSTEM

ICON PROJECT No. 18-019-SBB

DATE
JULY 2019

SHEET
8 OF 9

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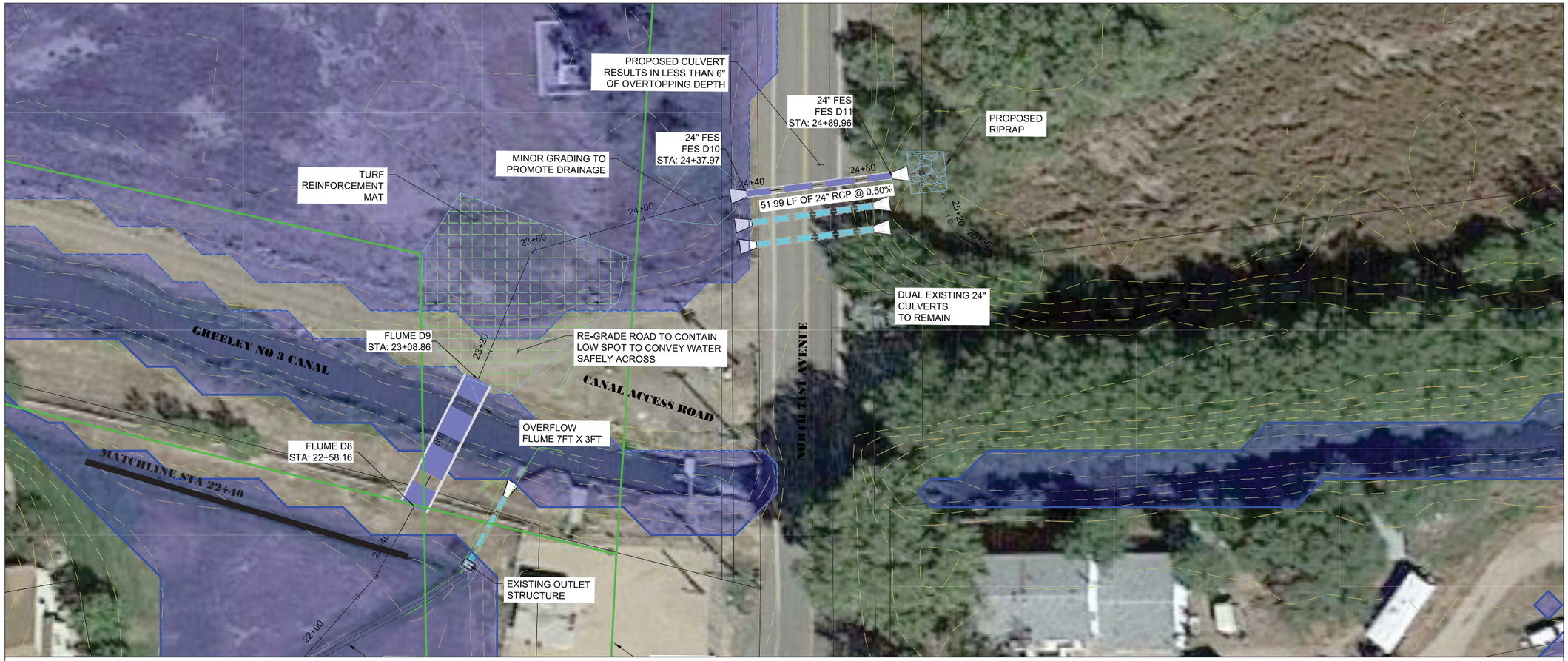

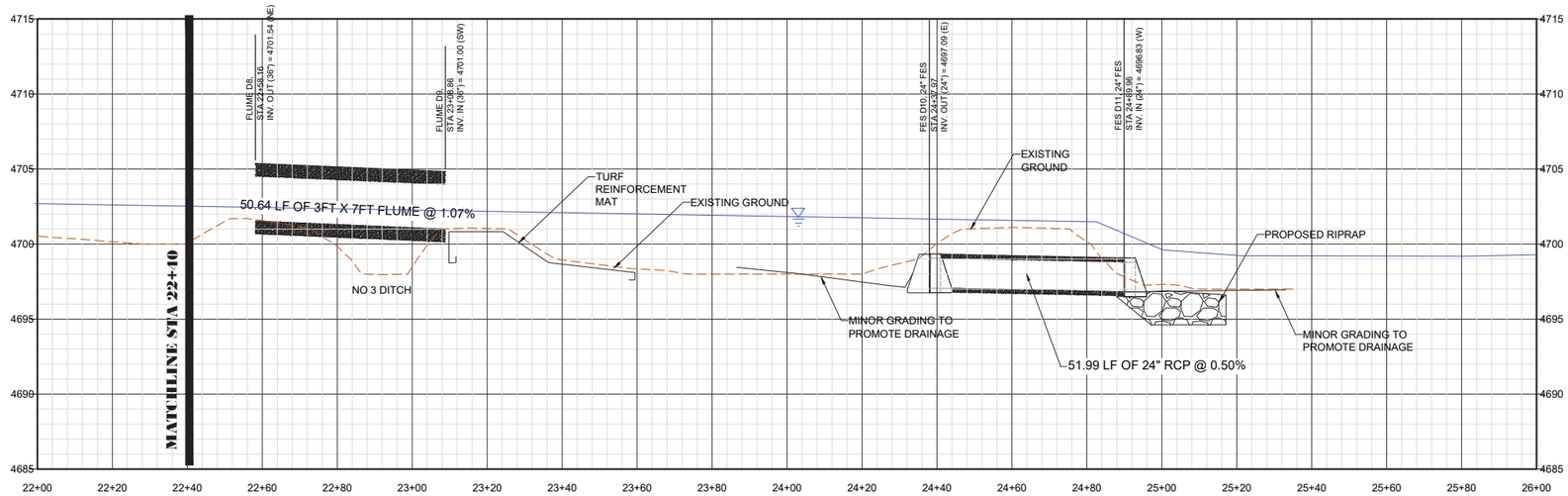

NORTH

0 10' 20' 40'
SCALE: 1" = 20'

No.	DATE	REVISIONS	APPR.

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SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

NORTHRIDGE DRAW CONCEPTUAL DESIGN

WEST C STREET AND 71ST AVENUE STORM DRAIN SYSTEM

ICON PROJECT No. 18-019-SBB

DATE
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SHEET
9 OF 9

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NORTH

0 100' 200' 400'

SCALE: 1" = 200'

COUNTY ROAD 62 (EAST): DRAINAGE CHANNEL

COUNTY ROAD 62 (EAST): 100 LF OF 3-42" RCPs WITH HEADWALLS AND WINGWALLS Q100 = 250 CFS

COUNTY ROAD 62

EXISTING 100-YEAR INUNDATION

83RD AVENUE

RIVER RUN DR

POUDRE RIVER RD

81ST AVENUE: EXISTING 4'x5' RCBC EXISTING CAPACITY OF SYSTEM =140CFS PROPOSED OVERTOPPING FLOW = 225CFS (PROPOSED DEPTH ON SURFACE LESS THAN 18 INCHES)

NORTH 81ST AVE

81ST AVENUE: RESIDUAL 100-YEAR INUNDATION ALONG 81ST AVENUE (LIGHT BLUE)

81ST AVENUE: 72" RCP OUTLET WITH STILLING BASIN AND HEADWALL AND WINGWALLS INV US = 4732.75 FT INV DS = 4732.50 FT

SKYVIEW ST

NORTH 78TH AVE

AMOUR HILL DR

AMOUR HILL DRIVE: RELAY STORM DRAIN TO PROMOTE DRAINAGE

WIEDEMAN FAMILY FARM LLC

ORR ED

81ST AVENUE: EXISTING 4' X 7' RCBC PROPOSED 100-YEAR OVERTOPPING FLOW Q = 17 CFS PROPOSED OVERTOPPING =< 6" DEPTH

78TH AVENUE: SWALE TO DISCHARGE INTO EXISTING AREA INLET

55 cfs

PROPOSED DRAINAGE EASEMENT

WSEL = 4742.44FT

PROPOSED PROPERTY ACQUISITION

78TH AVENUE: DRAINAGE SWALE DEPTH = 2.1 FT BOTTOM WIDTH = 5 FT 4:1 SIDE SLOPES @ 0.5% SLOPE

WIEDEMAN FAMILY FARM LLC

81ST AVENUE: PROPOSED DETENTION FACILITY 100-YEAR VOLUME = 22.7 AC-FT SURFACE AREA = 11 ACRES DEPTH AT 100-YR = 9.69 FT 100YR WSEL = 4742.44 FT

WIEDEMAN FAMILY FARM LLC

701 cfs

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SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

WIEDEMAN CREEK AND PLC CONCEPTUAL DESIGN

OVERALL LAYOUT

ICON PROJECT No. 18-019-SBB

DATE JULY 2019

SHEET 1 OF 6

NORTH

0 30' 60' 120'
SCALE: 1" = 60'

PROPOSED DRAINAGE ACQUISITION

100-YEAR WSEL = 4742.44 FT

EXISTING 4'x5' RCBC
CAPACITY =140CFS
PROPOSED OVERTOPPING FLOW = 225 CFS
< 18 INCHES DEPTH ON THE SURFACE

SKYVIEW ST

NORTH 81ST AVE

STILLING BASIN

TOP OF BERM = 4743.44FT

S = 1%

1.41%

1.55%

SPILLWAY AT 100YR WSEL (4742.44FT)

LOW FLOW TRICKLE CHANNEL WITH DROP STRUCTURES

EXISTING 100-YR INUNDATION

RESIDUAL EXISTING 100-YR INUNDATION (LIGHT BLUE)

HEADWALLS/WINGWALLS HEADWALL A1

HEADWALL/WINGWALLS HEADWALL A2

PROPOSED OUTLET 72 LF OF 72" RCP

EXISTING 7'X4' RCBC CULVERT
CAPACITY = 308CFS
PROPOSED OVERTOPPING FLOW = 17CFS
PROPOSED OVERTOPPING DEPTH < 6"

PROPOSED DETENTION POND TO LIMIT FLOWS DOWNSTREAM TO BE WITHIN CITY CRITERIA

100-YEAR WSEL = 4742.44 FT
SURFACE AREA = 11 ACRES
VOLUME = 22.7 AC-FT
QIN = 703 CFS
QOUT = 325CFS

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SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

WIEDEMAN CREEK CONCEPTUAL DESIGN

81ST AVENUE: PROPOSED DETENTION

ICON PROJECT No. 18-019-SBB

DATE
JULY 2019

SHEET
2 OF 6

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DRAINAGE CHANNEL
TYPICAL CROSS SECTION

NORTH

0 10' 20' 40'
SCALE: 1" = 20'

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PLAN
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DESIGNED JD
CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN
WIEDEMAN CREEK CONCEPTUAL DESIGN
78TH AVENUE: DRAINAGE CHANNEL

ICON PROJECT No. 18-019-SBB

DATE
JULY 2019

SHEET
3 OF 6

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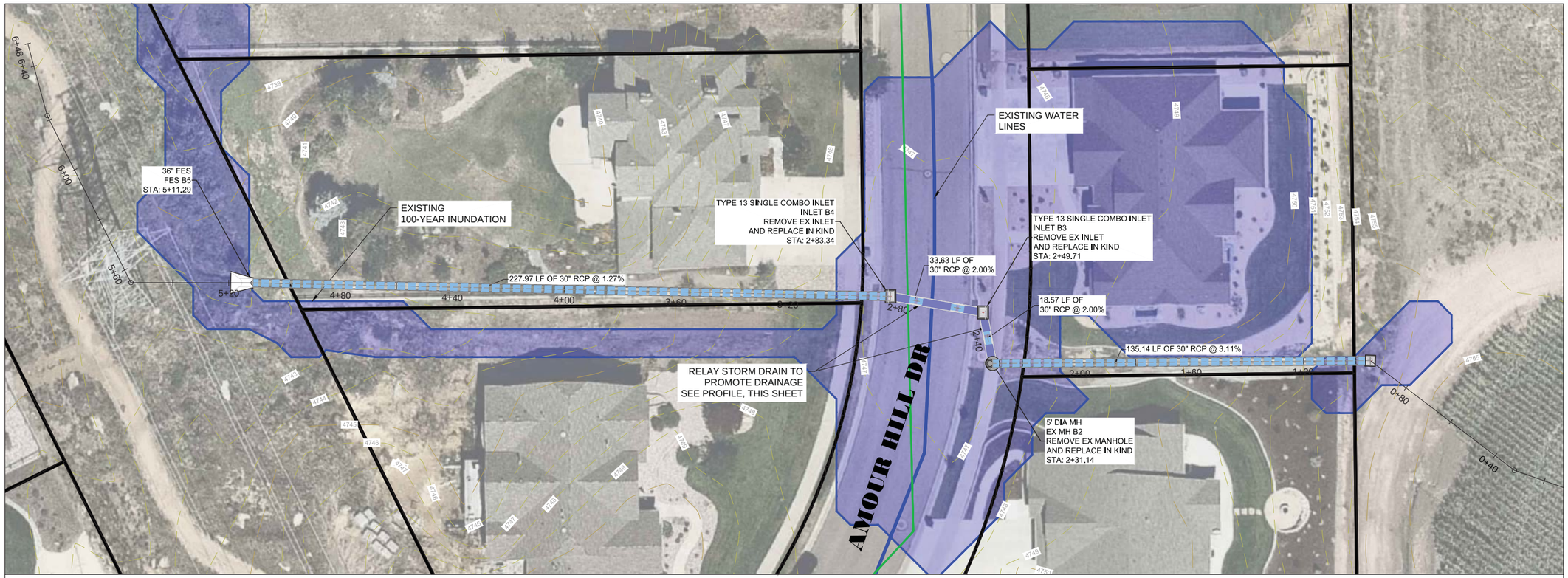

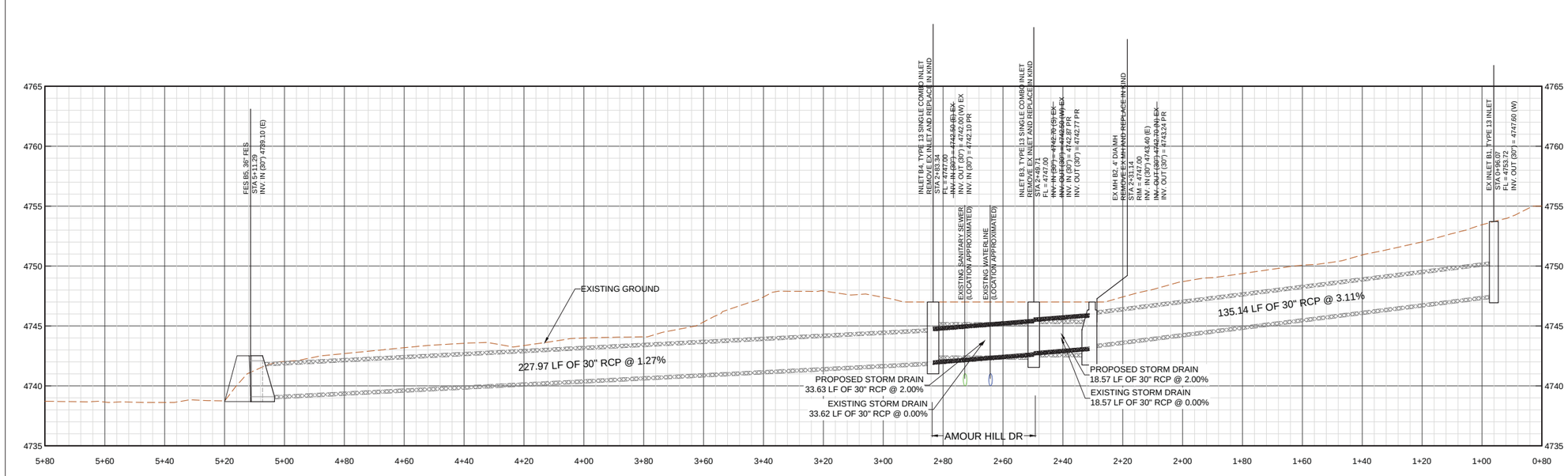

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CHECKED JD

SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

WIEDEMAN CREEK CONCEPTUAL DESIGN

AMOUR HILL DRIVE: STORM DRAIN IMPROVEMENTS

ICON PROJECT No. 18-019-SBB

DATE
JULY 2019

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4 OF 4

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COUNTY ROAD 62

COUNTY ROAD 62 (EAST):
100 LF OF 4FT X 6FT RCBC WITH
HEADWALLS AND WINGWALLS

EXISTING
100-YEAR
INUNDATION

PROPOSED
DRAINAGE
CHANNEL

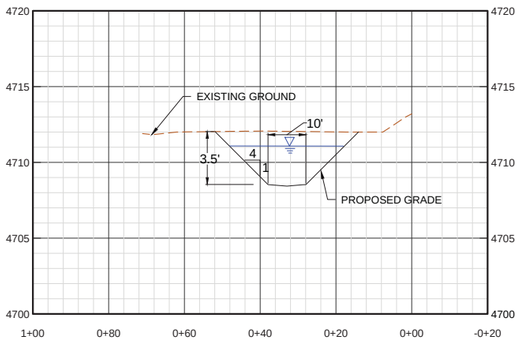
0.5% SLOPE

83RD AVENUE

POUDRE RIVER ROAD

NORTH

0 10' 20'
SCALE: 1" = 20'



DRAINAGE CHANNEL
TYPICAL CROSS SECTION

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SHARKTOOTH BLUFFS STORM DRAINAGE MASTER PLAN

POUDRE LEARNING CENTER CONCEPTUAL DESIGN

COUNTY ROAD 62 (EAST): DRAINAGE CHANNEL

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DATE
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5 OF 6

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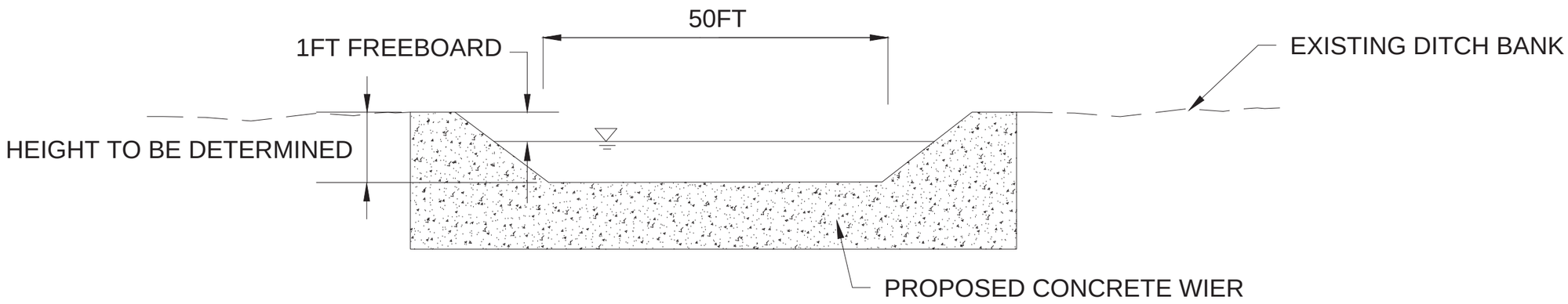

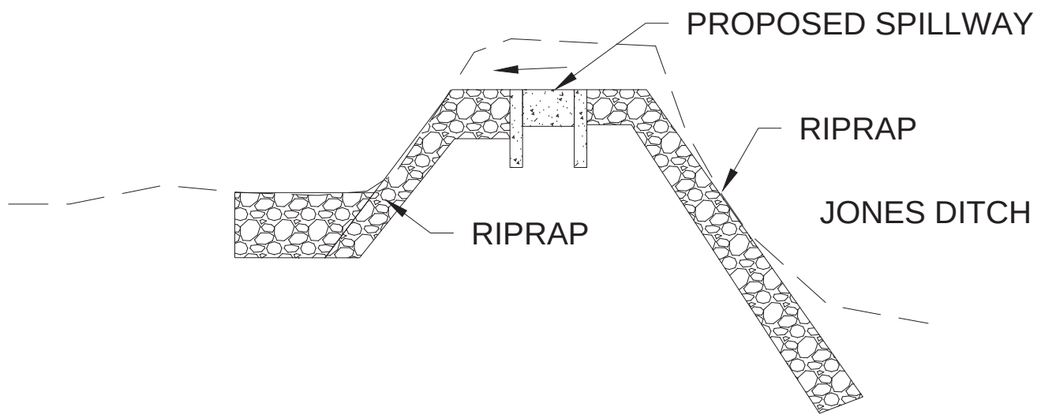

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POUDRE LEARNING CENTER CONCEPTUAL DESIGN
JONES DITCH CANAL SEPARATION

ICON PROJECT No. 18-019-SBB

DATE JULY 2019

SHEET 6 OF 6

Stream Restoration Planning Guidance	
Watershed:	Sharktooth Draw
Design Point:	95th Ave
Slope of Reach: ft/ft	0.020
Drainage Area (x): sq miles	1.220
Bankfull Area (y): ft^2 $y = 7.4051x^{0.6582}$	8.44
Stream Type based on slope of Reach	B
Stream Channel Design	
Width Range	**Depth Range**
10.1 ft	0.8 ft
9.2 ft	0.9 ft
Pool to Pool Spacing: 4 to 5 x Bankfull Width	38.5 ft - 48.1 ft
Entrenchment Ratio	Greater than 2.2
Meander Width: 2 to 8 x Bankfull Width	19.3 ft - 77 ft

Calculations		
Stream Type based on slope of Reach		B
Slope (ft/ft): 0.02-0.039		B
Slope (ft/ft): 0.004-0.02		C
Slope (ft/ft): 0.002-0.004		E
Width/Depth Ratio based on Stream Type		10-12
W/D = 10-12		B
W/D = 18-20		C
W/D = 10-12		E
Bank Full Width/Depth Ratio		
W/D: ft/ft		12
W/D: ft/ft		10
Bank full Depth range		
Based on Ratio of 12		0.84
Based on Ratio of 10		0.92
Bank full Width range		
Based on Ratio of 12		10.06
Based on Ratio of 10		9.19
Pool to Pool Spacing: 4 to 5 x Bankfull Width		
Min: ft		38.5
Max: ft		48.1
Entrenchment Ratio	**Greater than 2.2**	
Meander Width: 2 to 8 x Bankfull Width		
Min: ft		19.3
Max: ft		77

Stream Restoration Planning Guidance	
Watershed:	Sharktooth Draw
Design Point:	Sharktooth Bluffs to CR 62
Slope of Reach: ft/ft	0.020
Drainage Area (x): sq miles	1.560
Bankfull Area (y): ft^2 $y = 7.4051x^{0.6582}$	9.92
Stream Type based on slope of Reach	B
Stream Channel Design	
Width Range	**Depth Range**
10.9 ft	0.9 ft
10 ft	1 ft
Pool to Pool Spacing: 4 to 5 x Bankfull Width	41.7 ft - 52.2 ft
Entrenchment Ratio	Greater than 2.2
Meander Width: 2 to 8 x Bankfull Width	20.9 ft - 83.5 ft

Calculations		
Stream Type based on slope of Reach		B
Slope (ft/ft): 0.02-0.039		B
Slope (ft/ft): 0.004-0.02		C
Slope (ft/ft): 0.002-0.004		E
Width/Depth Ratio based on Stream Type		10-12
W/D = 10-12		B
W/D = 18-20		C
W/D = 10-12		E
Bank Full Width/Depth Ratio		
W/D: ft/ft		12
W/D: ft/ft		10
Bank full Depth range		
Based on Ratio of 12		0.91
Based on Ratio of 10		1.00
Bank full Width range		
Based on Ratio of 12		10.91
Based on Ratio of 10		9.96
Pool to Pool Spacing: 4 to 5 x Bankfull Width		
Min: ft		41.7
Max: ft		52.2
Entrenchment Ratio	**Greater than 2.2**	
Meander Width: 2 to 8 x Bankfull Width		
Min: ft		20.9
Max: ft		83.5

Stream Restoration Planning Guidance	
Watershed:	Poudre Learning Center
Design Point:	CR 62 to Poudre
Slope of Reach: ft/ft	0.014
Drainage Area (x): sq miles	0.473
Bankfull Area (y): ft^2 $y = 7.4051x^{0.6582}$	4.52
Stream Type based on slope of Reach	C
Stream Channel Design	
Width Range	**Depth Range**
9.5 ft	0.5 ft
9 ft	0.5 ft
Pool to Pool Spacing: 5 to 6 x Bankfull Width	46.3 ft - 55.6 ft
Entrenchment Ratio	Greater than 2.2
Meander Width: 8 to 14 x Bankfull Width	74.1 ft - 129.7 ft

Calculations	
Stream Type based on slope of Reach	C
Slope (ft/ft): 0.02-0.039	B
Slope (ft/ft): 0.004-0.02	C
Slope (ft/ft): 0.002-0.004	E
Width/Depth Ratio based on Stream Type	18-20
W/D = 10-12	B
W/D = 18-20	C
W/D = 10-12	E
Bank Full Width/Depth Ratio	
W/D: ft/ft	20
W/D: ft/ft	18
Bank full Depth range	
Based on Ratio of 20	0.48
Based on Ratio of 18	0.50
Bank full Width range	
Based on Ratio of 20	9.51
Based on Ratio of 18	9.02
Pool to Pool Spacing: 5 to 6 x Bankfull Width	
Min: ft	46.3
Max: ft	55.6
Entrenchment Ratio	**Greater than 2.2**
Meander Width: 8 to 14 x Bankfull Width	
Min: ft	74.1
Max: ft	129.7

Stream Restoration Planning Guidance	
Watershed:	Poudre Learning Center
Design Point:	DS of Bluffs to CR 62
Slope of Reach: ft/ft	0.040
Drainage Area (x): sq miles	0.276
Bankfull Area (y): ft^2 $y = 7.4051x^{0.6582}$	3.18
Stream Type based on slope of Reach	B
Stream Channel Design	
Width Range	**Depth Range**
6.2 ft	0.5 ft
5.6 ft	0.6 ft
Pool to Pool Spacing: 4 to 5 x Bankfull Width	23.6 ft - 29.5 ft
Entrenchment Ratio	Greater than 2.2
Meander Width: 2 to 8 x Bankfull Width	11.8 ft - 47.2 ft

Calculations	
Stream Type based on slope of Reach	B
Slope (ft/ft): 0.02-0.039	B
Slope (ft/ft): 0.004-0.02	C
Slope (ft/ft): 0.002-0.004	E
Width/Depth Ratio based on Stream Type	10-12
W/D = 10-12	B
W/D = 18-20	C
W/D = 10-12	E
Bank Full Width/Depth Ratio	
W/D: ft/ft	12
W/D: ft/ft	10
Bank full Depth range	
Based on Ratio of 12	0.51
Based on Ratio of 10	0.56
Bank full Width range	
Based on Ratio of 12	6.17
Based on Ratio of 10	5.64
Pool to Pool Spacing: 4 to 5 x Bankfull Width	
Min: ft	23.6
Max: ft	29.5
Entrenchment Ratio	**Greater than 2.2**
Meander Width: 2 to 8 x Bankfull Width	
Min: ft	11.8
Max: ft	47.2

Stream Restoration Planning Guidance	
Watershed:	Wiedeman Creek
Design Point:	4th St. to 81st Ave
Slope of Reach: ft/ft	0.022
Drainage Area (x): sq miles	1.083
Bankfull Area (y): ft^2 $y = 7.4051x^{0.6582}$	7.80
Stream Type based on slope of Reach	B
Stream Channel Design	
Width Range	**Depth Range**
9.7 ft	0.8 ft
8.8 ft	0.9 ft
Pool to Pool Spacing: 4 to 5 x Bankfull Width	37 ft - 46.3 ft
Entrenchment Ratio	Greater than 2.2
Meander Width: 2 to 8 x Bankfull Width	18.5 ft - 74 ft

Calculations		
Stream Type based on slope of Reach		B
Slope (ft/ft): 0.02-0.039		B
Slope (ft/ft): 0.004-0.02		C
Slope (ft/ft): 0.002-0.004		E
Width/Depth Ratio based on Stream Type		10-12
W/D = 10-12		B
W/D = 18-20		C
W/D = 10-12		E
Bank Full Width/Depth Ratio		
W/D: ft/ft		12
W/D: ft/ft		10
Bank full Depth range		
Based on Ratio of 12		0.81
Based on Ratio of 10		0.88
Bank full Width range		
Based on Ratio of 12		9.68
Based on Ratio of 10		8.83
Pool to Pool Spacing: 4 to 5 x Bankfull Width		
Min: ft		37
Max: ft		46.3
Entrenchment Ratio	**Greater than 2.2**	
Meander Width: 2 to 8 x Bankfull Width		
Min: ft		18.5
Max: ft		74

Stream Restoration Planning Guidance	
Watershed:	Wiedeman Creek
Design Point:	10th St to 4th St
Slope of Reach: ft/ft	0.020
Drainage Area (x): sq miles	0.523
Bankfull Area (y): ft^2 $y = 7.4051x^{0.6582}$	4.83
Stream Type based on slope of Reach	B
Stream Channel Design	
Width Range	**Depth Range**
7.6 ft	0.6 ft
7 ft	0.7 ft
Pool to Pool Spacing: 4 to 5 x Bankfull Width	29.1 ft - 36.4 ft
Entrenchment Ratio	Greater than 2.2
Meander Width: 2 to 8 x Bankfull Width	14.6 ft - 58.3 ft

Calculations		
Stream Type based on slope of Reach		B
Slope (ft/ft): 0.02-0.039		B
Slope (ft/ft): 0.004-0.02		C
Slope (ft/ft): 0.002-0.004		E
Width/Depth Ratio based on Stream Type		10-12
W/D = 10-12		B
W/D = 18-20		C
W/D = 10-12		E
Bank Full Width/Depth Ratio		
W/D: ft/ft		12
W/D: ft/ft		10
Bank full Depth range		
Based on Ratio of 12		0.63
Based on Ratio of 10		0.70
Bank full Width range		
Based on Ratio of 12		7.61
Based on Ratio of 10		6.95
Pool to Pool Spacing: 4 to 5 x Bankfull Width		
Min: ft		29.1
Max: ft		36.4
Entrenchment Ratio	**Greater than 2.2**	
Meander Width: 2 to 8 x Bankfull Width		
Min: ft		14.6
Max: ft		58.3