

APPENDIX D

Larimer County Working Group Materials



MEMORANDUM

TO: Mark R. Peterson, PE

FROM: Rich Follmer *RF*

DATE: November 13, 2018

SUBJECT: **Thornton Water Project**
- Summary of Existing Conditions and Project Impacts
FHU Reference No. 118104-05

This memorandum serves to summarize our analyses related to the Thornton Water Project and its potential impacts on traffic routing for the several pipeline alternatives. This memorandum summarizes several analysis components:

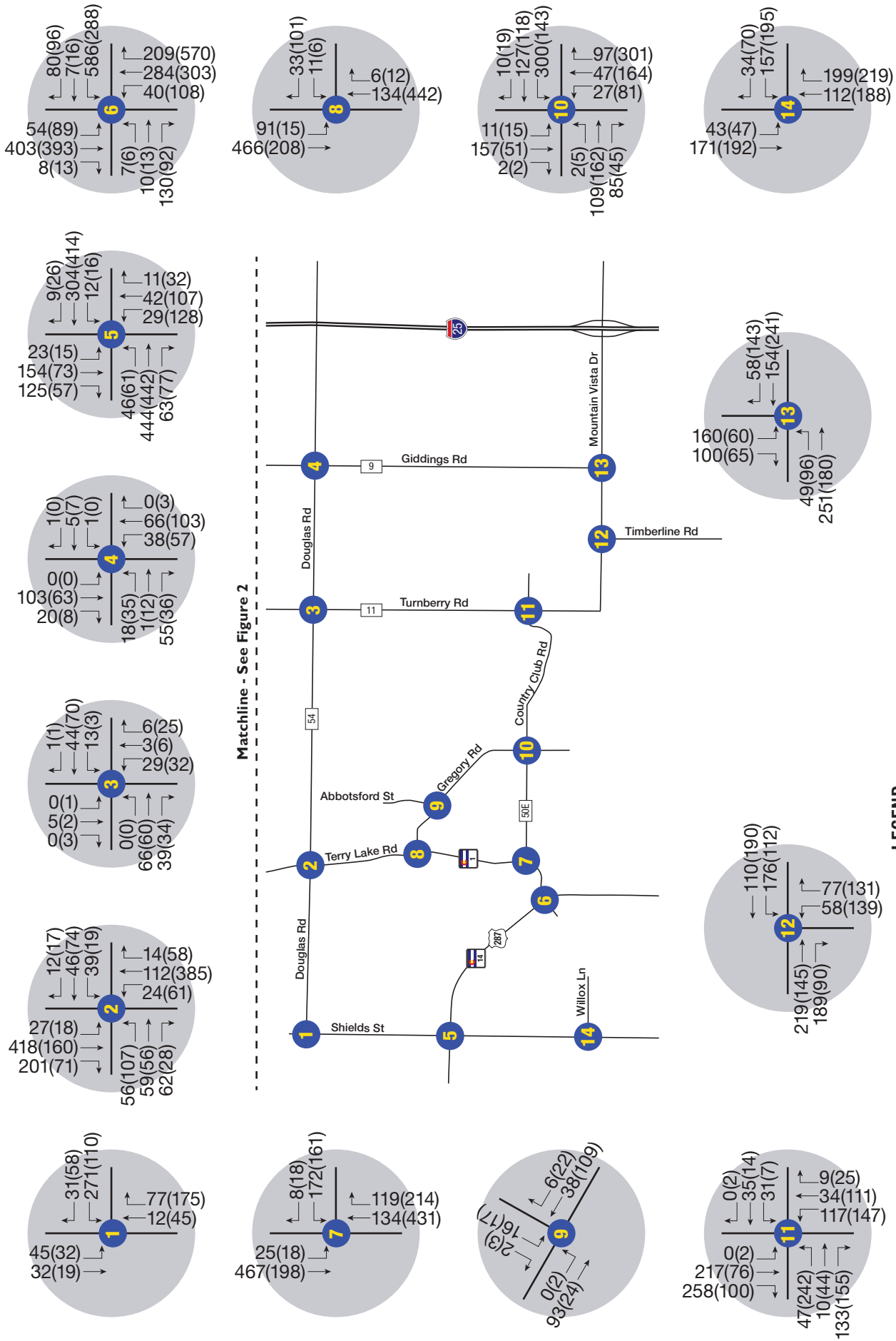
- Existing traffic volumes and level of service information for 21 intersections near the potential pipeline routes,
- The approximate number of disrupted homes during pipeline construction,
- Potential detour routes for the pipeline alignments,
- A summary of impacts for detoured traffic, and
- Temporary operational or infrastructure recommendations.

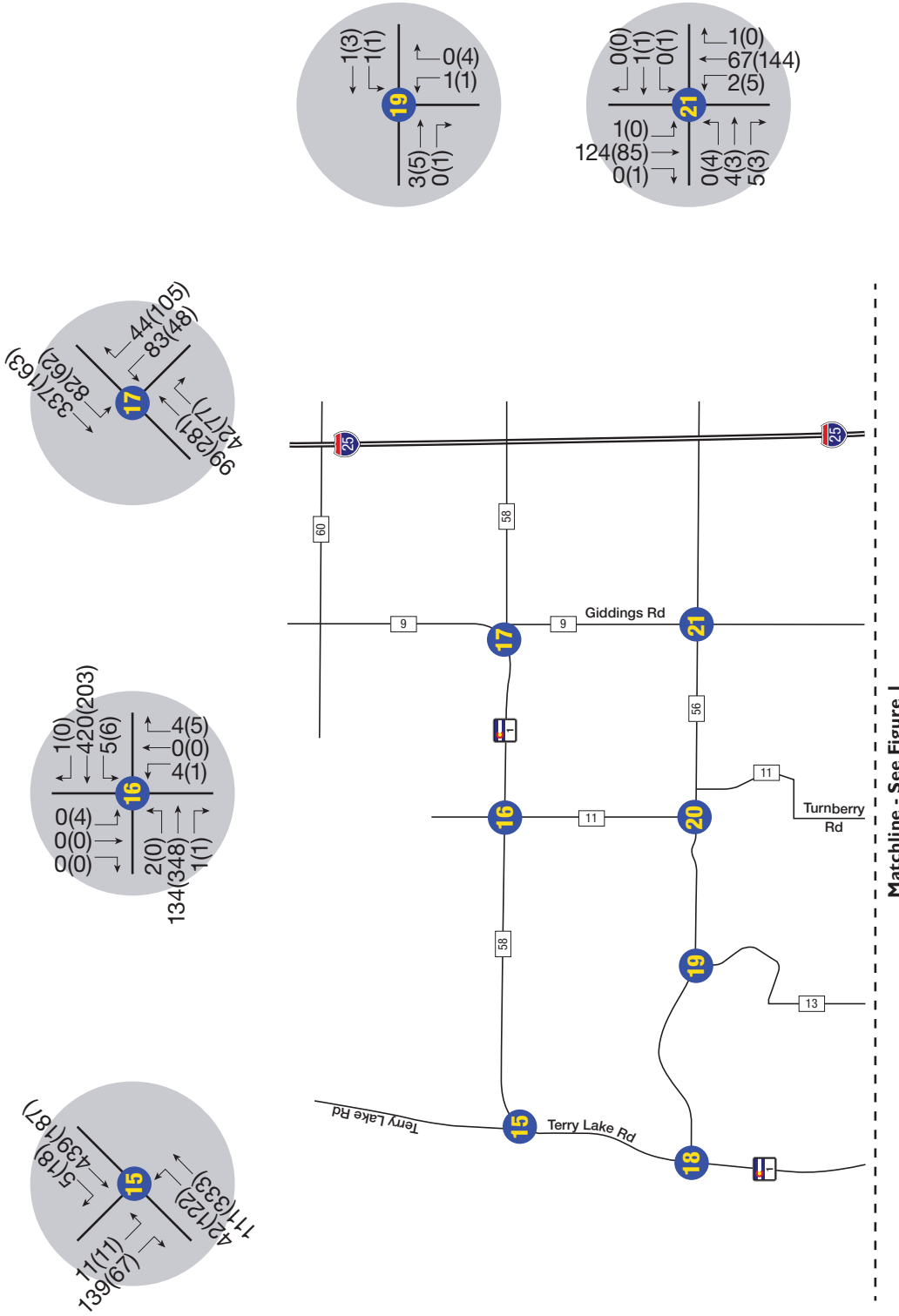
The following information summarizes each of these task elements.

Traffic Volumes

Traffic volume data was recorded at 21 intersections primarily along Larimer County Road (LCR) 56, Douglas Road, and Shields Street, but also at nearby/adjointing intersections that are likely to be influenced by the pipeline construction. As can be imagined, traffic volumes vary by intersection and by individual movement, with some movements experiencing a relatively high level of traffic, while others have quite low levels.

Figures 1 and 2 summarize the recorded traffic volumes; each intersection is numbered 1 through 21 for clarity purposes. This information is documented for the AM and PM peak hours of a typical weekday which represents the morning and evening times of typical commuter traffic when motorists are heading to/from work or other destinations. The AM and PM peak hours are usually the two highest hours of vehicle traffic along our roadways, with the PM peak hour typically the highest hour of the day. Traffic volumes can be quite directional sometimes. For example, the State Highway (SH) 1/LCR 56 intersection has a larger level of vehicle movements heading towards Fort Collins during the AM peak hour than are heading towards the north, while the opposite is true during the PM peak when motorists are leaving Fort Collins.





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XXX(XXX) = AM(PM) Peak Hour Traffic Volumes

You are likely already aware of some of the more critical intersection movements, but I wanted to point out a few of the ones that have the higher levels of existing traffic:

- NB/SB through movements approach/exceed 400 vehicles per hour (vph) during some peak hours on SH 1 from the Country Club Road intersection to the LCR 58 intersection; the through movements reach 575 vph at the SH 1/LCR 56 intersection in the southbound direction during the AM peak hour
- EB/WB through movements exceed 400 vph on US 287/SH 14 at the Shields Street intersection
- NB right turns (PM peak hour) and westbound left turns (AM peak hour) are reciprocal movements and they approach 600 vph at the US 287/SH 14/SH 1 intersection
- NB right turns (PM peak hour) and westbound left turns (AM peak hour) reach 300 vph at the Country Club Road/Gregory Road intersection (also reciprocal movements)
- SB right turns (AM peak hour) and eastbound left turns (PM peak hour) at the Country Club Road/Turnberry Road intersection are also reciprocal movements and they are approximately 250 vph

Also of importance to understand are the movements that have a relatively low level of traffic during the AM and PM peak hours. While there are certain movements with traffic volumes less than 10 vph sprinkled amongst the 21 intersections (not at all intersections), I wanted to point out the level of vehicle movements along LCR 56 since it is one of the possible pipeline routes. As you can see on **Figure 2**, all movements to/from or along LCR 56 are less than 10 vph (Intersection No's. 18 through 21).

Intersection Geometry & Traffic Control

Intersection geometry varies by location with some intersections having only one lane for left/through/right movements on each intersection approach, while others may have shared through/left or through/right lanes ("T" intersections for example). Exclusive left and right turn lanes exist at some locations and only one location has two through lanes (US 287/SH 14 at SH 1 – Intersection No. 6).

Traffic signals exist at four locations:

1. US 287/SH 14/Shields Street (Intersection No. 5)
2. US 287/SH 14/SH 1 (Intersection No. 6)
3. SH 1/Country Club Road (Intersection No. 7)
4. Shields Street/Willox Lane (Intersection No. 14)

We understand that two additional traffic signals are being planned, but their schedule for construction is not known:

1. SH 1/Douglas Road (Intersection No. 2)
2. Country Club Road/Turnberry Road (Intersection No. 11)

All other intersections are controlled by stop signs on the minor street approaches (16 total), with one intersection having stop signs on each intersection approach (Country Club Road/Gregory Road – Intersection No. 10).

Operational Analyses

Capacity analyses were conducted at the study area intersections using analysis methods documented in the *Highway Capacity Manual*, 2010 by the Transportation Research Board. These analyses use the existing traffic volumes, intersection lane geometry, and traffic control to develop a LOS, a measure of the ease of traffic flow through an intersection. Level of service A represents relatively uninterrupted flow with little or no vehicle delay, while LOS F represents undue delay and excessive congestion. LOS delay criteria for both signalized and stop-controlled intersections is shown in **Tables A1** and **A2** at the end of this memorandum.

As can be seen on **Figures 3** and **4**, overall intersection levels of service are LOS A or B (average motorist delay is less than 20 seconds) at the signalized intersections during both peak hours. Individual movements at the signalized intersections operate at LOS D or better during the peak hours (35 to 55 seconds of average delay).

Intersections controlled by stop signs have varying LOS for the differing movements that must yield to other traffic. Most intersection movements operate well at LOS C or better (15 to 25 seconds of average delay) which is considered very acceptable for peak hour conditions. Only a few movements operate in the LOS D (25 to 35 seconds of delay) to LOS F (>50 seconds of average delay) range during the AM and PM peak hours:

SH 1/Douglas Road Intersection

- Westbound left turn = LOS D (AM and PM peak hours)
- Eastbound left turn = LOS E (PM peak hour)

Country Club Road/Gregory Road

- Northbound right turn = LOS F (PM peak hour)

Country Club Road/Turnberry Road

- Eastbound through/left = LOS F (PM peak hour)
- Eastbound right turn = LOS F (PM peak hour)

Mountain Vista Drive/Timberline Road

- Northbound left/right movement = LOS D (PM peak hour)

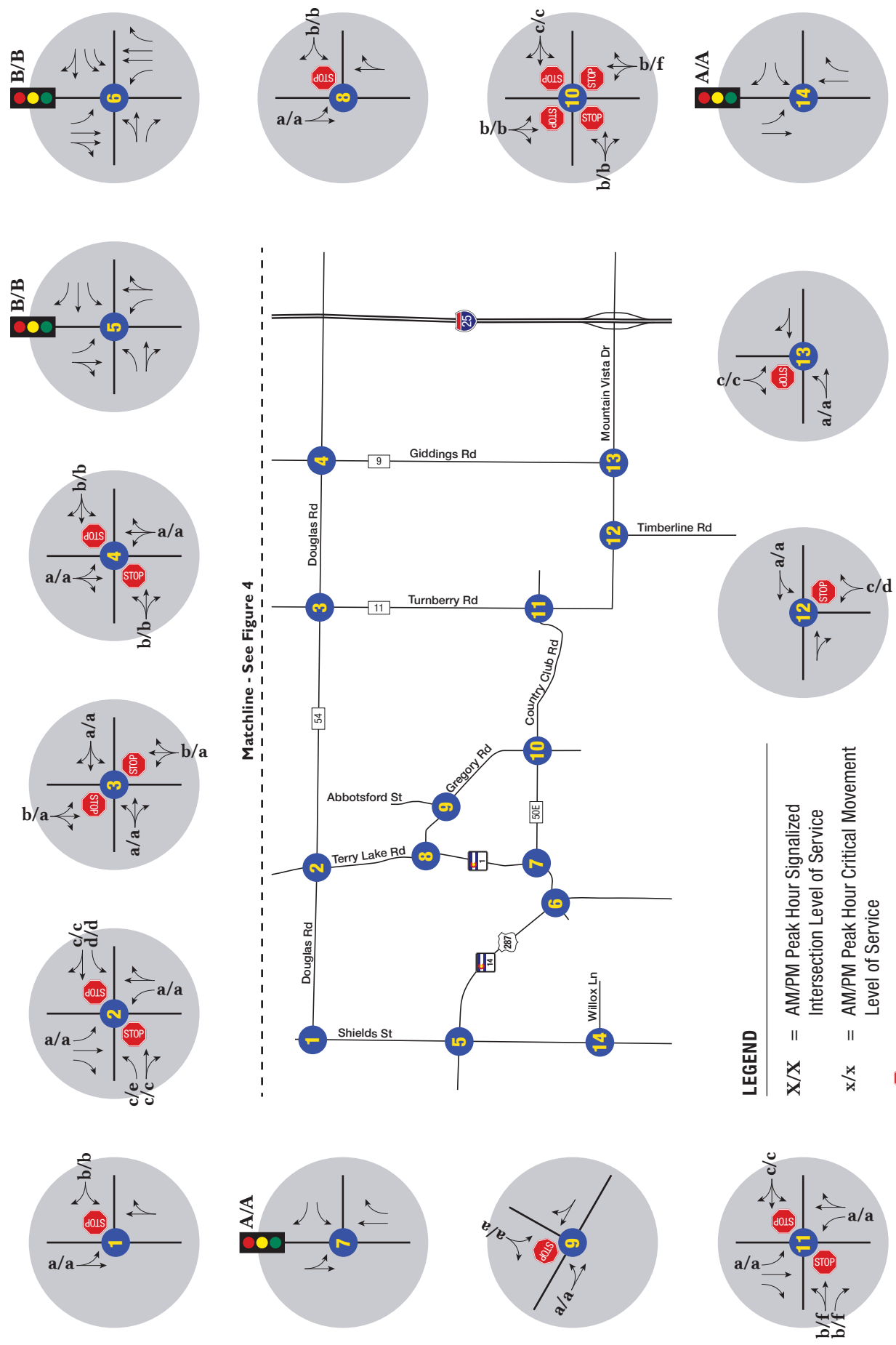
As you can see from this information, the movements with the poorer LOS occur mostly during the PM peak hour when traffic volumes are typically the highest on an average day; not a surprising result.



Geometry, Traffic Control and Levels of Service

FIGURE 3

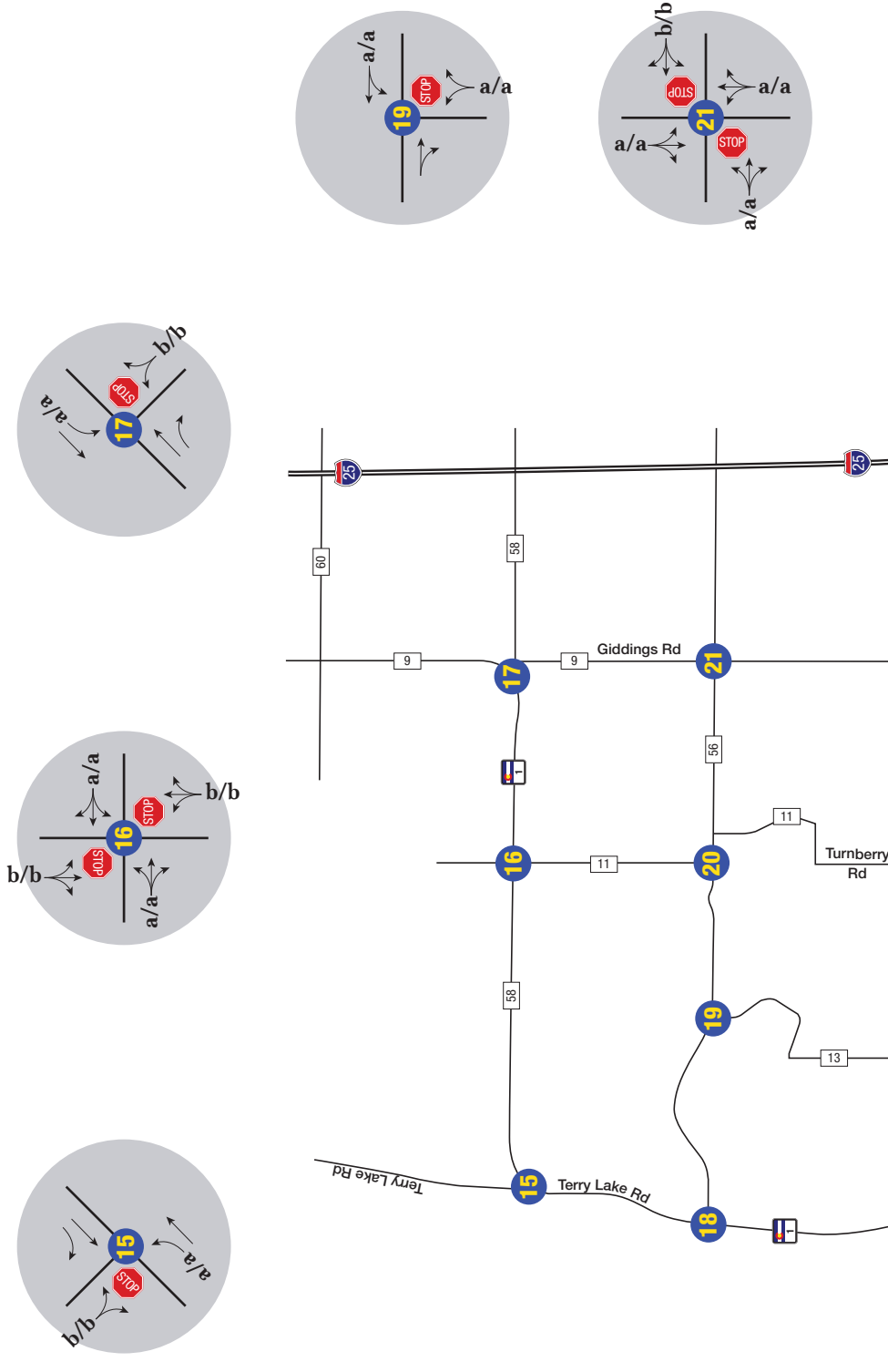
Larimer County - Douglas Rd Pipeline - MEMO UPDATE 18104-05 10/30/18



Existing Intersection and Levels of Service

FIGURE 4

Latimer County - Doughs Rd Pipeline - MEMO UPDATE 18104-05 10/31/18



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- X/X = AM/PM Peak Hour Signalized Intersection Level of Service
- x/x = AM/PM Peak Hour Critical Movement Level of Service
- = Stop Sign
- = Traffic Signal

Approximate Number of Disrupted Homes

A review of the number of homes that would be disrupted by construction activity was conducted. This review is based only on aerial photography research using GoogleEarth™, not on a detailed field investigation. **Table I** shows that the Douglas Road alignment would impact the most homes, while LCR 56 would be the least impacted. Keep in mind that not all of these homes would be impacted at the same time but would be impacted at some point during construction. Each home would always be provided with access, but residents may be required to take a different route while construction activity is near their driveway/access point.

Table I. Approximate Number of Disrupted Homes

Pipeline Alignment	Approximate Number of Disrupted Homes
Douglas Road	287
Larimer County Road 56	8
Shields Street	125

Detour Route Opportunities



Each of the three pipeline routes will impact intersections somewhat differently. Most of the alignment along LCR 56 is planned to be constructed in private easements with only a few shorter segments requiring that through traffic be detoured. Douglas Road would be impacted the most, with through traffic needing to be rerouted from the construction areas.

Shields Street would have relatively smaller impacts since most of the alignment is also projected to be within private easements. It is understood that one lane of vehicle traffic, with alternating directions, would always be available except for short time periods when pipeline construction needs to cross Shields Street. Motorists may still choose to avoid Shields Street for most of their regional trips; only using it for trips to/from destinations along Shields Street.

Regardless of the pipeline alignment, there are detour alternatives. **Figures 5** through **7** provide a simplistic graphical representation of detour route options. As you know, it will be necessary for the City of Thornton to provide detour route construction plans during the review process. Those documents will identify appropriate street closure signing and their locations which will be reviewed by Larimer County staff for approval.



LEGEND



-  = Detour Options
-  = Construction Area

NOTE: Drawing Not to Scale





LEGEND

-  = Detour Options
-  = Construction Area



NOTE: Drawing Not to Scale



NOTE:
One lane of Shields Street
will remain open at all times
except for short durations.



LEGEND

-  = Detour Options
-  = Construction Area

NOTE: Drawing Not to Scale



Traffic Impacts During Construction

Recognizing that motorists that travel along the pipeline routes would need to reroute their trip, an assessment of how motorists would be detoured was conducted for the LCR 56 and Douglas Road pipeline alignments. As noted, while motorists may avoid Shields Street, they can still travel along this street during construction. As such, Shields Street was not included in this analysis.

Analysis Assumptions

Since pipeline construction will not occur for a few years, there are some development and infrastructure changes that will transpire that will change the level of traffic volumes and also the operational conditions at a few locations. The evaluation of impacts include:

- Projected traffic from the Waters' Edge and Country Club Reserve projects were added to the recorded intersection vehicle turning movements, and
- The SH 1/Douglas Road (planned by Larimer County) and Country Club Road/Turnberry Road (planned by Fort Collins) will have traffic signals installed.

Analysis Process

Projected traffic volumes that are anticipated to be impacted by construction were reassigned to the local street network and through the 21 intersections that are a part of this analysis. The specific steps taken include the estimating of the number of through movements along an alignment, then reassigning those vehicle-trips to the potential detour routes based on current travel patterns and destinations.

For example, if the section of LCR 56 is closed between SH 1 and LCR 13, the vehicle-trips that turn onto or travel along this segment of LCR 56 are rerouted to the south or north along SH 1 or LCR 13 until they reach an intersection that they would have traveled to if they had not been detoured. This method was used for the three main segments of LCR 56 (SH 1 to LCR 13, LCR 13 to LCR 11, and LCR 11 to Giddings Road) and along the three main segments of Douglas Road (Shields Street to SH 1, SH 1 to Turnberry Road, and Turnberry Road to Giddings Road).

These analyses have only been conducted for the PM peak hour of vehicle activity, the time period when traffic volumes are at their highest. Intersection operations during the AM peak hour are projected to have less of an impact.

Analysis Results

The traffic volumes that result from the reassignment of vehicle-trips were used to evaluate changes in LOS similar to what was conducted for existing conditions. As can be imagined, since traffic volumes along LCR 56 are extremely low, the impact of rerouting through vehicle movements is almost undetectable. For the rerouting of vehicle-trips along Douglas Road, the same process was used and, given the higher level of vehicles along this route, the impacts are slightly greater.

In general, there is sufficient capacity for most of the 21 intersections to absorb the vehicle detouring. **Tables 2** (LCR 56) and **3** (Douglas Road) summarize whether there are any anticipated intersection impacts and, if so, their results. These tables include information for each of the three alignment segments described above for the PM Peak hour since traffic volumes are typically highest during that time period. As such, I believe this is a conservative approach to the analyses. Of note, the traffic signal timing parameters for the two additional traffic signals are based on my engineering judgment.

Table 2. Detour Impact Summary
- LOS Change is Compared to Existing Conditions

Intersection	Segment					
	SH I to LCR 13		LCR 13 to LCR 11		LCR 11 to Giddings	
	LOS Change?	What?	LOS Change?	What?	LOS Change?	What?
1-Douglas/Shields	No		No		No	
2-Douglas/SH I - Signalized	Yes	LOS A with 60s Cycle	Yes	LOS A with 60s Cycle	Yes	LOS A with 60s Cycle
3-Douglas/Turnberry	Yes	N/S; LOS a to b	Yes	N/S; LOS a to b	Yes	N/S; LOS a to b
4-Douglas/Giddings	No		No		No	
5-SH 14/Shields	No		No		No	
6-SH 14/SH I	No		No		No	
7-SH I/Country Club	No		No		No	
8-SH I/Gregory	No		No		No	
9-Gregory/Abbotsford	No		No		No	
10-Country Club/Gregory	Yes	EB LOS b to c	Yes	EB; LOS b to c	Yes	EB; LOS b to c
11-Country Club/Turnberry - Signalized	Yes	LOS B with 60s Cycle	Yes	LOS B with 60s Cycle	Yes	LOS B with 60s Cycle
12-Mountain Vista/ Timberline	Yes	NB; LOS d to e	Yes	NB; LOS d to e	Yes	NB; LOS d to e
13-Mountain Vista/ Giddings	No		No		No	
14-Shields/Wilcox	No		No		No	
15-SH I/Terry Lake	No		No		No	
16-SH I/CR 11	No		No		No	
17-SH I/Giddings	No		No		No	
18-SH I/CR 56	Yes	WB; LOS b to c	Yes	WB; LOS b to c	Yes	WB; LOS b to c
19-CR 56/CR 13	No		No		No	
20-CR 56/CR 11	No		No		No	
21-CR 56/Giddings	No		No		No	

Table 3. Detour Impact Summary
 - LOS Change is Compared to Existing Conditions

Intersection	Douglas Road Segment					
	Shields to SH I		SH I to Turnberry		Turnberry to Giddings	
	LOS Change?	What?	LOS Change?	What?	LOS Change?	What?
1-Douglas/Shields	Yes	WB; LOS b to a	No		No	
2-Douglas/SH I - Signalized	Yes	LOS B with 60s Cycle	Yes	LOS A with 60s Cycle	Yes	LOS A with 60s Cycle
3-Douglas/Turnberry	Yes	NB; LOS a to b	Yes	SB; LOS a to b	Yes	NB; LOS a to b
4-Douglas/Giddings	No		No		No	
5-SH 14/Shields	Yes	LOS C with 60s Cycle	No		No	
6-SH 14/SH I	No		No		No	
7-SH I/Country Club	No		Yes	LOS A to B	No	
8-SH I/Gregory	Yes	WB; LOS b to c	Yes	WB; LOS b to c	No	
9- Gregory/Abbotsford	No		No		No	
10-Country Club/Gregory	Yes	EB; LOS b to c	Yes	EB; LOS b to e WB; LOS c to f	Yes	EB; LOS b to c
11-Country Club/Turnberry - Signalized	Yes	LOS B with 60s Cycle	Yes	LOS B with 60s Cycle	Yes	LOS B with 60s Cycle
12-Mountain Vista/ Timberline	Yes	NB; LOS d to e	Yes	NB; LOS d to f	Yes	NB; LOS d to e
13-Mountain Vista/ Giddings	No		No		No	
14-Shields/Wilcox	No		No		No	
15-SH I/Terry Lake	No		No		No	
16-SH I/CR 11	No		No		No	
17-SH I/Giddings	No		No		No	
18-SH I/CR 56	No		No		No	
19-CR 56/CR 13	No		No		No	
20-CR 56/CR 11	No		No		No	
21-CR 56/Giddings	Yes	EB; LOS a to b	Yes	EB; LOS a to b	Yes	EB; LOS a to b

As you can see from the information contained in these two tables, some intersections will experience a change in LOS, but in most cases, it is from one good LOS to another; both are still good operational conditions for normal peak hours. In most cases, it is only a change in a few seconds of additional vehicle delay.

The only two locations that will experience some changes that are projected to result in relatively poor intersection operations are at the Country Club Road/Gregory Road and the Mountain Vista Drive/Timberline Road intersections.

The Country Club Road/Gregory Road/Lemay Avenue intersection will see some reductions in LOS for the eastbound and westbound directions of travel (not both for each construction segment, however). In fact, when construction is occurring between SH 1 and Turnberry Road, the eastbound and westbound directions are projected to experience LOS E or F during the PM peak hour. The Mountain Vista Drive/Timberline Road intersection will also see some deterioration into the LOS E or F levels.

Temporary Operational or Infrastructure Recommendations

As discussed in the previous section, minimal impacts are projected to develop related to the detouring of through traffic movements along LCR 56 or Douglas Road. Some temporary improvements will need to be considered if the Douglas Road alignment is the preferred pipeline construction option. A summary of recommended temporary improvements are summarized in **Table 4**.

Table 4. Temporary Improvement Recommendations

Location	Temporary Improvement Recommendation
Larimer County Road 56 Alignment	
No improvements are recommended	
Douglas Road Alignment	
Country Club Road/Gregory Road Intersection	Consider the installation of a temporary traffic signal.
SH 14/Shields Street Intersection SH 14/SH 1 Intersection SH 1/Gregory Road Intersection	Adjust traffic signal timing parameters as necessary to reflect traffic volume and pattern changes.

**TABLE A1
 LEVEL OF SERVICE CRITERIA FOR
 TWO-WAY STOP CONTROLLED (TWSC) INTERSECTIONS**

Level of Service	Delay Range (sec/veh)
A	0.0 - 10.0
B	>10.0 - 15.0
C	>15.0 - 25.0
D	>25.0 - 35.0
E	>35.0 - 50.0
F	> 50.0

Adapted from: *Highway Capacity Manual*, Transportation Research Board, 2010.

**TABLE A2
 LEVEL OF SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS**

Level of Service	Control Delay (sec/veh)	Qualitative Description
A	≤ 10.0	Good progression, short cycles, very few vehicle-stops.
B	>10.0 - 20.0	Good progression, and/or short cycle lengths, more vehicle-stops.
C	>20.0 - 35.0	Fair progression and/or longer cycle lengths, some individual cycle failures, many vehicle-stops
D	>35.0 - 55.0	Noticeable congestion and cycle failures, unfavorable progression, high v/c ratios, several stops.
E	>55.0 - 80.0	Limit of acceptable delay, poor progression, long cycles, high v/c ratios, frequent cycle failures.
F	> 80.0	Delay is unacceptable to most drivers, volume exceeds capacity, breakdown of traffic flow.

Adapted from: *Highway Capacity Manual*, Transportation Research Board, 2010.

wagner

SHIELDS STREET/POUDRE RIVER ALTERNATIVE TO THE THORNTON PIPELINE PROPOSAL

During the ten month 1041 Permit review process, and particularly during the two public comment periods before the Larimer County Board of Commissioners, several concerns were expressed by the Commissioners, the Larimer County Planning Commission, citizens, and various organizations representing stakeholder groups. These concerns centered on the disruptive nature of the Douglas Road Pipeline Proposal, the lack of public engagement in the decision making process, the short Proposal review period, the perception that the evaluation of Alternatives that utilize the Poudre River as a means of conveyance were superficial, and the summary dismissal of those Alternatives. In reference to Alternatives that utilize the Poudre River as a means of conveyance, the City of Thornton expressed concerns regarding water quality, delivery of the full allotment of water, compliance with the Colorado Water Court and Colorado Supreme Court Decrees that authorized the change in beneficial use from agricultural (Water Supply and Storage Company original rights) to municipal use (City of Thornton), and potential increases in the cost of the overall Project.

The Shields Street/Poudre River Alternative (SS/PR Alternative) is a compromise Alternative, based on the principle of regional cooperation that is designed to provide the least disruptive, most beneficial option for the delivery of water from the Poudre River to the City of Thornton in a cost effective manner. This Alternative builds on numerous ongoing efforts by a variety of entities that continue to improve the fluvial and biological functions of the Poudre River. While these improvements are often done as individual projects, each of these efforts positively reinforces and compliments the others. As these efforts continue, the overall stream function and health of the Poudre River will continue to improve.

ALIGNMENT

The SS/PR Alternative utilizes the existing Poudre River point-of-diversion to the Larimer County Canal (aka Larimer County Ditch) and the proposed outlet at Water Supply and Storage Company Reservoir #4 (WSSC #4). Therefore, this Alternative complies with the Colorado Water Court and Colorado Supreme Court Decrees that authorized the change in beneficial use. As a result, no injury to existing water rights related to the Canal, ditches, or laterals and the subsequent agricultural applications occur. The Alternative is comprised of three segments (please refer to the enclosed sketch map):

SEGMENT #1 – approximately 1.1 miles. Outtake at WSSC #4 at 5080 ft. elevation. Buried pipeline roughly contouring (with consistent gradient) with the Dry Creek Ditch easement, south across Douglas Road to the west side of Shields Street at 5040 ft. elevation. The 40 foot elevation differential (approximately 36 ft./mile gradient) eliminates the need for the controversial pump station within the residential/agricultural properties in the vicinity of WSSC #4. Some private residences might be affected by this routing, though considerably fewer than the more than 200 residential properties that would be impacted by the Douglass Road Proposal. By minimizing residential impacts and eliminating the pump station, this Alternative addresses many of the concerns expressed by Larimer County residents and their respective Home Owners Associations during the two Board of County Commissioners public hearings. Note that the properties in the immediate vicinity of the WSSC #4 outlet would be equally impacted regardless of which Alternative might be constructed. Equipment access via privately owned Starlite Drive would most likely still be needed during the construction phase.

SEGMENT #2 – approximately 2.3 miles of buried pipeline (or 1.9 miles of pipeline and 0.4 miles of lined ditch south of the Larimer Weld Canal) south to the Poudre River at 4980 ft. elevation. The 60 foot elevation differential provides for an average 26 ft./ mile gradient, allowing for gravity flow through this segment of the alignment. This routing utilizes the existing Shields Street utility right of way or could be sited immediately adjacent to the right of way. The majority of property on this route is undeveloped agricultural land, though there are approximately eleven private residences, two commercial structures, and one public facility that may require some adjustment of the alignment or negotiated easements. The Highway 287/Union Pacific Railroad corridor crossing and the Larimer Weld Canal crossing could employ boring technologies similar to the proposed borings under wetlands as described in the Thornton Pipeline Proposal. To reduce surge effects, water entering the Poudre River would be dispersed through a series of riprap check dams and vegetated distributary channels in the vicinity of the North Shields Ponds Natural Area. Total distance from the WSSC #4 outtake to the Poudre River is approximately 3.4 miles.

SEGMENT #3 – approximately 20 miles within the Poudre River (with the 14 mile Shields Street to I-25 reach within the city limits of Fort Collins) to the intersection of the Poudre River and County Line Road near the Town of Windsor per the proposed Thornton Pipeline Project Corridor (hereafter referred to as the “Windsor intake”). In this vicinity, an intake works, settling/storage basins, a pump station, and possibly a (pre)treatment facility would need to be constructed. Since approximately twenty miles of buried 48” pipeline are eliminated, and the Windsor pump station is located 24.5 miles to 26.5 (as opposed to 44.5 to 46.5) miles from the zone proposed for the Firestone/Frederick pump station, it is possible that one or both of the pump stations could be downsized; or could be consolidated into a single pump station, thereby reducing project and operational costs.

This alignment, particularly the Poudre River Segment, provides the greatest benefit with the least disruption to Larimer and Weld counties while protecting water quality and quantity (discussed below) for the City of Thornton.

The Windsor to Thornton segment of the pipeline remains identical to the existing Thornton Pipeline Proposal and is not impacted by the SS/PR Alternative.

OPERATION

The SS/PR Alternative would utilize a seasonal and daily operational reservoir fill and drawdown schedule that would be essentially identical to the Thornton Pipeline Proposal. Fluctuation of shoreline elevation, and any aesthetic impacts on surrounding properties as a result of reservoir drawdown, would remain the same for either Alternative.

WATER QUALITY MITIGATION

The City of Thornton has expressed a concern that water that would flow through the Poudre River may be degraded relative to the quality of water delivered from WSSC #4. Neither source would directly supply potable water to consumers in Thornton. It is the intent of this Alternative to deliver water to the Thornton water treatment facilities that is of similar quality as water delivered from WSSC #4.

Several factors need to be considered in regards to water quality. Among these factors are sediment load, agricultural runoff in the reach from the Canyon Mouth to Windsor, municipal stormwater runoff, discharge from three wastewater treatment facilities in the City of Fort

Collins, reduced biological function as a result of this combination of factors and, most importantly, the current depleted flow regime within the Poudre River.

The single most effective long-term water quality mitigation is simply the re-watering of the Poudre River from Shields Street to Windsor.

Sedimentation: With the exception of some periodic storm-induced increases in sediment load as a result of recent (2012) fire scars in the upper basin, the Poudre River has relatively low turbidity. A considerable amount of watershed restoration has been performed by the Coalition for the Poudre River Watershed and other volunteer organizations. These notable efforts are ongoing and help reduce the base sediment load through the entire river system. As a result, the stream water that would be “mixed” with outtake from WSSC #4 contains less sediment than pre-mitigation runoff. The Coalition’s “Upper Poudre Watershed Resilience Plan” (2017) provides a framework for future mitigation and presents a “Sediment Transport Model” for the Lower Basin.

Of course, turbidity is a function of streamflow (volume, velocity, and gradient) and therefore fluctuates throughout the course of the year. The existing four WSSC reservoirs, in conjunction with Kluver Reservoir, function as a “settling basin” for waters diverted from the Poudre River via the Larimer County Canal. While this water is relatively sediment free, it is not classified as potable and treatment is still required. In order to achieve similar water clarity, the SS/PR Alternative would require the construction of settling/storage basins in the vicinity of the Windsor intake and pump station. As with all works of this type, inlets to the settling/storage basins would need to have the capability to shunt water during flood events or anomalous incidents such as forest fire sediment load increases. This presents an opportunity for a collaborative effort in which the City of Fort Collins Natural Areas Program, Larimer County, and The Town of Windsor might cooperate in the design and construction of the settling/storage basins in conjunction with a floodplain enhancement and/or recreational development.

The annual hydrograph of the Poudre River indicates that the maximum volume, and therefore maximum sediment load, typically increases in May, peaks with the “June Rise,” and diminishes rapidly by early July. The water demand curve for the City of Thornton begins its annual rise from May to June, then peaks during the July and August lawn irrigation season, and begins to diminish in September. The implication of this lag in peak consumption demand relative to peak flow/sediment load is that maximum stream withdrawal would occur during periods (July and August) when the sediment load is naturally reduced as a function of reduced streamflow. This also coincides with maximum annual irrigation demand and maximum water diversion at the Canyon Mouth, thereby further reducing the peak flow and peak sediment load in the reach from the Canyon Mouth to Windsor.

Should Glade Reservoir of the Northern Integrated Supply Project (NISP) be constructed, considerable reductions in sediment load would be realized. By design, the peak flow/sediment load would be significantly truncated as this is the exact flow regime from which NISP would be drawing water out of the Poudre River at the Canyon Mouth diversion structure per the Northern Colorado Water Conservancy District’s 1980 priority right.

Agricultural Runoff: Agricultural runoff can negatively impact water quality by introducing nutrients, primarily phosphorous and nitrogen compounds, into the stream system. These nutrients often create conditions favorable to algal growth, and in turn increase Biological Oxygen Demand (BOD). Agricultural runoff in the Canyon Mouth to Windsor reach could be

significantly reduced by utilizing voluntary, market-driven Conservation Easements to create buffer zones along the river corridor. With the incentive of tax benefits for property owners, entities such as the Larimer County Open Lands Program, the City of Fort Collins Natural Areas Program, the Coalition of Colorado Land Trusts, and other non-governmental organizations (NGOs) could identify willing participants and negotiate mutually beneficial agreements that reduce non-point source pollutants while preserving the agricultural heritage of Larimer County. These agreements could include a menu of non-point source mitigation strategies such as berms, vegetated swales, improved fertilizer management, manure management, conservation tillage to reduce soil compaction and runoff, and the use of seasonal cover crops.

Additionally, ongoing improvements in floodplain connectivity (e.g. Fort Collins Natural Areas Program “Riverbend Ponds” enhancement) would increase the amount of time and surface area that river water would be filtered through plants and alluvium, thereby increasing the uptake of nitrogen and phosphorus compounds (while also providing the ancillary benefit of reducing sediment load).

Stormwater Management: Most stormwater runoff occurs in urban areas, particularly from non-permeable surfaces such as roofing and pavement. The primary source of stormwater runoff in the relevant reach of the Poudre River is the City of Fort Collins. Fort Collins continues to address this issue through its Stormwater Management Program. Infrastructure improvements, such as catchment basins that collect and temporarily retain stormwater runoff to facilitate plant and soil filtration, are a primary component of the Program. Also included are public education/enforcement components that focus on automotive byproducts; lawn care contaminants such as fertilizer, pesticides, and herbicides; and construction site runoff and building code modifications that encourage semi-permeable parking and other hardened surfaces. In some cases, rebates are available to facilitate reductions in surface runoff (and reduce overall water consumption). The Colorado State University Stormwater Center also provides resources for Best Management Practices for stormwater districts, so-called “green infrastructure” design and construction guidance, and Low Impact Development strategies.

Wastewater Treatment Discharge: The City of Fort Collins Mulberry, Drake, and Fossil Creek wastewater treatment plants are operated in a manner that meets or exceeds all state and federal standards for wastewater reclamation. Physical, biological, and chemical processes are used to treat wastewater prior to discharge into the Poudre River (Mulberry and Drake facilities) and into Fossil Creek Reservoir. This reclaimed water is essentially free of organic, pathogenic, and metal contaminants that may pose an environmental or human health risk. Aeration is utilized as a means of odor control. The City of Fort Collins has a cooperative service agreement with the United States Geological Survey to monitor water quality within the Poudre River. As with the raw water in WSSC #4, reclaimed municipal wastewater is not categorized as potable and must be treated prior to household consumption.

In view of the fact that the city of Fort Collins would receive considerable quality of life and economic benefits from a re-watered Poudre River, it is reasonable to suggest that the City of Fort Collins may be willing to enter into an Intergovernmental Agreement (IGA) with the City of Thornton to further improve the quality of effluent water from its reclamation operations, especially the Mulberry and Drake facilities that discharge directly into the Poudre River. This IGA could consist of enhanced treatment (e.g. increased aeration or ultraviolet irradiation) at the Fort Collins points of discharge or a financial/in-kind contribution to a pre-treatment facility

located at, or down pipeline of, the proposed Windsor pump station (in addition to the aforementioned settling basin/floodplain enhancement).

It is again important to emphasize that these mitigations would take place in conjunction with, and would complement, existing and future efforts designed to improve overall river health.

Biological Function: Functioning, intact river systems deliver a variety of ecosystem services. The services most relevant to municipal supply water quality are chemical and nutrient uptake, algae control, water temperature moderation, and the resulting dissolved oxygen content.

When healthy, the in-stream and riparian plant communities and streambank alluvium can remove much of the dissolved chemical and nutrient load, further enhancing the above mentioned mitigations related to agricultural and stormwater runoff.

The amount of algae in a stream will remain in general equilibrium unless impacted by increases in nutrients such as phosphorous and nitrogen. Water temperature and exposure to sunlight also influence algal growth. Hence, so called “algal blooms” occur most frequently in warm, standing water that is exposed to sunlight and a high nutrient content; conditions frequently found in water storage reservoirs. A flowing Poudre River would rarely present conditions conducive to algal blooms. Furthermore, a more natural stream ecosystem cools (shading and alluvial flow) and oxygenates the waters within it. These natural stream functions are so effective that the City of Aurora utilizes them as a major purification component in the Prairie Waters Project that treats wastewater effluent to such a high quality that it is mixed into the potable water supply. Increased flows from WSSC #4 would enhance these purifying functions of the stream ecosystem as well as improve ecosystem connectivity.

It is important to note that while some degradation of water quality in the Shields Street to Windsor reach would most likely occur as a result of agricultural runoff, stormwater runoff, and water reclamation discharge; the biological and fluvial functions of a healthier, re-watered Poudre River would simultaneously mitigate many of those impacts.

INSURING FULL ALLOTMENT

The City of Thornton is entitled to its full allotment of water as specified in the Colorado Water Court and Colorado Supreme Court Decrees. A legitimate concern with the SS/PR Alternative is water loss during conveyance within the Poudre River. Some loss would occur as a result of increased evapotranspiration from a more densely vegetated stream course, infiltration to the adjacent alluvium, and direct evaporation from the surface of the river.

The amount of consumed water would decrease over time. The initial increase in plant growth and the initial recharge of alluvial bank storage (not actually “consumed,” but retained in bank storage) would be greatest in the earliest operation of this Alternative; a timeframe in which full allotment exceeds consumptive demand. In particular, alluvial bank storage would reach a seasonal equilibrium within the first year of operation. While some WSSC water would be stored in the alluvium, the majority of recharge would still be the result of the (diminished) seasonal peak flows that currently occur within the Poudre River watershed. As an additional benefit, when water is released from bank storage during periods of low flow, it is cooler; more oxygenated, and contains less algal growth than water stored in a reservoir.

There are three mechanisms available to mitigate these potential losses. Since full allotment would not be required during the initial, somewhat higher consumption phase of alluvial recharge and stimulated plant growth, Alternative Transfer Methods (ATMs) could be employed to compensate for any potential shortage. The Colorado Water Plan calls for acquisition of

50,000 acre feet of water through this mechanism. The most frequently used ATM approach is the “interruptible water supply agreement.” Under recent State legislation, these agreements allow agricultural users to fallow lands and lease water held under an agricultural right for municipal use for three out of ten years. The agricultural right may not be challenged as “abandoned” under this legislation. This is an ideal mechanism for compensating for any possible initial shortage in the SS/PR Alternative in that the quantity of leased water can be easily reduced over time, agricultural land is not permanently taken out of production, and the cost is considerably less than outright purchase and conversion of agricultural water rights.

A second mechanism is the continued purchase of existing agricultural rights within the Poudre drainage. This is the least desirable option as it results in permanent removal of productive agricultural lands, has the potential to injure other existing water rights, and is expensive.

A final option that could be used to mitigate the long term evapotranspiration/evaporative loss is an in-kind exchange of water rights between entities that receive a benefit from a re-watered Poudre River, especially the City of Fort Collins. Fort Collins would need to analyze the value of any potential water rights transfer vis-à-vis the economic benefits inherent in a healthier, aesthetically more pleasing re-watered Poudre River flowing through a significant portion of the City. From a legal perspective, any such transfer should be relatively free of contentious litigation as it is a municipal-to-municipal transfer with little potential to injure other existing water rights.

One other potential should be considered. While no formal agreement has been reached, the Northern Colorado Water Conservancy District has discussed a mitigation plan with the City of Fort Collins that would allocate a minimum base flow for the Poudre River as a component of the NISP operational plan. Should such an agreement be reached, the minimal flow would eliminate the seasonal “dry up points” below irrigation diversion structures along the Poudre River and thereby provide ecosystem connectivity, enhancing stream function. This release would help maintain bank storage and partially compensate for evapotranspiration and evaporative losses. The net result would be a decrease in the long term need to acquire water to compensate for any possible depletion of the Thornton allocation.

COST COMPARISON

Until a more detailed engineering and construction cost analysis for the SS/PR Alternative and the final alignment of the Thornton Pipeline Proposal is completed, it is difficult to provide much more than a qualitative comparison of the two Alternatives.

Obviously, with a net decrease of approximately seventeen miles of buried 48” pipeline, some cost reduction would be realized with the SS/PR Alternative. The segment eliminated also represents some of the most expensive per mile costs of the pipeline as it includes the replacement of Douglas Road and increased costs associated with minimizing disruptions and maintaining emergency access during the construction phase. As previously mentioned, construction costs and operational costs would decrease as a result of downsizing or consolidating the Windsor and Firestone/Frederick pump stations.

Other costs would remain similar regardless of which Alternative is constructed. The outlet works at WSSC #4 would be essentially identical as would be the various “appurtenant structures” referred to in general terms in the Thornton Pipeline Proposal public presentations.

Components of the SS/PR Alternative that could be more expensive than the Thornton Pipeline Proposal include the intake works and settling/storage basins in the vicinity of the Windsor intake (see prior reference to potential collaborative approach). Permitting, water rights

acquisition (if needed), and potential adjudication might also be additional costs associated with the SS/PR Alternative.

Perhaps the most difficult cost to estimate is the possibility that a treatment plant or pre-treatment plant would be needed if the Poudre River is utilized as a means of conveyance. An important consideration is that the SS/PR Alternative need only supply water of a quality that is comparable to that supplied by WSSC #4. Again, neither source supplies potable water.

During the Public Hearing on August 1, the City of Thornton presented a table summarizing cost projections for a generic Poudre River Alternative withdrawing water at Windsor. Included in that table was an estimate of \$440 million to \$760 million for “water treatment.” The City of Thornton recently upgraded the Wes Brown Water Treatment Plant at a cost of \$75 million. Obviously, the costs of land acquisition and the basic infrastructure associated with a treatment plant are not reflected in the \$75 million retrofit. Based on the figures provided by Thornton, \$365 million to \$685 million is the estimated cost for the basic footprint of a treatment facility located at Windsor. Such a cost implies a design criteria based on a water quality parameter far exceeding the existing water quality in WSSC #4. The Wes Brown Water Treatment Plant is described by the City of Thornton as a facility that “uses advanced water treatment processes including state-of-the-art ultrafiltration membranes.” The current primary sources for Thornton’s raw water are Clear Creek and the South Platte River. While considerable mitigation has since occurred, it should be noted that the Clear Creek/Central City site was placed on the Superfund National Priority List in 1983. The South Platte River flows through the largest and most densely populated metropolitan area in the State of Colorado and contains some of the oldest stormwater infrastructure in the state. The City of Thornton reports that “aesthetic changes” of a “pondy or dirty taste and odor in your drinking water” occur on an annual basis as do algal blooms in the reservoirs that feed the two Thornton water treatment facilities.

It seems improbable that water that flows from an outtake at WSSC #4 through approximately twenty miles of the Poudre River could be similarly degraded. A Windsor (pre)treatment facility that is estimated to cost 5.8 to 10.1 times more than the Wes Brown Water Treatment Plant retrofit is difficult to reconcile with the water quality currently documented in the Poudre River. It is possible that some pre-treatment would be needed for water drawn from the Windsor settling/storage basins in order to insure that it is of similar quality as water drawn from WSSC #4. That such a facility could possibly cost multiple times more than one of the most sophisticated water treatment facilities in the State of Colorado seems implausible. To be valid, any cost comparison between Alternatives must be based on similar water quality standards and use the same platform for analysis.

PERMITTING and CONSTRUCTION

The SS/PR Alternative could potentially impact wetlands and would therefore be subject to environmental review and permitting. While these processes are time consuming, some factors suggest a somewhat more rapid timeline through permitting and construction. A considerable amount of stream function data, hydrologic modeling, and environmental impact projections are available for the reach contained in the SS/PR Alternative as a result of the extensive National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS) requirements for NISP. In addition to this body of work, the City of Fort Collins “River Health Assessment Framework” (2015) and the aforementioned “Sediment Transport Model” provided by the Coalition for the Poudre River Watershed (2017) could be directly incorporated into an assessment of the SS/PR Alternative. While public comment is required for any permitting

process, it seems reasonable to assume that there would be far fewer, if any, major objections to an Alternative that provides so many tangible, positive environmental benefits as the SS/PR Alternative. When compared to the possibility of lengthy and expensive litigation over permitting or eminent domain disputes related to the Thornton Pipeline Proposal, permitting of the SS/PR Alternative lies within a timeframe that appears to be less than onerous.

The City of Thornton began acquisition and planning for water delivery over three decades ago and expects the Project to meet future water needs through 2065. Relative to that timeframe, a reasonable amount of time is required for a thorough and transparent review and planning process that incorporates the involvement of the citizens of Larimer County and other impacted parties; and that utilizes a clearly defined, consistent analysis platform. While Thornton has stated a desire to begin water delivery in 2025, it should be noted that the full allotment of water would not be required at that time. It should also be noted that the 1041 Permit process is not required to be completed based on that proposed timeline, nor is the 1041 Permit process bound by Applicant defined "Exclusion Areas" that implicitly disqualify the Poudre River as a means of conveyance (see TWP Vol. 2, Appendix A, Sec. 2-1). A combination of continued water conservation, such as the commendable efforts under the Thornton Water Conservation Plan, and possible augmentation through temporary ATMs would be adequate to address any potential short-term deficits until permitting and construction of any Alternative is completed.

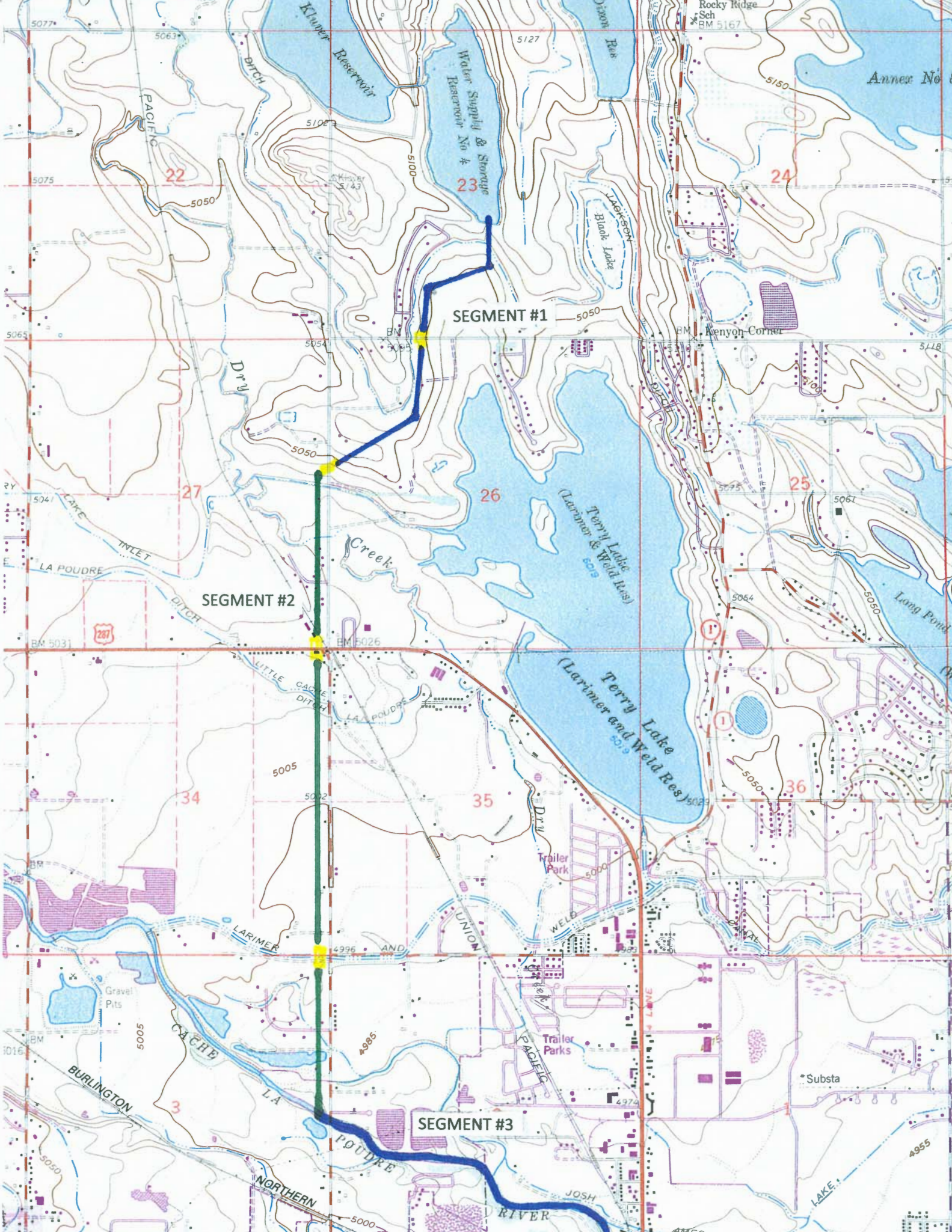
Since the Poudre River provides a natural physical break between segments in the SS/PR Alternative, construction of various segments of the supply system could occur simultaneously. For example, the WSSC #4 outlet works and Shields Street pipeline component could be built while simultaneously building the Windsor to Thornton segment of the pipeline. Since the Weld County segment of pipeline remains identical in either Alternative, construction could begin on that segment upon issuance of the Weld county and other jurisdictions' permits. Similarly, any intake works and other infrastructure needed to deliver raw water to either or both of Thornton's existing water treatment plants could also proceed.

A GENERATIONAL LEGACY

The SS/PR Alternative represents an irreplaceable opportunity to re-water a significant portion of the Poudre River and create what would truly be a generational legacy for Larimer County, Weld County, and the State of Colorado. The twenty mile Shields Street to Windsor reach would serve as a functional, permanent anchor and provide an incentive for continued restoration of the health of the entire length of the Poudre River. As mentioned above, a variety of entities are currently working to restore the Poudre River and have made significant improvements in river health and stream function. SB 97 (1973) created the legislative authority for the Colorado Water Conservation Board (CWCB) to acquire water rights for "in stream flows" to protect environmental values to a reasonable degree. Subsequent legislation has provided further opportunities to enhance in stream flows through leasing arrangements similar to ATMs. The Colorado Water Trust is actively engaged in acquiring and transferring to the CWCB such in stream flow rights. While it is imperative to protect the interests of the existing agricultural users and communities in Larimer County; even small, incremental increases in summertime flow in the eight miles from the Canyon Mouth diversions to Shields Street would lead to a connected river system in which the biological and hydrological functions of the Poudre River could be significantly restored. These flows could reduce or replace any potential consumptive loss that might result from an in-river conveyance and thereby deliver the full allotment under the City of Thornton's water rights. The benefits of even minimal in stream flow rights would positively

impact the entire River system, including the 30 mile reach from the Windsor intake to the confluence with the South Platte River at Greeley.

One can envision a future in which “the hardest working river in Colorado” would continue to deliver its historical benefit to the agricultural communities of Northern Colorado while enhancing the quality of life for a growing population along the Colorado Front Range. The SS/PR Alternative represents a unique opportunity for intergovernmental and NGO cooperation that respects the concerns of all stakeholders while providing the least disruptive and most beneficial solution to one of Colorado’s most important needs.



SEGMENT #1

SEGMENT #2

SEGMENT #3

Klauer Reservoir

Water Supply & Storage Reservoir No. 4

Terry Lake (Larimer and Weld Res.)

Terry Lake (Larimer and Weld Res.)

BURLINGTON

NORTHERN

RIVER

Rocky Ridge Sch

Kenyon Corner

Trailer Park

Trailer Parks

Substa

Annex No 8

22

23

24

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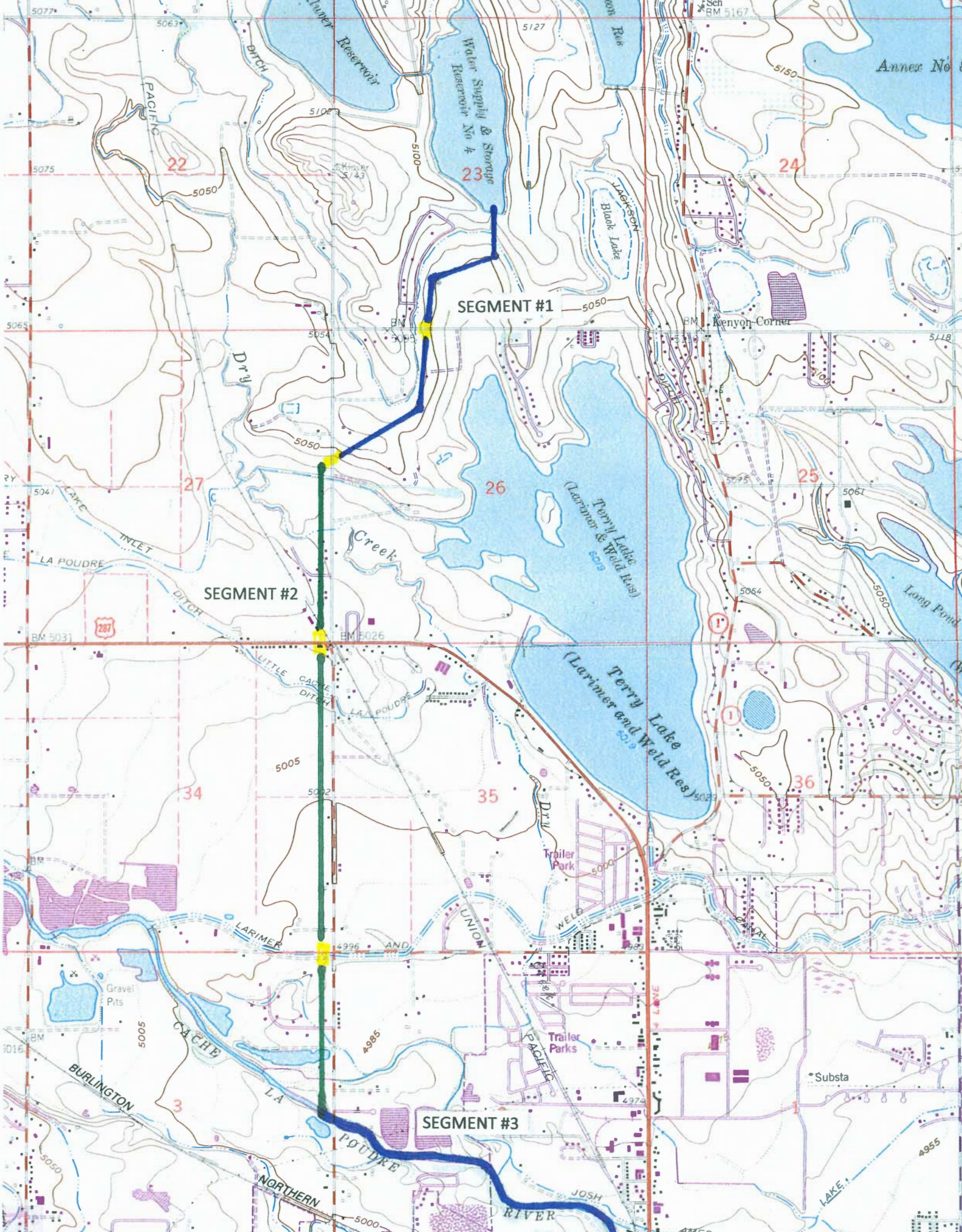
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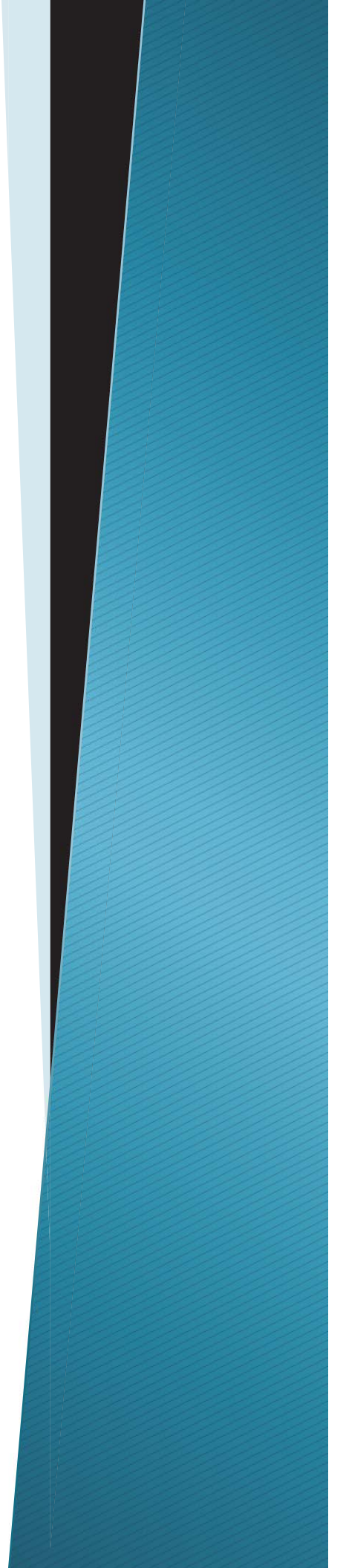
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Water Supply and Storage Company

Larimer County Working Group



WSSC Shareholders

- ▶ **Agricultural & Non-Municipal Use**
 - 128 Shareholders
 - 199 Shares (of 600 Issued)
 - 40,000 Acres in Agricultural Production
- ▶ **Municipal Use**
 - 10 Shareholders
 - 401 Shares (of 600 Issued)
 - All but 21 Shares in 2018 used for ag. irrigation
 - 289.1075 Shares owned by Thornton
 - 362.17 Shares “converted in water court”

WSSC System Facilities

- ▶ **Larimer County Canal**
 - 58 Miles in Length
 - 300 – 400 cfs normal diversion capacity
- ▶ **Major Lateral Ditches**
 - 36 Miles in Length

Reservoir Storage Capacities

- ▶ **2 Mountain Reservoirs – 19,700 Acre–Feet**
 - Chambers Reservoir & Long Draw
- ▶ **9 Plains Reservoirs – 27,200 Acre–Feet**
 - Res. #3, Res. #4, Kluver (subtotal for these 3 = 7,000 Aft)
 - Long Pond, Black Hollow, Curtis Res.,
 - Rocky Ridge, Richards, Lindenmeier

WSSC Water Rights

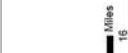
- ▶ Direct flow rights - 1862 to 1914
- ▶ Storage rights - 1882 to 1982
- ▶ Transbasin rights - 1882 to 1912
- ▶ CBT Shares - 1425 units (w/o private holdings)
- ▶ Jackson Ditch 1861 to 1879

Existing Agreements with Municipal Shareholders

- ▶ 1982 Fort Collins
- ▶ 1986 Thornton
 - Change of use to Municipal Use
 - Use of WSSC System
 - Storage and use of Excess Capacity
 - Local control of Board of Directors
- ▶ Greeley, ELCO, North Weld

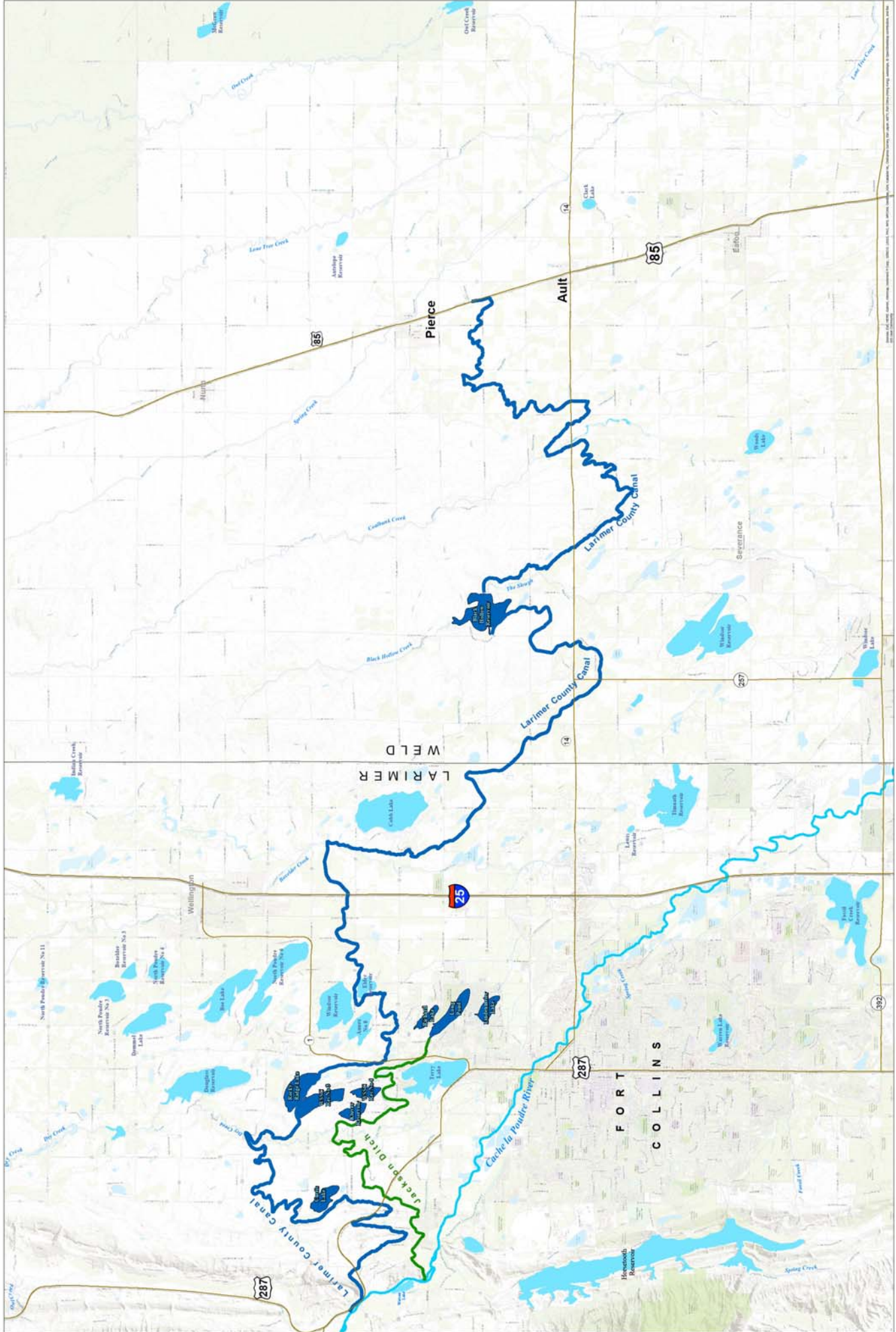
Water Supply and Storage Company

Main Canal

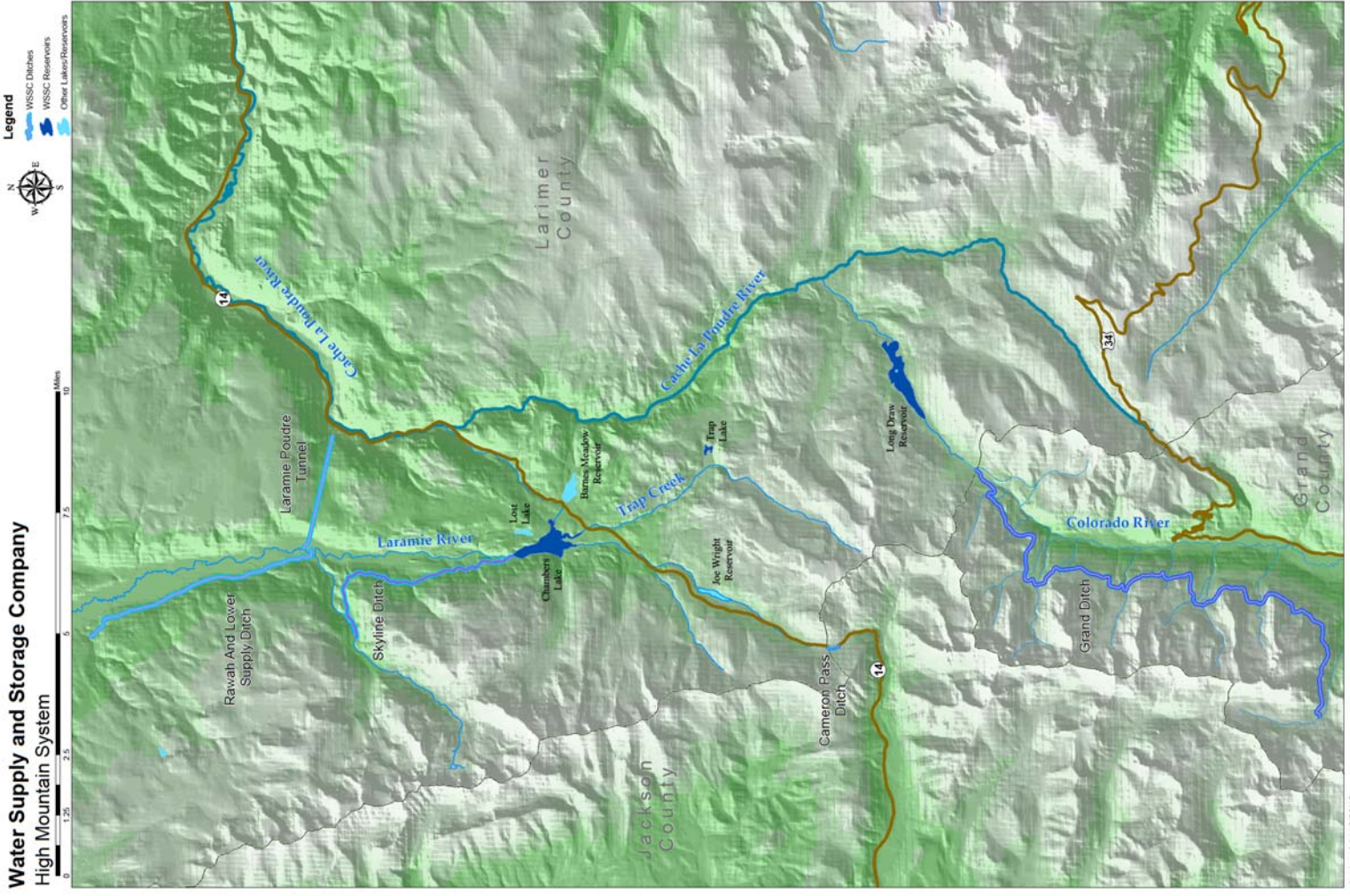


Legend

- Larimer County Canal
- Jackson Ditch
- WSSC Reservoirs
- Other Lakes/Reservoirs



Water Supply and Storage Company High Mountain System

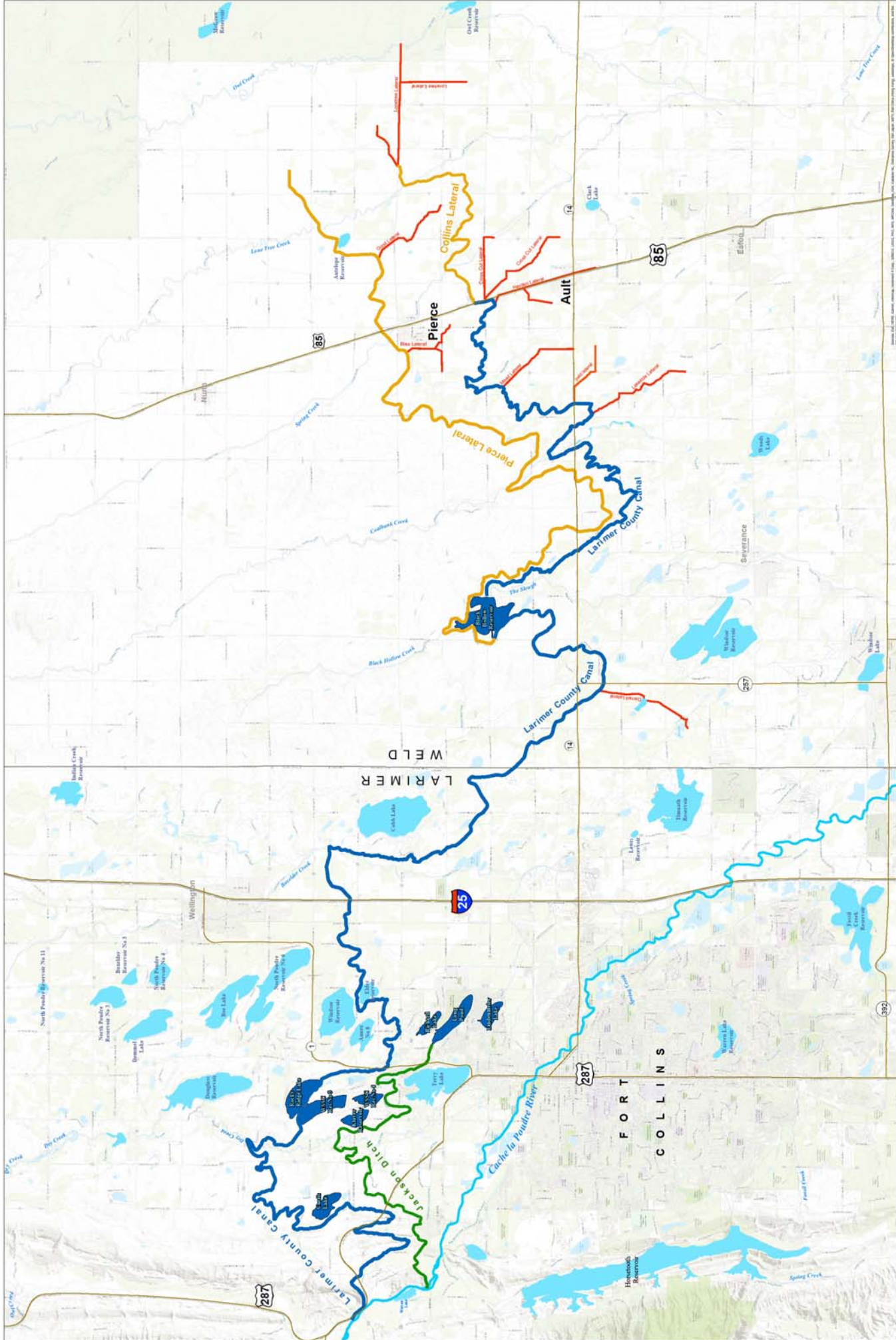


Water Supply and Storage Company Main Canal and Laterals



Legend

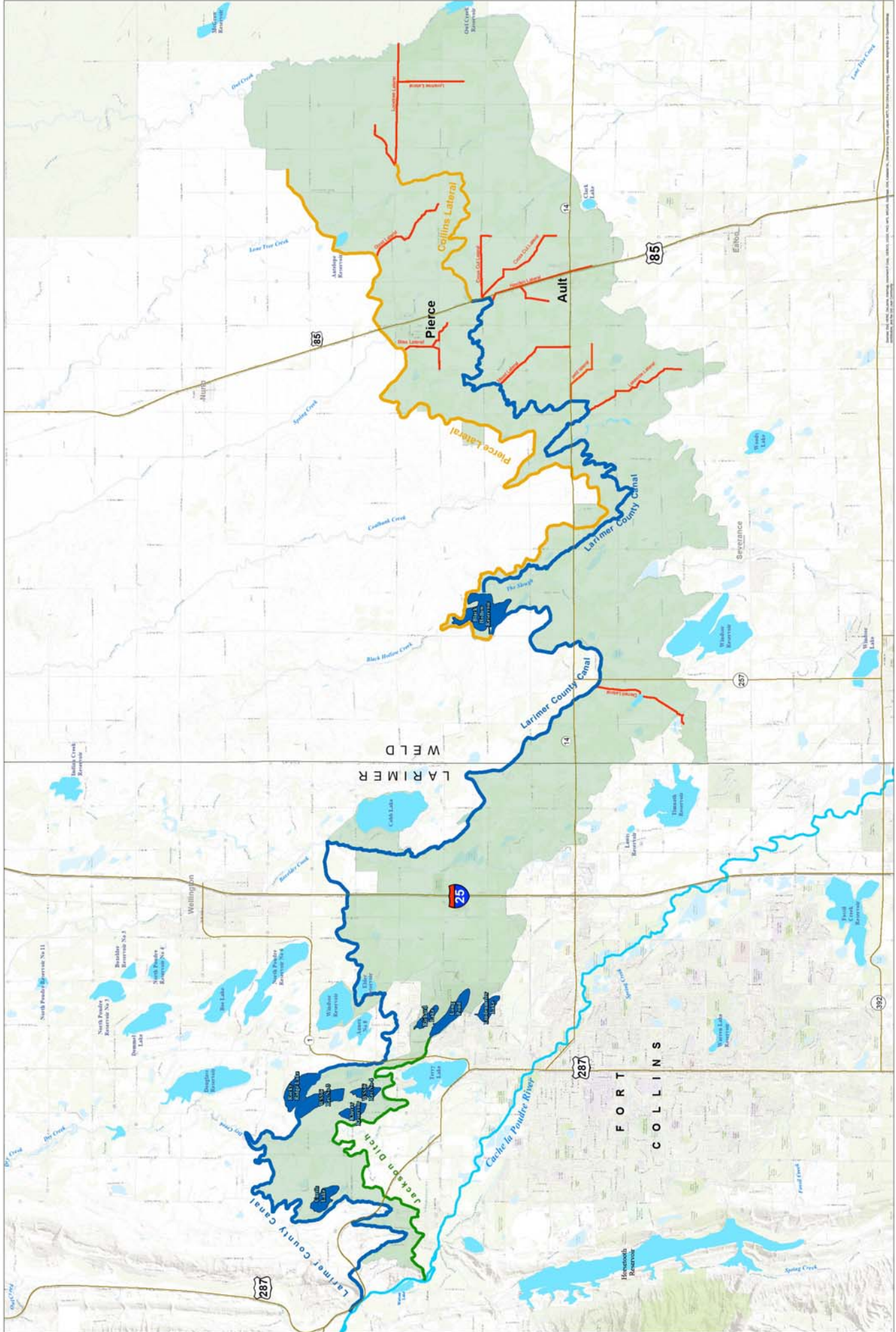
- Larimer County Canal
- Major Laterals
- Minor Laterals
- Jackson Ditch
- WSSC Reservoirs
- Other Lakes/Reservoirs



Water Supply and Storage Company Main Canal, Laterals and Service Area



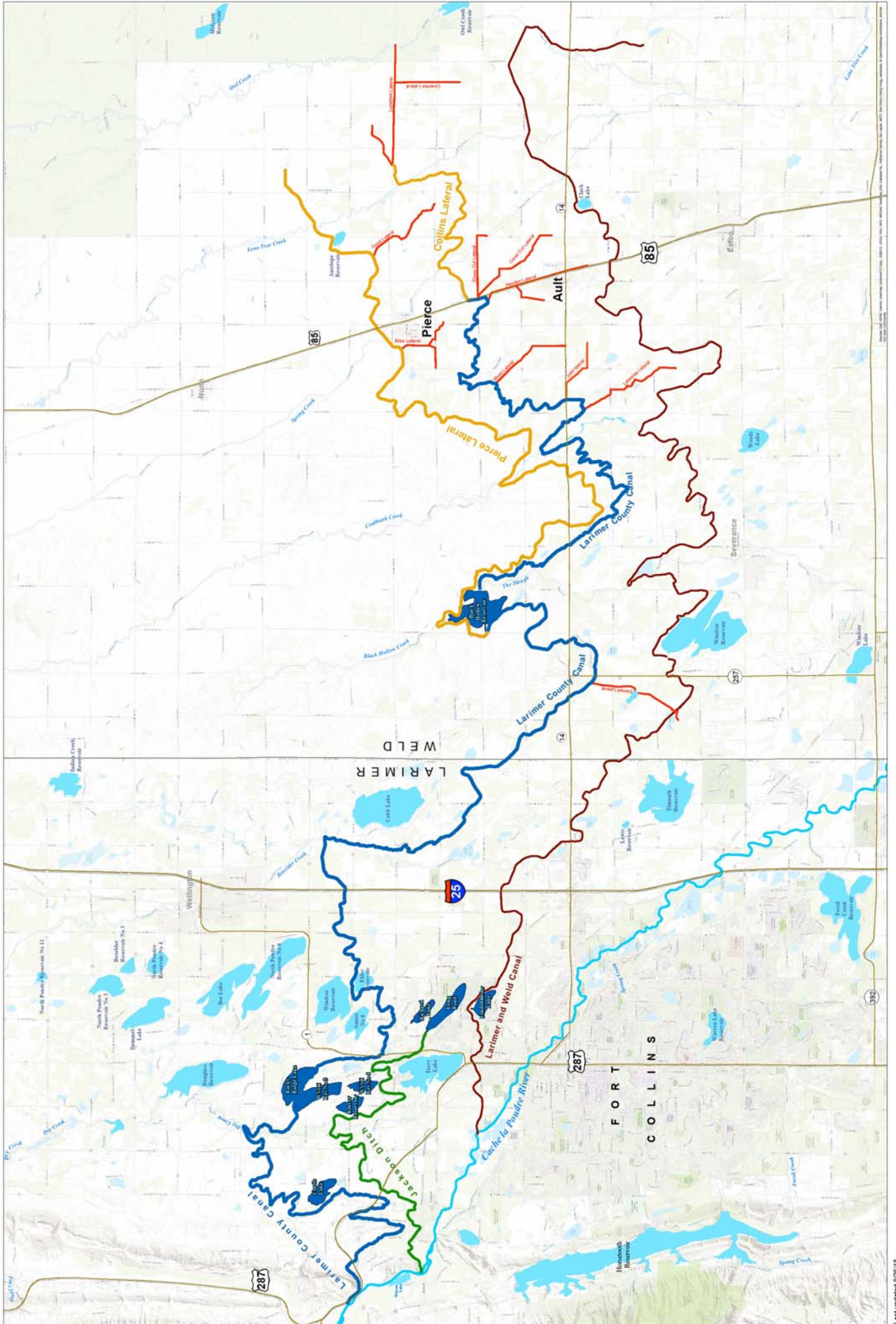
- Legend**
- Larimer County Canal
 - Major Laterals
 - Minor Laterals
 - Jackson Ditch
 - WSSC Service Area
 - WSSC Reservoirs
 - Other Lakes/Reservoirs



Water Supply and Storage Company Operations

Legend

-  Larimer County Canal
-  Jackson Ditch
-  WSSC Reservoirs
-  Major Laterals
-  Larimer and Weld Canal
-  Other Lakes/Reservoirs
-  Minor Laterals



WSSC Operations

- ▶ Delivery Season – May to mid-September
- ▶ Avg. Water Delivered – 51,896 aft
- ▶ System Operations – 4 to 5 Delivery Days / 2 to 3 System Recharge Days per week
- ▶ Delivery Days/Yr. – 63.64 (32 yr. avg.)
 - 64 days in 2018

History of Diversions

Avg. for 48 years (1970 - 2017)
(in Acre-Feet)

Cache la Poudre River	20,021
Trans-basin Diversions (never run thru Ft. Collins)	
Colorado River (Grand River Ditch)	16,663
Laramie River-No. Platte (L-P Tunnel)	12,912
CBT Units (NCWCD) 1 425 at est. 70% quota	998

	50,594
Jackson Ditch (6.25 of 24 sh. owned, est.)	1,302

Total	51,896

Pipeline Location

► Benefits to WSSC shareholders of the Res. #4 pipeline origin

Improves utilization of existing reservoir storage

- WSSC can dedicate 7,000 acre-foot of storage capacity solely to Thornton use, freeing up capacity in other company reservoirs for other shareholders.
- Resolves the need for future uncertain, irregular exchanges with other ditch companies for water stored in Reservoirs #3, #4 and Kløver Res. which historically have not always been available.

Mitigates impacts of reduced flows in main canal

- Maintains normal canal levels from river head gate to Res #4 and obviates the need for additional check structures which reduce canal efficiencies