Appendix A

Comments and Responses

To be included in the final environmental impact statement or assessment.

Appendix B

Project Maps

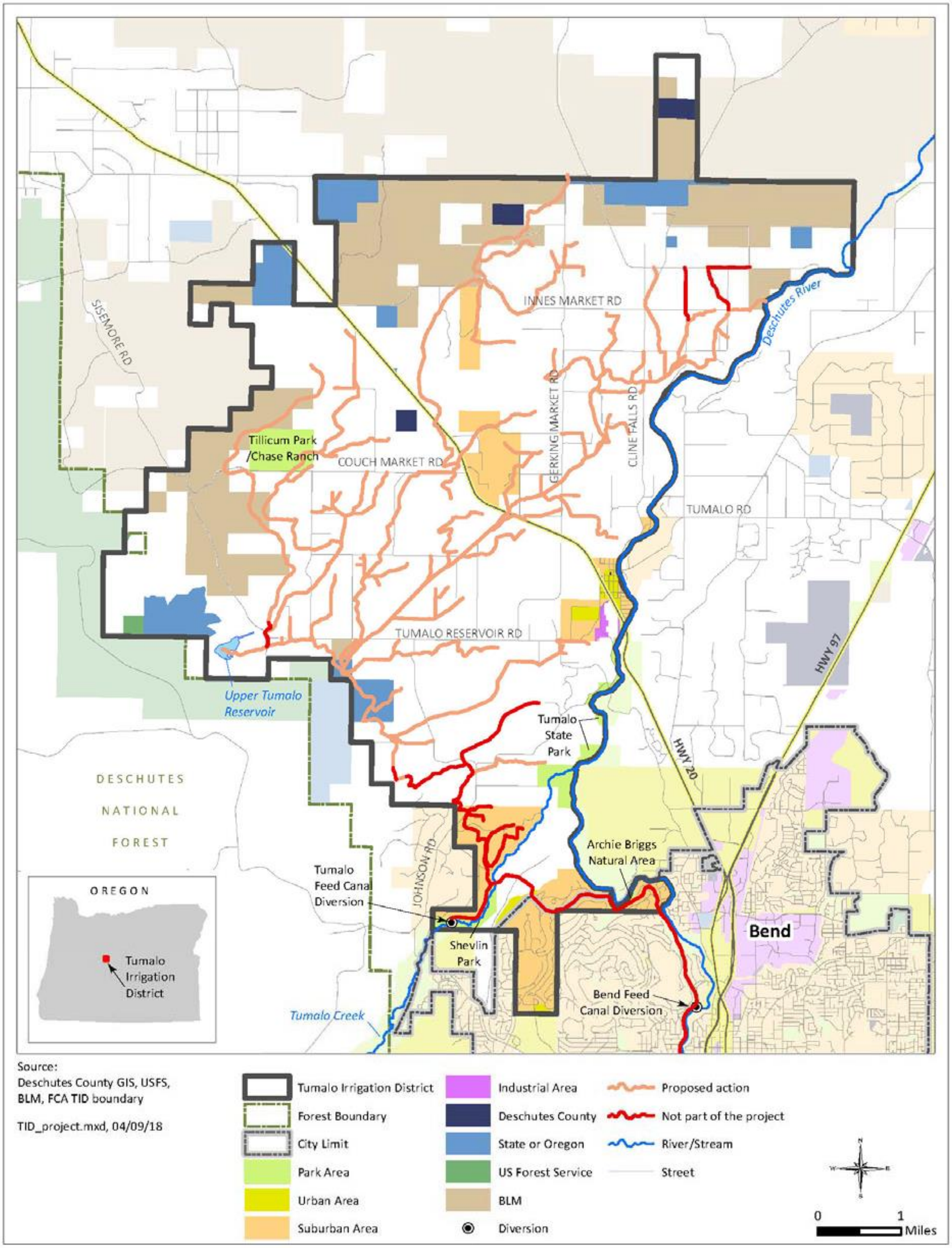


Figure B-1. Location of Tumalo Irrigation District – Irrigation Modernization Project.

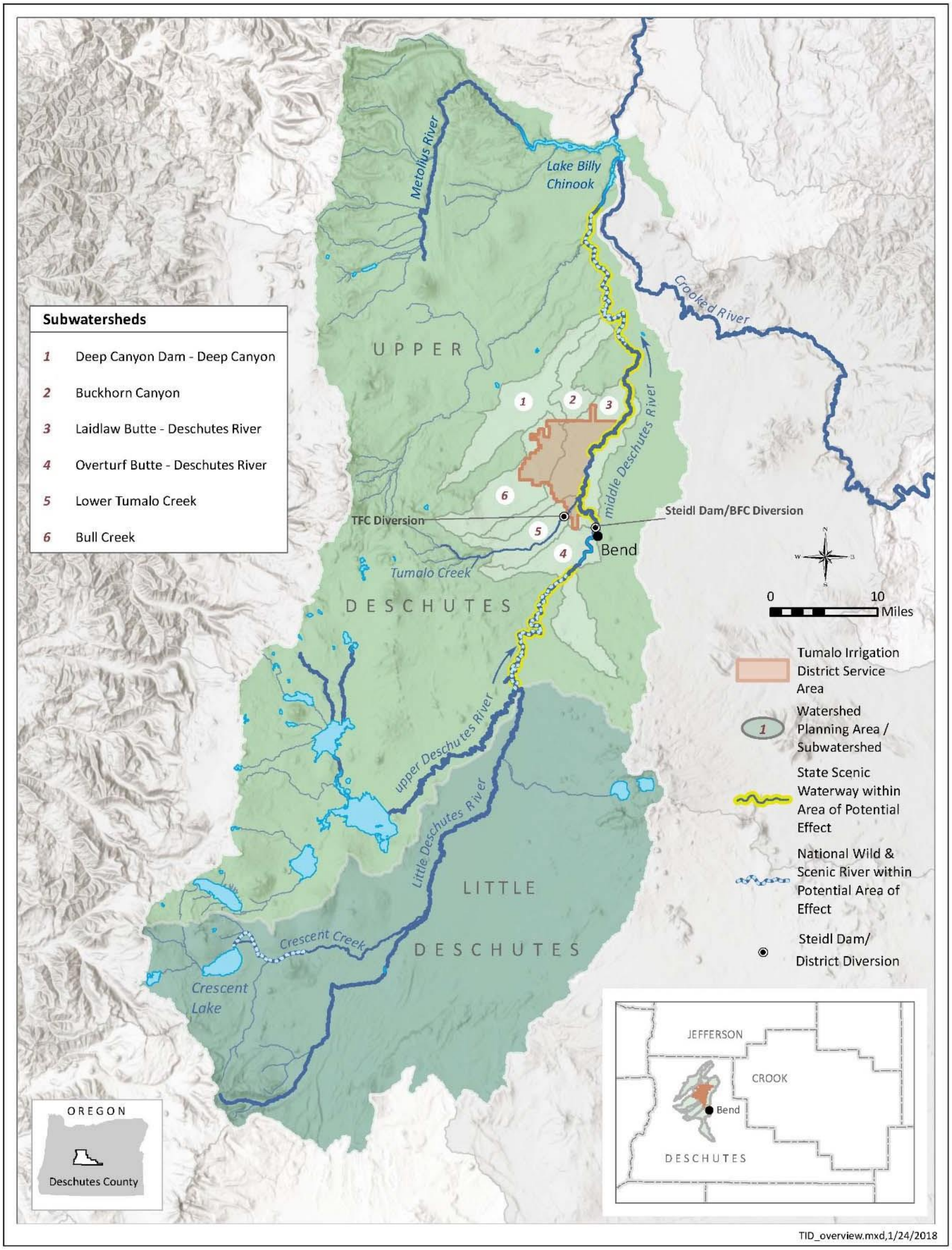


Figure B-2. The Six Subwatersheds Comprising the Tumalo Irrigation District Watershed Planning Area.

Appendix C

Supporting Maps

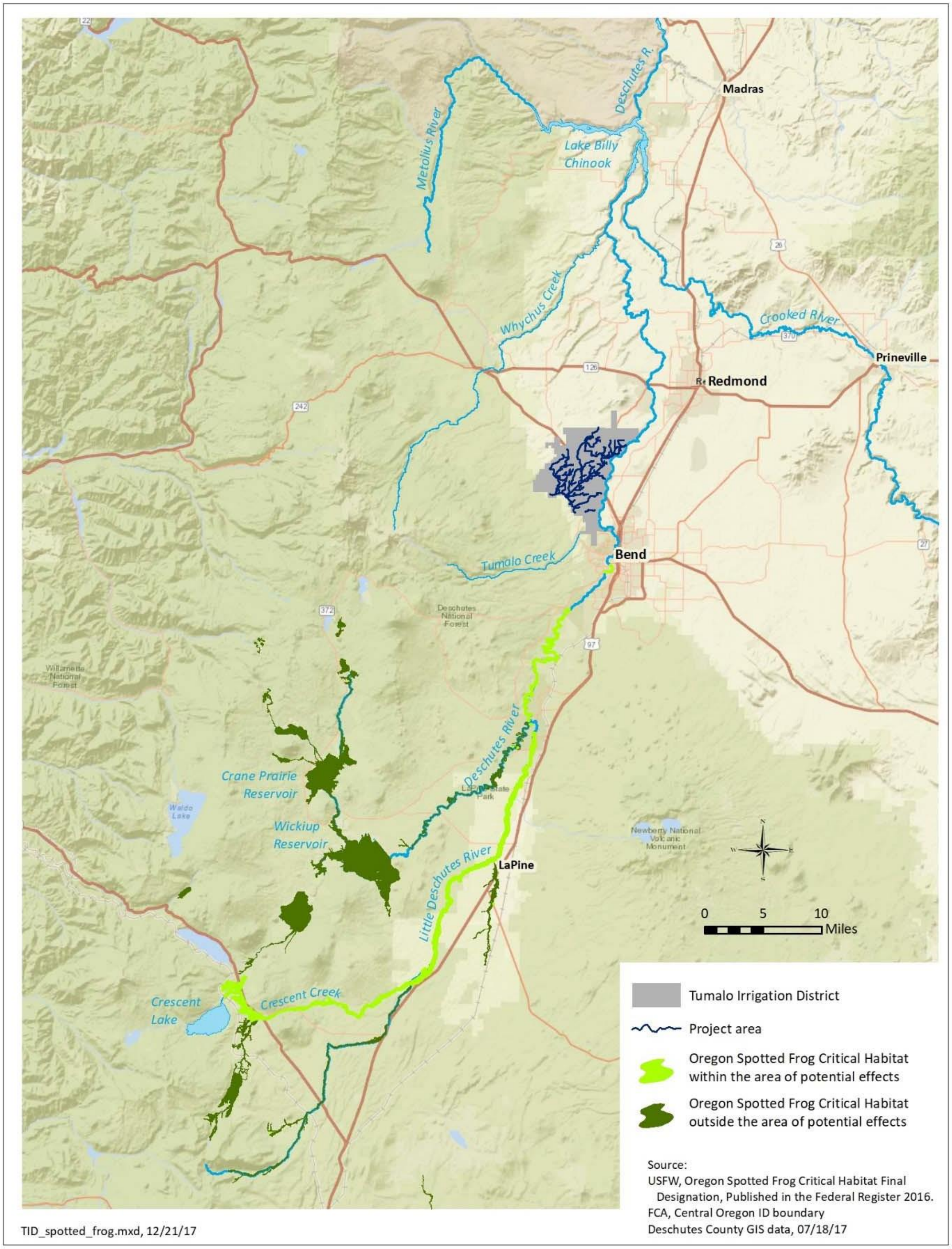


Figure C-1. Oregon Spotted Frog Critical Habitat near the Tumalo Irrigation District.

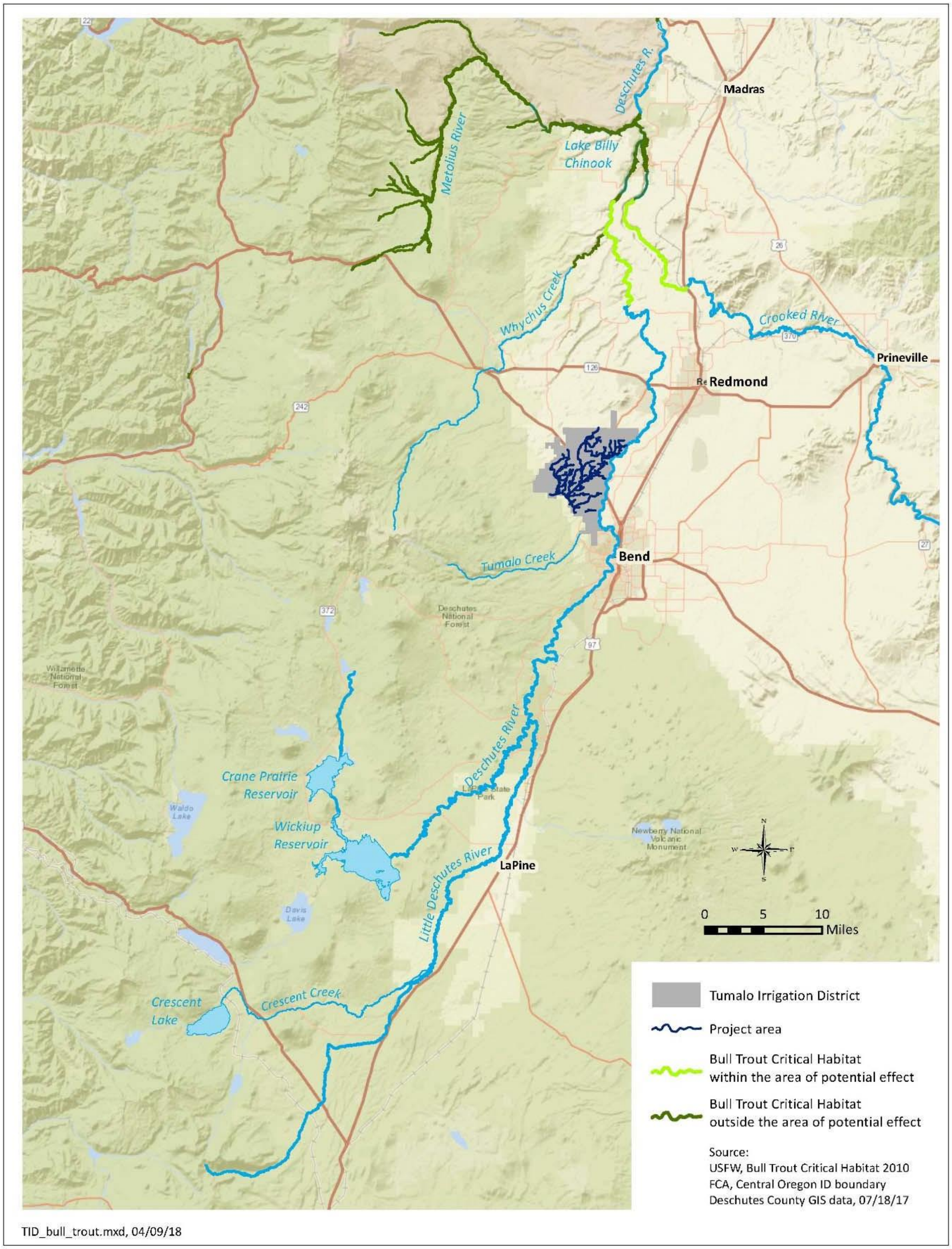


Figure C-2. Bull Trout Critical Habitat near the Tumalo Irrigation District.

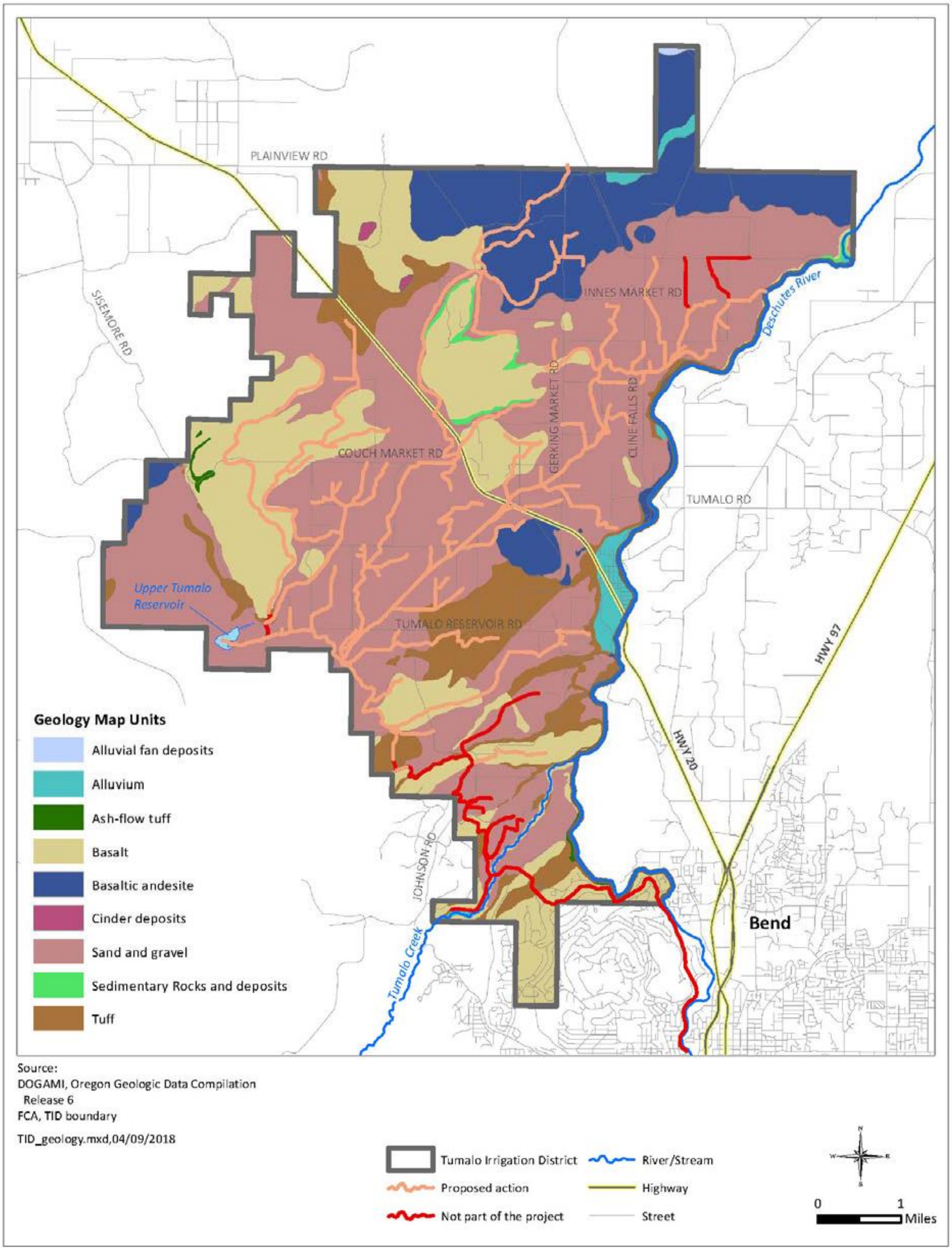


Figure C-3. Geologic Formations in the Tumalo Irrigation District.

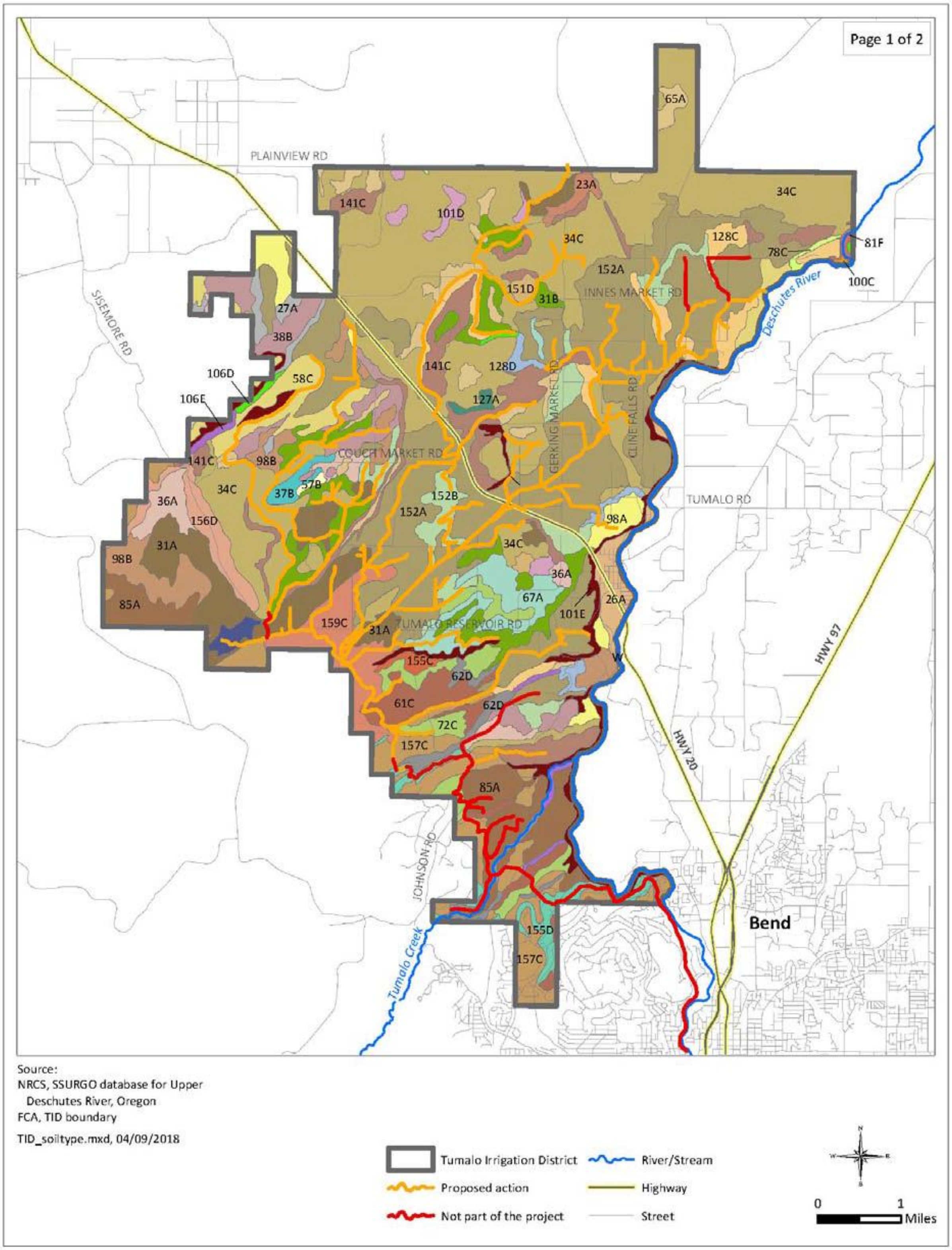


Figure C-4. General Soil Types in Tumalo Irrigation District.

Page 2 of 2

NRCS Map Unit Descriptions

Map Unit Symbol		Map Unit Name
23A		Buckbert sandy loam, 0 to 3 percent slopes
26A		Cinefalls sandy loam, 0 to 3 percent slopes
27A		Clovkamp loamy sand, 0 to 3 percent slopes
31A		Deschutes sandy loam, 0 to 3 percent slopes
31B		Deschutes sandy loam, 3 to 8 percent slopes
34C		Deschutes-Stukel complex, 0 to 15 percent slopes
36A		Deskamp loamy sand, 0 to 3 percent slopes
37B		Deskamp sandy loam, 3 to 8 percent slopes
38B		Deskamp-Gosney complex, 0 to 8 percent slopes
57B		Gosney stony loamy sand, 3 to 8 percent slopes
58C		Gosney-Rock outcrop-Deskamp complex, 0 to 15 percent slopes
61C		Henkle-Fryrear-Lava flow s complex, 0 to 15 percent slopes
62D		Henkle-Lava flow s-Fryrear complex, 15 to 50 percent slopes
65A		Houstake sandy loam, 0 to 3 percent slopes
67A		Houstake sandy loam, very gravelly substratum, 0 to 3 percent slopes
72C		Laidlaw sandy loam, 0 to 15 percent slopes
78C		Lickskillet-Deschutes complex, 0 to 15 percent slopes
81F		Lickskillet-Rock outcrop complex, 45 to 80 percent slopes
85A		Lundgren sandy loam, 0 to 3 percent slopes
98A		Plainview sandy loam, 0 to 3 percent slopes
98B		Plainview sandy loam, 3 to 8 percent slopes
100C		Redcliff-Lickskillet complex, 0 to 15 percent slopes
101D		Redcliff-Lickskillet-Rock outcrop complex, 15 to 30 percent south slopes
101E		Redcliff-Lickskillet-Rock outcrop complex, 30 to 50 percent south slopes
106D		Redslide-Lickskillet complex, 15 to 30 percent north slopes
106E		Redslide-Lickskillet complex, 30 to 50 percent north slopes
127A		Statz sandy loam, 0 to 3 percent slopes
128C		Statz-Deschutes complex, 0 to 15 percent slopes
128D		Statz-Deschutes complex, 15 to 30 percent slopes
141C		Stukel-Deschutes-Rock outcrop complex, 0 to 15 percent slopes
151D		Tetherow -Clovkamp complex, 8 to 50 percent slopes
152A		Tumalo sandy loam, 0 to 3 percent slopes
152B		Tumalo sandy loam, 3 to 8 percent slopes
155C		Wanoga sandy loam, 0 to 15 percent slopes
155D		Wanoga sandy loam, 15 to 30 percent slopes
156D		Wanoga-Fremkle-Henkle complex, 15 to 30 percent slopes
157C		Wanoga-Fremkle-Rock outcrop complex, 0 to 15 percent slopes
159C		Wilt sandy loam, 0 to 15 percent slopes
W		Water

Source:
NRCS, SSURGO database for Upper Deschutes River, Oregon

TID_soiltypelegend.mxd, 08/09/17

Figure C-5. Legend for General Soil Types in Tumalo Irrigation District.

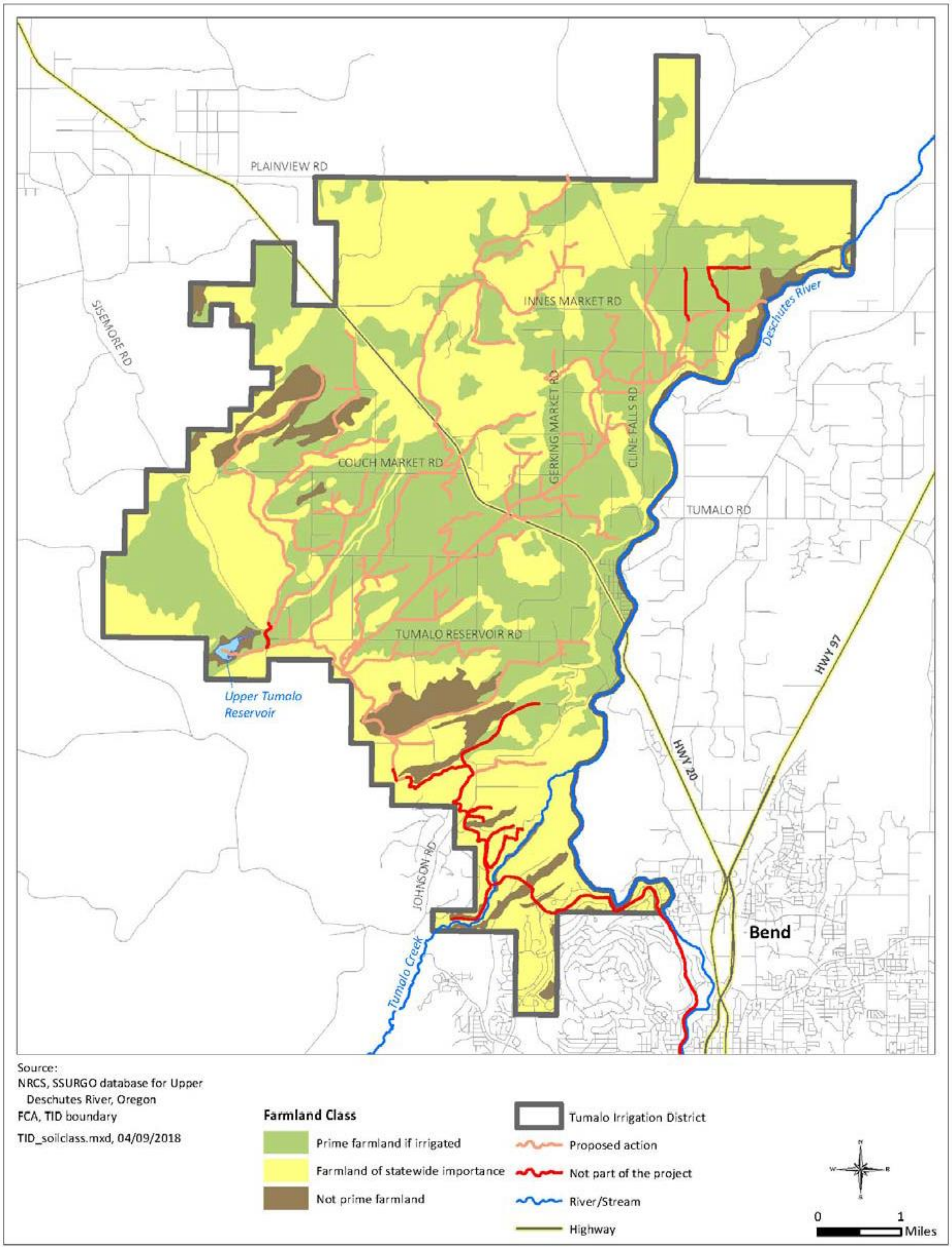


Figure C-6. NRCS Classification of Farmlands within the Tumalo Irrigation District.

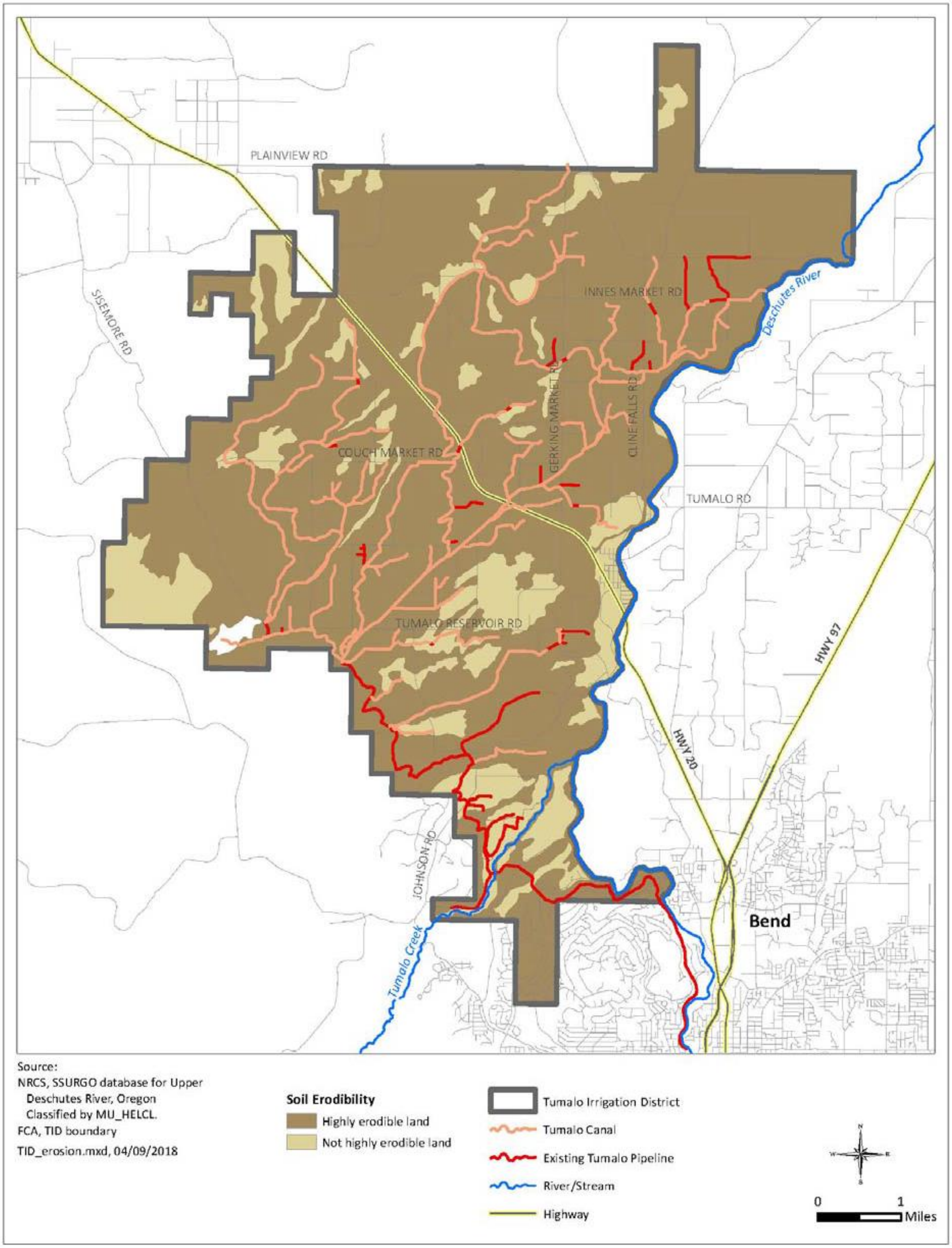


Figure C-7. Erosion Potential of Soils in the Tumalo Irrigation District.

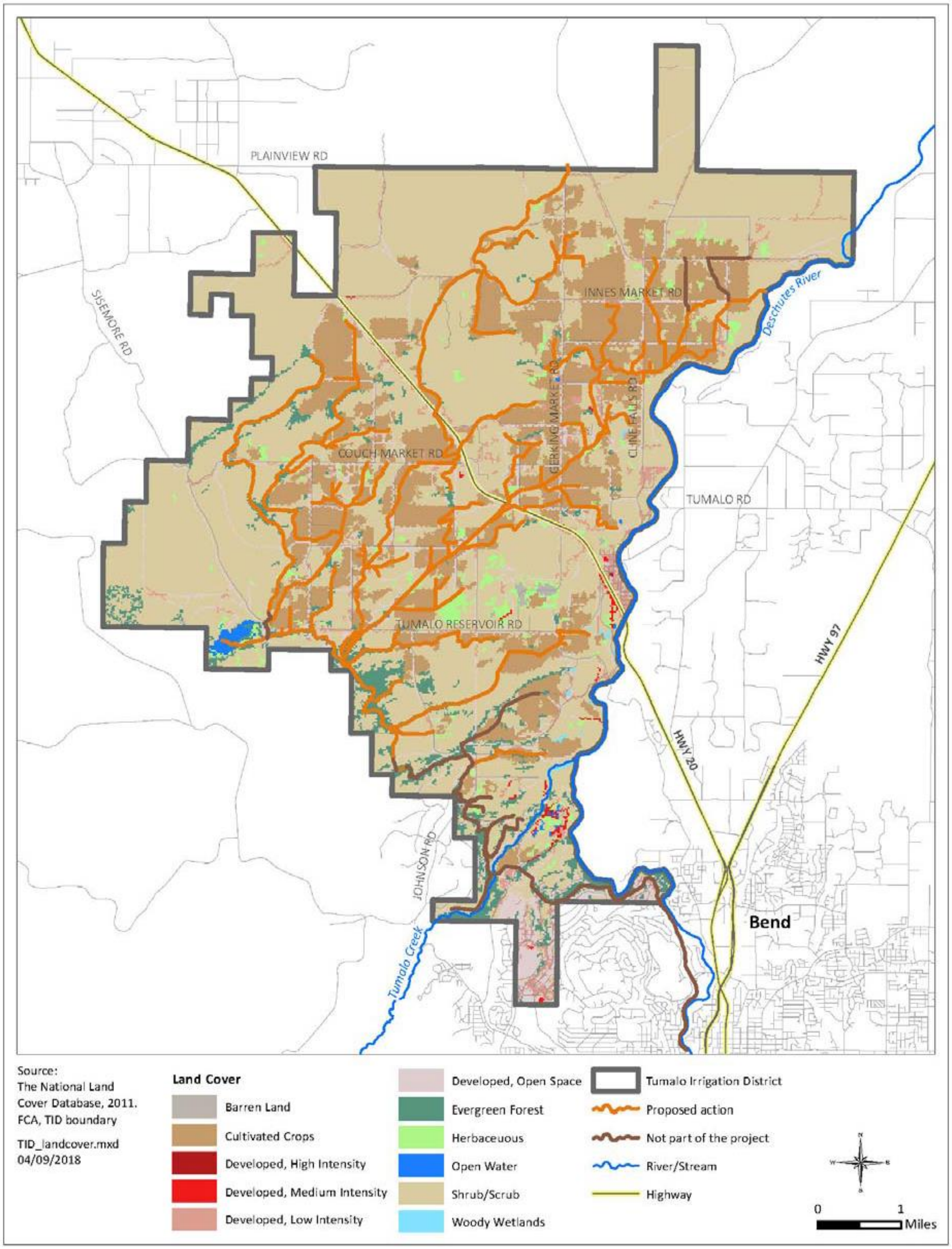


Figure C-8. Land Cover in the Tumalo Irrigation District.

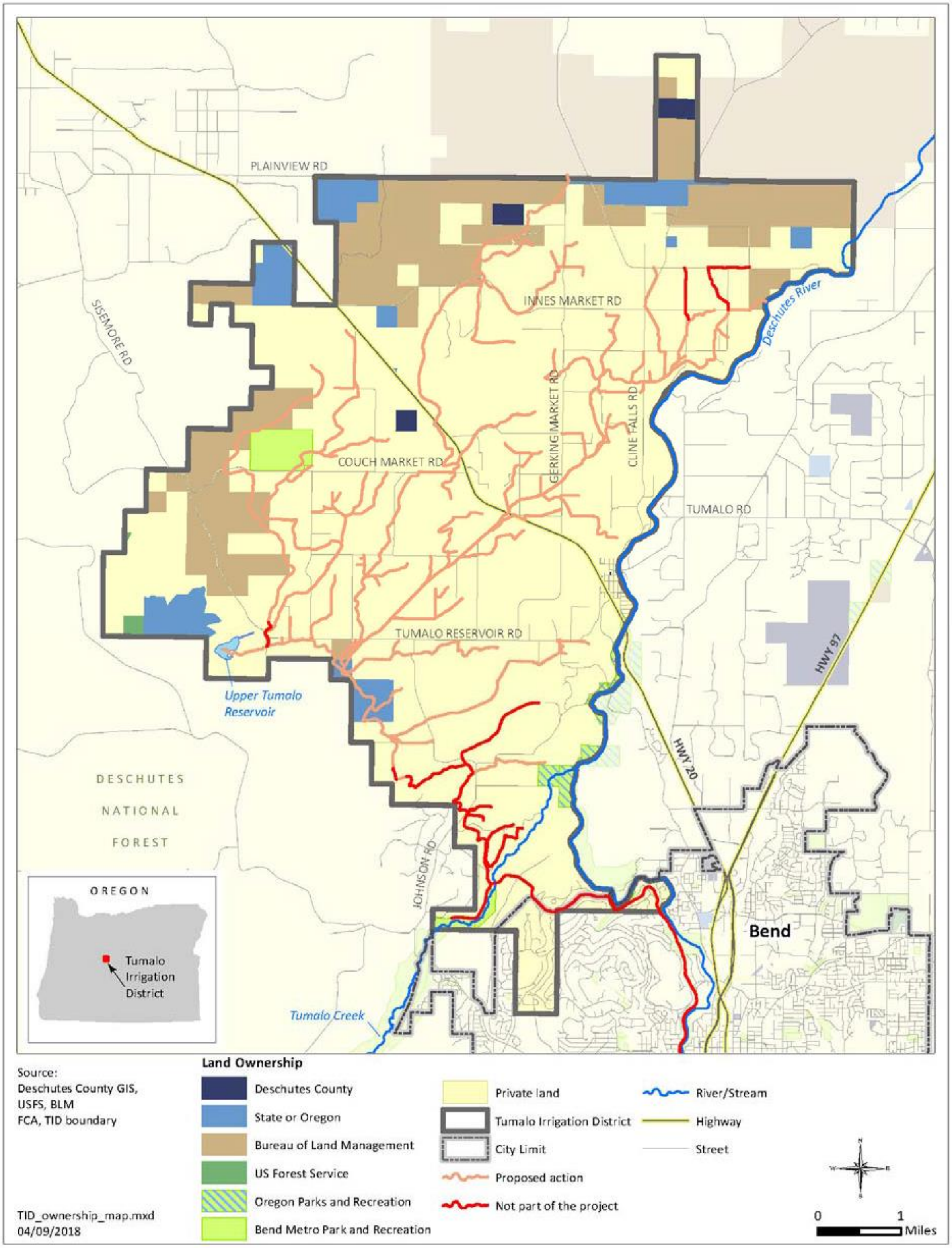


Figure C-9. Land Ownership within Tumalo Irrigation District.

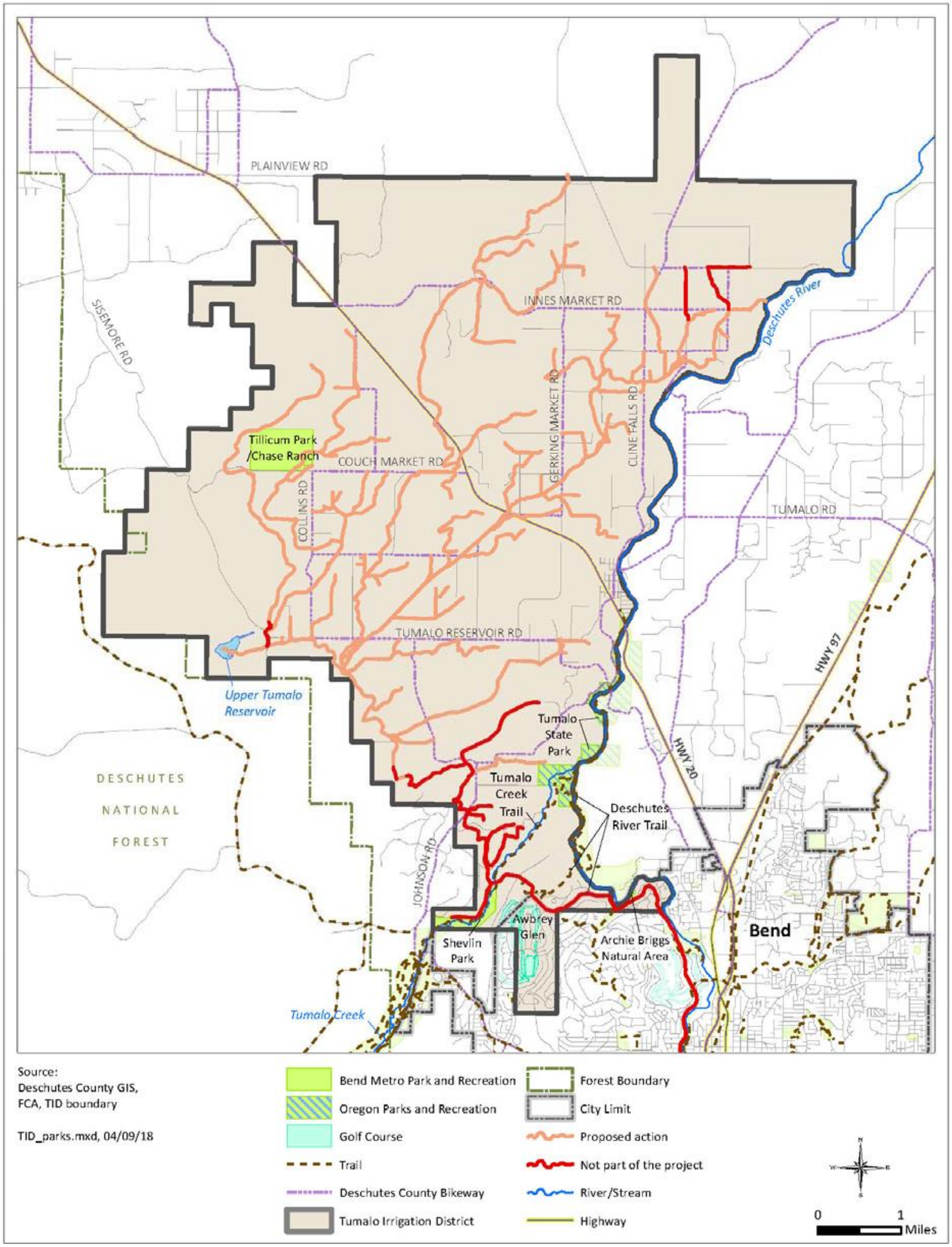


Figure C-10. Recreation Including Parks, Trails, and Bikeways in the Tumalo Irrigation District.

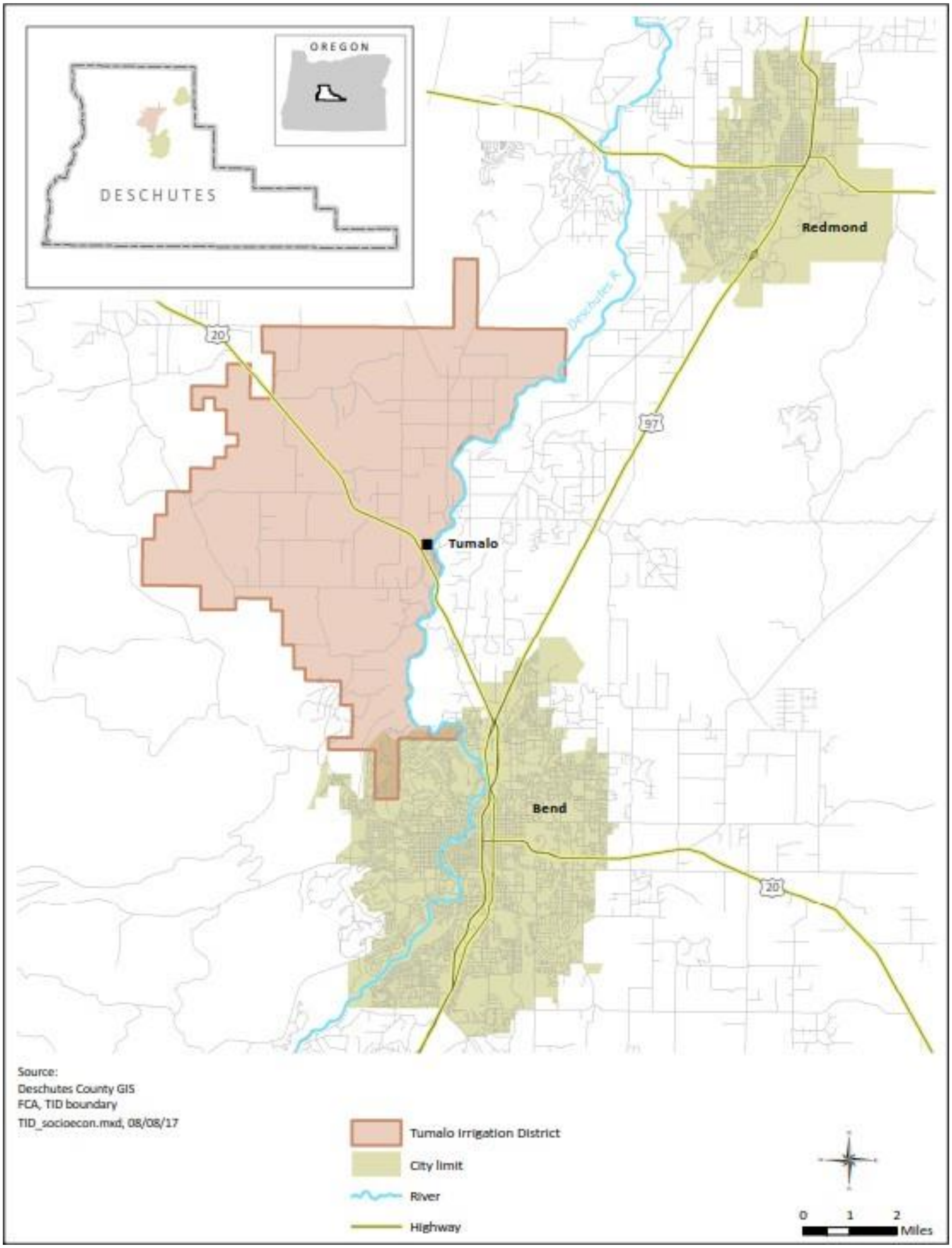


Figure C-11. Location of the Tumalo Irrigation District within the Socioeconomic Area of Potential Effect.

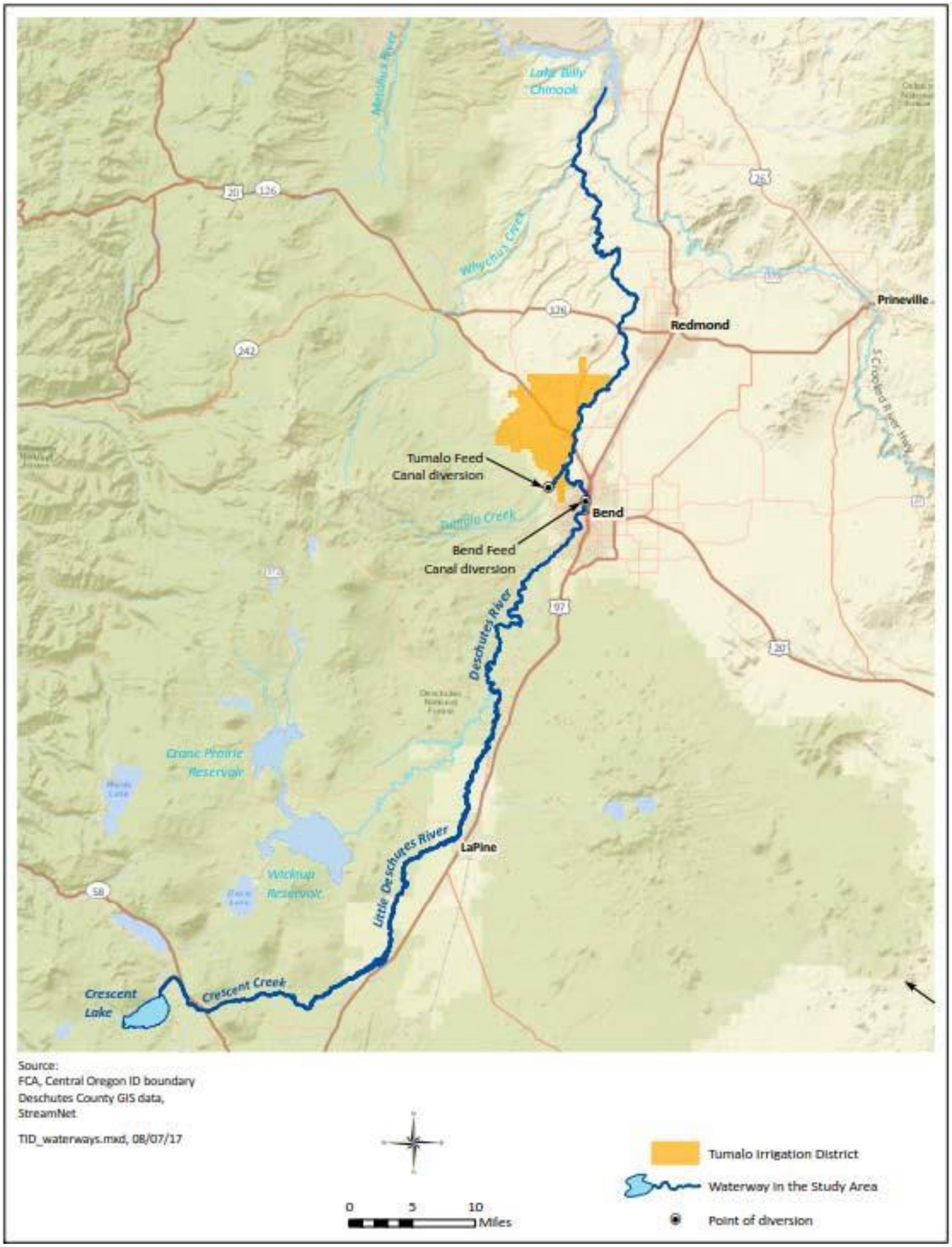


Figure C-12. Waterbodies Included in the Area of Potential Effect for Surface Water Resources.

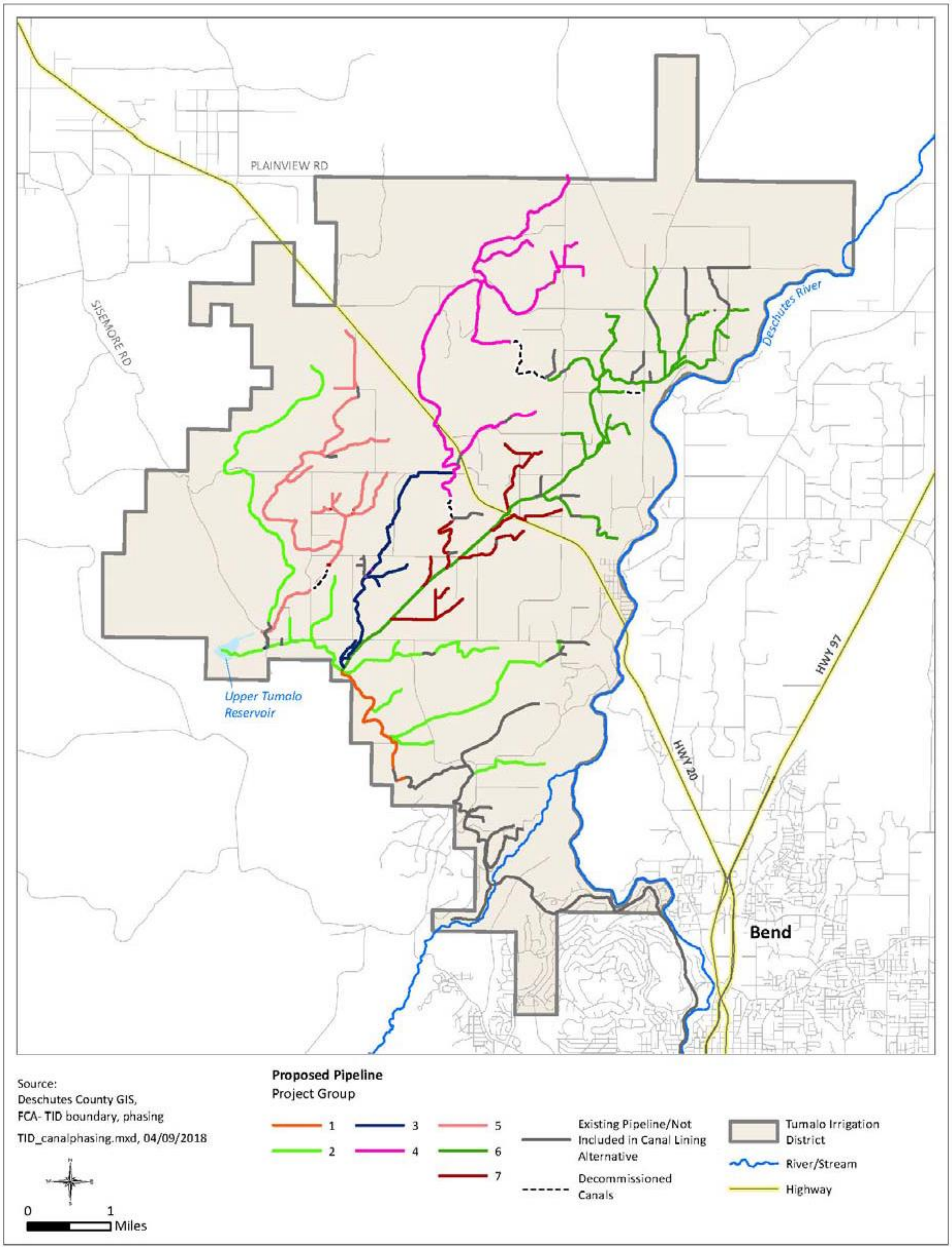


Figure C-13. Project Groups of the Canal Lining Alternative for Tumalo Irrigation District – Irrigation Modernization Project.

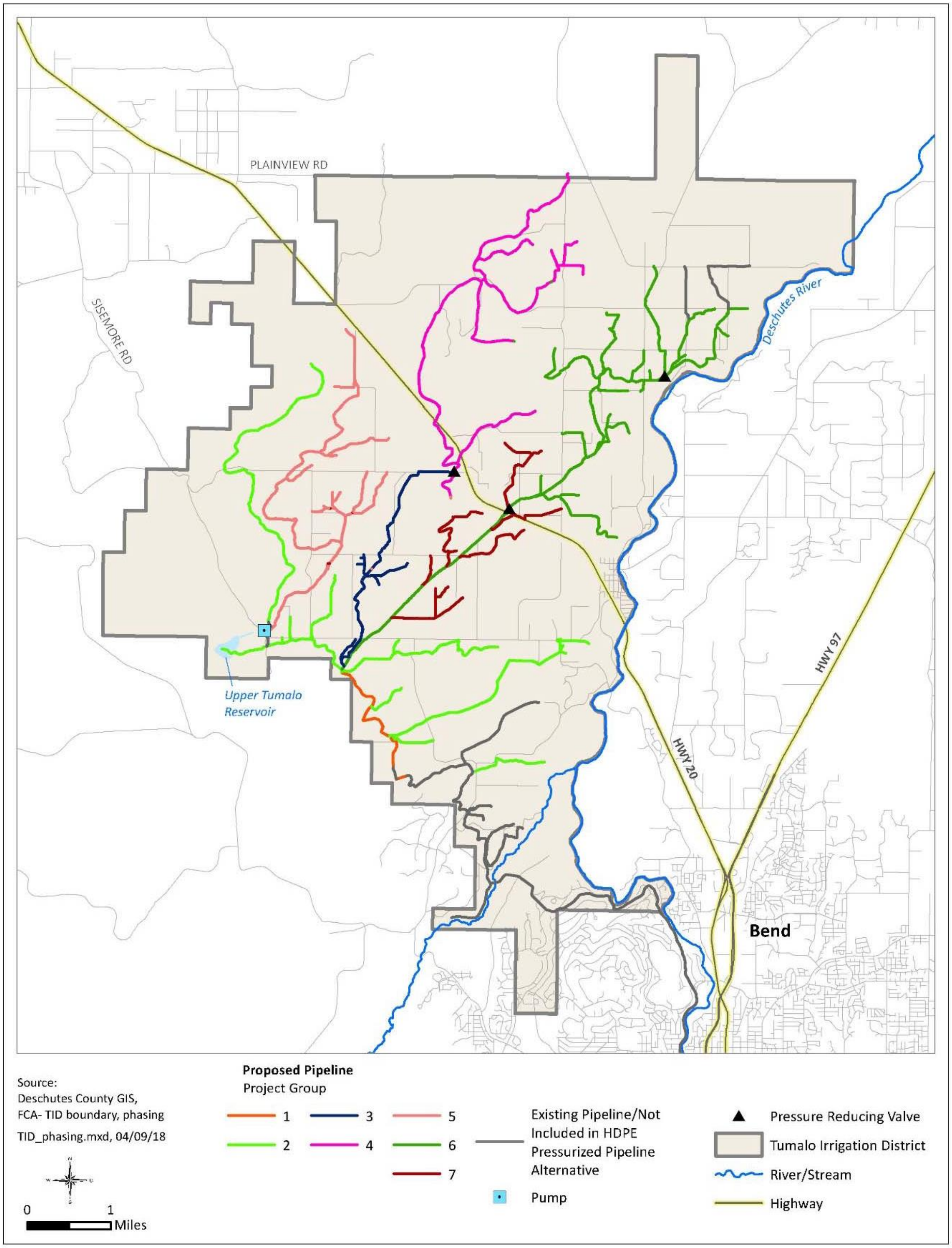


Figure C- 14. Project Groups of the HDPE Piping Alternative for Tumalo Irrigation District – Irrigation Modernization Project.

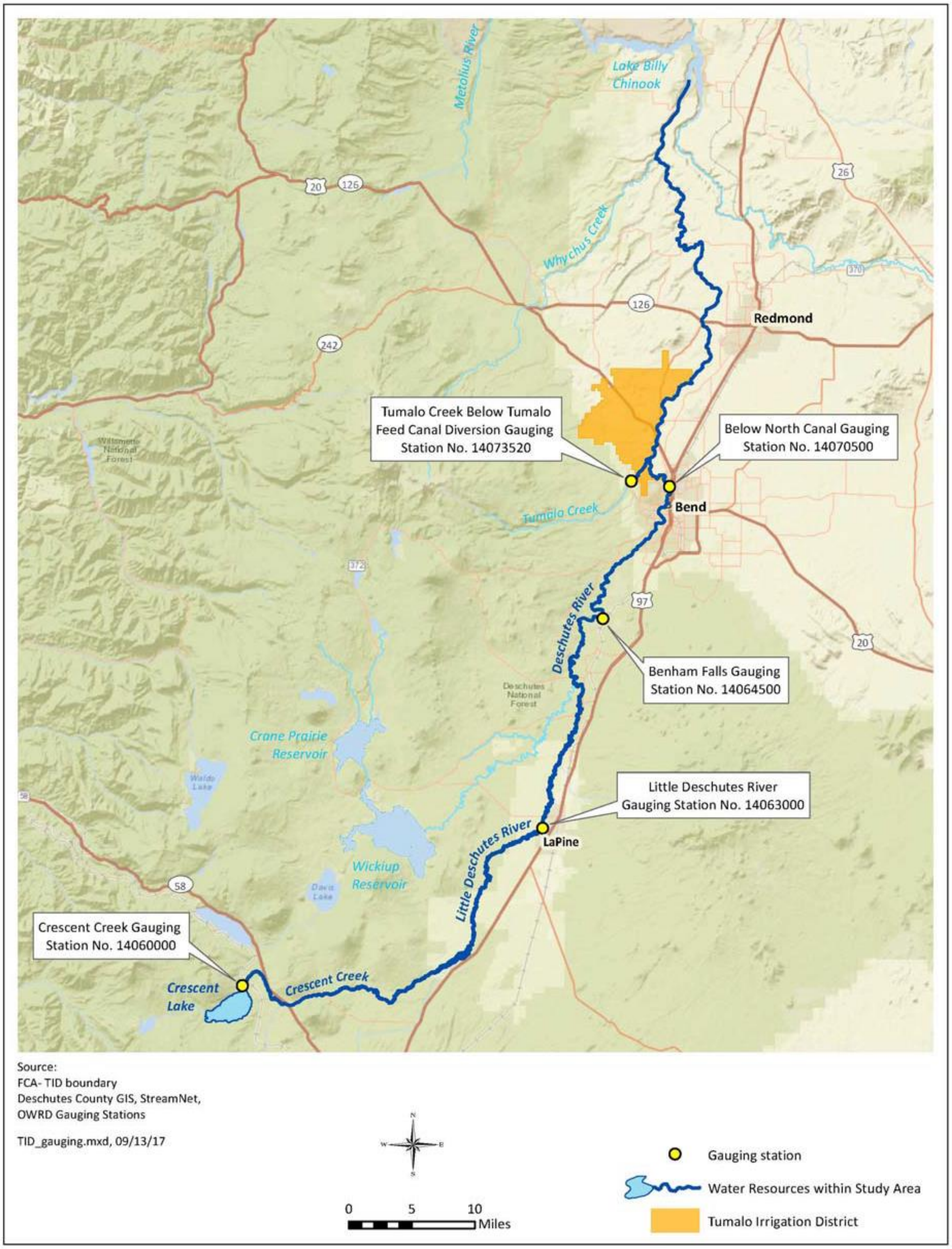


Figure C-15. Location of Gauging Stations No. 14060000, 14063000, and 14064500 within the Tumalo Irrigation District Area of Potential Effect.

Appendix D

Investigations and Analysis Reports

D.1 National Economic Development Analysis

Highland Economics LLC

National Economic Development Analysis

Barbara Wyse and Winston Oakley
12/22/2017

Benefits and Costs

This section provides a National Economic Development (NED) analysis that evaluates the costs and benefits of the HDPE Pressurized Piping Alternative compared to the No Action Alternative (referred to as No Action) and the Canal Lining Alternative. The analysis uses NRCS guidelines for the evaluation of NED benefits as outlined in the NRCS Natural Resources Economics Handbook and the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.

All economic benefits and costs are provided in 2017 dollars, and have been discounted and amortized to average annualized value using the 2017 federal water resources planning rate of 2.75 percent.

Analysis Parameters

This section describes the general parameters of the analysis, including funding sources and interest rates, the evaluation unit, the project implementation timeline, the period of analysis, and the project purpose.

Funding

According to TID District Manager (Rieck, Tumalo District Manager, 2017), nearly all funding is expected to be provided through grants. If necessary, approximately 25 percent of the project may be financed. If financing is required, TID expects to apply for funding through the Oregon Department of Environmental Quality Clean Water State Revolving Fund. TID expects that funding from this source would be at an interest rate of 2.5 percent with a 0.5 percent annual fee paid on the remaining loan balance. These financing costs are not included in the NED analysis. All funding sources other than PL 83-566 are from non-federal funds.

Evaluation Unit

There are seven proposed Project Groups in the proposed project. While some of the Project Groups depend on other Project Groups to produce water saving benefits, as long as the Project Groups are implemented in the proposed order, each of the Project Groups could be completed as stand-alone projects and have a positive net benefit. As such, the Project Group is defined as the evaluation unit. Note that for the incremental analysis, costs for constructing any given Project Group would not change if it were the only Project Group to be constructed.

Project Implementation Timeline

At present it is not known what the timing of implementation of the proposed project will be, or whether implementation will occur in project groups as this depends on the level and timing of Project funding. However, based on conversations with the District manager, it is likely that the construction will be completed over approximately ten years, with approximately one Project Group constructed each year. Some project groups, such as Project Group 1 and Project Group 6 are completed over several years. For all Project Groups, the analysis assumes that full benefits will be realized the following year after construction is completed (e.g., for Project Group 1, which is completed in Construction Year 1, full benefits are realized in Year 2). The analysis also assumes that Project Groups are completed in numeric order (i.e., Project Group 1 is completed first, followed by Project Group 2, and so on). This approach is expected to slightly understate the net present value of the proposed project as benefits are slightly over-discounted compared to costs as it is expected that only six months (rather than one year) will lapse between incurring construction costs for each Project Group and realizing benefits from each Project Group.

Table A. Construction Timeline and Construction Costs by Funding Source, Deschutes Watershed, Oregon, 2017$[1]

Construction Year	Works of Improvement	Public Law 83-566 Funds	Other, Non-Federal Funds	Total Construction Costs
0	Project Group 1	$2,385,500	$729,500	$3,115,000
1	Project Group 1	$2,385,500	$729,500	$3,115,000
2	Project Group 2	$2,582,000	$799,000	$3,381,000
3	Project Group 2	$2,975,000	$921,000	$3,896,000
4	Project Group 3	$3,020,000	$944,000	$3,964,000
5	Project Group 4	$3,560,000	$1,108,000	$4,668,000
6	Project Group 5	$2,966,000	$927,000	$3,893,000
7	Project Group 6	$2,644,000	$815,667	$3,459,667
8	Project Group 6	$4,725,000	$1,451,667	$6,176,667
9	Project Group 6	$2,573,000	$2,434,667	$5,007,667
10	Project Group 7	$265,000	$1,748,000	$2,013,000
Total project		$30,081,000	$12,608,000	$42,689,000

1/ Price Base: 2017 dollars Prepared April 2018

Period of Analysis

The period of analysis for each Project Group is defined as 101 to 102 years since the installation period varies from one to two years for each Project Group and 100 years is the expected project life of buried HDPE pipes and lined canals. Across the seven Project Groups, the period of analysis is 111 years (Year 0 to Year 110). Construction/installation of Project Group 1 is assumed to occur in Years 0 and 1, with project life from Year 2 to Year 101. As shown in Table A, in general, another project group is assumed to be installed in each of the following years, with Project Group 7 assumed to be installed in Year 10, with project life from Year 11 through Year 110. Per TID and Black Rock Consulting (Crew, 2017), during the life of the pipes, replacement costs are expected to be the same as existing costs, so there are no key replacement cost considerations in determining the period of analysis.

Project Purpose

The piping infrastructure is multipurpose, providing habitat benefits, agricultural production benefits, energy cost saving benefits, and potentially, recreation benefits. As there are no project cost items that separately serve a single purpose, this analysis does not allocate costs or benefits by purpose.

Proposed Project Costs

Table B (NWPM 506.11, Economic Table 1), Table C (NWPM 506.12, Economic Table 2), and Table D (NWPM 506.18, Economic Table 4) below summarize installation costs, distribution of costs, and total annual average costs for the HDPE Pressurized Piping Alternative. (Note that Economic Table 3, Structural Data—Dams with planned storage capacity, is omitted as there are no proposed dams). Tables E, F, and G present other direct costs associated with reduced groundwater recharge resulting from piping or lining of the canals. The subsections below provide detail on the derivation of the values in the tables.

Table B.
Economic Table 1—Estimated Installation Cost of HDPE Pressurized Piping Alternative Water Resource Project Measures, Deschutes Watershed, Oregon, 2017$[1,2]

Works of Improvement	Unit	Number			Estimated cost (dollars)[1]/						
					Public Law 83-566 Funds			Other Funds			Total
		Federal land[3]	Non-Federal land	Total	Federal land NRCS[4]	Non-Federal land NRCS	Total	Federal land	Non-Federal land	Total	
Project Group 1	Feet	0	10,206	10,206	$0	$4,771,000	$4,771,000	$0	$1,459,000	$1,459,000	$6,230,000
Project Group 2	Feet	11,660	72,800	84,460	$767,000	$4,790,000	$5,557,000	$237,000	$1,483,000	$1,720,000	$7,277,000
Project Group 3	Feet	2,193	23,326	25,519	$260,000	$2,760,000	$3,020,000	$81,000	$863,000	$944,000	$3,964,000
Project Group 4	Feet	9,634	51,917	61,551	$557,000	$3,003,000	$3,560,000	$173,000	$935,000	$1,108,000	$4,668,000
Project Group 5	Feet	1,620	54,330	55,950	$86,000	$2,880,000	$2,966,000	$27,000	$900,000	$927,000	$3,893,000
Project Group 6	Feet	436	89,727	90,163	$48,000	$9,894,000	$9,942,000	$23,000	$4,679,000	$4,702,000	$14,644,000
Project Group 7	Feet	0	35,650	35,650	$0	$265,000	$265,000	$0	$1,748,000	$1,748,000	$2,013,000
Total project	Feet	25,544	337,955	363,499	$1,718,000	$28,363,000	$30,081,000	$541,000	$12,067,000	$12,608,000	$42,689,000

1/ Price Base: 2017 dollars — Prepared April 2018
2/Project cost as identified in the Tumalo Irrigation District System Improvement Plan prepared by Black Rock Consulting, 2016, updated to 2017 dollars and including an additional three percent project administration cost and eight percent technical assistance cost.
3/Federal agency responsible for assisting in installation of works of improvement.
4/ BLM land. The Project would cross BLM land, however BLM is not assisting in the installation of the works of improvement.
Note: Figures may not sum due to rounding

Table C. Economic Table 2—Estimated Cost Distribution of HDPE Pressurized Piping Alternative - Water Resource Project Measures, Deschutes Watershed, Oregon, 2017[1,2]$

Works of Improvement	Installation Costs - PL 83-566 Funds				Installation Cost - Other Funds				Total installation costs
Piping	Construction	Engineering	Project Admin [3]	Total Public Law 566	Construction	Engineering	Project Admin [3]	Total Other	
Project Group 1	$4,049,000	$161,000	$561,000	$4,771,000	$1,349,000	$54,000	$56,000	$1,459,000	$6,230,000
Project Group 2	$4,649,000	$254,000	$654,000	$5,557,000	$1,549,000	$86,000	$85,000	$1,720,000	$7,277,000
Project Group 3	$2,541,000	$124,000	$355,000	$3,020,000	$847,000	$41,000	$56,000	$944,000	$3,964,000
Project Group 4	$2,973,000	$168,000	$419,000	$3,560,000	$990,000	$56,000	$62,000	$1,108,000	$4,668,000
Project Group 5	$2,460,000	$157,000	$349,000	$2,966,000	$820,000	$52,000	$55,000	$927,000	$3,893,000
Project Group 6	$8,228,000	$397,000	$1,317,000	$9,942,000	$4,418,000	$132,000	$152,000	$4,702,000	$14,644,000
Project Group 7	$0	$85,000	$180,000	$265,000	$1,681,000	$29,000	$38,000	$1,748,000	$2,013,000
TOTAL COSTS	$24,900,000	$1,346,000	$3,835,000	$30,081,000	$11,654,000	$450,000	$504,000	$12,608,000	$42,689,000

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars
2/Project cost as identified in the Tumalo Irrigation District System Improvement Plan prepared by Black Rock Consulting, 2016, updated to 2017 dollars and including an additional three percent project administration cost and eight percent technical assistance cost. Of total estimated costs presented in the System Improvement Plan, Black Rock Consulting estimated 75 percent is for construction and 25 percent for engineering.
3/ Project Admin includes project administration, technical assistance costs, and permitting costs.

Average annual costs include those associated with installation and other direct costs. There are two primary types of other direct costs: increased pumping costs from increased depth to groundwater due to reduced recharge, and potential reduction in aesthetic values to area residents due to the removal of canals. Only increased pumping costs are quantified in this NED as the aesthetic costs are not quantifiable with the available information available. Project Group 1 will also incur another direct costs associated with carbon emissions (as the increased pumping throughout the central Deschutes Basin associated with reduced recharge slightly outweigh the reduced pumping in TID from pressurization). Based on TID past experience of piping of irrigation canals, the District expects cost savings, not cost increases for maintenance/repair/replacement of infrastructure from the HDPE Pressurized Piping Alternative (Rieck, Tumalo Irrigation District Manager, 2017).

Table D. Economic Table 4—Estimated Average Annual NED Costs for HDPE Pressurized Piping Alternative, Deschutes Watershed, Oregon, 2017$[1]

Works of Improvement[2]	Project Outlays (Amortization of Installation Cost)	Other Direct Costs[3] (Increased Pumping Costs Elsewhere in Basin from Reduced GW Recharge)	Total
Project Group 1	$181,000	$6,000	$187,000
Project Group 2	$200,000	$2,000	$202,000
Project Group 3	$105,000	$1,000	$106,000
Project Group 4	$120,000	$1,000	$121,000
Project Group 5	$97,000	$1,000	$98,000
Project Group 6	$346,000	$4,000	$350,000
Project Group 7	$45,000	$1,000	$46,000
Total	**$1,094,000**	**$16,000**	**$1,110,000**

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent.
2/ This assumes approximately one project group will be completed in each year, such that Group 1 is completed in Year 1 and Group 7 is completed in Year 10.
3/ Other direct costs include the uncompensated economic losses due to changes in resource use or associated with installation, operation or replacement of project structures. For Project Groups 2 -7, other direct costs are presented for increased pumping costs elsewhere in the basin from reduced groundwater recharge (i.e. seepage from unlined canals). For Project Group 1, other direct costs include the cost of increased carbon emissions associated with increased groundwater pumping energy use (in all other project groups, total groundwater energy use declines so carbon is a benefit). This does not include operations, maintenance, and repair costs because these decline under the HDPE Pressurized Piping Alternative, so these are presented as a benefit.

Project Installation Costs

According to the 2016 System Improvement Plan conducted for Tumalo Irrigation District (Black Rock Consulting, 2016), and subsequent conversations with the District, the cost of piping and associated farm turnouts is $37,732,691 (2016 dollars). See Appendix D.3 for detailed cost derivation by pipe size, cost category, etc. All values in this analysis are presented in 2017 dollar values, and rounded to the nearest $1,000 value. To convert this cost to 2017 dollars, this analysis inflates the cost by 1.63 percent annually, which is the average annual increase in the RS Means construction cost index during the period July 2011 to July 2016 (RS Means, 2017). The resulting estimated capital cost in 2017 dollars is approximately $38,348,000. Of total estimated costs, Black Rock Consulting estimated the proportion that is for construction and the proportion that is for engineering (which varied by Project Group).

Adding an additional three percent for in-kind project administration from TID and eight percent technical assistance from NRCS, as well as permitting costs totaling $120,000, the total cost for the HDPE Pressurized Piping Alternative in 2017 dollars is estimated at $42,689,000. The average annual cost by Project Group is shown in Table D, with total average annual costs in 2017 dollars totaling to $1,110,000 for the HDPE Pressurized Piping Alternative (assuming piping projects are completed in the order shown in Table D). The total cost for the Canal Lining Alternative is estimated at $84,057,000.

Other Direct Costs: Groundwater Recharge Costs

Seepage of water from canals is one source of recharge for groundwater in the Deschutes Basin. Reduced recharge from canals may lead to groundwater declines, and thereby increase pumping costs for all groundwater users in the basin. This section estimates this potential cost of the project. A 2013 study by the US Geological Survey estimated the effects on groundwater recharge of changes in climate (reduced precipitation), groundwater pumping, and canal lining and piping. The study used data for the period 1997 to 2008. An important caveat to using the data and findings from this study is that the effects of lining TID canals may be different than previous lining projects that have occurred throughout the central basin.

The study indicates that since the mid-1990s, groundwater levels have dropped by approximately 5 to 14 feet in the central part of the Deschutes Basin that extends north from near Benham Falls to Lower Bridge, and east from Sisters to the community of Powell Butte. It also finds that approximately 10 percent of this decline in groundwater level is due to canal lining and pumping during this period, or approximately 0.5 to 1.4 feet. This is modeled as a result of a reduction of recharge from irrigation canal leakage of 58,000 acre-feet (AF) annually. This NED analysis uses this data to first estimate the effect of reduced irrigation canal seepage from the alternatives on groundwater levels, and then uses these data to roughly approximate the change in the cost of pumping for all groundwater users in the Deschutes Basin of the HDPE Pressurized Piping Alternative and the Canal Lining Alternative.

The cumulative effect of piping over the 12-year period of study (1997 to 2008) was 58,000 AF. Assuming a uniform increase in canal lining/piping over this timeframe, in 1997 there was a decreased canal seepage of 4,833 AF, rising each year by another 4,833 AF until there was a reduced canal seepage in 2008 of 58,000 AF. Cumulatively, this represents 377,000 AF of reduced recharge from canals during this time period. The USGS study finds that this level of reduced recharge caused an overall groundwater decline in the central basin of 0.5 to 1.4 feet. These data suggest that the average relationship between canal recharge and groundwater levels in this part of the basin is approximately 1 foot of groundwater elevation drop per 377,000 AF of reduced canal recharge, though local effects may be much higher or lower.

The HDPE Pressurized Piping Alternative would reduce canal seepage, and associated groundwater recharge, by up to approximately 15,116 AF annually in this part of the Deschutes Basin once all Project Groups are complete (see Appendix D for detailed derivation of reduced canal seepage).[1] On average, for this part of the central basin, this translates into a decreased groundwater elevation of approximately 0.04 feet annually (based on information presented above that a 1 foot groundwater elevation drop is expected to result from reduced recharge of 377,000 AF, so the

[1] Per Kenneth Rieck, Tumalo District Manager, July 2017.

corresponding drop from 15,116 AF is 0.04 since 15,116 AF divided by 377,000 AF is 0.04). An important caveat is that localized effects on groundwater of the HDPE Pressurized Piping Alternative would differ throughout the central basin. Over the course of approximately 100 years, this annual drop results in a cumulative decreased average groundwater elevation in the central basin of 4.0 feet (note that this drop in pumping elevation would have small effects on pumping costs, but would not be expected to result in the need for drilling deeper wells or replacing pumps at a faster rate).

This analysis combines this decreased groundwater elevation for each year in the 100-year analysis period with the estimated volume of groundwater pumping in the central Deschutes Basin to estimate the total increased cost of groundwater pumping in the Basin over time due to decreased recharge from the action alternatives of canal piping or lining. The USGS report identified approximately 25,000 AF per year of groundwater pumping for public supply and about 25,000 AF per year of groundwater pumping for irrigation use. A 2006 report for the Deschutes Water Alliance on future groundwater use indicates that public supply use may increase by an average of 2.5 percent annually (the report projected an increase of consumptive groundwater use from 35,895 to 58,594 over the 20-year period from 2005 to 2025) (Newton Consultants, 2006). Assuming this growth rate in pumping continues over the 111-year analysis period, groundwater pumping over 100 years may rise to 591,000 AF annually.

In terms of power rates, according to the 2010 *Water System Master Plan Update Optimization Study*, most of the City of Bend's 25 groundwater wells fall under Pacific Power's Rate Schedule 28, while three wells fall under Rate Schedule 30 (Optimatics, 2010). The current marginal cost for the City to pump groundwater is expected to be approximately $0.05970 per kilowatt-hour (kWh) under Schedule 28 (Pacific Power, 2017). Farmers who use electricity to irrigate fall under Schedule 41, which applies the same price to all electricity used during the summer (April 1 to November 30). This rate is $0.09624/kWh, which this analysis assumes is the marginal cost to farmers for pumping groundwater.[2]

Under the No Action scenario, groundwater levels would still decline. The USGS study cited above notes that groundwater levels in the area between Clines Butte and Redmond (the closest area in the study to the proposed project) fell approximately 12 to 14 feet from 1994 to 2008 from a combination of climate, increases in groundwater pumping, and reduced groundwater recharge from canal lining (Gannett & Lite, 2013). This is an average drop of roughly one foot per year, which we assume will continue under No Action. Data from the Oregon Department of Water Resources indicate that depths to groundwater vary widely within the area; depths in Bend are around 740 feet, while depths near Redmond are about 265 feet (Oregon Department of Water Resources, 2016). For the No Action scenario, we assume a current average groundwater pumping depth in the Central Deschutes Basin of 500 feet; assuming a one-foot drop in groundwater depth

[2] The costs to power a pump represent the vast majority of variable costs of irrigation pumping. Maintenance costs on electric pumps are minimal. One study estimated that maintenance costs represented only one to four percent of the variable costs of pumping, with electricity costs comprising the other 96 - 99 percent (Robinson, 2002). The costs of diesel pumps show a similar pattern. Because maintenance costs are such a small part of the variable costs of irrigation pumping and would have a small effect on expected average annual values, only energy costs are included in this analysis.

in each year, over 100 years in the No Action, groundwater depths will be approximately 600 feet. Over the course of 100 years, the HDPE Pressurized Piping Alternative and the Canal Lining Alternative both result in a pumping depth of approximately 604 feet, or an increased depth to groundwater of four feet compared to the No Action Alternative.

Table E.
Approximate Depth to Groundwater in Central Deschutes Basin, Deschutes Watershed, Oregon

Year	Volume Pumped (acre-feet per year)	Average Depth to Groundwater (feet)		
		No Action	HDPE Pressurized Piping Alternative (NED Alternative)	Canal Lining Alternative
1	51,000	500	500	500
10	64,000	510	510	510
20	82,000	520	521	521
30	105,000	530	531	531
40	134,000	540	542	542
50	172,000	550	552	552
60	220,000	560	562	562
70	282,000	570	573	573
80	360,000	580	583	583
90	461,000	590	594	594
100	591,000	600	604	604

Prepared April 2018

Applying the electricity prices, and assuming a pump irrigation efficiency of 70 percent[3], and using the volume of pumping and pumping depths shown in Table E, the total cost of groundwater pumping under No Action is projected to grow from around $2.9 million in Year 1 to $17.6 million in Year 100.

The increased depth to groundwater due to reduced recharge results in higher pumping costs in the Action alternatives (HDPE Pressurized Piping Alternative and the Canal Lining Alternative). The increased cost to groundwater pumpers over the 100-year evaluation period rises in each year as the cumulative effect of reduced recharge may cause the groundwater elevation to continue to decline. For example, as a result of reduced recharge due to installation of Project Group 1, the groundwater elevation may decline 0.007 feet in Year 1, rising up to 0.7-foot decline by Year 100 (0.007 multiplied by 100), with associated costs rising from approximately $40 to $21,000. In total, after discounting and amortizing these costs across all Project Groups, the estimated total annual average NED cost across 100 years is $14,000 per year for the HDPE Pressurized Piping Alternative (see Table F) and $13,000 per year under the Canal Lining Alternative (see Table G).

[3] As assumed in the Tumalo Irrigation District System Improvement Plan completed by Black Rock Consulting in 2016.

Table F.
Other Direct Cost of Reduced Recharge Under HDPE Pressurized Piping Alternative, Deschutes Watershed, Oregon, 2017$[1]

Works of Improvement	Water Conservation (cfs)	Water Conservation (AF/Year)	Change in Groundwater Depth (ft/year)	Annual Average NED Cost
Project Group 1	8.5	2,677	0.007	$3,000
Project Group 2	8.0	2,519	0.007	$2,000
Project Group 3	4.3	1,354	0.004	$1,000
Project Group 4	4.9	1,543	0.004	$1,000
Project Group 5	3.5	1,102	0.003	$1,000
Project Group 6	14.6	4,598	0.012	$4,000
Project Group 7	4.2	1,323	0.004	$1,000
Total	**48.0**	**15,116**	**0.040**	**$14,000**

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent

Table G. Other Direct Cost of Reduced Recharge Under Canal Lining Alternative, Deschutes Watershed, Oregon, 2017$[1]

Works of Improvement	Water Conservation (cfs)	Water Conservation (AF/Year)	Change in Groundwater Depth (ft/year)	Annual Average NED Cost
Project Group 1	7.7	2,409	0.006	$2,000
Project Group 2	7.2	2,267	0.006	$2,000
Project Group 3	3.8	1,219	0.003	$1,000
Project Group 4	4.4	1,389	0.004	$1,000
Project Group 5	3.1	992	0.003	$1,000
Project Group 6	13.1	4,138	0.011	$4,000
Project Group 7	3.7	1,190	0.003	$1,000
Total	**43.2**	**13,604**	**0.036**	**$13,000**

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent

Other Direct Costs: Change in Aesthetics and Associated Property/Recreation Values

A potential direct cost is that some local residents may experience adverse effects on property values and quality of life due to the change in aesthetics from piping the canals (as many people enjoy the aesthetics of the open canals). According to real estate agents in the area, many people interested in purchasing property in the area are willing to pay more for properties that have a view of a canal. On the other hand, some property owners or potential property owners may not want to have a canal adjacent to their property because of the safety hazard an open canal poses, potentially limiting the effect on property values.

In addition to property owners, there may be potential adverse effects on recreators that walk along the canals. The public can legally access and walk along canals on public lands or where TID has agreements with landowners (Rieck, Tumalo Irrigation District Manager, 2017). The quality and associated value of this recreation will likely decrease once the canals are piped as open water views are often sought by trail users. The number of affected recreationists, and the potential change in value of recreating on trails adjacent to the canals is not known.

The potential aesthetic cost to residential landowners and recreationists is not quantified due to a lack of available data. Interviewed real estate agents were not able to quantify the potential effect of a view of the canal. Furthermore, quantification is difficult due to scarce information in the economic literature. While the economic value of many natural views has been studied (such as for ocean front property, or of other scenic natural areas), the value of irrigation canals has been studied little, if at all. As such, while this effect is recognized as a likely cost[4], this analysis does not quantify the potential change in aesthetic values of the proposed project.

Benefits

Table H (NWPM 506.20, Economic Table 5a) below summarizes annual average NED project benefits, while Table I (NWPM 506.21, Economic Table 6) compares them to the annual average project costs presented in Table D. Onsite damage reduction benefits that will accrue to agriculture and the local rural community include increased agricultural production (increased net returns) and reduced power costs; off-site quantified benefits include the value of reduced carbon emissions and the value of enhanced fish and wildlife habitat. Other benefits not included in the analysis that may result indirectly from the HDPE Pressurized Piping Alternative include the potential for increased on-farm investment in increased irrigation efficiency (as patrons have more funds to increase investment in irrigation from increased yields and reduced pumping costs). The analysis recognizes that instream flows may affect recreation, both in-river and adjacent land-based recreation. However, aside from positive impacts on fish and wildlife-related recreation (both wildlife viewing and fishing) from improved species populations, it is not clear how recreation may be impacted. Numerous interviews with recreation planners and recreation industry professionals in the area indicate that effects on boating and in-water recreation of enhanced instream flows resulting from the HDPE Pressurized Piping Alternative may be both positive and adverse (depending on the timing and magnitude of the flows), with no indication of whether there may be net benefits or net costs to recreation. As such, this analysis assumes no net impact on (non-fish and wildlife-related) recreation. Table H presents total annual NED benefits, and Table I compares annual NED benefits and costs.

[4] Note that increased agricultural production value due to a more reliable water supply to TID patrons may tend to increase property values (all else equal), which could offset the effect on property values. The value of increased water supply reliability is quantified and captured below in the discussion on the benefits of increased agricultural production value. While the aesthetic value and the agricultural production value are not necessarily similar in magnitude, the population affected (patrons of TID) is largely the same (there may be some residents in the area who benefit from canal views who are not patrons of TID).

Table H. Economic Table 5a—Estimated Average Annual Watershed Protection Damage Reduction Benefits of HDPE Pressurized Piping Alternative for Tumalo Irrigation District 2017 Watershed Plan, Deschutes Watershed, Oregon, 2017$[1]

	Damage Reduction Benefit, Average Annual	
Item	**Agricultural- related**	**Non-Agricultural-related**
Project Group 1		
On-Site Damage Reduction Benefits		
Other - Increased Productivity	$6,000	
Other - Reduced O&M	$4,000	
Other - Power Cost Savings	$1,000	
Subtotal	$11,000	
Off-Site Damage Reduction Benefits		$0
Water Conservation		$195,000
Subtotal		$195,000
Total Quantified Benefits	$11,000	$195,000
Project Group 2		
On-Site Damage Reduction Benefits		
Other - Increased Productivity	$99,000	
Other - Reduced O&M	$32,000	
Other - Power Cost Savings	$49,000	
Subtotal	$180,000	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$19,000
Water Conservation		$174,000
Subtotal		$193,000

Total Quantified Benefits	$180,000	$193,000
Project Group 3		
On-Site Damage Reduction Benefits		
Other - Increased Productivity	$31,000	
Other - Reduced O&M	$9,000	
Other - Power Cost Savings	$25,000	
Subtotal	$65,000	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$10,000
Water Conservation		$91,000
Subtotal		$101,000
Total Quantified Benefits	$65,000	$101,000
Project Group 4		
On-Site Damage Reduction Benefits		
Other - Increased Productivity	$61,000	
Other - Reduced O&M	$22,000	
Other - Power Cost Savings	$59,000	
Subtotal	$142,000	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$24,000
Water Conservation		$101,000
Subtotal		$125,000
Total Quantified Benefits	$142,000	$125,000

Project Group 5		
On-Site Damage Reduction Benefits		
Other - Increased Productivity	$47,000	
Other - Reduced O&M	$19,000	
Other - Power Cost Savings	$31,000	
Subtotal	$97,000	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$13,000
Water Conservation		$70,000
Subtotal		$83,000
Total Quantified Benefits	$97,000	$83,000
Project Group 6		
On-Site Damage Reduction Benefits		
Other - Increased Productivity	$136,000	
Other - Reduced O&M	$30,000	
Other - Power Cost Savings	$133,000	
Subtotal	$299,000	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$53,000
Water Conservation		$279,000
Subtotal		$332,000
Total Quantified Benefits	$299,000	$332,000
Project Group 7		
On-Site Damage Reduction Benefits		

Other - Increased Productivity	$27,000	
Other - Reduced O&M	$11,000	
Other - Power Cost Savings	$27,000	
Subtotal	$65,000	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[2]		$10,000
Water Conservation		$76,000
Subtotal		$86,000
Total Quantified Benefits	$65,000	$86,000

Note: Totals may not sum due to rounding. Prepared April 2018

1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent

2/ These benefits would also accrue to local residents, but the majority of the value would be experienced outside the proposed project area.

Table I. Economic Table 6—Comparison of Average Annual NED Benefits and Costs Under the HDPE Pressurized Piping Alternative, Deschutes Watershed, Oregon, 2017$[1]

Works of Improvement	Agriculture-related			Nonagricultural		Average Annual Benefits	Average Annual Cost[2]	Benefit cost ratio
	Intensification	Reduced O&M	Power Cost Savings	Carbon Value	Instream Flow Value			
Project Group 1	$6,000	$4,000	$1,000	$0	$195,000	$206,000	$187,000	1.10
Project Group 2	$99,000	$32,000	$49,000	$19,000	$174,000	$373,000	$202,000	1.85
Project Group 3	$31,000	$9,000	$25,000	$10,000	$91,000	$166,000	$106,000	1.57
Project Group 4	$61,000	$22,000	$59,000	$24,000	$101,000	$267,000	$121,000	2.21
Project Group 5	$47,000	$19,000	$31,000	$13,000	$70,000	$180,000	$98,000	1.84
Project Group 6	$136,000	$30,000	$133,000	$53,000	$279,000	$631,000	$350,000	1.80
Project Group 7	$27,000	$11,000	$27,000	$10,000	$76,000	$151,000	$46,000	3.28
Total	$407,000	$127,000	$325,000	$129,000	$986,000	$1,974,000	$1,110,000	1.78

Note: Totals may not sum due to rounding Prepared April 2018

1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent

2/ From Economic Table 4

The HDPE Pressurized Piping Alternative is also evaluated using an incremental analysis, which identifies how total costs and benefits change as Project Groups are added. In the incremental analysis project group pipe sizes and costs remain the same for each project group assessed.

The engineering pipeline design (pipe diameters, pressure ratings, etc.) is independent of the number of project groups and the order that the project groups are installed. The District's System Improvement Plan (TID 2017) describes how the District designed modern pipelines to replace its open canals and laterals. The District mapped and collected digital elevation data along its entire delivery system. The District determined that the system needed to be able to deliver 7.48 gallons per minute per acre served. The system also needed to be able to handle an upper limit of 9 gallons per minute per acre served.

As the pipeline is installed from the "top down" (from the diversion at higher elevations to the lowest elevations in the district), the design had to account for all of the irrigation demand in the system. That is, the system had to be designed for the future full demand rather than the current project group demand.

For example, assume that there are two planned project groups for a 2-mile pipeline to replace a leaky canal. Project Group I construction is the upper 1 mile of pipeline starting at the diversion gate. Project Group II construction is the lower 1 mile. The irrigation demand (water right) for the Project Group I construction is 5 cfs. The irrigation demand for the Project Group II construction is 15 cfs. Total irrigation demand for the pipeline equals 20 cfs.

If the engineer designs a pipeline for 5 cfs for Project Group I, this will be a relatively small pipeline. This small pipeline will then be connected to the larger Project Group II pipe. The small Project Group I pipeline will have to convey 20 cfs of flow through a pipeline designed for 5 cfs. This will result in a pipeline that does not meet NRCS design standards, and will likely not function and meet the goals of the project.

Pipelines typically decrease in size as the irrigation demand decreases with the number of acres served at lower elevations in the system. Project Groups are not considered when determining when to reduce from a larger to smaller pipe.

The District used the information and assumptions above to create a hydraulic model that determined pipe sizes for each pipeline (canal or lateral to be piped) in the system. The District designed each pipeline to deliver water under its existing water rights, and these pipelines are not designed to deliver water under any additional water rights. The District does not discharge to any waterbodies or connect with any other district's canals, laterals, or pipelines.

While costs are the same for each Project Group in the incremental analysis (as presented in Table D above), before the benefits of pressurization can be achieved, the piping pressure must be greater than 60 pounds per square inch. For Project Group 1, this does not occur until Project Group 2 is added. Accordingly, the benefits of pressurization in Group 1 (totaling $2,000 per year) are not realized if it is a stand-alone project (Farmers Conservation Alliance, 2017). Table J shows the incremental analysis of the Project Groups.

Table J. Incremental Analysis of Annual NED Costs and Benefits Under the HDPE Pressurized Piping Alternative for Tumalo Irrigation District 2017 Watershed Plan, Deschutes Watershed, Oregon, 2017$[1]

Groups	Total Costs	Incremental Costs	Total Benefits	Incremental Benefits	Net Benefits
1	$187,000		$204,000		$17,000
1,2	$389,000	$202,000	$579,000	$375,000	$190,000
1,2,3	$495,000	$106,000	$745,000	$166,000	$250,000
1,2,3,4	$616,000	$121,000	$1,012,000	$267,000	$396,000
1,2,3,4,5	$714,000	$98,000	$1,192,000	$180,000	$478,000
1,2,3,4,5,6	$1,064,000	$350,000	$1,823,000	$631,000	$759,000
1,2,3,4,5,6,7	$1,110,000	$46,000	$1,974,000	$151,000	$864,000

Note: Totals may not sum due to rounding Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent

Agricultural Intensification Benefit

While all conserved water (48 cfs under the HDPE Pressurized Piping Alternative and 43.2 cfs under the Canal Lining Alternative) will go to enhance instream flow, through enhanced operational flexibility and efficiency and reduced canal breaches, the HDPE Pressurized Piping Alternative will increase water supply reliability to District patrons. The District's antiquated canal and laterals make it difficult to deliver the correct amount of water to patrons at the correct time, particularly early and late in the irrigation season. During these periods, the District's water rights require it to divert water at a reduced rate. At these reduced flow rates, the canals and laterals are more sensitive to small changes in streamflows at the diversion or deliveries at each point-of-delivery. The reduced flow rates in the open canal and laterals make it much more challenging for the District to deliver the sufficient amount of water that patrons need when they need it. For example, a point-of-delivery near the end of a lateral may receive no water in the morning and excess water in the evening. The District also has to pass excess water, known as carry water, to ensure that adequate water reaches all points-of-delivery when required by patrons according to their water rights. When the patrons' demand subsides, this excess water operationally spills onto non-productive lands at the ends of the conveyance system.

In other words, in addition to conservation of 48 cfs from reduced canal seepage, the HDPE Pressurized Piping Alternative will also increase water supply delivery to TID patrons. This, in turn, will increase agricultural production value and net returns to growers. Lining the canals under the Canal Lining Alternative is not expected to bring any reliability enhancements or benefits to agricultural production, as these benefits require pressurization. Table K below summarizes expected future water supply reliability under HDPE Pressurized Piping Alternative and the No Action/ Canal Lining Alternative. As shown in the table below, the hydrology of the area results in dry and wet water years each occurring 30 percent of the time, and average water years occurring 40 percent of the time. Currently, this results in an average water delivery capacity of approximately 3.5 AF per acre per year to District patrons; with piping, this average annual delivery capacity increases to 5.0 AF per acre per year.

Recent surveys of TID patrons indicate that grass hay is the predominant crop produced in the District (Tumalo Irrigation District, 2016), although some high value crops such as lavender, garlic, and hops are also grown. We conservatively model benefits of increased water supply reliability using hay as the representative crop for the District. According to data from the US Bureau of Reclamation Agrimet station in Madras, crop consumptive water needs for hay in the area are 3.3 AF per year (US Bureau of Reclamation, 2017). As described in the TID System Improvement Plan (Black Rock Consulting, 2016), irrigation efficiency in the District is approximately 70 percent. This implies that to fully irrigate grass hay to maximize yield, approximately 4.7 AF per year of water is needed. Currently, only in wet years do TID patrons receive close to this amount of water (approximately 4.4 AF per acre per year on average is delivered to TID farms in wet years now). With the HDPE Pressurized Piping Alternative, TID patrons will be able to fully irrigated grass hay in average and wet years.

Table K. District Water Delivery Reliability and Grass Hay Yields: No Action vs. HDPE Pressurized Piping Alternative

Water Year Type	Probability of Water Year Type	Future No Action		HDPE Pressurized Piping Alternative	
		Water Delivery to Farm (AF/Yr)	Grass Hay Yield (Ton/Yr)	Water Delivery to Farm (AF/Yr)	Grass Hay Yield (Ton/Yr)
Dry	30%	1.9	3.0	3.9	4.0
Average	40%	3.9	4.0	5.5	4.5
Wet	30%	4.4	4.5	5.5	4.5
Average Annual Value		3.5	3.9	5.0	4.4

Prepared April 2018

Currently, in dry water years grass hay yields are approximately 3 ton per acre (slightly less than the county average); average yields of grass hay are 4 ton per acre; and in wet years yields are estimated at 4.5 ton per acre (Rieck, Tumalo Irrigation District Manager, 2017).[5] This translates into an average estimated yield of approximately 3.9 tons grass hay per acre per year. As shown below in Table L, the average estimate annual net return for this yield is estimated at $270 per acre. With increased water supply deliveries, yields in dry and average water years are expected to increase, such that average annual yields in the District are expected to increase by approximately one-half ton (see Table K), from an average of approximately 3.9 tons per acre to 4.4 tons per acre. Assuming a price of $213.66 per ton[6], this translates into increased production value of over $106 per acre.

Recognizing that costs also rise with increased harvest (and also rise with very low water supplies), this analysis estimates the difference in net returns with a more reliable water supply using published

[5] The NRCS Water Resources Handbook for Economics instructs that yields used in NRCS evaluations should be the difference between current conditions and with project conditions. Current yields are to be "based on average management". TID does not collect or report on yield data. This analysis relies on yield information from hay producers in TID, reported through the Tumalo Irrigation District manager (Rieck, Tumalo District Manager, 2017).

[6] Based on State of Oregon normalized price data for all hay, accessed through Economic Research Service (ERS), online at https://www.ers.usda.gov/data-products/normalized-prices/.

grass hay and alfalfa hay enterprise budgets (to model representative grass hay production costs and returns) (Oregon State University, 2009) (University of Idaho, 2015). Production costs were updated to current (2017) values using the Producers Price Index (NASS, 2017). The information from the publication on grass hay production costs from University of Idaho was supplemented by information from irrigators in the area. Specifically, for low water years the irrigation labor costs were modeled to be double when compared to average and wet years due to the frequency of moving equipment relative to the amount of water used in irrigation. Further, because hay is a perennial crop and benefits are reported in annual terms, the establishment costs of production are amortized at the Federal water resource discount rate (2.75%) over the life of the grass hay stand (6 years) (NRCS, 2017). As shown in Table L below, net returns increase with increased yield, such that the average net economic benefit of increasing the average yield by 0.5 ton is just over $80 per acre.

Table L. Grass Hay Yields and Net Returns: No Action vs. HDPE Pressurized Piping Alternative

Variable	Low Water Delivery	Medium Water Delivery	High Water Delivery	Weighted Average $/Acre Return (2017$[1])
Yield (Ton/Acre/Year)	3.0	4.0	4.5	
Net Return ($/Year)	$200	$381	$451	
HDPE Pressurized Piping Alternative Water Delivery Probability (%)/Net Return ($)	0%	30%	70%	$430
No Action Water Delivery Probability (%)/Net Return ($)	30%	40%	30%	$350
Estimated Increased Average Annual Return				**$80**

1/ Price base: 2017 dollars Prepared April 2018

Conservatively assuming harvested acreage is approximately 85 percent of the 7,002 District acreage currently served (up to 10 percent of TID acreage may not be cropped, and some may be fallowed in any given year) (Rieck, Tumalo District Manager, 2017), or approximately 5,950 acres, this equates to increased net economic value to District patrons of approximately $476,000 per year once all project groups are constructed (this is the increase over and above the $2.08 million in current and expected future average net returns under the No Action Alternative and Canal Lining Alternative). Table M presents the annual average net return benefit of the HDPE Pressurized Alternative by Project Group, based on the acres serviced.

Table M. Annual Increased Net Returns (Reduced Damage Benefit) of HDPE Pressurized Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2017$[1]

Works of Improvement	Acreage Currently Served[2]	Estimated Annual Average Harvested Acreage	Undiscounted Future Production Value Under No Action/Canal Lining	Undiscounted Production Value Under HDPE Pressurized Piping Alternative	Undiscounted Annual Increased Production Value	Average Annual NED Benefits (Discounted and Amortized)
Project Group 1	94	80	$28,000	$34,000	$6,000	$6,000
Project Group 2	1,572	1,336	$468,000	$574,000	$107,000	$99,000
Project Group 3	507	431	$151,000	$185,000	$34,000	$31,000
Project Group 4	1,029	875	$306,000	$376,000	$70,000	$61,000

Project Group 5	804	683	$239,000	$294,000	$55,000	$47,000
Project Group 6	2,461	2,092	$732,000	$899,000	$167,000	$136,000
Project Group 7	535	454	$159,000	$195,000	$36,000	$27,000
Total	**7,002**	**5,952**	**$2,083,000**	**$2,558,000**	**$476,000**	**$407,000**

Note: Numbers may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent
2/As estimated by Black Rock Consulting in the TID System Improvement Plan, 2016.

Operations and Maintenance Cost Savings Benefit

The current annual operation and maintenance (O&M) costs for TID are roughly $947,000, which includes maintenance of equipment, buildings, and irrigation systems; payroll expenses; and administrative expenses (Tumalo Irrigation District, 2017). It is expected that these costs will continue in the future under the No Action scenario. Implementing the HDPE Pressurized Piping Alternative is expected to reduce costs by roughly $147,000 per year as a result of reduced maintenance and salary expenses. The Canal Lining Alternative is expected increase maintenance and administrative costs by about $61,000 per year, which are presented in the table as negative benefits (Tumalo Irrigation District, 2017). For the HDPE Pressurized Piping Alternative and the Canal Lining Alternative, expected operation and maintenance costs were provided by the irrigation district manager and calculated based on miles of canal that will be piped.[7] Tables N and O allocate these savings or cost increases to TID for each Project Group.

Table N. Annual Reduced Operation and Maintenance Costs to TID Patrons of HDPE Pressurized Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2017$

Works of Improvement	Mileage	Undiscounted Annualized Cost of No Action	Undiscounted Annualized Cost under HDPE Pressurized Piping Alternative	Undiscounted Annual Benefit	Average Annual NED Benefits (Discounted and Amortized, 2017$[1])
Project Group 1	1.9	$27,000	$23,000	$4,000	$4,000
Project Group 2	16.0	$220,000	$186,000	$34,000	$32,000
Project Group 3	4.8	$66,000	$56,000	$10,000	$9,000
Project Group 4	11.7	$160,000	$135,000	$25,000	$22,000
Project Group 5	10.6	$146,000	$123,000	$23,000	$19,000
Project Group 6	17.1	$235,000	$198,000	$37,000	$30,000

[7] Estimated operation and maintenance savings for the HDPE Pressurized Piping Alternative include a reduction in equipment usage, fuel, repairs, and labor. For example, to ensure the irrigation ditch operates properly, open ditch canals require cleaning to ensure water delivery is unobstructed by debris and repairing infrastructure when there is a blowout. Labor includes both administration and field time.

Project Group 7	6.8	$93,000	$79,000	$14,000	$11,000
Total	**68.8**	**$947,000**	**$800,000**	**$147,000**	$127,000

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent

Table O. Annual Increased Operation and Maintenance Costs to TID Patrons of Canal Lining Alternative by Project Group, Deschutes Watershed, Oregon, 2017$

Works of Improvement	Mileage	Undiscounted Annualized Cost of No Action	Undiscounted Annualized Cost under Canal Lining Alternative	Undiscounted Annual Benefit	Average Annual NED Benefits (Discounted and Amortized, 2017$[1])
Project Group 1	0.1	$27,000	$27,000	$0	$0
Project Group 2	14.5	$220,000	$234,000	-$14,000	-$13,000
Project Group 3	4.9	$66,000	$71,000	-$5,000	-$4,000
Project Group 4	11.0	$160,000	$171,000	-$11,000	-$9,000
Project Group 5	10.2	$146,000	$156,000	-$10,000	-$8,000
Project Group 6	18.8	$235,000	$253,000	-$18,000	-$14,000
Project Group 7	3.3	$93,000	$96,000	-$3,000	-$2,000
Total	**62.8**	**$947,000**	**$1,008,000**	**-$61,000**	-$53,000

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent

Energy Cost Savings and Carbon Benefits

The System Improvement Plan for TID estimates that compared to No Action and the HDPE Pressurized Piping Alternative, system improvements would result in a net energy savings of 4,002,951 kWh per year since it is much more efficient for patrons to receive pressurized water than to pressurize it themselves (Black Rock Consulting, 2016). This cost savings due to this energy savings is evaluated based on a cost of summer irrigation pumping of $0.09624 per kWh (the marginal cost for summer irrigation pumping, as noted above.) Table P presents the energy use under the No Action and Canal Lining Alternative scenarios, and displays the savings to TID patrons for each Project Group under the HDPE Pressurized Piping Alternative. Once all project groups are complete, the savings to TID patrons would be approximately $385,000 each year.

Table P. Annual Increased Average Energy Cost Savings to TID Patrons of HDPE Pressurized Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2017$[1]

Works of Improvement	Total Annual Energy Use Under No Action/Canal Lining Alternative (kWh)	Annual Energy Use Under HDPE Pressurized Piping Alternative	Reduced Annual Energy Use (kWh)[2]	Undiscounted Annual Energy Cost Savings (2017$)	Average Annual NED Benefits (Avoided Energy Costs, Discounted and Amortized, 2017$)
Project Group 1	81,439	75,738	5,701	$1,000	$1,000
Project Group 2	1,363,656	806,433	557,223	$53,000	$49,000
Project Group 3	439,895	145,144	294,751	$28,000	$25,000
Project Group 4	892,452	197,836	694,616	$67,000	$59,000
Project Group 5	697,222	313,747	383,475	$37,000	$31,000
Project Group 6	2,134,425	435,841	1,698,584	$163,000	$133,000
Project Group 7	463,659	95,669	367,990	$35,000	$27,000
Total	**6,072,748**	**2,070,408**	**4,002,340**	**$385,000**	**$325,000**

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent
2/ As estimated by Black Rock Consulting in the TID System Improvement Plan, 2016.

Reduced energy use also reduces carbon dioxide emissions from power generation. Every MWh of reduced on-farm energy use is estimated to translate into an estimated reduction of 0.75251 metric tons of carbon emissions.[8] Accordingly, compared to No Action, the annual net energy savings of the HDPE Pressurized Piping Alternative would reduce CO_2 emissions by approximately 3,012 metric tons (approximately 4,003 MWh multiplied by 0.7521), adjusted to approximately 2,255 metrics tons each year (on average) to take into account the average annual increased energy usage associated with reduced recharge throughout the 100-year project life for each Project Group (see Table Q). To value this reduced carbon emissions, this analysis uses an estimate of the social cost of carbon (which is the estimated total cost to society of emitting carbon related to the expected damages associated with future climate change). The Environmental Protection Agency and other federal agencies use a social cost of carbon estimate recommended by the federal Interagency

[8] This assumes that marginal changes in energy demand are met with fossil fuel-based production (renewable energy is typically used first and then fossil fuel powered generation is then used), such that 100 percent of energy use reduction and green energy production results in reduced fossil fuel-powered generation. Furthermore, this estimate assumes 0.75251 metric tons of carbon emitted from one MWh of fossil fuel powered electricity generation based on 1) the current proportion of fuel source - oil, natural gas, and coal – for fossil fuel-powered electrical power generation in the West, and 2) the associated metric tons of CO2 produced per MWh powered by each fossil fuel source, as reported by the Energy Information Administration.

Working Group on the Social Costs of Greenhouse Gases, of approximately $42 per metric ton (2017 dollars) (Interagency Working Group on Social Cost of Greenhouse Gases, 2013). At this value, the avoided carbon emissions from the HDPE Pressurized Piping Alternative provide an estimated average annual benefit of approximately $129,000, as shown in Table R.

Table Q. Annual Average Carbon Emissions (Metric Tons) by Project Group, Deschutes Watershed, Oregon

Works of Improvement	No Action		HDPE Pressurized Piping Alternative (NED Alternative)		Net Carbon	Canal Lining Alternative		
	Average Annual Carbon Emissions, Basinwide Pumping	Annual Carbon Emissions, TID Patron Pumping	Average Annual Carbon Emissions, Basinwide Pumping	Annual Carbon Emissions, TID Patron Pumping	Net Annual Carbon Savings (Compared to No Action)	Average Annual Carbon Emissions, Basinwide Pumping	Annual Carbon Emissions, TID Patron Pumping	Net Annual Carbon Savings (Compared to No Action)
Project Group 1	N/A	61	N/A	170	-109	N/A	61	102
Project Group 2	N/A	1,026	N/A	718	308	N/A	1,026	100
Project Group 3	N/A	331	N/A	171	160	N/A	331	55
Project Group 4	N/A	672	N/A	222	450	N/A	672	65
Project Group 5	N/A	525	N/A	290	235	N/A	525	48
Project Group 6	N/A	1,606	N/A	566	1040	N/A	1,606	214
Project Group 7	N/A	349	N/A	146	203	N/A	349	67
Total	**97,413[1]**	**4,570**	**98,170**	**2,282**	**2,288**	**98,065**	**4,570**	**652**

Note: Prepared April 2018

1/Note this values rises from 27,920 in Year 1 to 264,031 in Year 109. The average value is 97,413. Carbon emissions rise over time because groundwater pumping volume increases throughout the basin through time, and the depth to groundwater also rises through time due to reduced recharge from canals.

Table R. Annual Increased Average Carbon Cost Savings of HDPE Pressurized Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2017$[1]

Works of Improvement	Annual Avoided Emissions (Reduced TID Patron Energy Use, Metric Tons Carbon)	Average Annual Increased Emissions (from Reduced Recharge, Metric Tons Carbon)[2]	Net Average Avoided Emissions	Average Annual NED Benefits (Social Cost of Carbon, 2017$)[3]
Project Group 1	4	113	-109	-$3,000
Project Group 2	419	111	309	$19,000
Project Group 3	222	62	160	$10,000
Project Group 4	523	73	450	$24,000
Project Group 5	289	54	235	$13,000
Project Group 6	1,278	238	1,040	$53,000
Project Group 7	277	74	203	$10,000
Total	**3,012**	**724**	**2,288**	**$129,000**

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent
2/Additional energy use elsewhere rises through time as the effects of reduced recharge accumulate and cause groundwater depths to drop over time. The average annual energy use increase elsewhere in the basin represents the average change in energy use across the 50 project years for each Project Group.
3/Note that the average annual NED benefits differs from the change in tons of carbon emitted multiplied by the $42 value per metric ton of carbon. The increased emissions rise through time (and are thus highest at later time periods when the values are most discounted, while the decreased carbon emissions are the same through time).

The Canal Lining Alternative would not provide pressurization, so it would not reduce pumping or generate carbon benefits. However, it would carry higher carbon costs compared to No Action because of the increased energy use associated with falling groundwater depths, which is expected to average roughly 681 metric tons annually. These emissions would incur a cost valued at approximately $11,000 per year, shown as a cost in Table S below.

Table S. Annual Increased Average Carbon Costs of Canal Lining Alternative by Project Group, Deschutes Watershed, Oregon, 2017$[1]

Works of Improvement	Annual Avoided Emissions (Reduced TID Patron Energy Use, Metric Tons Carbon)	Average Annual Increased Emissions (from Reduced Recharge, Metric Tons Carbon)[2]	Average Annual NED Costs (Social Cost of Carbon, 2017$)[3]
Project Group 1	0	102	$2,000
Project Group 2	0	100	$2,000
Project Group 3	0	55	$1,000
Project Group 4	0	65	$1,000
Project Group 5	0	48	$1,000
Project Group 6	0	214	$4,000
Project Group 7	0	67	$1,000
Total	**0**	**652**	**$11,000**

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent
2/Additional energy use elsewhere rises through time as the effects of reduced recharge accumulate and cause groundwater depths to drop over time. The average annual energy use increase elsewhere in the basin represents the average change in energy use across the 50 project years for each Project Group.
3/Note that the average annual NED benefits differs from the change in tons of carbon emitted multiplied by the $42 value per metric ton of carbon. The increased emissions rise through time (and are thus highest at later time periods when the values are most discounted, while the decreased carbon emissions are the same through time).

Public Safety Avoided Costs

Piping irrigation water removes the hazard of drownings in canals, and also eliminates the potential for unlined canals to fail, with potential damages to downstream property and lives. While TID routinely experiences canal failure, the extent of damage varies dramatically depending on the timing and location of failure. Given the limited amount of available data on the cost of these canal failures, this public safety (and property damage reduction) benefit of piping is not analyzed in this analysis. However, a history of recent drownings in Central Oregon irrigation canals provides evidence that fast moving water in irrigation canals, often with steep and slippery banks, can be a threat to public safety. In 2004, a toddler drowned in a Central Oregon Irrigation District canal, and in 1996 and 1997, respectively, a 12-year old boy and a 28-year old man drowned in North Unit Irrigation District canals (Flowers, 2004). Other drownings may have occurred in the past, as a comprehensive list of drownings in Central Oregon irrigation canals was not available from the Bureau of Reclamation or other sources. However, the data indicate at least 3 drownings over the last 21 years (1996 through 2016), or 0.143 deaths per year during this time period. As the population in Central Oregon continues to grow and areas surrounding irrigation canals continue to urbanize, the risk to public safety will increase.

The HDPE Pressurized Piping Alternative would pipe approximately 69.5 miles of canals at TID, of which 62.8 miles will consist of newly-piped reaches (6.75 miles are already piped but will be re-piped under the Project). Under the Canal Lining Alternative, the canals will be fenced, which is expected to provide public safety benefits, those less than under the HDPE Pressurized Piping Alternative as fencing does not guarantee all drownings would be prevented.

This section qualitatively discusses the potential magnitude of the public safety benefit of piping the remaining exposed canals in TID. The analysis presents some information on the potential public safety hazard of the existing unlined irrigation canals (based on the recent history of drownings and the mileage of exposed canals) at TID proposed for lining/piping.

Level of Public Safety Hazard

This analysis estimates the public safety hazard of unlined canals in TID based on past drownings in unlined canals in Central Oregon. Based on data from Oregon Water Resources Department on canals in Central Oregon, there are 1,072 miles of irrigation canals in Central Oregon districts (see Table T). Starting in the late 1980s and early 1990s, sections of these canals began to be piped, with the result that today, the OWRD database records that approximately 209 miles have been piped. Assuming piping occurred uniformly across the 21-year period of 1996 to 2016, there were approximately 9.9 miles piped each year, leaving approximately 973 miles unpiped on an average annual basis during this period. Given that there was an average of 0.143 drowning deaths annually during this period (3 deaths over 21 years as described above), during that timeframe the annual drowning risk per mile of exposed canal was 0.000147 (0.143 divided by 973). This may be an overestimate of risk if there were an abnormally high number of drownings in the last twenty years or so, but may also be an underestimate of risk as the population of Bend continues to grow and the areas around irrigation canals continues to urbanize (thereby increasing the risks of drownings).

Under No Action, TID would continue to have approximately 89 miles of unpiped canal. Assuming that the three drownings over the past 21 years are representative of future drowning risk, and that the 0.000147 deaths per mile of exposed canal experienced during this period is an appropriate estimate of future risk, the unpiped canals in TID carry a risk of 0.013 deaths per year.

Table T. Irrigation Canal Mileage by District

District	Canal and Lateral Mileage
Arnold Irrigation District	47.3
Central Oregon Irrigation District	430.0
Lone Pine	2.4
North Unit Irrigation District	300.1
Ochoco Irrigation District	100.3
Swalley Irrigation District	27.6
Tumalo Irrigation District	95.8
Three Sisters Irrigation District	68.7
Total	**1072.0**

Note: Totals may not sum due to rounding. Prepared April 2018
Source: Oregon Water Resources Department, database maintained and provided by Jonathon LaMarche on March 9th, 2017.

Value of Conserved Water

The value of the conserved irrigation water can be looked at in two ways: the value of increased water instream, or the value of maintaining irrigated agricultural production value. This analysis focuses on the value of instream flow as the conserved water from the HDPE Pressurized Piping

Alternative will be used to augment instream flows. However, this analysis also presents the value of water to agriculture as the HDPE Pressurized Piping Alternative also enhances water supply reliability to the District. (As described elsewhere, the TID agreement to augment flows in Crescent Creek could further reduce deliveries in the District in the future. This Project provides the water for this flow augmentation, limiting the effects on TID water deliveries of this flow augmentation agreement).

This section provides several types of information on the value of instream flow. First, this analysis examines the value that environmental groups, federal agencies, and other funders of conservation have been willing to pay for water conservation projects that restore flow in the Deschutes Basin. While these values are in fact costs, rather than a measurement of benefit, the amounts paid in the past for water conservation projects to enhance instream flow represent the minimum value to the funding entities of conserved water projects (benefits as perceived by funding entities are expected to at least equal costs or funding would not be provided). Similarly, there is some limited water market data available for what environmental or governmental groups have paid to directly purchase water rights and dedicate the water to instream flow. These values also represent the cost of increasing instream flow, and similar to the data on costs of water conservation projects, may significantly underestimate the full value of instream flow augmentation. This analysis also presents market information on the value of water rights to irrigators in TID, as this indicates that potential cost of purchasing water rights from these irrigators.

Based on the following discussion, we assume that the economic benefit of instream flow augmentation would be at least $75/AF/year, such that this enhanced instream flow is estimated to have a value of approximately $1.13 million value per year once all Project Groups are complete under the HDPE Pressurized Piping Alternative (because of the timing, on an average annualized basis the NED benefit is just under $1.0 million as presented in Table V). This value is expected to be reasonable as a proxy for the value to the public of enhanced fish and wildlife populations (which is the true measure of the economic benefit of enhanced instream flow to benefit fish and wildlife populations). Values published in the economic literature are often quite high for enhancements to trout and other fish and wildlife populations, such as those that would benefit from the instream flows provided by the action alternatives. As quantitative information on how instream flows will improve fish and wildlife populations is not available, the analysis is not able to directly measure the economic benefit of enhanced instream flow. As such, the value of conserved water is directly estimated using the value of water transactions in the western United States. Transaction value from the Deschutes Basin itself are not used as there are regulatory limitations on the amount paid for leased water and much of the water is temporarily leased and donated to instream flows, not reflecting the true instream flow value of the water.

This value of $75 per AF per year is based on the following information:

1. Prices paid for water by environmental buyers throughout the Western United States. In the period 2000 to 2009, purchase price of environmental water varied from just over $0 to nearly $1,665 per AF per year, with an average permanent sale transaction price of $165 per AF per year. Amongst the 51 permanent water right purchases with the sales price and volume recorded in the database, the permanent sales price value in 27 transactions (53 percent) was above $75 per AF per year. As discussed at length below, these values paid are expected to provide a low range estimate of instream flow value to society.

2. Value of water to irrigators in TID. Depending on method used, this is estimated at $40 to $120 per AF per year (for an average value of water to agriculture of approximately $80 per AF). This value is important as the value of water to local agriculture is a key factor determining water sales and lease prices to environmental buyers in the project area (i.e., the marginal value of water to agriculture will determine agricultural sellers' willingness to accept a price for water), and because conserved water avoids potential future reductions in TID deliveries.

Table U. Value Per AF per Year of Water (Market Prices and Value to Agriculture), Deschutes Watershed, Oregon, 2017$

Type of Value	Low Value	High Value	Median Value	Average Value
Permanent Water Right Transaction in Western US, 2000 to 2009 *(Converted to Annual Values)*	~$0	$1,665	~$75	$165
Value of Water to TID Irrigators *(Income Capitalization Approach and Sales Price of Water in Ag to Ag Transfers, Converted to Annual Values)*	$40	$120	N/A	~$80

Table V shows the estimated average annual benefits of enhanced instream flow for the HDPE Pressurized Piping Alternative, while Table W shows these benefits for the Canal Piping Alternative.

Table V. Annual Estimated Instream Flow Value of HDPE Pressurized Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2017$[1]

Project Group	Water Conservation Under HDPE Pressurized Piping Alternative (AF/year)	Instream Flow Value Under No Action	Annualized Average Net Benefits of HDPE Pressurized Piping Alternative
Project Group 1	2,677	$0	$195,000
Project Group 2	2,519	$0	$174,000
Project Group 3	1,354	$0	$91,000
Project Group 4	1,543	$0	$101,000
Project Group 5	1,102	$0	$70,000
Project Group 6	4,598	$0	$279,000
Project Group 7	1,323	$0	$76,000
Total	**15,116**	**$0**	**$986,000**

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent

Table W. Annual Estimated Instream Flow Value of Canal Lining Alternative by Project Group, Deschutes Watershed, Oregon, 2017$[1]

Project Group	Water Conservation Under Canal Lining Alternative (AF/year)	Instream Flow Value Under No Action	Annualized Average Net Benefits of Canal Lining Alternative
Project Group 1	2,409	$0	$176,000
Project Group 2	2,267	$0	$157,000
Project Group 3	1,219	$0	$82,000
Project Group 4	1,389	$0	$91,000
Project Group 5	992	$0	$63,000
Project Group 6	4,138	$0	$251,000
Project Group 7	1,190	$0	$68,000
Total	**13,604**	**$0**	$888,000

Note: Totals may not sum due to rounding. Prepared April 2018
1/ Price base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent

Past Costs Paid as a Proxy for Value

Past piping projects in the Deschutes Basin highlight the willingness of funding entities to pay for instream flow augmentation. These values are evidence of the *minimum* benefit of the instream flows purchased, as perceived and experienced by these entities. Project costs paid are indicative of the *minimum* perceived benefit as (barring very unusual circumstances) entities only pay for projects for which they believe benefits exceed costs. Furthermore, funding organizations do not necessarily represent all individuals who value instream flow benefits. Only if all people who value instream flow were to pay their maximum willingness to pay for instream flow restoration would the value paid equal the benefits received. Finally, it is important to recognize that these values fundamentally represent *costs* and not benefits; the values paid are based on the cost to conserve water or for agriculture to reduce their use of water (as evident through water right transactions from agriculture to environmental flows).

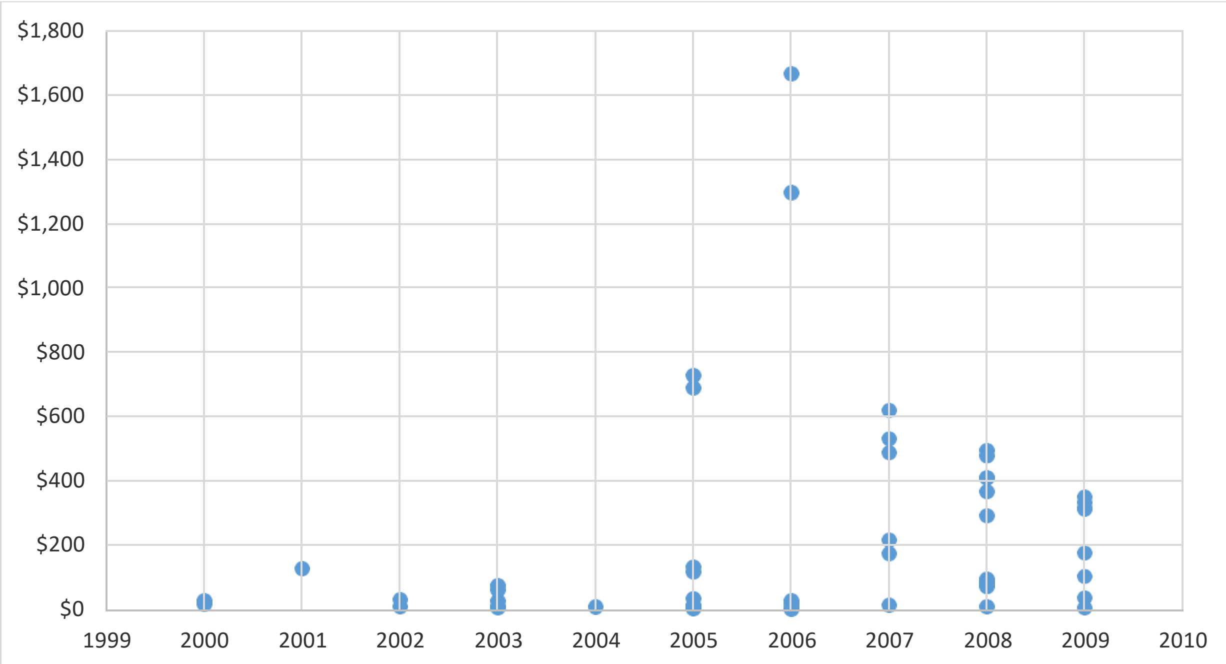
In the Deschutes Basin, approximately 90 projects have restored approximately 80,000 AF of water instream (Central Oregon Irrigation District, 2016). Based on data from the Deschutes River Conservancy, costs of instream flow augmentation from piping projects have ranged from approximately $104,000 to approximately $342,000 per cfs conserved; this may equate to roughly $300 to $1,000 per AF conserved.

Water rights can be purchased or leased in Oregon. It is important to note that the value paid per AF depends on many variables, including the value of water to the seller, funding available to the buyer, characteristics of the affected stream/river (including current flow levels, flow targets, and presence of threatened or endangered species), characteristics of the water right (seniority, time of use, point of diversion, etc.), and the size of the water right.

Water right leases and purchases for environmental purposes across the western United States were analyzed in a 2003 paper (Loomis, Quattlebaum, Brown, & Alexander, 2003). During the timeframe between 1995 and 1999, six transactions of water right purchases averaged $360 per AF in Oregon, while five water right leases averaged $114 per AF per year on average. The paper also shows lease and purchase price by environmental use, including for riparian areas, for wetlands, for recreation, and for instream flow. For instream flows, the average purchase price across 18 transactions was $1,114, while across 35 lease transactions the annual price per acre foot was $68.

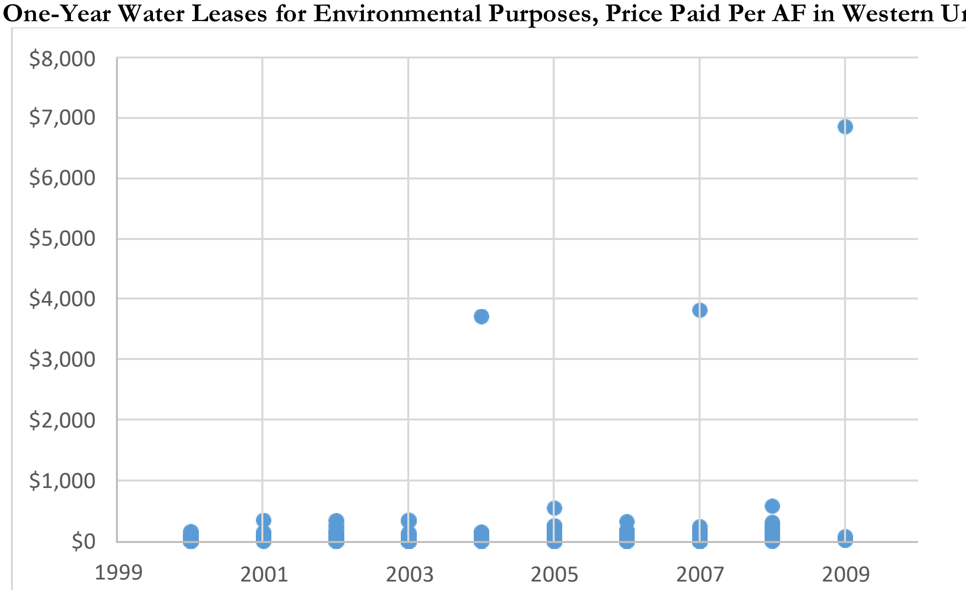
The Bren School of Environmental Science & Management at the University of California, Santa Barbara maintains a database of water transfers in the Western U.S., and distinguishes between the terms of the transaction (i.e. sale or lease) and sector of the buyer and seller (e.g. agricultural or environmental) (Bren School of Environmental Science & Management, University of California, Santa Barbara, 2017). The two graphs below show more recent sales and leases of water rights by environmental buyers from 2000 to 2009 on a price per AF per year basis. The figures show how water right transaction values vary widely, but sale prices (amortized to an annual price) typically are less than $200 per year while one-year leases typically fall below $800 per AF per year (with several transactions showing prices rising over a $1,000 per AF per year). Amongst the 51 permanent water right purchases with the sales price and volume recorded in the database, the sales price value in 27 transactions (53 percent) was above $75 per AF per year. However, it is also important to note that the amount paid per AF tends to decline with an increase in water volume traded: weighting the purchase price by the volume of water sold decreases the average permanent sale transaction price to $20 per AF per year.

Figure A: Western Water Right Purchases for Environmental Purposes, 2000 to 2009, Price Paid per AF per Year[1]



1/Note that dollar per AF purchase prices were amortized using a 2.75 percent interest rate and a 100-year time period to derive dollar per AF per year values.

Figure B: One-Year Water Leases for Environmental Purposes, Price Paid Per AF in Western United States



Current and Potential Future Water Right Purchase Values in TID

Specific to the Project Area, water rights sold from one irrigator to another within TID have typically had a purchase price of between $5,000 to $7,500 per acre (Rieck, Tumalo Irrigation District Manager, 2017). These values are very similar to values provided by area real estate agents regarding the increased value of property with irrigation water rights, all else equal. Assuming approximately four AF per year delivered on average to acreage in the district, this equates to approximately $1,250 to $1,875 per AF ($5000 to $7500 per acre divided by four acre feet per acre delivery), or a value of approximately $40 to $60 per AF per year.

Prices paid for the limited number of agricultural water right sales may not reflect the average value of water to irrigators in TID and the cost of acquiring water in the future. The value of water to irrigators in TID (i.e., the increased farm income from having access to water) is important as it is a key determinant of the price at which irrigators would be willing to sell water rights (and the price at which environmental water buyers could obtain water from agricultural water right holders—which are the primary water right holders that could sell water rights to augment instream flows). The price paid per AF in the limited number of current TID water transactions is lower than the value derived from the effect on farm income of increased access to irrigation water (income capitalization approach).[9] Based on the findings in Table L, increasing water delivery from 1.9 to 4.5 AF to TID farms producing grass hay results in increased farm income of an estimated $80 to $120 per AF per year. (The range is due to the fact that the effect of water on farm income depends on the amount of water available – water is more valuable in water short years as crop yields are highly impacted by very low water application. As more water becomes available, the impact of increased water on crop revenue declines.)

The fact that current water right transactions trade for a lower value than derived through the income capitalization approach may be because some farms in TID are not commercial farms or are not farming all of their lands, and so derive less income from some of their water rights than commercial farms producing grass hay or other crops. This indicates that while some water may trade for the lower value of approximately $40 to $60 per AF, if instream flow buyers were to purchase water rights, then as more water rights were acquired, the cost per AF would likely rise to the level as derived through the income capitalization approach (i.e., $80 to $120 per AF).

[9] This may be because some farms in TID are not commercial farms or are not farming all of their lands, and so derive less income from some of their water rights than commercial farms producing grass hay or other crops.

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NED Appendix 1 Hay Enterprise Budget

This appendix presents the assumptions used in estimating agricultural production benefits. The agricultural production benefits are estimated using an enterprise budget approach, which identifies typical costs and returns of producing grass hay in the Deschutes watershed of Oregon. Enterprise budgets aim to reflect common practices and relevant costs for grass hay production in the region, and thus do not represent conditions of any particular farm. Many of the assumptions used in constructing the enterprise budget were derived from the following grass hay enterprise budget publications:

- Painter, Kathleen et al, 2015 Grass Hay Enterprise Budget, University of Idaho, College of Agriculture and Life Sciences (Painter, 2015)
- Oregon State University, South Central Valley, Irrigated Alfalfa, EM8352A (Oregon State University)

Operating costs were indexed to 2017 values using the Producer Price Index (NASS, 2017).

Three enterprise budgets were generated for this analysis, based on three water supply delivery scenarios (low, medium, and high). The primary difference between the three budgets is the yield (and associated gross return), although irrigation costs also varied between the three water years. Further details on assumptions and data sources used in this enterprise budget are provided below:

Stand Establishment

This enterprise budget assumes hay is established and the stand is maintained over a six-year period. Establishment costs ($162 per acre) are amortized over these six years at a discount rate equivalent to the water resources planning rate of 2.75 percent (NRCS, 2017).

Land

Land costs in this budget were calculated for the landlord (ownership costs) but are meant to also represent the opportunity costs of the land. The land cost calculation is based on a lease agreement of one-third landowner and two-third tenant crop share (Painter, 2015). The assumed agreement has the landowner paying land taxes, one-third of the fertilizer cost, one-third of the chemical cost, and one-third of the crop insurance. Land costs for the three scenarios for the landlord are therefore estimated at $166 (low water supply), $227 (medium water supply) and $258 (high water supply).

Irrigation

The enterprise budget assumes the field is sprinkler irrigated at a cost of $40 per acre, which covers water, pumping and labor costs. In low water year conditions, the cost to irrigate is assumed to rise to $80 per acre based on higher labor costs (more frequent irrigations) (Oregon State University) (Rieck, Tumalo Irrigation District Manager, 2017).

Labor

Machinery labor costs were assumed to be $16.67 per hour (Painter, 2015), which is slightly higher than mean hourly wages for agricultural equipment operators ($13.35 per hour), and other agricultural workers ($16.40) (Bureau of Labor Statistics, 2016). Custom rates for stacking and hauling hay at $8.43 per ton are modeled. A management fee of $9.37 per acre is also included in the enterprise budget for management activities (Painter, 2015).

Inputs (Fertility, Pesticides and Other)

Input costs are based on University of Idaho's annual survey of input suppliers for each region, available online at: http://web.cals.uidaho.edu/idahoagbiz/enterprise-budgets/

Machinery and Equipment

The machinery components and associated hourly machinery costs include depreciation, interest, property taxes, insurance, and housing (Painter, 2015).

Other Expenses

An overhead charge of just over $4 per acre is included to cover general tools, office supplies and other expenses.

Gross Returns

Yield

Currently (No Action Alternative and Canal Lining Alternative), in dry water years grass hay yields are approximately 3 ton per acre (slightly less than the county average); average yields of grass hay are 4 ton per acre; and in wet years yields are estimated at 4.5 ton per acre (Rieck, Tumalo Irrigation District Manager, 2017).[10] This translates into an average estimated yield of approximately 3.9 tons grass hay per acre per year. With increased water supply deliveries under the HDPE Pressurized Piping Alternative, yields in dry and average water years are expected to increase, such that average annual yields in the District are expected to increase by approximately one-half ton, from an average of approximately 3.85 tons per acre to 4.35 tons per acre (see the table below)

Table 1: District Water Delivery Reliability and Grass Hay Yields: No Action vs. Proposed Action

Water Year Type	Probability of Water Year Type	Future No Action		Proposed Project	
		Water Delivery to Farm (AF/Yr)	Grass Hay Yield (Ton/Yr)	Water Delivery to Farm (AF/Yr)	Grass Hay Yield (Ton/Yr)
Dry	30%	1.9	3	3.9	4
Average	40%	3.9	4	5.5	4.5

[10] The NRCS Water Resources Handbook for Economics instructs that yields used in NRCS evaluations should be the difference between current conditions and with project conditions. Current yields are to be "based on average management". TID does not collect or report on yield data. This analysis relies on yield information from hay producers in TID, reported through the Tumalo Irrigation District manager (Rieck, Tumalo District Manager, 2017).

Wet	30%	4.4	4.5	5.5	4.5
Average Annual		3.45	3.85	5.02	4.35

Prices Received

The price received assumption of $213.66 per ton is based on State of Oregon normalized price data for all hay, accessed through Economic Research Service (Economic Research Services, 2017). Normalized prices reported by ERS are intended to smooth out the effects of short-run seasonal or cyclical variation, for key agricultural products.

Enterprise Budget Tables

The following tables present the three enterprise budgets that reflect all costs and returns for the three water delivery scenarios:

Low Water Delivery Scenario

Item		Quantity Per Acre		Unit		Price or Cost / Unit		Value or Cost / Acre
Low Water Delivery Scenario:								
Gross Returns								
Grass Hay		3.00		ton		$213.66		$640.98
Variable Costs								
Fertilizer:								**$52.03**
Base your rate on your soil test results.								
The following fertilizer estimates are typical:								
Nitrogen		25		lb		$0.57		$13.35
Phosphorus		70		lb		$0.55		$36.06
Sulfur		10		lb		$0.28		$2.62
Machinery:								**$30.68**
Fuel		0.00		gal		$3.00		$9.41
Lubricants		1		acre		$0.00		$0.95
Machinery Repairs		1		acre		$0.00		$7.71
Machinery Labor		0.00		acre		$17.80		$12.61

Item	Quantity Per Acre	Unit	Price or Cost / Unit	Value or Cost / Acre
Low Water Delivery Scenario:				
Custom & Consultants:				**$26.22**
Custom Haul & Stack	3.00	ton	**$9.00**	$25.29
Fertilizer Rental	1	acre	**$1.00**	$0.94
Other:				**$90.82**
Baling twine	3.00	ton	$3.85	$10.82
Irrigate				$80.00
Operating Interest[1]				$5.74
Total Variable Costs				**$205.49**
Net Returns Above Variable Costs				**$376.36**
Ownership Costs:				
Machinery depreciation			**$0.00**	$14.69
Machinery interest			**$0.00**	$9.06
Machinery insurance, taxes, housing, licenses			**$0.00**	$2.73
Land Cost*	1	acre		$166.19
*Based on share rent percentage:				
Landlord	**33%**			
Tenant	**67%**			
Amortization of establishment costs**	2.750%	acre	$0.00	$29.74
**Based on years of production:	6			
Overhead				$4.21
Management fee				$9.37
Total Fixed Costs				**$235.98**
Total Costs per Acre				**$441.48**
Total Costs per Unit				**$147.16**
Returns to Risk				**$199.50**

Medium Water Delivery Scenario

Item	Quantity Per Acre	Unit	Price or Cost / Unit	Value or Cost / Acre
Medium Water Delivery Scenario:				
Gross Returns				
Grass Hay	4.00	ton	$213.66	$854.64
Variable Costs				
Fertilizer:				**$52.03**
Base your rate on your soil test results.				
The following fertilizer estimates are typical:				
Nitrogen	25	lb	$0.57	$13.35
Phosphorus	70	lb	$0.55	$36.06
Sulfur	10	lb	$0.28	$2.62
Machinery:				**$30.68**
Fuel	0.00	gal	$3.00	$9.41
Lubricants	1	acre	$0.00	$0.95
Machinery Repairs	1	acre	$0.00	$7.71
Machinery Labor	0.00	acre	$17.80	$12.61
Custom & Consultants:				**$34.65**
Custom Haul & Stack	4.00	ton	$9.00	$33.72
Fertilizer Rental	1	acre	$1.00	$0.94
Other:				**$54.42**
Baling twine	4.00	ton	$3.85	$14.42
Irrigate				$40.00
Operating Interest[1]				$4.94
Total Variable Costs				**$176.73**
Net Returns Above Variable Costs				**$599.07**
Ownership Costs:				
Machinery depreciation			$0.00	$14.69
Machinery interest			$0.00	$9.06
Machinery insurance, taxes, housing, licenses			$0.00	$2.73
Land Cost*	1	acre		$227.41

Item		Quantity Per Acre		Unit		Price or Cost / Unit		Value or Cost / Acre
Medium Water Delivery Scenario:								
*Based on share rent percentage:								
Landlord		**33%**						
Tenant		**67%**						
Amortization of establishment costs**		2.750%		acre		$0.00		$29.74
**Based on years of production:		6						
Overhead								$4.21
Management fee								$9.37
Total Fixed Costs								**$297.21**
Total Costs per Acre								**$473.93**
Total Costs per Unit								**$118.48**
Returns to Risk								**$380.71**

High Water Delivery Scenario

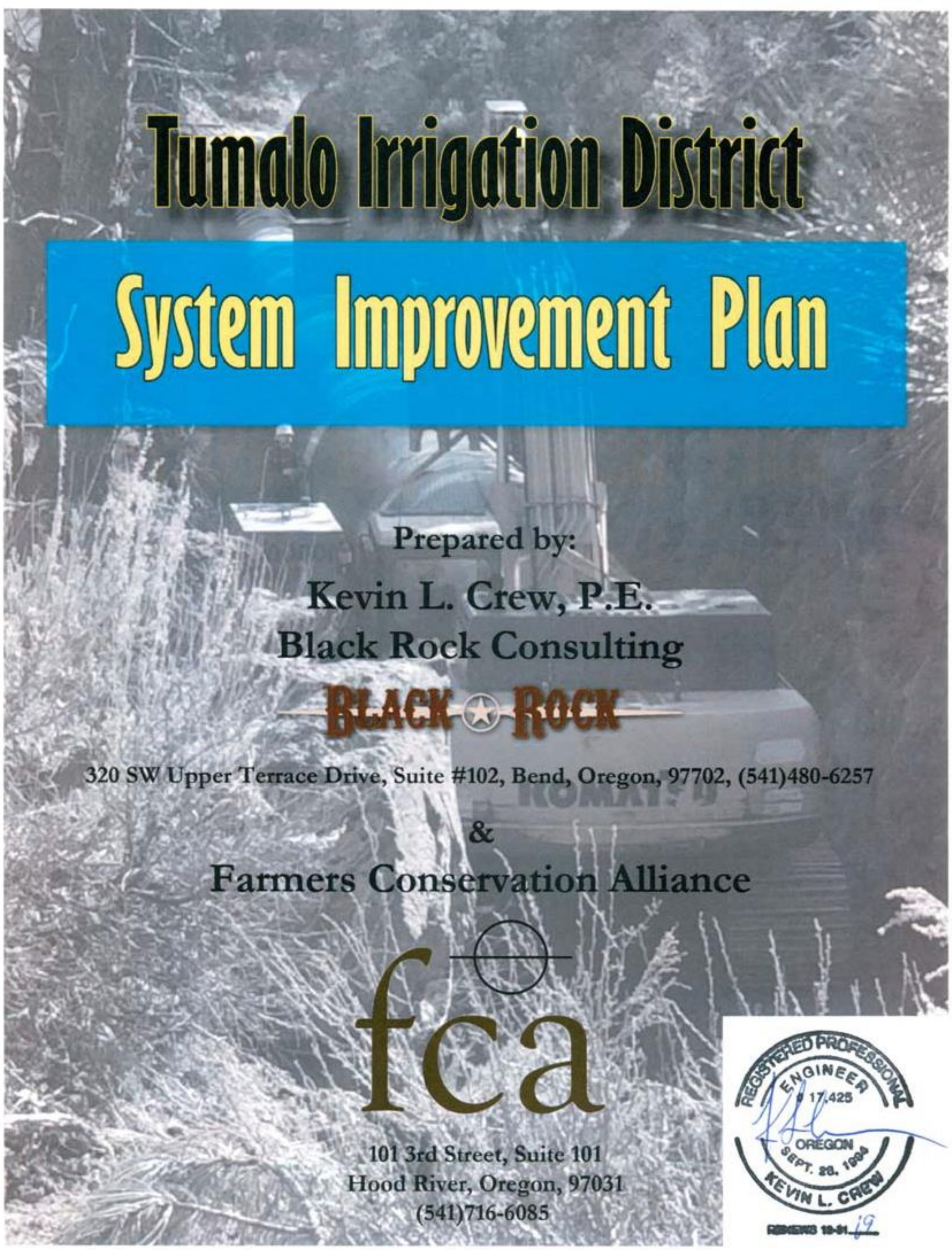
Item		Quantity Per Acre		Unit		Price or cost / Unit		Value or Cost/Acre
High Water Delivery Scenario:								
Gross Returns								
Grass Hay		4.50		ton		$213.66		$961.47
Variable Costs								
Fertilizer:								**$52.03**
Base your rate on your soil test results.								
The following fertilizer estimates are typical:								
Nitrogen		25		lb		$0.57		$13.35
Phosphorus		70		lb		$0.55		$36.06
Sulfur		10		lb		$0.28		$2.62
Machinery:								**$30.68**
Fuel		0.00		gal		$3.00		$9.41
Lubricants		1		acre		$0.00		$0.95
Machinery Repairs		1		acre		$0.00		$7.71
Machinery Labor		0.00		acre		$17.80		$12.61
Custom & Consultants:								**$38.87**
Custom Haul & Stack		4.50		ton		$9.00		$37.93
Fertilizer Rental		1		acre		$1.00		$0.94
Other:								**$56.23**
Baling twine		4.50		ton		$3.85		$16.23
Irrigate								$40.00
Operating Interest[1]								$5.11
Total Variable Costs								**$182.92**
Net Returns Above Variable Costs								**$778.55**
Ownership Costs:								
Machinery depreciation						$0.00		$14.69
Machinery interest						$0.00		$9.06
Machinery insurance, taxes, housing, licenses						$0.00		$2.73
Land Cost*		1		acre				$258.02

Item		Quantity Per Acre		Unit		Price or cost / Unit		Value or Cost/Acre
High Water Delivery Scenario:								
*Based on share rent percentage:								
Landlord		**33%**						
Tenant		**67%**						
Amortization of establishment costs**		2.750%		acre		$0.00		$29.74
**Based on years of production:		6						
Overhead								$4.21
Management fee								$9.37
Total Fixed Costs								**$327.82**
Total Costs per Acre								**$510.73**
Total Costs per Unit								**$113.50**
Returns to Risk								**$450.74**

D.2 Engineering

This appendix section presents the System Improvement Plan and dimensions and capital costs for the eliminated alternatives, which includes canal lining, PVC piping, steel piping, and partial groundwater use.

System Improvement Plan



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Executive Summary

This study was funded by the Tumalo Irrigation District in partnership with the City of Bend and authorized February 2015 through a Consultant Services Agreement by and between the Tumalo Irrigation District (TID) and Black Rock Consulting (BRC). Additionally, Farmers Conservation Alliance, with support from Energy Trust of Oregon, commissioned an evaluation of system seepage losses, LIDAR imagery, and base files for use in hydraulic modeling. The purpose of this System Improvement Plan (SIP) was to develop a well-considered evaluation of the District's primary and secondary canal systems, a mitigation plan for the seepage losses, and consideration of resulting pressurized deliveries. System piping was the primary method proposed for such mitigation.

In July and August of 2016, two meetings were held with District staff to confirm approach on the SIP. Data requests were fulfilled by the District. The District also determined that it planned to provide patron delivery pressurization where possible. The District determined that a value of 7.48 GPM/Acre should be used for hydraulic modeling and pipe sizing purposes. Lastly, that the cost estimating in this SIP should provide District flexibility, therefore, should provide logical project groups including seepage loss and cost of mitigation (through piping) information.

The District's approximate 7,417 acres are served by two primary diversion canals – the Tumalo Feed Canal and the Bend Feed Canal. The unpiped portions of the primary canal and laterals were evaluated for seepage loss using state-of-the-art measurement equipment and it was found that approximately 50.4 CFS were being lost at the time of measurements. It was also determined that approximately 53 CFS might be conserved if the system were completely piped and Tumalo Reservoir lined (assuming certificated peak flows of 7.48 GPM/Acre delivered). For the purposes of this SIP, 50 CFS was held as the total potential conservation attributed to piping projects.

The District chose to consider pressurization to patron deliveries as a priority for its SIP. Given this approach, where pressure reduction was required, pressure sustaining downstream was incorporated. This approach resulted in hydroelectric power potential estimated at 1.5 GWh and an estimated reduction of 4.0 GWh in patron pumping per season. A total of three pressure reducing stations combined with hydroelectric power potential were evaluated in the SIP.

A pipe manufacturer/vendor was contacted to provide budgetary pipe cost information for pipe delivered to Central Oregon. This information was used to develop reconnaissance-level cost estimates to design and construct the entire piped system to all patron and private delivery points. The cost estimates were evaluated and broken into grouped cost elements. An At-A-Glance Map and summary tables are provided in Section 1 indicating the summary results of this System Improvement Plan.

D.3 Capital Costs for Alternatives

This appendix section presents dimensions and capital costs for the alternatives, which include HDPE, PVC & HDPE piping, steel piping, partial groundwater use and canal lining.

HDPE Piping Alternative

Project Group	Canal/Lateral	Length (feet)	Piping & Turnout Construction Cost	Engineering, Construction Management, Survey (E,CM,S)	Construction Management, General Contractor (CM,GC)	Contingency	Costs (2016$)	Flow (gpm)	Diameter (in)	Pressure Rating Index	Upgraded Turnouts	Pressure Reducing Valves
1	Tumalo Feed Canal	10206	$4,208,813	$383,846	$929,618	$0	$5,522,277	47,106-50,545	84	N/A	7	N/A
2	Tumalo Res. Feed	10784	$1,663,600	$165,881	$199,633	$608,736	$2,637,850	299-11,473	6-63	32.5	129	N/A
2	Steele	5010	$167,384	$23,108	$23,908	$64,320	$278,720	301-774	6-10	32.5		
2	Rock Springs	1516	$42,611	$6,392	$6,392	$16,618	$72,013	288-333	6	32.5		
2	Highline	26099	$937,794	$113,255	$113,255	$349,292	$1,513,596	800-3,756	6-24	17-32.5		
2	2 Rivers	5097	$93,094	$13,964	$13,964	$36,307	$157,329	-	6-12	32.5		
2	Kerns	2864	$36,045	$5,407	$5,407	$14,058	$60,917	224	6	32.5		
2	Parkhurst	17309	$740,803	$94,416	$94,416	$278,891	$1,208,526	672-2,761	6-18	21-32.5		
2	Gill	2635	$26,445	$3,967	$3,967	$10,313	$44,692	0	6	32.5		
2	Lacy	13146	$271,825	$40,774	$40,774	$106,012	$459,385	52-1,734	6-12	26-32.5		
3	Allen	17689	$2,043,318	$204,332	$245,198	$747,855	$3,240,703	7,698-11,492	28-34	26-32.5	46	N/A
3	Allen Sublateral West	2040	$46,279	$6,942	$6,942	$18,049	$78,212	290-316	6	32.5		
3	Allen Sublateral South	1899	$37,292	$5,594	$5,594	$14,544	$63,024	183-247	6	32.5		
3	McGinnis Ditch	3891	$67,236	$10,085	$10,085	$26,222	$113,628	147-312	6	32.5		
4	West Branch Columbia So. West	25979	$1,506,760	$151,476	$181,291	$551,858	$2,391,385	4,771-7,535	6-28	26-32.5	91	1
4	Beasley	6671	$211,322	$31,698	$25,359	$80,514	$348,893	153-687	6-8	26-32.5		
4	Spaulding	13462	$654,320	$98,148	$78,518	$249,296	$1,080,282	1,671-3,226	6-20	19-26		
4	N. Spaulding	15439	$177,090	$26,563	$26,563	$69,065	$299,281	142	6	19-32.5		
5	Couch	9421	$633,820	$95,073	$95,073	$247,190	$1,071,156	103-5,976	6-26	32.5	89	N/A
5	West Couch	24365	$825,973	$100,557	$100,557	$308,126	$1,335,213	696-3,416	6-20	15.5-32.5		
5	West Couch Sublateral East	4868	$130,584	$19,588	$19,588	$50,928	$220,688	384-1,166	6-10	26-32.5		
5	Chambers (Lafores) Ditch	2066	$78,462	$11,769	$11,769	$30,600	$132,600	52-322	6	32.5		
5	East Couch	11339	$347,144	$52,072	$41,657	$132,262	$573,135	202-672	6-16	32.5		

5	Gainsforth	3891	$59,237	$8,886	$8,886	$23,102	$100,111	161-282	6	32.5		
6	Columbia Southern TFC to PRV	14977	$3,565,144	$213,909	$427,817	$1,262,061	$5,468,931	18,555-33,899	48-63	21-32.5		
6	Columbia Southern PRV to Tail	22065	$2,573,064	$205,845	$308,768	$926,303	$4,013,980	10,280-17,760	6-42	26-32.5		
6	North Columbia So. East	8426	$248,086	$37,213	$37,213	$96,753	$419,265	37-1,794	6-24	32.5		
6	North Columbia So. West	6020	$301,383	$45,207	$45,207	$117,539	$509,336	334-2,615	6-16	32.5		
6	Jewett	7777	$326,384	$48,958	$48,958	$127,290	$551,590	880-2,256	10-16	26-32.5		
6	Conarn East	789	$22,315	$3,347	$3,347	$8,703	$37,712	75	6	26		
6	Putnam	5505	$124,651	$18,698	$18,698	$48,614	$210,661	1,297-1,757	6-14	21-32.5	221	2
6	West Branch Columbia So. East	6562	$293,554	$44,033	$44,033	$114,486	$496,106	37-1,193	6-12	26		
6	Conarn	2071	$96,567	$14,485	$14,485	$37,661	$163,198	85-355	6	26		
6	Phiffer	5011	$248,304	$37,246	$37,246	$96,839	$419,635	302-1,679	6-12	32.5		
6	Hooker Creek	2918	$154,395	$23,159	$23,159	$60,214	$260,927	888-1,260	10-12	32.5		
6	Hammond	7532	$200,061	$30,009	$30,009	$78,024	$338,103	368-1,808	6-14	26-32.5		
6	North Hammond	510	$43,803	$6,571	$6,571	$17,083	$74,028	300-710	6-8	32.5		
7	Hillburner	7345	$308,646	$46,297	$46,297	$120,372	$521,612	338-676	6-24	32.5		
7	Gerking	5255	$203,845	$30,577	$30,577	$79,500	$344,499	75-494	6-8	19-21		
7	Kickbush	5290	$108,701	$16,305	$16,305	$42,393	$183,704	461-574	6-8	21	79	N/A
7	West Branch Columbia So. South	7610	$245,676	$36,851	$36,851	$95,814	$415,192	561-1,215	6-8	26		
7	Flannery Ditch	2178	$47,248	$7,087	$7,087	$18,427	$79,849	162-452	6-12	26		
7	Tellin Ditch	7972	$130,619	$19,593	$19,593	$50,942	$220,747	202-589	6	32.5		
Totals:		**363,498**	**$24,249,697**	**$2,559,183**	**$3,490,635**	**$7,433,176**	**$37,732,691**				**662**	**3**

PVC & HDPE Piping Alternative

Project Group	Name	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
1	Tumalo Feed Canal Phase V	Pipe	HDPE	84	2,260	NA	LF	$500	$1,130,000	6%	10%	8%	$67,800	$113,000	$104,864	$1,415,664
1	Tumalo Feed Canal Final Phase(s) After Phase V	Pipe	HDPE	84	7,946	NA	LF	$680	$5,403,280	4%	12%	30%	$216,131	$648,394	$1,880,341	$8,148,146
1	Tumalo Feed Canal Phase V	Turnout	HDPE	1	NA	3	EA	$8,000	$24,000	6%	10%	8%	$1,440	$2,400	$2,227	$30,067
1	Tumalo Feed Canal Final Phase(s) After Phase V	Turnout	HDPE	1	NA	4	EA	$8,000	$32,000	4%	12%	30%	$1,280	$3,840	$11,136	$48,256
2	Tumalo Feed Canal Reservoir Feed and Sublateral	Pipe	HDPE	63	718	NA	LF	$196	$140,897	10%	12%	30%	$14,090	$16,908	$51,568	$223,463
2	Tumalo Feed Canal Reservoir Feed and Sublateral	Pipe	PVC	6	4,983	50	LF	$3	$66,037.19	10%	12%	30%	$6,604	$7,924	$24,170	$104,735
2	Tumalo Feed Canal Reservoir Feed and Sublateral	Pipe	PVC	48	177	2	LF	$180	$33,610.73	10%	12%	30%	$3,361	$4,033	$12,302	$53,307
2	Tumalo Feed Canal Reservoir Feed and Sublateral	Pipe	PVC	54	4,906	49	LF	$227	$1,162,854.58	10%	12%	30%	$116,285	$139,543	$425,605	$1,844,287
2	Steele Lateral	Pipe	PVC	6	1,813	18	LF	$3	$24,026.78	15%	15%	30%	$3,604	$3,604	$9,370	$40,605
2	Steele Lateral	Pipe	PVC	8	2,916	29	LF	$6	$45,204.11	15%	15%	30%	$6,781	$6,781	$17,630	$76,395
2	Steele Lateral	Pipe	PVC	10	281	3	LF	$9	$5,209.77	15%	15%	30%	$781	$781	$2,032	$8,805
2	Rock Springs Lateral	Pipe	PVC	6	1,516	15	LF	$3	$20,090.78	15%	15%	30%	$3,014	$3,014	$7,835	$33,953
2	Highline Lateral	Pipe	PVC	6	1,819	18	LF	$3	$24,106.29	12%	12%	30%	$2,893	$2,893	$8,968	$38,859
2	Highline Lateral	Pipe	PVC	10	71	1	LF	$9	$1,316.35	12%	12%	30%	$158	$158	$490	$2,122
2	Highline Lateral	Pipe	PVC	12	7,884	79	LF	$12	$173,658.47	12%	12%	30%	$20,839	$20,839	$64,601	$279,937
2	Highline Lateral	Pipe	PVC	12	3,235	32	LF	$12	$71,256.36	12%	12%	30%	$8,551	$8,551	$26,507	$114,865
2	Highline Lateral	Pipe	PVC	16	4,727	47	LF	$21	$146,339.29	12%	12%	30%	$17,561	$17,561	$54,438	$235,899
2	Highline Lateral	Pipe	PVC	18	4,381	44	LF	$26	$159,159.04	12%	12%	30%	$19,099	$19,099	$59,207	$256,564
2	Highline Lateral	Pipe	PVC	20	2,131	21	LF	$32	$90,160.22	12%	12%	30%	$10,819	$10,819	$33,540	$145,338
2	Highline Lateral	Pipe	PVC	24	1,851	19	LF	$46	$103,827.59	12%	12%	30%	$12,459	$12,459	$38,624	$167,370
2	2 Rivers (Box S) Lateral	Pipe	PVC	6	2,426	24	LF	$3	$32,150.56	15%	15%	30%	$4,823	$4,823	$12,539	$54,334
2	2 Rivers (Box S) Lateral	Pipe	PVC	8	828	8	LF	$6	$12,835.74	15%	15%	30%	$1,925	$1,925	$5,006	$21,692
2	2 Rivers (Box S) Lateral	Pipe	PVC	12	1,843	18	LF	$12	$40,595.20	15%	15%	30%	$6,089	$6,089	$15,832	$68,606
2	Kerns Lateral	Pipe	PVC	6	2,864	29	LF	$3	$37,955.15	15%	15%	30%	$5,693	$5,693	$14,803	$64,144
2	Parkhurst Lateral	Pipe	PVC	6	2,519	25	LF	$3	$33,383.04	12%	12%	30%	$4,006	$4,006	$12,418	$53,813
2	Parkhurst Lateral	Pipe	PVC	6	474	5	LF	$3	$6,281.68	12%	12%	30%	$754	$754	$2,337	$10,126

Project Group	Name	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
2	Parkhurst Lateral	Pipe	PVC	8	982	10	LF	$6	$15,223.06	12%	12%	30%	$1,827	$1,827	$5,663	$24,540
2	Parkhurst Lateral	Pipe	PVC	10	5	0	LF	$9	$92.70	12%	12%	30%	$11	$11	$34	$149
2	Parkhurst Lateral	Pipe	PVC	12	3,666	37	LF	$12	$80,749.87	12%	12%	30%	$9,690	$9,690	$30,039	$130,169
2	Parkhurst Lateral	Pipe	PVC	14	1,380	14	LF	$16	$36,149.43	12%	12%	30%	$4,338	$4,338	$13,448	$58,273
2	Parkhurst Lateral	Pipe	PVC	16	8,000	80	LF	$21	$247,665.39	12%	12%	30%	$29,720	$29,720	$92,132	$399,237
2	Parkhurst Lateral	Pipe	PVC	18	283	3	LF	$26	$10,281.22	12%	12%	30%	$1,234	$1,234	$3,825	$16,573
2	Gill Lateral	Pipe	PVC	6	2,635	26	LF	$3	$34,920.33	15%	15%	30%	$5,238	$5,238	$13,619	$59,015
2	Lacy Lateral and Lacy Sublateral	Pipe	PVC	6	952	10	LF	$3	$12,616.38	15%	15%	30%	$1,892	$1,892	$4,920	$21,322
2	Lacy Lateral and Lacy Sublateral	Pipe	PVC	6	5,611	56	LF	$3	$74,359.76	15%	15%	30%	$11,154	$11,154	$29,000	$125,668
2	Lacy Lateral and Lacy Sublateral	Pipe	PVC	8	1,327	13	LF	$6	$20,571.28	15%	15%	30%	$3,086	$3,086	$8,023	$34,765
2	Lacy Lateral and Lacy Sublateral	Pipe	PVC	10	1,447	14	LF	$9	$26,827.55	15%	15%	30%	$4,024	$4,024	$10,463	$45,339
2	Lacy Lateral and Lacy Sublateral	Pipe	PVC	12	3,809	38	LF	$12	$83,899.69	15%	15%	30%	$12,585	$12,585	$32,721	$141,790
2	Tumalo Feed Canal Reservoir Feed and Sublateral	Turnout	HDPE	1	NA	16	EA	$8,000	$128,000	10%	12%	30%	$12,800	$15,360	$46,848	$203,008
2	Steele Lateral	Turnout	HDPE	1	NA	16	EA	$8,000	$128,000	15%	15%	30%	$19,200	$19,200	$49,920	$216,320
2	Rock Springs Lateral	Turnout	HDPE	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
2	Highline Lateral	Turnout	HDPE	1	NA	25	EA	$8,000	$200,000	12%	12%	30%	$24,000	$24,000	$74,400	$322,400
2	2 Rivers (Box S) Lateral	Turnout	HDPE	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
2	Kerns Lateral	Turnout	HDPE	1	NA	2	EA	$8,000	$16,000	15%	15%	30%	$2,400	$2,400	$6,240	$27,040
2	Parkhurst Lateral	Turnout	HDPE	1	NA	43	EA	$8,000	$344,000	12%	12%	30%	$41,280	$41,280	$127,968	$554,528
2	Gill Lateral	Turnout	HDPE	1	NA	1	EA	$8,000	$8,000	15%	15%	30%	$1,200	$1,200	$3,120	$13,520
2	Lacy Lateral and Lacy Sublateral	Turnout	HDPE	1	NA	17	EA	$8,000	$136,000	15%	15%	30%	$20,400	$20,400	$53,040	$229,840
3	Allen Sublateral South	Pipe	PVC	6	1,899	19	LF	$3	$25,166.49	15%	15%	30%	$3,775	$3,775	$9,815	$42,531
3	Allen Lateral	Pipe	PVC	28	1,713	17	LF	$62	$123,866.41	10%	12%	30%	$12,387	$14,864	$45,335	$196,452
3	Allen Lateral	Pipe	PVC	30	1,743	17	LF	$71	$141,759.11	10%	12%	30%	$14,176	$17,011	$51,884	$224,830
3	Allen Lateral	Pipe	PVC	30	2,287	23	LF	$71	$186,002.92	10%	12%	30%	$18,600	$22,320	$68,077	$295,001
3	Allen Lateral	Pipe	PVC	32	5,096	51	LF	$81	$463,530.63	10%	12%	30%	$46,353	$55,624	$169,652	$735,160
3	Allen Lateral	Pipe	PVC	34	6,850	69	LF	$91	$693,200.47	10%	12%	30%	$69,320	$83,184	$253,711	$1,099,416
3	Allen Sublateral West	Pipe	PVC	6	2,040	20	LF	$3	$27,035.09	15%	15%	30%	$4,055	$4,055	$10,544	$45,689

Project Group	Name	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
3	McGinnis Ditch	Pipe	PVC	6	3,891	39	LF	$3	$51,565.46	15%	15%	30%	$7,735	$7,735	$20,111	$87,146
3	Allen Lateral	Turnout	HDPE	1	NA	34	EA	$8,000	$272,000	10%	12%	30%	$27,200	$32,640	$99,552	$431,392
3	Allen Sublateral West	Turnout	HDPE	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
3	Allen Sublateral South	Turnout	HDPE	1	NA	3	EA	$8,000	$24,000	15%	15%	30%	$3,600	$3,600	$9,360	$40,560
3	McGinnis Ditch	Turnout	HDPE	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
4	West Branch Columbia Southern West	Pipe	PVC	6	2,421	24	LF	$3	$32,084.29	10%	12%	30%	$3,208	$3,850	$11,743	$50,886
4	West Branch Columbia Southern West	Pipe	PVC	8	2,632	26	LF	$6	$40,801.52	10%	12%	30%	$4,080	$4,896	$14,933	$64,711
4	West Branch Columbia Southern West	Pipe	PVC	10	3,803	38	LF	$9	$70,508.08	10%	12%	30%	$7,051	$8,461	$25,806	$111,826
4	West Branch Columbia Southern West	Pipe	PVC	24	7,555	76	LF	$46	$423,780.34	10%	12%	30%	$42,378	$50,854	$155,104	$672,116
4	West Branch Columbia Southern West	Pipe	PVC	26	8,803	88	LF	$54	$562,485.55	10%	12%	30%	$56,249	$67,498	$205,870	$892,102
4	West Branch Columbia Southern West	Pipe	PVC	28	765	8	LF	$62	$55,316.87	10%	12%	30%	$5,532	$6,638	$20,246	$87,733
4	Beasley Lateral	Pipe	PVC	6	2,931	29	LF	$3	$38,843.07	15%	12%	30%	$5,826	$4,661	$14,799	$64,130
4	Beasley Lateral	Pipe	PVC	6	2,050	21	LF	$3	$27,167.62	15%	12%	30%	$4,075	$3,260	$10,351	$44,854
4	Beasley Lateral	Pipe	PVC	8	1,690	17	LF	$6	$26,198.54	15%	12%	30%	$3,930	$3,144	$9,982	$43,254
4	Spaulding Lateral	Pipe	PVC	6	4,899	49	LF	$3	$64,923.98	15%	12%	30%	$9,739	$7,791	$24,736	$107,189
4	Spaulding Lateral	Pipe	PVC	6	841	8	LF	$3	$11,145.35	15%	12%	30%	$1,672	$1,337	$4,246	$18,401
4	Spaulding Lateral	Pipe	PVC	10	3	0	LF	$9	$55.62	15%	12%	30%	$8	$7	$21	$92
4	Spaulding Lateral	Pipe	PVC	14	1,933	19	LF	$16	$50,635.40	15%	12%	30%	$7,595	$6,076	$19,292	$83,599
4	Spaulding Lateral	Pipe	PVC	16	2,347	23	LF	$21	$72,658.83	15%	12%	30%	$10,899	$8,719	$27,683	$119,960
4	Spaulding Lateral	Pipe	PVC	16	126	1	LF	$21	$3,900.73	15%	12%	30%	$585	$468	$1,486	$6,440
4	Spaulding Lateral	Pipe	PVC	18	3,029	30	LF	$26	$110,041.71	15%	12%	30%	$16,506	$13,205	$41,926	$181,679
4	Spaulding Lateral	Pipe	PVC	20	284	3	LF	$32	$12,015.72	15%	12%	30%	$1,802	$1,442	$4,578	$19,838
4	North Spaulding Lateral	Pipe	PVC	6	9,376	94	LF	$3	$124,255.40	15%	15%	30%	$18,638	$18,638	$48,460	$209,992
4	North Spaulding Lateral	Pipe	PVC	6	4,446	44	LF	$3	$58,920.60	15%	15%	30%	$8,838	$8,838	$22,979	$99,576
4	North Spaulding Lateral	Pipe	PVC	6	1,617	16	LF	$3	$21,429.29	15%	15%	30%	$3,214	$3,214	$8,357	$36,215
4	West Branch Columbia Southern West	Turnout	HDPE	1	NA	33	EA	$8,000	$264,000	10%	12%	30%	$26,400	$31,680	$96,624	$418,704
4	Beasley Lateral	Turnout	HDPE	1	NA	20	EA	$8,000	$160,000	15%	12%	30%	$24,000	$19,200	$60,960	$264,160
4	Spaulding Lateral	Turnout	HDPE	1	NA	34	EA	$8,000	$272,000	15%	12%	30%	$40,800	$32,640	$103,632	$449,072

Project Group	Name	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
4	North Spaulding Lateral	Turnout	HDPE	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
5	Couch Lateral	Pipe	PVC	6	355	4	LF	$3	$4,704.64	15%	15%	30%	$706	$706	$1,835	$7,951
5	Couch Lateral	Pipe	PVC	24	5,252	53	LF	$46	$294,598.85	15%	15%	30%	$44,190	$44,190	$114,894	$497,872
5	Couch Lateral	Pipe	PVC	26	3,814	38	LF	$54	$243,703.27	15%	15%	30%	$36,555	$36,555	$95,044	$411,859
5	West Couch Lateral	Pipe	PVC	6	3,503	35	LF	$3	$46,423.49	12%	12%	30%	$5,571	$5,571	$17,270	$74,835
5	West Couch Lateral	Pipe	PVC	6	1,771	18	LF	$3	$23,470.17	12%	12%	30%	$2,816	$2,816	$8,731	$37,834
5	West Couch Lateral	Pipe	PVC	6	611	6	LF	$3	$8,097.28	12%	12%	30%	$972	$972	$3,012	$13,053
5	West Couch Lateral	Pipe	PVC	8	349	3	LF	$6	$5,410.23	12%	12%	30%	$649	$649	$2,013	$8,721
5	West Couch Lateral	Pipe	PVC	8	4	0	LF	$6	$62.01	12%	12%	30%	$7	$7	$23	$100
5	West Couch Lateral	Pipe	PVC	10	11	0	LF	$9	$203.94	12%	12%	30%	$24	$24	$76	$329
5	West Couch Lateral	Pipe	PVC	10	3,165	32	LF	$9	$58,679.48	12%	12%	30%	$7,042	$7,042	$21,829	$94,591
5	West Couch Lateral	Pipe	PVC	10	2,754	28	LF	$9	$51,059.49	12%	12%	30%	$6,127	$6,127	$18,994	$82,308
5	West Couch Lateral	Pipe	PVC	16	3,235	32	LF	$21	$100,149.69	12%	12%	30%	$12,018	$12,018	$37,256	$161,441
5	West Couch Lateral	Pipe	PVC	18	8,943	89	LF	$26	$324,893.69	12%	12%	30%	$38,987	$38,987	$120,860	$523,729
5	West Couch Lateral	Pipe	PVC	20	19	0	LF	$32	$803.87	12%	12%	30%	$96	$96	$299	$1,296
5	West Couch Sublateral East	Pipe	PVC	6	1,104	11	LF	$3	$14,630.76	15%	15%	30%	$2,195	$2,195	$5,706	$24,726
5	West Couch Sublateral East	Pipe	PVC	8	890	9	LF	$6	$13,796.87	15%	15%	30%	$2,070	$2,070	$5,381	$23,317
5	West Couch Sublateral East	Pipe	PVC	8	409	4	LF	$6	$6,340.36	15%	15%	30%	$951	$951	$2,473	$10,715
5	West Couch Sublateral East	Pipe	PVC	10	2,465	25	LF	$9	$45,701.40	15%	15%	30%	$6,855	$6,855	$17,824	$77,235
5	Chambers (Lafores) Ditch	Pipe	PVC	6	2,066	21	LF	$3	$27,379.66	15%	15%	30%	$4,107	$4,107	$10,678	$46,272
5	East Couch Lateral	Pipe	PVC	6	6,600	66	LF	$3	$87,466.47	15%	12%	30%	$13,120	$10,496	$33,325	$144,407
5	East Couch Lateral	Pipe	PVC	8	1,052	11	LF	$6	$16,308.20	15%	12%	30%	$2,446	$1,957	$6,213	$26,925
5	East Couch Lateral	Pipe	PVC	10	590	6	LF	$9	$10,938.67	15%	12%	30%	$1,641	$1,313	$4,168	$18,060
5	East Couch Lateral	Pipe	PVC	14	1,806	18	LF	$16	$47,308.61	15%	12%	30%	$7,096	$5,677	$18,025	$78,107
5	East Couch Lateral	Pipe	PVC	16	1,291	13	LF	$21	$39,967.00	15%	12%	30%	$5,995	$4,796	$15,227	$65,986
5	Gainsforth Ditch	Pipe	PVC	6	3,891	39	LF	$3	$51,565.46	15%	15%	30%	$7,735	$7,735	$20,111	$87,146
5	Couch Lateral	Turnout	HDPE	1	NA	12	EA	$8,000	$96,000	15%	15%	30%	$14,400	$14,400	$37,440	$162,240
5	West Couch Lateral	Turnout	HDPE	1	NA	29	EA	$8,000	$232,000	12%	12%	30%	$27,840	$27,840	$86,304	$373,984
5	West Couch Sublateral East	Turnout	HDPE	1	NA	10	EA	$8,000	$80,000	15%	15%	30%	$12,000	$12,000	$31,200	$135,200
5	Chambers (Lafores) Ditch	Turnout	HDPE	1	NA	8	EA	$8,000	$64,000	15%	15%	30%	$9,600	$9,600	$24,960	$108,160
5	East Couch Lateral	Turnout	HDPE	1	NA	26	EA	$8,000	$208,000	15%	12%	30%	$31,200	$24,960	$79,248	$343,408

Project Group	Name	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
5	Gainsforth Ditch	Turnout	HDPE	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
6	Columbia Southern Lateral TFC to Hillburner/PRV	Pipe	PVC	63	256	NA	LF	$196	$50,236	6%	12%	30%	$3,014	$6,028	$17,784	$77,063
6	Columbia Southern Lateral TFC to Hillburner/PRV	Pipe	PVC	48	197	2	LF	$180	$37,408.55	6%	12%	30%	$2,245	$4,489	$13,243	$57,385
6	Columbia Southern Lateral TFC to Hillburner/PRV	Pipe	PVC	48	6,098	61	LF	$180	$1,157,956.08	6%	12%	30%	$69,477	$138,955	$409,916	$1,776,305
6	Columbia Southern Lateral TFC to Hillburner/PRV	Pipe	HDPE	48	8,426	84	LF	$180	$1,600,022.61	6%	12%	30%	$96,001	$192,003	$566,408	$2,454,435
6	North Columbia Southern West Lateral and Sublateral	Pipe	PVC	6	1,864	19	LF	$3	$24,702.65	15%	15%	30%	$3,705	$3,705	$9,634	$41,747
6	North Columbia Southern West Lateral and Sublateral	Pipe	PVC	8	639	6	LF	$6	$9,905.84	15%	15%	30%	$1,486	$1,486	$3,863	$16,741
6	North Columbia Southern West Lateral and Sublateral	Pipe	PVC	12	512	5	LF	$12	$11,277.67	15%	15%	30%	$1,692	$1,692	$4,398	$19,059
6	North Columbia Southern West Lateral and Sublateral	Pipe	PVC	14	426	4	LF	$16	$11,159.17	15%	15%	30%	$1,674	$1,674	$4,352	$18,859
6	North Columbia Southern West Lateral and Sublateral	Pipe	PVC	16	2,579	26	LF	$21	$79,841.13	15%	15%	30%	$11,976	$11,976	$31,138	$134,932
6	Jewett Lateral	Pipe	PVC	10	59	1	LF	$9	$1,093.87	15%	15%	30%	$164	$164	$427	$1,849
6	Jewett Lateral	Pipe	PVC	10	2,644	26	LF	$9	$49,020.08	15%	15%	30%	$7,353	$7,353	$19,118	$82,844
6	Jewett Lateral	Pipe	PVC	14	3,056	31	LF	$16	$80,052.66	15%	15%	30%	$12,008	$12,008	$31,221	$135,289
6	Jewett Lateral	Pipe	PVC	16	2,018	20	LF	$21	$62,473.59	15%	15%	30%	$9,371	$9,371	$24,365	$105,580
6	Conarn East	Pipe	PVC	6	789	8	LF	$3	$10,456.22	15%	15%	30%	$1,568	$1,568	$4,078	$17,671
6	Putnam Lateral	Pipe	PVC	6	2,468	25	LF	$3	$32,707.16	15%	15%	30%	$4,906	$4,906	$12,756	$55,275
6	Putnam Lateral	Pipe	PVC	12	423	4	LF	$12	$9,317.29	15%	15%	30%	$1,398	$1,398	$3,634	$15,746
6	Putnam Lateral	Pipe	PVC	12	1,375	14	LF	$12	$30,286.71	15%	15%	30%	$4,543	$4,543	$11,812	$51,185
6	Putnam Lateral	Pipe	PVC	14	1,239	12	LF	$16	$32,455.90	15%	15%	30%	$4,868	$4,868	$12,658	$54,850
6	West Branch Columbia Southern East	Pipe	PVC	6	4,103	41	LF	$3	$54,374.99	15%	15%	30%	$8,156	$8,156	$21,206	$91,894
6	West Branch Columbia Southern East	Pipe	PVC	8	444	4	LF	$6	$6,882.93	15%	15%	30%	$1,032	$1,032	$2,684	$11,632
6	West Branch Columbia Southern East	Pipe	PVC	12	2,015	20	LF	$12	$44,383.79	15%	15%	30%	$6,658	$6,658	$17,310	$75,009
6	Conarn Lateral	Pipe	PVC	6	2,071	21	LF	$3	$27,445.92	15%	15%	30%	$4,117	$4,117	$10,704	$46,384
6	Phiffer Lateral	Pipe	PVC	6	1,684	17	LF	$3	$22,317.20	15%	15%	30%	$3,348	$3,348	$8,704	$37,716
6	Phiffer Lateral	Pipe	PVC	8	2,089	21	LF	$6	$32,383.88	15%	15%	30%	$4,858	$4,858	$12,630	$54,729
6	Phiffer Lateral	Pipe	PVC	12	1,238	12	LF	$12	$27,269.05	15%	15%	30%	$4,090	$4,090	$10,635	$46,085

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Project Group	Name	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
6	Hooker Creek Lateral	Pipe	PVC	10	1,948	19	LF	$9	$36,116.15	15%	15%	30%	$5,417	$5,417	$14,085	$61,036
6	Hooker Creek Lateral	Pipe	PVC	12	970	10	LF	$12	$21,365.90	15%	15%	30%	$3,205	$3,205	$8,333	$36,108
6	Hammond Lateral	Pipe	PVC	6	2,515	25	LF	$3	$33,330.03	15%	15%	30%	$5,000	$5,000	$12,999	$56,328
6	Hammond Lateral	Pipe	PVC	6	344	3	LF	$3	$4,558.86	15%	15%	30%	$684	$684	$1,778	$7,704
6	Hammond Lateral	Pipe	PVC	8	1,499	15	LF	$6	$23,237.64	15%	15%	30%	$3,486	$3,486	$9,063	$39,272
6	Hammond Lateral	Pipe	PVC	10	1,417	14	LF	$9	$26,271.35	15%	15%	30%	$3,941	$3,941	$10,246	$44,399
6	Hammond Lateral	Pipe	PVC	12	284	3	LF	$12	$6,255.58	15%	15%	30%	$938	$938	$2,440	$10,572
6	Hammond Lateral	Pipe	PVC	14	1,473	15	LF	$16	$38,585.59	15%	15%	30%	$5,788	$5,788	$15,048	$65,210
6	North Hammond Lateral	Pipe	PVC	6	278	3	LF	$3	$3,684.19	15%	15%	30%	$553	$553	$1,437	$6,226
6	North Hammond Lateral	Pipe	PVC	8	232	2	LF	$6	$3,596.49	15%	15%	30%	$539	$539	$1,403	$6,078
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	PVC	6	3,385	34	LF	$3	$44,859.70	15%	15%	30%	$6,729	$6,729	$17,495	$75,813
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	PVC	6	1,160	12	LF	$3	$15,372.90	15%	15%	30%	$2,306	$2,306	$5,995	$25,980
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	PVC	8	331	3	LF	$6	$5,131.19	15%	15%	30%	$770	$770	$2,001	$8,672
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	PVC	28	3,729	37	LF	$62	$269,642.65	15%	15%	30%	$40,446	$40,446	$105,161	$455,696
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	PVC	30	941	9	LF	$71	$76,532.03	15%	15%	30%	$11,480	$11,480	$29,847	$129,339
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	PVC	32	315	3	LF	$81	$28,652.31	15%	15%	30%	$4,298	$4,298	$11,174	$48,422
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	PVC	36	943	9	LF	$102	$105,656.43	15%	15%	30%	$15,848	$15,848	$41,206	$178,559
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	PVC	36	5,162	52	LF	$102	$578,365.33	15%	15%	30%	$86,755	$86,755	$225,562	$977,437
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	PVC	42	6,099	61	LF	$138	$904,053.20	15%	15%	30%	$135,608	$135,608	$352,581	$1,527,850
6	North Columbia Southern East Lateral and Sublateral	Pipe	PVC	6	909	9	LF	$3	$12,046.52	15%	15%	30%	$1,807	$1,807	$4,698	$20,359
6	North Columbia Southern East Lateral and Sublateral	Pipe	PVC	12	3,588	36	LF	$12	$79,031.79	15%	15%	30%	$11,855	$11,855	$30,822	$133,564
6	North Columbia Southern East Lateral and Sublateral	Pipe	PVC	14	3,407	34	LF	$16	$89,247.19	15%	15%	30%	$13,387	$13,387	$34,806	$150,828

Project Group	Name	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
6	North Columbia Southern East Lateral and Sublateral	Pipe	PVC	24	522	5	LF	$46	$29,280.39	15%	15%	30%	$4,392	$4,392	$11,419	$49,484
6	Columbia Southern Lateral TFC to Hillburner/PRV	Turnout	HDPE	1	NA	42	EA	$8,000	$336,000	6%	12%	30%	$20,160	$40,320	$118,944	$515,424
6	North Columbia Southern West Lateral and Sublateral	Turnout	HDPE	1	NA	23	EA	$8,000	$184,000	15%	15%	30%	$27,600	$27,600	$71,760	$310,960
6	Jewett Lateral	Turnout	HDPE	1	NA	21	EA	$8,000	$168,000	15%	15%	30%	$25,200	$25,200	$65,520	$283,920
6	Conarn East	Turnout	HDPE	1	NA	2	EA	$8,000	$16,000	15%	15%	30%	$2,400	$2,400	$6,240	$27,040
6	Putnam Lateral	Turnout	HDPE	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
6	West Branch Columbia Southern East	Turnout	HDPE	1	NA	27	EA	$8,000	$216,000	15%	15%	30%	$32,400	$32,400	$84,240	$365,040
6	Conarn Lateral	Turnout	HDPE	1	NA	10	EA	$8,000	$80,000	15%	15%	30%	$12,000	$12,000	$31,200	$135,200
6	Phiffer Lateral	Turnout	HDPE	1	NA	25	EA	$8,000	$200,000	15%	15%	30%	$30,000	$30,000	$78,000	$338,000
6	Hooker Creek Lateral	Turnout	HDPE	1	NA	12	EA	$8,000	$96,000	15%	15%	30%	$14,400	$14,400	$37,440	$162,240
6	Hammond Lateral	Turnout	HDPE	1	NA	18	EA	$8,000	$144,000	15%	15%	30%	$21,600	$21,600	$56,160	$243,360
6	North Hammond Lateral	Turnout	HDPE	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Turnout	HDPE	1	NA	20	EA	$8,000	$160,000	15%	15%	30%	$24,000	$24,000	$62,400	$270,400
6	North Columbia Southern East Lateral and Sublateral	Turnout	HDPE	1	NA	11	EA	$8,000	$88,000	15%	15%	30%	$13,200	$13,200	$34,320	$148,720
7	Hillburner Lateral	Pipe	PVC	6	2,697	27	LF	$3	$35,741.98	15%	15%	30%	$5,361	$5,361	$13,939	$60,404
7	Hillburner Lateral	Pipe	PVC	6	968	10	LF	$3	$12,828.42	15%	15%	30%	$1,924	$1,924	$5,003	$21,680
7	Hillburner Lateral	Pipe	PVC	8	3,680	37	LF	$6	$57,047.71	15%	15%	30%	$8,557	$8,557	$22,249	$96,411
7	Gerking Lateral	Pipe	PVC	6	2,629	26	LF	$3	$34,840.81	15%	15%	30%	$5,226	$5,226	$13,588	$58,881
7	Gerking Lateral	Pipe	PVC	8	2,626	26	LF	$6	$40,708.50	15%	15%	30%	$6,106	$6,106	$15,876	$68,797
7	Kickbush Lateral	Pipe	PVC	6	4,099	41	LF	$3	$54,321.98	15%	15%	30%	$8,148	$8,148	$21,186	$91,804
7	Kickbush Lateral	Pipe	PVC	8	1,191	12	LF	$6	$18,463.00	15%	15%	30%	$2,769	$2,769	$7,201	$31,202
7	West Branch Columbia Southern South	Pipe	PVC	6	2,479	25	LF	$3	$32,852.94	15%	15%	30%	$4,928	$4,928	$12,813	$55,521
7	West Branch Columbia Southern South	Pipe	PVC	8	4,167	42	LF	$6	$64,597.23	15%	15%	30%	$9,690	$9,690	$25,193	$109,169
7	West Branch Columbia Southern South	Pipe	PVC	10	777	8	LF	$9	$14,405.67	15%	15%	30%	$2,161	$2,161	$5,618	$24,346
7	West Branch Columbia Southern South	Pipe	PVC	12	187	2	LF	$12	$4,118.99	15%	15%	30%	$618	$618	$1,606	$6,961
7	Flannery Ditch	Pipe	PVC	6	2,178	22	LF	$3	$28,863.94	15%	15%	30%	$4,330	$4,330	$11,257	$48,780

Project Group	Name	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
7	Tellin Lateral	Pipe	PVC	6	5,152	52	LF	$3	$68,276.86	15%	15%	30%	$10,242	$10,242	$26,628	$115,388
7	Tellin Lateral	Pipe	PVC	8	2,820	28	LF	$6	$43,715.91	15%	15%	30%	$6,557	$6,557	$17,049	$73,880
7	Hillburner Lateral	Turnout	HDPE	1	NA	24	EA	$8,000	$192,000	15%	15%	30%	$28,800	$28,800	$74,880	$324,480
7	Gerking Lateral	Turnout	HDPE	1	NA	13	EA	$8,000	$104,000	15%	15%	30%	$15,600	$15,600	$40,560	$175,760
7	Kickbush Lateral	Turnout	HDPE	1	NA	8	EA	$8,000	$64,000	15%	15%	30%	$9,600	$9,600	$24,960	$108,160
7	West Branch Columbia Southern South	Turnout	HDPE	1	NA	21	EA	$8,000	$168,000	15%	15%	30%	$25,200	$25,200	$65,520	$283,920
7	Flannery Ditch	Turnout	HDPE	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
7	Tellin Lateral	Turnout	HDPE	1	NA	9	EA	$8,000	$72,000	15%	15%	30%	$10,800	$10,800	$28,080	$121,680
															Capital Costs	**$41,864,887**

Steel Piping Alternative

Project Group	Name	Feature	Diameter (in)	Length (ft)	Turnout	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
1	Tumalo Feed Canal Phase V	Turnout	1	NA	3	EA	$8,000	$24,000	6%	10%	30%	$1,440	$2,400	$8,352	$36,192
1	Tumalo Feed Canal Phase V	Pipe	84	5,500	55	LF	$361	$2,040,817.86	6%	10%	30%	$122,449	$204,082	$710,205	$3,077,553
1	Tumalo Feed Canal Final Phase(s) After Phase V	Turnout	1	NA	4	EA	$8,000	$32,000	4%	12%	30%	$1,280	$3,840	$11,136	$48,256
1	Tumalo Feed Canal Final Phase(s) After Phase V	Pipe	84	7,946	79.46	LF	$361	$2,948,425.22	4%	12%	30%	$117,937	$353,811	$1,026,052	$4,446,225
2	Tumalo Feed Canal Reservoir Feed and Sublateral	Turnout	1	NA	16	EA	$8,000	$128,000	10%	12%	30%	$12,800	$15,360	$46,848	$203,008
2	Tumalo Feed Canal Reservoir Feed and Sublateral	Pipe	6	4,983	49.83	LF	$40	$247,300.91	10%	12%	30%	$24,730	$29,676	$90,512	$392,219
2	Tumalo Feed Canal Reservoir Feed and Sublateral	Pipe	48	177	1.77	LF	$329	$60,019.34	10%	12%	30%	$6,002	$7,202	$21,967	$95,191
2	Tumalo Feed Canal Reservoir Feed and Sublateral	Pipe	54	4,906	49.06	LF	$370	$1,866,459.49	10%	12%	30%	$186,646	$223,975	$683,124	$2,960,205
2	Tumalo Feed Canal Reservoir Feed and Sublateral	Pipe	63	718	7.18	LF	$432	$317,694.99	10%	12%	30%	$31,769	$38,123	$116,276	$503,864
2	Steele Lateral	Turnout	1	NA	16	EA	$8,000	$128,000	15%	15%	30%	$19,200	$19,200	$49,920	$216,320
2	Steele Lateral	Pipe	6	1,813	18.13	LF	$40	$89,977.23	15%	15%	30%	$13,497	$13,497	$35,091	$152,062
2	Steele Lateral	Pipe	8	2,916	29.16	LF	$53	$184,911.99	15%	15%	30%	$27,737	$27,737	$72,116	$312,501
2	Steele Lateral	Pipe	10	281	2.81	LF	$67	$21,692.32	15%	15%	30%	$3,254	$3,254	$8,460	$36,660
2	Rock Springs Lateral	Turnout	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
2	Rock Springs Lateral	Pipe	6	1,516	15.16	LF	$40	$75,237.44	15%	15%	30%	$11,286	$11,286	$29,343	$127,151
2	Highline Lateral	Turnout	1	NA	25	EA	$8,000	$200,000	12%	12%	30%	$24,000	$24,000	$74,400	$322,400
2	Highline Lateral	Pipe	6	1,819	18.19	LF	$40	$90,275.01	12%	12%	30%	$10,833	$10,833	$33,582	$145,523
2	Highline Lateral	Pipe	10	71	0.71	LF	$67	$5,480.98	12%	12%	30%	$658	$658	$2,039	$8,835
2	Highline Lateral	Pipe	12	7,884	78.84	LF	$81	$717,292.91	12%	12%	30%	$86,075	$86,075	$266,833	$1,156,276
2	Highline Lateral	Pipe	12	3,235	32.35	LF	$81	$294,323.01	12%	12%	30%	$35,319	$35,319	$109,488	$474,449
2	Highline Lateral	Pipe	16	4,727	47.27	LF	$109	$560,380.09	12%	12%	30%	$67,246	$67,246	$208,461	$903,333
2	Highline Lateral	Pipe	18	4,381	43.81	LF	$122	$579,749.79	12%	12%	30%	$69,570	$69,570	$215,667	$934,557
2	Highline Lateral	Pipe	20	2,131	21.31	LF	$136	$311,374.74	12%	12%	30%	$37,365	$37,365	$115,831	$501,936
2	Highline Lateral	Pipe	24	1,851	18.51	LF	$164	$321,490.32	12%	12%	30%	$38,579	$38,579	$119,594	$518,242

Project Group	Name	Feature	Diameter (in)	Length (ft)	Turnout	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
2	2 Rivers (Box S) Lateral	Turnout	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
2	2 Rivers (Box S) Lateral	Pipe	6	2,426	24.26	LF	$40	$120,399.76	15%	15%	30%	$18,060	$18,060	$46,956	$203,476
2	2 Rivers (Box S) Lateral	Pipe	8	828	8.28	LF	$53	$52,505.87	15%	15%	30%	$7,876	$7,876	$20,477	$88,735
2	2 Rivers (Box S) Lateral	Pipe	12	1,843	18.43	LF	$81	$167,677.68	15%	15%	30%	$25,152	$25,152	$65,394	$283,375
2	Kerns Lateral	Turnout	1	NA	2	EA	$8,000	$16,000	15%	15%	30%	$2,400	$2,400	$6,240	$27,040
2	Kerns Lateral	Pipe	6	2,864	28.64	LF	$40	$142,137.23	15%	15%	30%	$21,321	$21,321	$55,434	$240,212
2	Parkhurst Lateral	Turnout	1	NA	43	EA	$8,000	$344,000	12%	12%	30%	$41,280	$41,280	$127,968	$554,528
2	Parkhurst Lateral	Pipe	6	2,519	25.19	LF	$40	$125,015.25	12%	12%	30%	$15,002	$15,002	$46,506	$201,525
2	Parkhurst Lateral	Pipe	6	474	4.74	LF	$40	$23,524.11	12%	12%	30%	$2,823	$2,823	$8,751	$37,921
2	Parkhurst Lateral	Pipe	8	982	9.82	LF	$53	$62,271.46	12%	12%	30%	$7,473	$7,473	$23,165	$100,382
2	Parkhurst Lateral	Pipe	10	5	0.05	LF	$67	$385.98	12%	12%	30%	$46	$46	$144	$622
2	Parkhurst Lateral	Pipe	12	3,666	36.66	LF	$81	$333,535.75	12%	12%	30%	$40,024	$40,024	$124,075	$537,660
2	Parkhurst Lateral	Pipe	14	1,380	13.8	LF	$95	$144,575.44	12%	12%	30%	$17,349	$17,349	$53,782	$233,056
2	Parkhurst Lateral	Pipe	16	8,000	80	LF	$109	$948,390.24	12%	12%	30%	$113,807	$113,807	$352,801	$1,528,805
2	Parkhurst Lateral	Pipe	18	283	2.83	LF	$122	$37,450.17	12%	12%	30%	$4,494	$4,494	$13,931	$60,370
2	Gill Lateral	Turnout	1	NA	1	EA	$8,000	$8,000	15%	15%	30%	$1,200	$1,200	$3,120	$13,520
2	Gill Lateral	Pipe	6	2,635	26.35	LF	$40	$130,772.20	15%	15%	30%	$19,616	$19,616	$51,001	$221,005
2	Lacy Lateral and Lacy Sublateral	Turnout	1	NA	17	EA	$8,000	$136,000	15%	15%	30%	$20,400	$20,400	$53,040	$229,840
2	Lacy Lateral and Lacy Sublateral	Pipe	6	952	9.52	LF	$40	$47,246.73	15%	15%	30%	$7,087	$7,087	$18,426	$79,847
2	Lacy Lateral and Lacy Sublateral	Pipe	6	5,611	56.11	LF	$40	$278,467.87	15%	15%	30%	$41,770	$41,770	$108,602	$470,611
2	Lacy Lateral and Lacy Sublateral	Pipe	8	1,327	13.27	LF	$53	$84,148.91	15%	15%	30%	$12,622	$12,622	$32,818	$142,212
2	Lacy Lateral and Lacy Sublateral	Pipe	10	1,447	14.47	LF	$67	$111,703.86	15%	15%	30%	$16,756	$16,756	$43,565	$188,780
2	Lacy Lateral and Lacy Sublateral	Pipe	12	3,809	38.09	LF	$81	$346,546.01	15%	15%	30%	$51,982	$51,982	$135,153	$585,663
3	Allen Lateral	Turnout	1	NA	34	EA	$8,000	$272,000	10%	12%	30%	$27,200	$32,640	$99,552	$431,392
3	Allen Lateral	Pipe	28	1,713	17.13	LF	$191	$344,745.73	10%	12%	30%	$34,475	$41,369	$126,177	$546,767
3	Allen Lateral	Pipe	30	1,743	17.43	LF	$205	$374,808.77	10%	12%	30%	$37,481	$44,977	$137,180	$594,447
3	Allen Lateral	Pipe	30	2,287	22.87	LF	$205	$491,788.67	10%	12%	30%	$49,179	$59,015	$179,995	$779,977
3	Allen Lateral	Pipe	32	5,096	50.96	LF	$219	$1,166,069.56	10%	12%	30%	$116,607	$139,928	$426,781	$1,849,386
3	Allen Lateral	Pipe	34	6,850	68.5	LF	$233	$1,661,841.03	10%	12%	30%	$166,184	$199,421	$608,234	$2,635,680

Project Group	Name	Feature	Diameter (in)	Length (ft)	Turnout	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
3	Allen Sublateral South	Pipe	6	1,899	18.99	LF	$40	$94,245.32	15%	15%	30%	$14,137	$14,137	$36,756	$159,275
3	Allen Sublateral West	Turnout	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
3	Allen Sublateral West	Pipe	6	2,040	20.4	LF	$40	$101,243.00	15%	15%	30%	$15,186	$15,186	$39,485	$171,101
3	Allen Sublateral South	Turnout	1	NA	3	EA	$8,000	$24,000	15%	15%	30%	$3,600	$3,600	$9,360	$40,560
3	McGinnis Ditch	Turnout	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
3	McGinnis Ditch	Pipe	6	3,891	38.91	LF	$40	$193,106.13	15%	15%	30%	$28,966	$28,966	$75,311	$326,349
4	West Branch Columbia Southern West	Turnout	1	NA	33	EA	$8,000	$264,000	10%	12%	30%	$26,400	$31,680	$96,624	$418,704
4	West Branch Columbia Southern West	Pipe	6	2,421	24.21	LF	$40	$120,151.61	10%	12%	30%	$12,015	$14,418	$43,975	$190,560
4	West Branch Columbia Southern West	Pipe	8	2,632	26.32	LF	$53	$166,902.73	10%	12%	30%	$16,690	$20,028	$61,086	$264,708
4	West Branch Columbia Southern West	Pipe	10	3,803	38.03	LF	$67	$293,579.67	10%	12%	30%	$29,358	$35,230	$107,450	$465,617
4	West Branch Columbia Southern West	Pipe	24	7,555	75.55	LF	$164	$1,312,187.67	10%	12%	30%	$131,219	$157,463	$480,261	$2,081,130
4	West Branch Columbia Southern West	Pipe	26	8,803	88.03	LF	$177	$1,650,286.45	10%	12%	30%	$165,029	$198,034	$604,005	$2,617,354
4	West Branch Columbia Southern West	Pipe	28	765	7.65	LF	$191	$153,958.25	10%	12%	30%	$15,396	$18,475	$56,349	$244,178
4	Beasley Lateral	Turnout	1	NA	20	EA	$8,000	$160,000	15%	12%	30%	$24,000	$19,200	$60,960	$264,160
4	Beasley Lateral	Pipe	6	2,931	29.31	LF	$40	$145,462.36	15%	12%	30%	$21,819	$17,455	$55,421	$240,158
4	Beasley Lateral	Pipe	6	2,050	20.5	LF	$40	$101,739.29	15%	12%	30%	$15,261	$12,209	$38,763	$167,972
4	Beasley Lateral	Pipe	8	1,690	16.9	LF	$53	$107,167.79	15%	12%	30%	$16,075	$12,860	$40,831	$176,934
4	Spaulding Lateral	Turnout	1	NA	34	EA	$8,000	$272,000	15%	12%	30%	$40,800	$32,640	$103,632	$449,072
4	Spaulding Lateral	Pipe	6	4,899	48.99	LF	$40	$243,132.08	15%	12%	30%	$36,470	$29,176	$92,633	$401,411
4	Spaulding Lateral	Pipe	6	841	8.41	LF	$40	$41,737.92	15%	12%	30%	$6,261	$5,009	$15,902	$68,909
4	Spaulding Lateral	Pipe	10	3	0.03	LF	$67	$231.59	15%	12%	30%	$35	$28	$88	$382
4	Spaulding Lateral	Pipe	14	1,933	19.33	LF	$95	$202,510.37	15%	12%	30%	$30,377	$24,301	$77,156	$334,345
4	Spaulding Lateral	Pipe	16	2,347	23.47	LF	$109	$278,233.99	15%	12%	30%	$41,735	$33,388	$106,007	$459,364
4	Spaulding Lateral	Pipe	16	126	1.26	LF	$109	$14,937.15	15%	12%	30%	$2,241	$1,792	$5,691	$24,661
4	Spaulding Lateral	Pipe	18	3,029	30.29	LF	$122	$400,835.91	15%	12%	30%	$60,125	$48,100	$152,718	$661,780
4	Spaulding Lateral	Pipe	20	284	2.84	LF	$136	$41,497.15	15%	12%	30%	$6,225	$4,980	$15,810	$68,512
4	North Spaulding Lateral	Turnout	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
4	North Spaulding Lateral	Pipe	6	9,376	93.76	LF	$40	$465,320.75	15%	15%	30%	$69,798	$69,798	$181,475	$786,392
4	North Spaulding Lateral	Pipe	6	4,446	44.46	LF	$40	$220,650.18	15%	15%	30%	$33,098	$33,098	$86,054	$372,899

Project Group	Name	Feature	Diameter (in)	Length (ft)	Turnout	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
4	North Spaulding Lateral	Pipe	6	1,617	16.17	LF	$40	$80,249.96	15%	15%	30%	$12,037	$12,037	$31,297	$135,622
5	Couch Lateral	Turnout	1	NA	12	EA	$8,000	$96,000	15%	15%	30%	$14,400	$14,400	$37,440	$162,240
5	Couch Lateral	Pipe	6	355	3.55	LF	$40	$17,618.27	15%	15%	30%	$2,643	$2,643	$6,871	$29,775
5	Couch Lateral	Pipe	24	5,252	52.52	LF	$164	$912,191.88	15%	15%	30%	$136,829	$136,829	$355,755	$1,541,604
5	Couch Lateral	Pipe	26	3,814	38.14	LF	$177	$715,005.40	15%	15%	30%	$107,251	$107,251	$278,852	$1,208,359
5	West Couch Lateral	Turnout	1	NA	29	EA	$8,000	$232,000	12%	12%	30%	$27,840	$27,840	$86,304	$373,984
5	West Couch Lateral	Pipe	6	3,503	35.03	LF	$40	$173,850.11	12%	12%	30%	$20,862	$20,862	$64,672	$280,246
5	West Couch Lateral	Pipe	6	1,771	17.71	LF	$40	$87,892.82	12%	12%	30%	$10,547	$10,547	$32,696	$141,683
5	West Couch Lateral	Pipe	6	611	6.11	LF	$40	$30,323.27	12%	12%	30%	$3,639	$3,639	$11,280	$48,881
5	West Couch Lateral	Pipe	8	349	3.49	LF	$53	$22,131.10	12%	12%	30%	$2,656	$2,656	$8,233	$35,675
5	West Couch Lateral	Pipe	8	4	0.04	LF	$53	$253.65	12%	12%	30%	$30	$30	$94	$409
5	West Couch Lateral	Pipe	10	11	0.11	LF	$67	$849.17	12%	12%	30%	$102	$102	$316	$1,369
5	West Couch Lateral	Pipe	10	3,165	31.65	LF	$67	$244,328.07	12%	12%	30%	$29,319	$29,319	$90,890	$393,857
5	West Couch Lateral	Pipe	10	2,754	27.54	LF	$67	$212,600.16	12%	12%	30%	$25,512	$25,512	$79,087	$342,711
5	West Couch Lateral	Pipe	16	3,235	32.35	LF	$109	$383,505.30	12%	12%	30%	$46,021	$46,021	$142,664	$618,211
5	West Couch Lateral	Pipe	18	8,943	89.43	LF	$122	$1,183,451.81	12%	12%	30%	$142,014	$142,014	$440,244	$1,907,724
5	West Couch Lateral	Pipe	20	19	0.19	LF	$136	$2,776.22	12%	12%	30%	$333	$333	$1,033	$4,475
5	West Couch Sublateral East	Turnout	1	NA	10	EA	$8,000	$80,000	15%	15%	30%	$12,000	$12,000	$31,200	$135,200
5	West Couch Sublateral East	Pipe	6	1,104	11.04	LF	$40	$54,790.33	15%	15%	30%	$8,219	$8,219	$21,368	$92,596
5	West Couch Sublateral East	Pipe	8	890	8.9	LF	$53	$56,437.47	15%	15%	30%	$8,466	$8,466	$22,011	$95,379
5	West Couch Sublateral East	Pipe	8	409	4.09	LF	$53	$25,935.87	15%	15%	30%	$3,890	$3,890	$10,115	$43,832
5	West Couch Sublateral East	Pipe	10	2,465	24.65	LF	$67	$190,290.27	15%	15%	30%	$28,544	$28,544	$74,213	$321,591
5	Chambers (Lafores) Ditch	Turnout	1	NA	8	EA	$8,000	$64,000	15%	15%	30%	$9,600	$9,600	$24,960	$108,160
5	Chambers (Lafores) Ditch	Pipe	6	2,066	20.66	LF	$40	$102,533.35	15%	15%	30%	$15,380	$15,380	$39,988	$173,281
5	East Couch Lateral	Turnout	1	NA	26	EA	$8,000	$208,000	15%	12%	30%	$31,200	$24,960	$79,248	$343,408
5	East Couch Lateral	Pipe	6	6,600	66	LF	$40	$327,550.87	15%	12%	30%	$49,133	$39,306	$124,797	$540,786
5	East Couch Lateral	Pipe	8	1,052	10.52	LF	$53	$66,710.36	15%	12%	30%	$10,007	$8,005	$25,417	$110,139
5	East Couch Lateral	Pipe	10	590	5.9	LF	$67	$45,546.15	15%	12%	30%	$6,832	$5,466	$17,353	$75,197
5	East Couch Lateral	Pipe	14	1,806	18.06	LF	$95	$189,205.24	15%	12%	30%	$28,381	$22,705	$72,087	$312,378

Project Group	Name	Feature	Diameter (in)	Length (ft)	Turnout	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
5	East Couch Lateral	Pipe	16	1,291	12.91	LF	$109	$153,046.48	15%	12%	30%	$22,957	$18,366	$58,311	$252,680
5	Gainsforth Ditch	Turnout	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
5	Gainsforth Ditch	Pipe	6	3,891	38.91	LF	$40	$193,106.13	15%	15%	30%	$28,966	$28,966	$75,311	$326,349
6	Columbia Southern Lateral TFC to Hillburner/PRV	Turnout	1	NA	42	EA	$8,000	$336,000	6%	12%	30%	$20,160	$40,320	$118,944	$515,424
6	Columbia Southern Lateral TFC to Hillburner/PRV	Pipe	48	197	1.97	LF	$329	$66,801.19	6%	12%	30%	$4,008	$8,016	$23,648	$102,473
6	Columbia Southern Lateral TFC to Hillburner/PRV	Pipe	48	6,098	60.98	LF	$329	$2,067,785.06	6%	12%	30%	$124,067	$248,134	$731,996	$3,171,982
6	Columbia Southern Lateral TFC to Hillburner/PRV	Pipe	48	8,426	84.26	LF	$329	$2,857,192.01	6%	12%	30%	$171,432	$342,863	$1,011,446	$4,382,933
6	Columbia Southern Lateral TFC to Hillburner/PRV	Pipe	63	256	2.56	LF	$432	$113,272.86	6%	12%	30%	$6,796	$13,593	$40,099	$173,761
6	North Columbia Southern West Lateral and Sublateral	Turnout	1	NA	23	EA	$8,000	$184,000	15%	15%	30%	$27,600	$27,600	$71,760	$310,960
6	North Columbia Southern West Lateral and Sublateral	Pipe	6	1,864	18.64	LF	$40	$92,508.31	15%	15%	30%	$13,876	$13,876	$36,078	$156,339
6	North Columbia Southern West Lateral and Sublateral	Pipe	8	639	6.39	LF	$53	$40,520.84	15%	15%	30%	$6,078	$6,078	$15,803	$68,480
6	North Columbia Southern West Lateral and Sublateral	Pipe	12	512	5.12	LF	$81	$46,582.19	15%	15%	30%	$6,987	$6,987	$18,167	$78,724
6	North Columbia Southern West Lateral and Sublateral	Pipe	14	426	4.26	LF	$95	$44,629.81	15%	15%	30%	$6,694	$6,694	$17,406	$75,424
6	North Columbia Southern West Lateral and Sublateral	Pipe	16	2,579	25.79	LF	$109	$305,737.30	15%	15%	30%	$45,861	$45,861	$119,238	$516,696
6	Jewett Lateral	Turnout	1	NA	21	EA	$8,000	$168,000	15%	15%	30%	$25,200	$25,200	$65,520	$283,920
6	Jewett Lateral	Pipe	10	59	0.59	LF	$67	$4,554.61	15%	15%	30%	$683	$683	$1,776	$7,697
6	Jewett Lateral	Pipe	10	2,644	26.44	LF	$67	$204,108.51	15%	15%	30%	$30,616	$30,616	$79,602	$344,943
6	Jewett Lateral	Pipe	14	3,056	30.56	LF	$95	$320,161.25	15%	15%	30%	$48,024	$48,024	$124,863	$541,073
6	Jewett Lateral	Pipe	16	2,018	20.18	LF	$109	$239,231.44	15%	15%	30%	$35,885	$35,885	$93,300	$404,301
6	Conarn East	Turnout	1	NA	2	EA	$8,000	$16,000	15%	15%	30%	$2,400	$2,400	$6,240	$27,040
6	Conarn East	Pipe	6	789	7.89	LF	$40	$39,157.22	15%	15%	30%	$5,874	$5,874	$15,271	$66,176
6	Putnam Lateral	Turnout	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
6	Putnam Lateral	Pipe	6	2,468	24.68	LF	$40	$122,484.17	15%	15%	30%	$18,373	$18,373	$47,769	$206,998
6	Putnam Lateral	Pipe	12	423	4.23	LF	$81	$38,484.89	15%	15%	30%	$5,773	$5,773	$15,009	$65,039
6	Putnam Lateral	Pipe	12	1,375	13.75	LF	$81	$125,098.65	15%	15%	30%	$18,765	$18,765	$48,788	$211,417
6	Putnam Lateral	Pipe	14	1,239	12.39	LF	$95	$129,803.60	15%	15%	30%	$19,471	$19,471	$50,623	$219,368
6	West Branch Columbia	Turnout	1	NA	27	EA	$8,000	$216,000	15%	15%	30%	$32,400	$32,400	$84,240	$365,040

Project Group	Name	Feature	Diameter (in)	Length (ft)	Turnout	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
	Southern East														
6	West Branch Columbia Southern East	Pipe	6	4,103	41.03	LF	$40	$203,627.46	15%	15%	30%	$30,544	$30,544	$79,415	$344,130
6	West Branch Columbia Southern East	Pipe	8	444	4.44	LF	$53	$28,155.32	15%	15%	30%	$4,223	$4,223	$10,981	$47,582
6	West Branch Columbia Southern East	Pipe	12	2,015	20.15	LF	$81	$183,326.39	15%	15%	30%	$27,499	$27,499	$71,497	$309,822
6	Conarn Lateral	Turnout	1	NA	10	EA	$8,000	$80,000	15%	15%	30%	$12,000	$12,000	$31,200	$135,200
6	Conarn Lateral	Pipe	6	2,071	20.71	LF	$40	$102,781.49	15%	15%	30%	$15,417	$15,417	$40,085	$173,701
6	Phiffer Lateral	Turnout	1	NA	25	EA	$8,000	$200,000	15%	15%	30%	$30,000	$30,000	$78,000	$338,000
6	Phiffer Lateral	Pipe	12	1,238	12.38	LF	$81	$112,634.28	15%	15%	30%	$16,895	$16,895	$43,927	$190,352
6	Phiffer Lateral	Pipe	8	2,089	20.89	LF	$53	$132,469.53	15%	15%	30%	$19,870	$19,870	$51,663	$223,874
6	Phiffer Lateral	Pipe	6	1,684	16.84	LF	$40	$83,575.10	15%	15%	30%	$12,536	$12,536	$32,594	$141,242
6	Hooker Creek Lateral	Turnout	1	NA	12	EA	$8,000	$96,000	15%	15%	30%	$14,400	$14,400	$37,440	$162,240
6	Hooker Creek Lateral	Pipe	10	1,948	19.48	LF	$67	$150,379.49	15%	15%	30%	$22,557	$22,557	$58,648	$254,141
6	Hooker Creek Lateral	Pipe	12	970	9.7	LF	$81	$88,251.41	15%	15%	30%	$13,238	$13,238	$34,418	$149,145
6	Hammond Lateral	Turnout	1	NA	18	EA	$8,000	$144,000	15%	15%	30%	$21,600	$21,600	$56,160	$243,360
6	Hammond Lateral	Pipe	6	2,515	25.15	LF	$40	$124,816.73	15%	15%	30%	$18,723	$18,723	$48,679	$210,940
6	Hammond Lateral	Pipe	6	344	3.44	LF	$40	$17,072.35	15%	15%	30%	$2,561	$2,561	$6,658	$28,852
6	Hammond Lateral	Pipe	8	1,499	14.99	LF	$53	$95,055.93	15%	15%	30%	$14,258	$14,258	$37,072	$160,645
6	Hammond Lateral	Pipe	10	1,417	14.17	LF	$67	$109,387.96	15%	15%	30%	$16,408	$16,408	$42,661	$184,866
6	Hammond Lateral	Pipe	12	284	2.84	LF	$81	$25,838.56	15%	15%	30%	$3,876	$3,876	$10,077	$43,667
6	Hammond Lateral	Pipe	14	1,473	14.73	LF	$95	$154,318.56	15%	15%	30%	$23,148	$23,148	$60,184	$260,798
6	North Hammond Lateral	Turnout	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
6	North Hammond Lateral	Pipe	6	278	2.78	LF	$40	$13,796.84	15%	15%	30%	$2,070	$2,070	$5,381	$23,317
6	North Hammond Lateral	Pipe	8	232	2.32	LF	$53	$14,711.79	15%	15%	30%	$2,207	$2,207	$5,738	$24,863
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Turnout	1	NA	20	EA	$8,000	$160,000	15%	15%	30%	$24,000	$24,000	$62,400	$270,400
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	42	6,099	60.99	LF	$288	$1,815,918.81	15%	15%	30%	$272,388	$272,388	$708,208	$3,068,903
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	36	5,162	51.62	LF	$246	$1,323,477.45	15%	15%	30%	$198,522	$198,522	$516,156	$2,236,677
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	36	943	9.43	LF	$246	$241,774.36	15%	15%	30%	$36,266	$36,266	$94,292	$408,599

Project Group	Name	Feature	Diameter (in)	Length (ft)	Turnout	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	32	315	3.15	LF	$219	$72,078.48	15%	15%	30%	$10,812	$10,812	$28,111	$121,813
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	30	941	9.41	LF	$205	$202,349.43	15%	15%	30%	$30,352	$30,352	$78,916	$341,971
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	28	3,729	37.29	LF	$191	$750,470.99	15%	15%	30%	$112,571	$112,571	$292,684	$1,268,296
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	8	331	3.31	LF	$53	$20,989.67	15%	15%	30%	$3,148	$3,148	$8,186	$35,473
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	6	1,160	11.6	LF	$40	$57,569.55	15%	15%	30%	$8,635	$8,635	$22,452	$97,293
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	Pipe	6	3,385	33.85	LF	$40	$167,993.89	15%	15%	30%	$25,199	$25,199	$65,518	$283,910
6	North Columbia Southern East Lateral and Sublateral	Turnout	1	NA	11	EA	$8,000	$88,000	15%	15%	30%	$13,200	$13,200	$34,320	$148,720
6	North Columbia Southern East Lateral and Sublateral	Pipe	6	909	9.09	LF	$40	$45,112.69	15%	15%	30%	$6,767	$6,767	$17,594	$76,240
6	North Columbia Southern East Lateral and Sublateral	Pipe	12	3,588	35.88	LF	$81	$326,439.24	15%	15%	30%	$48,966	$48,966	$127,311	$551,682
6	North Columbia Southern East Lateral and Sublateral	Pipe	14	3,407	34.07	LF	$95	$356,933.70	15%	15%	30%	$53,540	$53,540	$139,204	$603,218
6	North Columbia Southern East Lateral and Sublateral	Pipe	24	522	5.22	LF	$164	$90,663.40	15%	15%	30%	$13,600	$13,600	$35,359	$153,221
7	Hillburner Lateral	Turnout	1	NA	24	EA	$8,000	$192,000	15%	15%	30%	$28,800	$28,800	$74,880	$324,480
7	Hillburner Lateral	Pipe	6	2,697	26.97	LF	$40	$133,849.20	15%	15%	30%	$20,077	$20,077	$52,201	$226,205
7	Hillburner Lateral	Pipe	6	968	9.68	LF	$40	$48,040.79	15%	15%	30%	$7,206	$7,206	$18,736	$81,189
7	Hillburner Lateral	Pipe	8	3,680	36.8	LF	$53	$233,359.44	15%	15%	30%	$35,004	$35,004	$91,010	$394,377
7	Gerking Lateral	Turnout	1	NA	13	EA	$8,000	$104,000	15%	15%	30%	$15,600	$15,600	$40,560	$175,760
7	Gerking Lateral	Pipe	6	2,629	26.29	LF	$40	$130,474.43	15%	15%	30%	$19,571	$19,571	$50,885	$220,502
7	Gerking Lateral	Pipe	8	2,626	26.26	LF	$53	$166,522.25	15%	15%	30%	$24,978	$24,978	$64,944	$281,423
7	Kickbush Lateral	Turnout	1	NA	8	EA	$8,000	$64,000	15%	15%	30%	$9,600	$9,600	$24,960	$108,160
7	Kickbush Lateral	Pipe	6	4,099	40.99	LF	$40	$203,428.94	15%	15%	30%	$30,514	$30,514	$79,337	$343,795
7	Kickbush Lateral	Pipe	8	1,191	11.91	LF	$53	$75,524.75	15%	15%	30%	$11,329	$11,329	$29,455	$127,637
7	West Branch Columbia Southern South	Turnout	1	NA	21	EA	$8,000	$168,000	15%	15%	30%	$25,200	$25,200	$65,520	$283,920
7	West Branch Columbia Southern South	Pipe	6	2,479	24.79	LF	$40	$123,030.09	15%	15%	30%	$18,455	$18,455	$47,982	$207,921

Project Group	Name	Feature	Diameter (in)	Length (ft)	Turnout	Unit	$/Unit	Total Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
7	West Branch Columbia Southern South	Pipe	8	4,167	41.67	LF	$53	$264,241.52	15%	15%	30%	$39,636	$39,636	$103,054	$446,568
7	West Branch Columbia Southern South	Pipe	10	777	7.77	LF	$67	$59,981.96	15%	15%	30%	$8,997	$8,997	$23,393	$101,370
7	West Branch Columbia Southern South	Pipe	12	187	1.87	LF	$81	$17,013.42	15%	15%	30%	$2,552	$2,552	$6,635	$28,753
7	Flannery Ditch	Turnout	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
7	Flannery Ditch	Pipe	6	2,178	21.78	LF	$40	$108,091.79	15%	15%	30%	$16,214	$16,214	$42,156	$182,675
7	Tellin Lateral	Turnout	1	NA	9	EA	$8,000	$72,000	15%	15%	30%	$10,800	$10,800	$28,080	$121,680
7	Tellin Lateral	Pipe	6	5,152	51.52	LF	$40	$255,688.20	15%	15%	30%	$38,353	$38,353	$99,718	$432,113
														Capital Costs	**$82,598,978**

Groundwater Pumping Alternative

Construction Cost for 1 patron Well				
Item	**Unit**	**Quantity**	**Unit Cost**	**Total cost**
Install Conductor Casing	ft	50	$175	$8,750
Drill Pilot Hole	ft	268	$45	$12,038
E-log	ea	1	$1,500	$1,500
Ream Pilot Hole	ft	268	$60	$16,050
Install Blank Casing	ft	235	$7	$1,589
Install Screen	ft	268	$2	$535
Install Gravel Pack	ft	268	$15	$4,013
Grout Seal	ft	268	$15	$4,013
Plumb & Alignment Test	ea	1	$1,500	$1,500
Surge/Airflit Development	ea	1	$1,500	$1,500
Pumping Development	ea	1	$1,500	$1,500
Step Test	ea	1	$1,500	$1,500
Constant Q Test	ea	1	$1,500	$1,500
Pump Cost	ea	1	$15,000	$15,000
Install Pump	ea	1	$1,500	$1,500
Electric & Wellhead Finish	ea	1	$1,500	$1,500
			Total Cost per Well	**$73,986**

Total Construction Cost for All Patrons			
	Project Group 6	**Project Group 7**	**Total**

Number of Patrons	60	59	119
Total Cost	**$4,439,179**	**$4,365,192**	**$8,804,371**

Ongoing Annual Groundwater Energy Costs	
	Total
Acreage Served	1,920
Patron Demand (gpm)	14,365
Number of Patrons	119
Flow Requirements (cfs)	32
Total af used per year	13,662
Patron Demand per patron (gpm)	121
af used per patron per year	115
kwh per year	39,530
Cost per patron year	$2,432
Total Operating Costs	**$289,393**

Canal Lining Alternative

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
1	Tumalo Feed Canal Final Phase(s) After Phase V	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	12%	30%	$600	$480	$1,524	$6,604
1	Tumalo Feed Canal Phase V	10,206.00	NA	28	4	6	35	NA	$427,725	$1,981,773	$10,206	$2,419,704	15%	15%	30%	$362,956	$362,956	$943,685	$4,089,300
1	Tumalo Feed Canal Phase V	NA	3	NA	NA	NA	NA	$3,000	NA	NA	NA	$3,000	15%	15%	30%	$450	$450	$1,170	$5,070
2	Box S Lateral (2 Rivers)	517.84	NA	18	2	4	24	NA	$16,885	$69,382	$518	$86,784	15%	15%	30%	$13,018	$13,018	$33,846	$146,666
2	Box S Lateral (2 Rivers)	1909.96	NA	15	3	3	21	NA	$56,640	$219,429	$1,910	$277,979	15%	15%	30%	$41,697	$41,697	$108,412	$469,785
2	Box S Lateral (2 Rivers)	828.55	NA	15	3	3	21	NA	$24,571	$95,190	$829	$120,590	15%	15%	30%	$18,088	$18,088	$47,030	$203,796
2	Box S Lateral (2 Rivers)	1843.20	NA	12	4	2	17	NA	$49,221	$176,561	$1,843	$227,625	15%	15%	30%	$34,144	$34,144	$88,774	$384,686
2	Box S Lateral (2 Rivers)	NA	5	NA	NA	NA	NA	$5,000	NA	NA	NA	$5,000	12%	12%	30%	$600	$600	$1,860	$8,060
2	Gill Lateral	2599.54	NA	5	1	1	10	NA	$52,907	$142,178	$2,600	$197,685	15%	15%	30%	$29,653	$29,653	$77,097	$334,087
2	Gill Lateral	264.07	NA	5	1	1	10	NA	$5,375	$14,443	$264	$20,082	15%	15%	30%	$3,012	$3,012	$7,832	$33,938
2	Gill Lateral	2634.98	NA	5	1	1	10	NA	$53,629	$144,116	$2,635	$200,380	15%	15%	30%	$30,057	$30,057	$78,148	$338,642
2	Gill Lateral	NA	1	NA	NA	NA	NA	$1,000	NA	NA	NA	$1,000	15%	15%	30%	$150	$150	$390	$1,690
2	Highline Lateral	116.80	NA	12	4	2	17	NA	$3,119	$11,188	$117	$14,424	15%	15%	30%	$2,164	$2,164	$5,625	$24,377
2	Highline Lateral	478.21	NA	12	4	2	17	NA	$12,770	$45,808	$478	$59,056	15%	15%	30%	$8,858	$8,858	$23,032	$99,805
2	Highline Lateral	268.69	NA	12	4	2	17	NA	$7,175	$25,737	$269	$33,181	15%	15%	30%	$4,977	$4,977	$12,941	$56,076
2	Highline Lateral	940.52	NA	12	4	2	17	NA	$25,116	$90,092	$941	$116,148	15%	15%	30%	$17,422	$17,422	$45,298	$196,291
2	Highline Lateral	174.08	NA	12	4	2	17	NA	$4,649	$16,675	$174	$21,497	15%	15%	30%	$3,225	$3,225	$8,384	$36,331
2	Highline Lateral	269.34	NA	12	4	2	17	NA	$7,192	$25,800	$269	$33,261	15%	15%	30%	$4,989	$4,989	$12,972	$56,212
2	Highline Lateral	1311.70	NA	12	4	2	17	NA	$35,028	$125,648	$1,312	$161,987	15%	15%	30%	$24,298	$24,298	$63,175	$273,758
2	Highline Lateral	35.89	NA	12	4	2	17	NA	$958	$3,438	$36	$4,433	15%	15%	30%	$665	$665	$1,729	$7,491
2	Highline Lateral	242.83	NA	12	4	2	17	NA	$6,485	$23,261	$243	$29,988	15%	15%	30%	$4,498	$4,498	$11,695	$50,680
2	Highline Lateral	1425.53	NA	12	4	2	17	NA	$38,067	$136,552	$1,426	$176,044	15%	15%	30%	$26,407	$26,407	$68,657	$297,515
2	Highline Lateral	958.71	NA	12	4	2	17	NA	$25,601	$91,835	$959	$118,395	15%	15%	30%	$17,759	$17,759	$46,174	$200,088
2	Highline Lateral	406.40	NA	12	4	2	17	NA	$10,853	$38,930	$406	$50,189	15%	15%	30%	$7,528	$7,528	$19,574	$84,819
2	Highline Lateral	325.41	NA	12	4	2	17	NA	$8,690	$31,171	$325	$40,186	15%	15%	30%	$6,028	$6,028	$15,673	$67,914
2	Highline Lateral	9.61	NA	12	4	2	17	NA	$257	$920	$10	$1,187	15%	15%	30%	$178	$178	$463	$2,005
2	Highline Lateral	3652.63	NA	12	4	2	17	NA	$97,540	$349,886	$3,653	$451,079	15%	15%	30%	$67,662	$67,662	$175,921	$762,323
2	Highline Lateral	739.49	NA	12	4	2	17	NA	$19,747	$70,836	$739	$91,322	15%	15%	30%	$13,698	$13,698	$35,616	$154,335
2	Highline Lateral	4872.65	NA	12	4	2	17	NA	$130,119	$466,752	$4,873	$601,744	15%	15%	30%	$90,262	$90,262	$234,680	$1,016,947
2	Highline Lateral	2111.93	NA	12	4	2	17	NA	$56,397	$202,302	$2,112	$260,811	15%	15%	30%	$39,122	$39,122	$101,716	$440,771
2	Highline Lateral	905.73	NA	12	4	2	17	NA	$24,187	$86,760	$906	$111,852	15%	15%	30%	$16,778	$16,778	$43,622	$189,031
2	Highline Lateral	217.03	NA	12	4	2	17	NA	$5,796	$20,789	$217	$26,802	15%	15%	30%	$4,020	$4,020	$10,453	$45,295
2	Highline Lateral	3011.53	NA	12	4	2	17	NA	$80,420	$288,475	$3,012	$371,906	15%	15%	30%	$55,786	$55,786	$145,044	$628,522
2	Highline Lateral	71.26	NA	12	4	2	17	NA	$1,903	$6,826	$71	$8,800	15%	15%	30%	$1,320	$1,320	$3,432	$14,872

[11] The total capital costs shown in this table are using 2016 dollars. An inflator value of 1.0164 was used in the NED to adjust costs to 2017 dollars.

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering , CM, Survey	CMGC	Contingency	Engineering , CM, Survey	CMGC	Contingency	Total Cost[11]
2	Highline Lateral	1819.30	NA	12	4	2	17	NA	$48,582	$174,271	$1,819	$224,673	15%	15%	30%	$33,701	$33,701	$87,622	$379,697
2	Highline Lateral	NA	22	NA	NA	NA	NA	$22,000	NA	NA	NA	$22,000	15%	15%	30%	$3,300	$3,300	$8,580	$37,180
2	Kerns Lateral	NA	2	NA	NA	NA	NA	$2,000	NA	NA	NA	$2,000	15%	15%	30%	$300	$300	$780	$3,380
2	Lacy Lateral and Lacy Sublateral	1808.93	NA	5	1	1	10	NA	$36,816	$98,937	$1,809	$137,562	15%	15%	30%	$20,634	$20,634	$53,649	$232,480
2	Lacy Lateral and Lacy Sublateral	1999.87	NA	5	1	1	10	NA	$40,703	$109,380	$2,000	$152,082	15%	15%	30%	$22,812	$22,812	$59,312	$257,019
2	Lacy Lateral and Lacy Sublateral	431.51	NA	5	1	1	10	NA	$8,782	$23,601	$432	$32,815	15%	15%	30%	$4,922	$4,922	$12,798	$55,457
2	Lacy Lateral and Lacy Sublateral	181.47	NA	5	1	1	10	NA	$3,693	$9,925	$181	$13,800	15%	15%	30%	$2,070	$2,070	$5,382	$23,322
2	Lacy Lateral and Lacy Sublateral	834.32	NA	5	1	1	10	NA	$16,981	$45,632	$834	$63,447	15%	15%	30%	$9,517	$9,517	$24,744	$107,225
2	Lacy Lateral and Lacy Sublateral	578.28	NA	5	1	1	10	NA	$11,770	$31,628	$578	$43,976	15%	15%	30%	$6,596	$6,596	$17,151	$74,320
2	Lacy Lateral and Lacy Sublateral	1032.39	NA	5	1	1	10	NA	$21,012	$56,465	$1,032	$78,509	15%	15%	30%	$11,776	$11,776	$30,619	$132,681
2	Lacy Lateral and Lacy Sublateral	659.14	NA	5	1	1	10	NA	$13,415	$36,050	$659	$50,125	15%	15%	30%	$7,519	$7,519	$19,549	$84,711
2	Lacy Lateral and Lacy Sublateral	581.53	NA	5	1	1	10	NA	$11,836	$31,806	$582	$44,223	15%	15%	30%	$6,633	$6,633	$17,247	$74,736
2	Lacy Lateral and Lacy Sublateral	578.93	NA	5	1	1	10	NA	$11,783	$31,664	$579	$44,025	15%	15%	30%	$6,604	$6,604	$17,170	$74,403
2	Lacy Lateral and Lacy Sublateral	832.29	NA	5	1	1	10	NA	$16,939	$45,521	$832	$63,292	15%	15%	30%	$9,494	$9,494	$24,684	$106,964
2	Lacy Lateral and Lacy Sublateral	1096.32	NA	5	1	1	10	NA	$22,313	$59,961	$1,096	$83,371	15%	15%	30%	$12,506	$12,506	$32,515	$140,896
2	Lacy Lateral and Lacy Sublateral	830.57	NA	5	1	1	10	NA	$16,904	$45,427	$831	$63,161	15%	15%	30%	$9,474	$9,474	$24,633	$106,743
2	Lacy Lateral and Lacy Sublateral	952.34	NA	5	1	1	10	NA	$19,383	$52,087	$952	$72,422	15%	15%	30%	$10,863	$10,863	$28,244	$122,393
2	Lacy Lateral and Lacy Sublateral	NA	16	NA	NA	NA	NA	$16,000	NA	NA	NA	$16,000	15%	15%	30%	$2,400	$2,400	$6,240	$27,040
2	Parkhurst Lateral	282.60	NA	5	1	1	10	NA	$5,752	$15,456	$283	$21,490	6%	12%	30%	$1,289	$2,579	$7,608	$32,966
2	Parkhurst Lateral	660.84	NA	5	1	1	10	NA	$13,450	$36,144	$661	$50,255	6%	12%	30%	$3,015	$6,031	$17,790	$77,091
2	Parkhurst Lateral	6480.00	NA	5	1	1	10	NA	$131,885	$354,414	$6,480	$492,779	6%	12%	30%	$29,567	$59,133	$174,444	$755,923
2	Parkhurst Lateral	857.50	NA	5	1	1	10	NA	$17,452	$46,900	$858	$65,210	6%	12%	30%	$3,913	$7,825	$23,084	$100,031
2	Parkhurst Lateral	1.53	NA	5	1	1	10	NA	$31	$84	$2	$116	6%	12%	30%	$7	$14	$41	$178
2	Parkhurst Lateral	1379.98	NA	5	1	1	10	NA	$28,086	$75,476	$1,380	$104,942	6%	12%	30%	$6,297	$12,593	$37,150	$160,981
2	Parkhurst Lateral	1037.39	NA	5	1	1	10	NA	$21,114	$56,738	$1,037	$78,889	6%	12%	30%	$4,733	$9,467	$27,927	$121,016
2	Parkhurst Lateral	471.29	NA	5	1	1	10	NA	$9,592	$25,776	$471	$35,840	6%	12%	30%	$2,150	$4,301	$12,687	$54,978
2	Parkhurst Lateral	625.48	NA	5	1	1	10	NA	$12,730	$34,210	$625	$47,565	6%	12%	30%	$2,854	$5,708	$16,838	$72,965
2	Parkhurst Lateral	571.53	NA	5	1	1	10	NA	$11,632	$31,259	$572	$43,463	6%	12%	30%	$2,608	$5,216	$15,386	$66,672
2	Parkhurst Lateral	4.84	NA	5	1	1	10	NA	$99	$265	$5	$368	6%	12%	30%	$22	$44	$130	$565
2	Parkhurst Lateral	72.85	NA	5	1	1	10	NA	$1,483	$3,984	$73	$5,540	6%	12%	30%	$332	$665	$1,961	$8,498
2	Parkhurst Lateral	796.59	NA	5	1	1	10	NA	$16,213	$43,568	$797	$60,578	6%	12%	30%	$3,635	$7,269	$21,444	$92,926
2	Parkhurst Lateral	112.59	NA	5	1	1	10	NA	$2,292	$6,158	$113	$8,562	6%	12%	30%	$514	$1,027	$3,031	$13,134
2	Parkhurst Lateral	86.49	NA	5	1	1	10	NA	$1,760	$4,730	$86	$6,577	6%	12%	30%	$395	$789	$2,328	$10,089
2	Parkhurst Lateral	NA	20	NA	NA	NA	NA	$20,000	NA	NA	NA	$20,000	6%	12%	30%	$1,200	$2,400	$7,080	$30,680
2	Rock Springs Lateral	20.98	NA	15	3	3	21	NA	$622	$2,410	$21	$3,053	15%	12%	30%	$458	$366	$1,163	$5,041
2	Rock Springs Lateral	1191.09	NA	15	3	3	21	NA	$35,322	$136,841	$1,191	$173,354	15%	12%	30%	$26,003	$20,802	$66,048	$286,207
2	Rock Springs Lateral	3.81	NA	15	3	3	21	NA	$113	$438	$4	$554	15%	12%	30%	$83	$67	$211	$915
2	Rock Springs	299.98	NA	15	3	3	21	NA	$8,896	$34,464	$300	$43,660	15%	12%	30%	$6,549	$5,239	$16,635	$72,083

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
	Lateral																		
2	Rock Springs Lateral	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	12%	30%	$600	$480	$1,524	$6,604
2	Steele Lateral	280.61	NA	15	3	3	21	NA	$8,322	$32,238	$281	$40,841	15%	15%	30%	$6,126	$6,126	$15,928	$69,021
2	Steele Lateral	536.96	NA	15	3	3	21	NA	$15,924	$61,690	$537	$78,151	15%	15%	30%	$11,723	$11,723	$30,479	$132,074
2	Steele Lateral	285.25	NA	15	3	3	21	NA	$8,459	$32,771	$285	$41,515	15%	15%	30%	$6,227	$6,227	$16,191	$70,161
2	Steele Lateral	7.05	NA	15	3	3	21	NA	$209	$809	$7	$1,025	15%	15%	30%	$154	$154	$400	$1,733
2	Steele Lateral	77.54	NA	15	3	3	21	NA	$2,299	$8,908	$78	$11,285	15%	15%	30%	$1,693	$1,693	$4,401	$19,072
2	Steele Lateral	712.91	NA	15	3	3	21	NA	$21,142	$81,905	$713	$103,759	15%	15%	30%	$15,564	$15,564	$40,466	$175,353
2	Steele Lateral	1079.26	NA	15	3	3	21	NA	$32,006	$123,993	$1,079	$157,078	15%	15%	30%	$23,562	$23,562	$61,260	$265,462
2	Steele Lateral	217.07	NA	15	3	3	21	NA	$6,437	$24,939	$217	$31,593	15%	15%	30%	$4,739	$4,739	$12,321	$53,393
2	Steele Lateral	852.05	NA	15	3	3	21	NA	$25,268	$97,889	$852	$124,009	15%	15%	30%	$18,601	$18,601	$48,363	$209,575
2	Steele Lateral	3.20	NA	15	3	3	21	NA	$95	$368	$3	$466	15%	15%	30%	$70	$70	$182	$787
2	Steele Lateral	957.40	NA	15	3	3	21	NA	$28,392	$109,992	$957	$139,342	15%	15%	30%	$20,901	$20,901	$54,343	$235,487
2	Steele Lateral	NA	11	NA	NA	NA	NA	$11,000	NA	NA	NA	$11,000	15%	15%	30%	$1,650	$1,650	$4,290	$18,590
2	Tumalo Feed Canal Reservoir Feed and Sublateral	26.74	NA	15	3	3	21	NA	$793	$3,072	$27	$3,892	10%	12%	30%	$389	$467	$1,424	$6,172
2	Tumalo Feed Canal Reservoir Feed and Sublateral	132.70	NA	15	3	3	21	NA	$3,935	$15,246	$133	$19,313	10%	12%	30%	$1,931	$2,318	$7,069	$30,631
2	Tumalo Feed Canal Reservoir Feed and Sublateral	1833.01	NA	15	3	3	21	NA	$54,358	$210,589	$1,833	$266,780	10%	12%	30%	$26,678	$32,014	$97,642	$423,114
2	Tumalo Feed Canal Reservoir Feed and Sublateral	3016.81	NA	15	3	3	21	NA	$89,464	$346,592	$3,017	$439,073	10%	12%	30%	$43,907	$52,689	$160,701	$696,370
2	Tumalo Feed Canal Reservoir Feed and Sublateral	589.03	NA	15	3	3	21	NA	$17,468	$67,672	$589	$85,729	10%	12%	30%	$8,573	$10,287	$31,377	$135,966
2	Tumalo Feed Canal Reservoir Feed and Sublateral	937.44	NA	15	3	3	21	NA	$27,800	$107,700	$937	$136,437	10%	12%	30%	$13,644	$16,372	$49,936	$216,389
2	Tumalo Feed Canal Reservoir Feed and Sublateral	43.29	NA	15	3	3	21	NA	$1,284	$4,973	$43	$6,301	10%	12%	30%	$630	$756	$2,306	$9,993
2	Tumalo Feed Canal Reservoir Feed and Sublateral	20.78	NA	15	3	3	21	NA	$616	$2,387	$21	$3,024	10%	12%	30%	$302	$363	$1,107	$4,797
2	Tumalo Feed Canal Reservoir Feed and Sublateral	1228.87	NA	15	3	3	21	NA	$36,442	$141,181	$1,229	$178,853	10%	12%	30%	$17,885	$21,462	$65,460	$283,660
2	Tumalo Feed Canal Reservoir Feed and Sublateral	11.54	NA	15	3	3	21	NA	$342	$1,326	$12	$1,680	10%	12%	30%	$168	$202	$615	$2,664
2	Tumalo Feed Canal Reservoir Feed and Sublateral	504.79	NA	15	3	3	21	NA	$14,970	$57,994	$505	$73,468	10%	12%	30%	$7,347	$8,816	$26,889	$116,521

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
2	Tumalo Feed Canal Reservoir Feed and Sublateral	263.66	NA	15	3	3	21	NA	$7,819	$30,291	$264	$38,374	10%	12%	30%	$3,837	$4,605	$14,045	$60,861
2	Tumalo Feed Canal Reservoir Feed and Sublateral	530.90	NA	15	3	3	21	NA	$15,744	$60,994	$531	$77,268	10%	12%	30%	$7,727	$9,272	$28,280	$122,548
2	Tumalo Feed Canal Reservoir Feed and Sublateral	279.32	NA	15	3	3	21	NA	$8,283	$32,090	$279	$40,653	10%	12%	30%	$4,065	$4,878	$14,879	$64,475
2	Tumalo Feed Canal Reservoir Feed and Sublateral	NA	15	NA	NA	NA	NA	$15,000	NA	NA	NA	$15,000	10%	12%	30%	$1,500	$1,800	$5,490	$23,790
3	Allen Lateral	3947.15	NA	15	3	3	21	NA	$117,054	$453,476	$3,947	$574,477	15%	15%	30%	$86,172	$86,172	$224,046	$970,866
3	Allen Lateral	1.62	NA	15	3	3	21	NA	$48	$186	$2	$236	15%	15%	30%	$35	$35	$92	$399
3	Allen Lateral	588.13	NA	15	3	3	21	NA	$17,441	$67,568	$588	$85,598	15%	15%	30%	$12,840	$12,840	$33,383	$144,660
3	Allen Lateral	261.83	NA	15	3	3	21	NA	$7,765	$30,081	$262	$38,108	15%	15%	30%	$5,716	$5,716	$14,862	$64,402
3	Allen Lateral	673.42	NA	15	3	3	21	NA	$19,971	$77,368	$673	$98,011	15%	15%	30%	$14,702	$14,702	$38,224	$165,639
3	Allen Lateral	404.80	NA	15	3	3	21	NA	$12,004	$46,506	$405	$58,915	15%	15%	30%	$8,837	$8,837	$22,977	$99,566
3	Allen Lateral	273.78	NA	15	3	3	21	NA	$8,119	$31,454	$274	$39,847	15%	15%	30%	$5,977	$5,977	$15,540	$67,342
3	Allen Lateral	418.98	NA	15	3	3	21	NA	$12,425	$48,135	$419	$60,979	15%	15%	30%	$9,147	$9,147	$23,782	$103,054
3	Allen Lateral	18.00	NA	15	3	3	21	NA	$534	$2,068	$18	$2,619	15%	15%	30%	$393	$393	$1,022	$4,427
3	Allen Lateral	314.39	NA	15	3	3	21	NA	$9,323	$36,119	$314	$45,757	15%	15%	30%	$6,864	$6,864	$17,845	$77,329
3	Allen Lateral	567.31	NA	15	3	3	21	NA	$16,824	$65,177	$567	$82,568	15%	15%	30%	$12,385	$12,385	$32,201	$139,540
3	Allen Lateral	4.31	NA	15	3	3	21	NA	$128	$495	$4	$627	15%	15%	30%	$94	$94	$244	$1,059
3	Allen Lateral	6.03	NA	15	3	3	21	NA	$179	$693	$6	$878	15%	15%	30%	$132	$132	$342	$1,484
3	Allen Lateral	3.85	NA	15	3	3	21	NA	$114	$442	$4	$560	15%	15%	30%	$84	$84	$218	$947
3	Allen Lateral	1910.27	NA	15	3	3	21	NA	$56,650	$219,466	$1,910	$278,026	15%	15%	30%	$41,704	$41,704	$108,430	$469,863
3	Allen Lateral	0.44	NA	15	3	3	21	NA	$13	$50	$0	$64	15%	15%	30%	$10	$10	$25	$108
3	Allen Lateral	438.36	NA	15	3	3	21	NA	$13,000	$50,361	$438	$63,799	15%	15%	30%	$9,570	$9,570	$24,882	$107,821
3	Allen Lateral	563.78	NA	15	3	3	21	NA	$16,719	$64,772	$564	$82,054	15%	15%	30%	$12,308	$12,308	$32,001	$138,672
3	Allen Lateral	668.28	NA	15	3	3	21	NA	$19,818	$76,776	$668	$97,263	15%	15%	30%	$14,589	$14,589	$37,932	$164,374
3	Allen Lateral	643.65	NA	15	3	3	21	NA	$19,088	$73,947	$644	$93,678	15%	15%	30%	$14,052	$14,052	$36,534	$158,316
3	Allen Lateral	239.77	NA	15	3	3	21	NA	$7,110	$27,546	$240	$34,896	15%	15%	30%	$5,234	$5,234	$13,610	$58,975
3	Allen Lateral	273.19	NA	15	3	3	21	NA	$8,101	$31,386	$273	$39,760	15%	15%	30%	$5,964	$5,964	$15,506	$67,195
3	Allen Lateral	128.49	NA	15	3	3	21	NA	$3,810	$14,762	$128	$18,701	15%	15%	30%	$2,805	$2,805	$7,293	$31,604
3	Allen Lateral	1.90	NA	15	3	3	21	NA	$56	$219	$2	$277	15%	15%	30%	$42	$42	$108	$468
3	Allen Lateral	530.41	NA	15	3	3	21	NA	$15,729	$60,937	$530	$77,197	15%	15%	30%	$11,579	$11,579	$30,107	$130,462
3	Allen Lateral	0.28	NA	15	3	3	21	NA	$8	$32	$0	$40	15%	15%	30%	$6	$6	$16	$68
3	Allen Lateral	1087.70	NA	15	3	3	21	NA	$32,256	$124,963	$1,088	$158,306	15%	15%	30%	$23,746	$23,746	$61,739	$267,538
3	Allen Lateral	5.52	NA	15	3	3	21	NA	$164	$635	$6	$804	15%	15%	30%	$121	$121	$314	$1,359
3	Allen Lateral	1059.48	NA	15	3	3	21	NA	$31,419	$121,721	$1,059	$154,199	15%	15%	30%	$23,130	$23,130	$60,138	$260,597
3	Allen Lateral	900.46	NA	15	3	3	21	NA	$26,703	$103,451	$900	$131,055	15%	15%	30%	$19,658	$19,658	$51,111	$221,483
3	Allen Lateral	108.32	NA	15	3	3	21	NA	$3,212	$12,445	$108	$15,766	15%	15%	30%	$2,365	$2,365	$6,149	$26,644
3	Allen Lateral	569.66	NA	15	3	3	21	NA	$16,893	$65,446	$570	$82,909	15%	15%	30%	$12,436	$12,436	$32,335	$140,116
3	Allen Lateral	812.69	NA	15	3	3	21	NA	$24,101	$93,368	$813	$118,281	15%	15%	30%	$17,742	$17,742	$46,130	$199,895
3	Allen Lateral	470.11	NA	15	3	3	21	NA	$13,941	$54,009	$470	$68,420	15%	15%	30%	$10,263	$10,263	$26,684	$115,630

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
3	Allen Lateral	673.20	NA	15	3	3	21	NA	$19,964	$77,342	$673	$97,979	15%	15%	30%	$14,697	$14,697	$38,212	$165,585
3	Allen Lateral	638.57	NA	15	3	3	21	NA	$18,937	$73,363	$639	$92,939	15%	15%	30%	$13,941	$13,941	$36,246	$157,067
3	Allen Lateral	538.34	NA	15	3	3	21	NA	$15,965	$61,848	$538	$78,351	15%	15%	30%	$11,753	$11,753	$30,557	$132,413
3	Allen Lateral	98.93	NA	15	3	3	21	NA	$2,934	$11,366	$99	$14,398	15%	15%	30%	$2,160	$2,160	$5,615	$24,333
3	Allen Lateral	NA	34	NA	NA	NA	NA	$34,000	NA	NA	NA	$34,000	15%	15%	30%	$5,100	$5,100	$13,260	$57,460
3	Allen Sublateral South	262.35	NA	18	2	4	24	NA	$8,554	$35,151	$262	$43,968	15%	15%	30%	$6,595	$6,595	$17,147	$74,305
3	Allen Sublateral South	1508.67	NA	18	2	4	24	NA	$49,193	$202,137	$1,509	$252,838	15%	15%	30%	$37,926	$37,926	$98,607	$427,297
3	Allen Sublateral South	18.90	NA	18	2	4	24	NA	$616	$2,532	$19	$3,167	15%	15%	30%	$475	$475	$1,235	$5,352
3	Allen Sublateral South	4.56	NA	18	2	4	24	NA	$149	$611	$5	$764	15%	15%	30%	$115	$115	$298	$1,292
3	Allen Sublateral South	366.75	NA	18	2	4	24	NA	$11,958	$49,138	$367	$61,464	15%	15%	30%	$9,220	$9,220	$23,971	$103,873
3	Allen Sublateral South	NA	3	NA	NA	NA	NA	$3,000	NA	NA	NA	$3,000	15%	15%	30%	$450	$450	$1,170	$5,070
3	Allen Sublateral West	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	15%	30%	$600	$600	$1,560	$6,760
3	McGinnis Ditch	758.99	NA	18	2	4	24	NA	$24,748	$101,692	$759	$127,199	15%	15%	30%	$19,080	$19,080	$49,608	$214,967
3	McGinnis Ditch	708.36	NA	18	2	4	24	NA	$23,097	$94,908	$708	$118,714	15%	15%	30%	$17,807	$17,807	$46,298	$200,626
3	McGinnis Ditch	812.93	NA	18	2	4	24	NA	$26,507	$108,920	$813	$136,240	15%	15%	30%	$20,436	$20,436	$53,134	$230,245
3	McGinnis Ditch	413.49	NA	18	2	4	24	NA	$13,482	$55,400	$413	$69,296	15%	15%	30%	$10,394	$10,394	$27,026	$117,111
3	McGinnis Ditch	196.00	NA	18	2	4	24	NA	$6,391	$26,261	$196	$32,848	15%	15%	30%	$4,927	$4,927	$12,811	$55,514
3	McGinnis Ditch	1001.08	NA	18	2	4	24	NA	$32,642	$134,128	$1,001	$167,771	15%	15%	30%	$25,166	$25,166	$65,431	$283,533
3	McGinnis Ditch	NA	5	NA	NA	NA	NA	$5,000	NA	NA	NA	$5,000	15%	15%	30%	$750	$750	$1,950	$8,450
4	Beasley Lateral	13.82	NA	5	1	1	10	NA	$281	$756	$14	$1,051	15%	15%	30%	$158	$158	$410	$1,776
4	Beasley Lateral	80.68	NA	5	1	1	10	NA	$1,642	$4,413	$81	$6,135	15%	15%	30%	$920	$920	$2,393	$10,369
4	Beasley Lateral	164.16	NA	5	1	1	10	NA	$3,341	$8,979	$164	$12,484	15%	15%	30%	$1,873	$1,873	$4,869	$21,098
4	Beasley Lateral	681.91	NA	5	1	1	10	NA	$13,879	$37,296	$682	$51,857	15%	15%	30%	$7,779	$7,779	$20,224	$87,638
4	Beasley Lateral	104.12	NA	5	1	1	10	NA	$2,119	$5,694	$104	$7,918	15%	15%	30%	$1,188	$1,188	$3,088	$13,381
4	Beasley Lateral	555.73	NA	5	1	1	10	NA	$11,311	$30,395	$556	$42,261	15%	15%	30%	$6,339	$6,339	$16,482	$71,422
4	Beasley Lateral	1.67	NA	5	1	1	10	NA	$34	$91	$2	$127	15%	15%	30%	$19	$19	$50	$215
4	Beasley Lateral	685.93	NA	5	1	1	10	NA	$13,960	$37,516	$686	$52,162	15%	15%	30%	$7,824	$7,824	$20,343	$88,154
4	Beasley Lateral	117.04	NA	5	1	1	10	NA	$2,382	$6,401	$117	$8,900	15%	15%	30%	$1,335	$1,335	$3,471	$15,041
4	Beasley Lateral	689.80	NA	5	1	1	10	NA	$14,039	$37,728	$690	$52,457	15%	15%	30%	$7,868	$7,868	$20,458	$88,652
4	Beasley Lateral	463.90	NA	5	1	1	10	NA	$9,442	$25,372	$464	$35,278	15%	15%	30%	$5,292	$5,292	$13,758	$59,619
4	Beasley Lateral	336.81	NA	5	1	1	10	NA	$6,855	$18,421	$337	$25,613	15%	15%	30%	$3,842	$3,842	$9,989	$43,286
4	Beasley Lateral	181.33	NA	5	1	1	10	NA	$3,691	$9,918	$181	$13,790	15%	15%	30%	$2,068	$2,068	$5,378	$23,304
4	Beasley Lateral	1144.91	NA	5	1	1	10	NA	$23,302	$62,619	$1,145	$87,066	15%	15%	30%	$13,060	$13,060	$33,956	$147,142
4	Beasley Lateral	315.96	NA	5	1	1	10	NA	$6,431	$17,281	$316	$24,028	15%	15%	30%	$3,604	$3,604	$9,371	$40,607
4	Beasley Lateral	NA	20	NA	NA	NA	NA	$20,000	NA	NA	NA	$20,000	15%	15%	30%	$3,000	$3,000	$7,800	$33,800
4	North Spaulding Lateral	1616.60	NA	12	4	2	17	NA	$43,170	$154,855	$1,617	$199,641	15%	15%	30%	$29,946	$29,946	$77,860	$337,394
4	North Spaulding Lateral	4445.76	NA	12	4	2	17	NA	$118,719	$425,860	$4,446	$549,025	15%	15%	30%	$82,354	$82,354	$214,120	$927,852
4	North Spaulding Lateral	3924.89	NA	12	4	2	17	NA	$104,810	$375,966	$3,925	$484,701	15%	15%	30%	$72,705	$72,705	$189,033	$819,144
4	North Spaulding Lateral	5451.29	NA	12	4	2	17	NA	$145,571	$522,180	$5,451	$673,203	15%	15%	30%	$100,980	$100,980	$262,549	$1,137,712
4	North Spaulding Lateral	284.06	NA	12	4	2	17	NA	$7,585	$27,210	$284	$35,079	15%	15%	30%	$5,262	$5,262	$13,681	$59,284

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
4	North Spaulding Lateral	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	15%	30%	$600	$600	$1,560	$6,760
4	Spaulding Lateral	435.21	NA	12	4	2	17	NA	$11,622	$41,689	$435	$53,746	15%	15%	30%	$8,062	$8,062	$20,961	$90,830
4	Spaulding Lateral	5.12	NA	12	4	2	17	NA	$137	$491	$5	$632	15%	15%	30%	$95	$95	$247	$1,069
4	Spaulding Lateral	575.41	NA	12	4	2	17	NA	$15,366	$55,119	$575	$71,060	15%	15%	30%	$10,659	$10,659	$27,713	$120,091
4	Spaulding Lateral	120.99	NA	12	4	2	17	NA	$3,231	$11,590	$121	$14,942	15%	15%	30%	$2,241	$2,241	$5,827	$25,251
4	Spaulding Lateral	2346.99	NA	12	4	2	17	NA	$62,674	$224,819	$2,347	$289,839	15%	15%	30%	$43,476	$43,476	$113,037	$489,829
4	Spaulding Lateral	388.61	NA	12	4	2	17	NA	$10,378	$37,225	$389	$47,992	15%	15%	30%	$7,199	$7,199	$18,717	$81,106
4	Spaulding Lateral	1629.32	NA	12	4	2	17	NA	$43,509	$156,073	$1,629	$201,212	15%	15%	30%	$30,182	$30,182	$78,473	$340,048
4	Spaulding Lateral	1069.75	NA	12	4	2	17	NA	$28,566	$102,471	$1,070	$132,107	15%	15%	30%	$19,816	$19,816	$51,522	$223,262
4	Spaulding Lateral	860.04	NA	12	4	2	17	NA	$22,966	$82,383	$860	$106,209	15%	15%	30%	$15,931	$15,931	$41,422	$179,494
4	Spaulding Lateral	3.70	NA	12	4	2	17	NA	$99	$355	$4	$457	15%	15%	30%	$69	$69	$178	$773
4	Spaulding Lateral	2.76	NA	12	4	2	17	NA	$74	$265	$3	$341	15%	15%	30%	$51	$51	$133	$577
4	Spaulding Lateral	339.30	NA	12	4	2	17	NA	$9,061	$32,502	$339	$41,902	15%	15%	30%	$6,285	$6,285	$16,342	$70,814
4	Spaulding Lateral	1695.07	NA	12	4	2	17	NA	$45,265	$162,371	$1,695	$209,332	15%	15%	30%	$31,400	$31,400	$81,639	$353,770
4	Spaulding Lateral	440.98	NA	12	4	2	17	NA	$11,776	$42,241	$441	$54,458	15%	15%	30%	$8,169	$8,169	$21,239	$92,034
4	Spaulding Lateral	1033.09	NA	12	4	2	17	NA	$27,587	$98,960	$1,033	$127,580	15%	15%	30%	$19,137	$19,137	$49,756	$215,610
4	Spaulding Lateral	60.92	NA	12	4	2	17	NA	$1,627	$5,835	$61	$7,523	15%	15%	30%	$1,128	$1,128	$2,934	$12,713
4	Spaulding Lateral	2171.05	NA	12	4	2	17	NA	$57,975	$207,965	$2,171	$268,112	15%	15%	30%	$40,217	$40,217	$104,564	$453,109
4	Spaulding Lateral	NA	17	NA	NA	NA	NA	$17,000	NA	NA	NA	$17,000	15%	15%	30%	$2,550	$2,550	$6,630	$28,730
4	West Branch Columbia Southern West	765.00	NA	15	3	3	21	NA	$22,686	$87,889	$765	$111,340	15%	15%	30%	$16,701	$16,701	$43,423	$188,164
4	West Branch Columbia Southern West	2444.81	NA	15	3	3	21	NA	$72,501	$280,877	$2,445	$355,823	15%	15%	30%	$53,373	$53,373	$138,771	$601,341
4	West Branch Columbia Southern West	670.91	NA	15	3	3	21	NA	$19,896	$77,079	$671	$97,646	15%	15%	30%	$14,647	$14,647	$38,082	$165,022
4	West Branch Columbia Southern West	141.38	NA	15	3	3	21	NA	$4,193	$16,243	$141	$20,577	15%	15%	30%	$3,087	$3,087	$8,025	$34,775
4	West Branch Columbia Southern West	1788.95	NA	15	3	3	21	NA	$53,052	$205,527	$1,789	$260,367	15%	15%	30%	$39,055	$39,055	$101,543	$440,021
4	West Branch Columbia Southern West	616.33	NA	15	3	3	21	NA	$18,278	$70,809	$616	$89,703	15%	15%	30%	$13,455	$13,455	$34,984	$151,597
4	West Branch Columbia Southern West	21.17	NA	15	3	3	21	NA	$628	$2,432	$21	$3,081	15%	15%	30%	$462	$462	$1,202	$5,207
4	West Branch Columbia Southern West	77.78	NA	15	3	3	21	NA	$2,307	$8,936	$78	$11,321	15%	15%	30%	$1,698	$1,698	$4,415	$19,132
4	West Branch Columbia Southern West	1272.56	NA	15	3	3	21	NA	$37,738	$146,201	$1,273	$185,211	15%	15%	30%	$27,782	$27,782	$72,232	$313,007
4	West Branch Columbia Southern West	1336.91	NA	15	3	3	21	NA	$39,647	$153,594	$1,337	$194,578	15%	15%	30%	$29,187	$29,187	$75,885	$328,836
4	West Branch Columbia Southern West	8.76	NA	15	3	3	21	NA	$260	$1,006	$9	$1,275	15%	15%	30%	$191	$191	$497	$2,155
4	West Branch Columbia Southern West	423.59	NA	15	3	3	21	NA	$12,562	$48,665	$424	$61,650	15%	15%	30%	$9,247	$9,247	$24,043	$104,188

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4	West Branch Columbia Southern West	727.16	NA	12	4	2	17	NA	$19,418	$69,655	$727	$89,800	15%	15%	30%	$13,470	$13,470	$35,022	$151,762
4	West Branch Columbia Southern West	854.50	NA	12	4	2	17	NA	$22,819	$81,853	$855	$105,526	15%	15%	30%	$15,829	$15,829	$41,155	$178,339
4	West Branch Columbia Southern West	0.48	NA	12	4	2	17	NA	$13	$46	$0	$59	15%	15%	30%	$9	$9	$23	$100
4	West Branch Columbia Southern West	8.38	NA	12	4	2	17	NA	$224	$803	$8	$1,035	15%	15%	30%	$155	$155	$404	$1,749
4	West Branch Columbia Southern West	490.27	NA	12	4	2	17	NA	$13,092	$46,963	$490	$60,545	15%	15%	30%	$9,082	$9,082	$23,613	$102,322
4	West Branch Columbia Southern West	1369.00	NA	12	4	2	17	NA	$36,558	$131,137	$1,369	$169,063	15%	15%	30%	$25,360	$25,360	$65,935	$285,717
4	West Branch Columbia Southern West	1815.52	NA	12	4	2	17	NA	$48,481	$173,909	$1,816	$224,206	15%	15%	30%	$33,631	$33,631	$87,440	$378,908
4	West Branch Columbia Southern West	816.70	NA	12	4	2	17	NA	$21,809	$78,232	$817	$100,857	15%	15%	30%	$15,129	$15,129	$39,334	$170,449
4	West Branch Columbia Southern West	2.18	NA	12	4	2	17	NA	$58	$209	$2	$269	15%	15%	30%	$40	$40	$105	$455
4	West Branch Columbia Southern West	842.76	NA	12	4	2	17	NA	$22,505	$80,728	$843	$104,076	15%	15%	30%	$15,611	$15,611	$40,590	$175,888
4	West Branch Columbia Southern West	345.68	NA	12	4	2	17	NA	$9,231	$33,112	$346	$42,689	15%	15%	30%	$6,403	$6,403	$16,649	$72,144
4	West Branch Columbia Southern West	401.22	NA	12	4	2	17	NA	$10,714	$38,433	$401	$49,548	15%	15%	30%	$7,432	$7,432	$19,324	$83,737
4	West Branch Columbia Southern West	694.19	NA	12	4	2	17	NA	$18,538	$66,497	$694	$85,729	15%	15%	30%	$12,859	$12,859	$33,434	$144,881
4	West Branch Columbia Southern West	1239.81	NA	12	4	2	17	NA	$33,108	$118,762	$1,240	$153,110	15%	15%	30%	$22,966	$22,966	$59,713	$258,756
4	West Branch Columbia Southern West	1385.17	NA	12	4	2	17	NA	$36,990	$132,686	$1,385	$171,061	15%	15%	30%	$25,659	$25,659	$66,714	$289,093
4	West Branch Columbia Southern West	435.85	NA	12	4	2	17	NA	$11,639	$41,751	$436	$53,825	15%	15%	30%	$8,074	$8,074	$20,992	$90,965
4	West Branch Columbia Southern West	2562.74	NA	12	4	2	17	NA	$68,435	$245,485	$2,563	$316,483	15%	15%	30%	$47,472	$47,472	$123,428	$534,856
4	West Branch Columbia Southern West	NA	31	NA	NA	NA	NA	$31,000	NA	NA	NA	$31,000	15%	15%	30%	$4,650	$4,650	$12,090	$52,390
5	Chambers (Lafores) Ditch	12.70	NA	5	1	1	10	NA	$258	$694	$13	$966	15%	15%	30%	$145	$145	$377	$1,632
5	Chambers (Lafores) Ditch	12.81	NA	5	1	1	10	NA	$261	$701	$13	$974	15%	15%	30%	$146	$146	$380	$1,647
5	Chambers (Lafores) Ditch	509.50	NA	5	1	1	10	NA	$10,370	$27,866	$510	$38,746	15%	15%	30%	$5,812	$5,812	$15,111	$65,480
5	Chambers (Lafores) Ditch	642.90	NA	5	1	1	10	NA	$13,085	$35,162	$643	$48,890	15%	15%	30%	$7,334	$7,334	$19,067	$82,624
5	Chambers (Lafores) Ditch	215.19	NA	5	1	1	10	NA	$4,380	$11,769	$215	$16,364	15%	15%	30%	$2,455	$2,455	$6,382	$27,655

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5	Chambers (Lafores) Ditch	390.87	NA	5	1	1	10	NA	$7,955	$21,378	$391	$29,724	15%	15%	30%	$4,459	$4,459	$11,592	$50,234
5	Chambers (Lafores) Ditch	282.09	NA	5	1	1	10	NA	$5,741	$15,428	$282	$21,452	15%	15%	30%	$3,218	$3,218	$8,366	$36,253
5	Chambers (Lafores) Ditch	NA	7	NA	NA	NA	NA	$7,000	NA	NA	NA	$7,000	15%	15%	30%	$1,050	$1,050	$2,730	$11,830
5	Couch Lateral	2462.91	NA	12	4	2	17	NA	$65,769	$235,923	$2,463	$304,155	15%	15%	30%	$45,623	$45,623	$118,620	$514,022
5	Couch Lateral	1350.97	NA	12	4	2	17	NA	$36,076	$129,410	$1,351	$166,837	15%	15%	30%	$25,026	$25,026	$65,066	$281,954
5	Couch Lateral	354.71	NA	12	4	2	17	NA	$9,472	$33,978	$355	$43,805	15%	15%	30%	$6,571	$6,571	$17,084	$74,031
5	Couch Lateral	1494.79	NA	12	4	2	17	NA	$39,917	$143,186	$1,495	$184,598	15%	15%	30%	$27,690	$27,690	$71,993	$311,970
5	Couch Lateral	872.98	NA	12	4	2	17	NA	$23,312	$83,623	$873	$107,809	15%	15%	30%	$16,171	$16,171	$42,045	$182,196
5	Couch Lateral	320.08	NA	12	4	2	17	NA	$8,547	$30,660	$320	$39,528	15%	15%	30%	$5,929	$5,929	$15,416	$66,802
5	Couch Lateral	1095.21	NA	12	4	2	17	NA	$29,246	$104,911	$1,095	$135,252	15%	15%	30%	$20,288	$20,288	$52,748	$228,577
5	Couch Lateral	301.52	NA	12	4	2	17	NA	$8,052	$28,882	$302	$37,236	15%	15%	30%	$5,585	$5,585	$14,522	$62,928
5	Couch Lateral	97.20	NA	12	4	2	17	NA	$2,596	$9,311	$97	$12,004	15%	15%	30%	$1,801	$1,801	$4,682	$20,287
5	Couch Lateral	14.86	NA	12	4	2	17	NA	$397	$1,424	$15	$1,835	15%	15%	30%	$275	$275	$716	$3,102
5	Couch Lateral	699.60	NA	12	4	2	17	NA	$18,682	$67,015	$700	$86,396	15%	15%	30%	$12,959	$12,959	$33,695	$146,010
5	Couch Lateral	1106.72	NA	12	4	2	17	NA	$29,554	$106,013	$1,107	$136,673	15%	15%	30%	$20,501	$20,501	$53,302	$230,977
5	Couch Lateral	29.63	NA	12	4	2	17	NA	$791	$2,838	$30	$3,659	15%	15%	30%	$549	$549	$1,427	$6,183
5	Couch Lateral	605.56	NA	12	4	2	17	NA	$16,171	$58,007	$606	$74,783	15%	15%	30%	$11,217	$11,217	$29,165	$126,383
5	Couch Lateral	159.02	NA	12	4	2	17	NA	$4,247	$15,233	$159	$19,639	15%	15%	30%	$2,946	$2,946	$7,659	$33,189
5	Couch Lateral	337.38	NA	12	4	2	17	NA	$9,009	$32,318	$337	$41,665	15%	15%	30%	$6,250	$6,250	$16,249	$70,414
5	Couch Lateral	497.21	NA	12	4	2	17	NA	$13,278	$47,628	$497	$61,403	15%	15%	30%	$9,210	$9,210	$23,947	$103,771
5	Couch Lateral	95.12	NA	12	4	2	17	NA	$2,540	$9,112	$95	$11,747	15%	15%	30%	$1,762	$1,762	$4,581	$19,853
5	Couch Lateral	361.83	NA	12	4	2	17	NA	$9,662	$34,660	$362	$44,684	15%	15%	30%	$6,703	$6,703	$17,427	$75,517
5	Couch Lateral	94.14	NA	12	4	2	17	NA	$2,514	$9,018	$94	$11,626	15%	15%	30%	$1,744	$1,744	$4,534	$19,648
5	Couch Lateral	1169.70	NA	12	4	2	17	NA	$31,236	$112,046	$1,170	$144,452	15%	15%	30%	$21,668	$21,668	$56,336	$244,123
5	Couch Lateral	13.71	NA	12	4	2	17	NA	$366	$1,313	$14	$1,693	15%	15%	30%	$254	$254	$660	$2,862
5	Couch Lateral	603.93	NA	12	4	2	17	NA	$16,127	$57,851	$604	$74,582	15%	15%	30%	$11,187	$11,187	$29,087	$126,044
5	Couch Lateral	9.41	NA	12	4	2	17	NA	$251	$902	$9	$1,163	15%	15%	30%	$174	$174	$453	$1,965
5	Couch Lateral	823.56	NA	12	4	2	17	NA	$21,992	$78,889	$824	$101,705	15%	15%	30%	$15,256	$15,256	$39,665	$171,882
5	Couch Lateral	0.15	NA	12	4	2	17	NA	$4	$14	$0	$18	15%	15%	30%	$3	$3	$7	$31
5	Couch Lateral	NA	12	NA	NA	NA	NA	$12,000	NA	NA	NA	$12,000	15%	15%	30%	$1,800	$1,800	$4,680	$20,280
5	East Couch Lateral	560.45	NA	5	1	1	10	NA	$11,407	$30,653	$560	$42,620	15%	15%	30%	$6,393	$6,393	$16,622	$72,028
5	East Couch Lateral	47.09	NA	5	1	1	10	NA	$958	$2,575	$47	$3,581	15%	15%	30%	$537	$537	$1,397	$6,052
5	East Couch Lateral	222.72	NA	5	1	1	10	NA	$4,533	$12,181	$223	$16,937	15%	15%	30%	$2,541	$2,541	$6,605	$28,623
5	East Couch Lateral	17.68	NA	5	1	1	10	NA	$360	$967	$18	$1,345	15%	15%	30%	$202	$202	$524	$2,272
5	East Couch Lateral	1082.62	NA	5	1	1	10	NA	$22,034	$59,212	$1,083	$82,329	15%	15%	30%	$12,349	$12,349	$32,108	$139,136
5	East Couch Lateral	16.44	NA	5	1	1	10	NA	$335	$899	$16	$1,250	15%	15%	30%	$188	$188	$488	$2,113
5	East Couch Lateral	890.62	NA	5	1	1	10	NA	$18,126	$48,711	$891	$67,728	15%	15%	30%	$10,159	$10,159	$26,414	$114,460
5	East Couch Lateral	10.94	NA	5	1	1	10	NA	$223	$599	$11	$832	15%	15%	30%	$125	$125	$325	$1,407
5	East Couch Lateral	229.97	NA	5	1	1	10	NA	$4,681	$12,578	$230	$17,488	15%	15%	30%	$2,623	$2,623	$6,820	$29,555
5	East Couch Lateral	202.99	NA	5	1	1	10	NA	$4,131	$11,102	$203	$15,436	15%	15%	30%	$2,315	$2,315	$6,020	$26,087

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
5	East Couch Lateral	159.97	NA	5	1	1	10	NA	$3,256	$8,749	$160	$12,165	15%	15%	30%	$1,825	$1,825	$4,744	$20,559
5	East Couch Lateral	NA	26	NA	NA	NA	NA	$26,000	NA	NA	NA	$26,000	15%	15%	30%	$3,900	$3,900	$10,140	$43,940
5	Gainsforth Ditch	2307.47	NA	5	1	1	10	NA	$46,963	$126,204	$2,307	$175,475	15%	15%	30%	$26,321	$26,321	$68,435	$296,552
5	Gainsforth Ditch	847.10	NA	5	1	1	10	NA	$17,241	$46,331	$847	$64,418	15%	15%	30%	$9,663	$9,663	$25,123	$108,867
5	Gainsforth Ditch	570.14	NA	5	1	1	10	NA	$11,604	$31,183	$570	$43,357	15%	15%	30%	$6,504	$6,504	$16,909	$73,274
5	Gainsforth Ditch	166.24	NA	5	1	1	10	NA	$3,383	$9,092	$166	$12,642	15%	15%	30%	$1,896	$1,896	$4,930	$21,365
5	Gainsforth Ditch	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	15%	30%	$600	$600	$1,560	$6,760
5	West Couch Lateral	445.56	NA	12	4	2	17	NA	$11,898	$42,680	$446	$55,023	15%	15%	30%	$8,254	$8,254	$21,459	$92,990
5	West Couch Lateral	3951.10	NA	12	4	2	17	NA	$105,510	$378,477	$3,951	$487,938	15%	15%	30%	$73,191	$73,191	$190,296	$824,616
5	West Couch Lateral	4.52	NA	12	4	2	17	NA	$121	$433	$5	$558	15%	15%	30%	$84	$84	$218	$943
5	West Couch Lateral	771.78	NA	12	4	2	17	NA	$20,609	$73,929	$772	$95,310	15%	15%	30%	$14,296	$14,296	$37,171	$161,073
5	West Couch Lateral	594.89	NA	12	4	2	17	NA	$15,886	$56,985	$595	$73,466	15%	15%	30%	$11,020	$11,020	$28,652	$124,157
5	West Couch Lateral	2608.22	NA	12	4	2	17	NA	$69,650	$249,842	$2,608	$322,100	15%	15%	30%	$48,315	$48,315	$125,619	$544,348
5	West Couch Lateral	1351.80	NA	12	4	2	17	NA	$36,098	$129,490	$1,352	$166,940	15%	15%	30%	$25,041	$25,041	$65,107	$282,128
5	West Couch Lateral	571.03	NA	12	4	2	17	NA	$15,249	$54,699	$571	$70,518	15%	15%	30%	$10,578	$10,578	$27,502	$119,176
5	West Couch Lateral	1413.37	NA	12	4	2	17	NA	$37,743	$135,387	$1,413	$174,543	15%	15%	30%	$26,181	$26,181	$68,072	$294,978
5	West Couch Lateral	469.71	NA	12	4	2	17	NA	$12,543	$44,993	$470	$58,006	15%	15%	30%	$8,701	$8,701	$22,622	$98,030
5	West Couch Lateral	2226.19	NA	12	4	2	17	NA	$59,448	$213,247	$2,226	$274,921	15%	15%	30%	$41,238	$41,238	$107,219	$464,617
5	West Couch Lateral	3149.72	NA	12	4	2	17	NA	$84,110	$301,713	$3,150	$388,972	15%	15%	30%	$58,346	$58,346	$151,699	$657,363
5	West Couch Lateral	13.40	NA	12	4	2	17	NA	$358	$1,284	$13	$1,655	15%	15%	30%	$248	$248	$646	$2,797
5	West Couch Lateral	1.48	NA	12	4	2	17	NA	$39	$141	$1	$182	15%	15%	30%	$27	$27	$71	$308
5	West Couch Lateral	0.90	NA	12	4	2	17	NA	$24	$86	$1	$111	15%	15%	30%	$17	$17	$43	$187
5	West Couch Lateral	348.55	NA	12	4	2	17	NA	$9,308	$33,388	$349	$43,044	15%	15%	30%	$6,457	$6,457	$16,787	$72,745
5	West Couch Lateral	111.70	NA	12	4	2	17	NA	$2,983	$10,699	$112	$13,794	15%	15%	30%	$2,069	$2,069	$5,380	$23,311
5	West Couch Lateral	1659.27	NA	12	4	2	17	NA	$44,309	$158,942	$1,659	$204,911	15%	15%	30%	$30,737	$30,737	$79,915	$346,299
5	West Couch Lateral	3502.96	NA	12	4	2	17	NA	$93,543	$335,549	$3,503	$432,595	15%	15%	30%	$64,889	$64,889	$168,712	$731,086
5	West Couch Lateral	1291.35	NA	12	4	2	17	NA	$34,484	$123,699	$1,291	$159,474	15%	15%	30%	$23,921	$23,921	$62,195	$269,512
5	West Couch Lateral	NA	23	NA	NA	NA	NA	$23,000	NA	NA	NA	$23,000	15%	15%	30%	$3,450	$3,450	$8,970	$38,870
5	West Couch Sublateral East	551.54	NA	5	1	1	10	NA	$11,225	$30,166	$552	$41,942	15%	15%	30%	$6,291	$6,291	$16,358	$70,883
5	West Couch Sublateral East	6.16	NA	5	1	1	10	NA	$125	$337	$6	$468	15%	15%	30%	$70	$70	$183	$791
5	West Couch Sublateral East	1907.27	NA	5	1	1	10	NA	$38,818	$104,315	$1,907	$145,040	15%	15%	30%	$21,756	$21,756	$56,566	$245,118
5	West Couch Sublateral East	8.25	NA	5	1	1	10	NA	$168	$451	$8	$628	15%	15%	30%	$94	$94	$245	$1,061
5	West Couch Sublateral East	210.32	NA	5	1	1	10	NA	$4,281	$11,503	$210	$15,994	15%	15%	30%	$2,399	$2,399	$6,238	$27,030
5	West Couch	190.39	NA	5	1	1	10	NA	$3,875	$10,413	$190	$14,479	15%	15%	30%	$2,172	$2,172	$5,647	$24,469

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
	Sublateral East																		
5	West Couch Sublateral East	541.35	NA	5	1	1	10	NA	$11,018	$29,608	$541	$41,167	15%	15%	30%	$6,175	$6,175	$16,055	$69,573
5	West Couch Sublateral East	348.45	NA	5	1	1	10	NA	$7,092	$19,058	$348	$26,498	15%	15%	30%	$3,975	$3,975	$10,334	$44,782
5	West Couch Sublateral East	132.13	NA	5	1	1	10	NA	$2,689	$7,227	$132	$10,048	15%	15%	30%	$1,507	$1,507	$3,919	$16,981
5	West Couch Sublateral East	972.21	NA	5	1	1	10	NA	$19,787	$53,173	$972	$73,932	15%	15%	30%	$11,090	$11,090	$28,834	$124,946
5	West Couch Sublateral East	NA	10	NA	NA	NA	NA	$10,000	NA	NA	NA	$10,000	15%	15%	30%	$1,500	$1,500	$3,900	$16,900
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	197.00	NA	18	2	4	24	NA	$6,423	$26,395	$197	$33,015	15%	15%	30%	$4,952	$4,952	$12,876	$55,796
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	21.02	NA	18	2	4	24	NA	$685	$2,816	$21	$3,523	15%	15%	30%	$528	$528	$1,374	$5,953
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1921.29	NA	18	2	4	24	NA	$62,647	$257,421	$1,921	$321,989	15%	15%	30%	$48,298	$48,298	$125,576	$544,161
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1043.16	NA	18	2	4	24	NA	$34,014	$139,766	$1,043	$174,824	15%	15%	30%	$26,224	$26,224	$68,181	$295,452
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	874.97	NA	18	2	4	24	NA	$28,530	$117,232	$875	$146,636	15%	15%	30%	$21,995	$21,995	$57,188	$247,816
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	25.17	NA	18	2	4	24	NA	$821	$3,373	$25	$4,219	15%	15%	30%	$633	$633	$1,645	$7,130
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	202.69	NA	18	2	4	24	NA	$6,609	$27,157	$203	$33,969	15%	15%	30%	$5,095	$5,095	$13,248	$57,407
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	0.67	NA	18	2	4	24	NA	$22	$89	$1	$112	15%	15%	30%	$17	$17	$44	$189
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	2.52	NA	18	2	4	24	NA	$82	$337	$3	$422	15%	15%	30%	$63	$63	$164	$713
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1930.50	NA	18	2	4	24	NA	$62,947	$258,655	$1,930	$323,533	15%	15%	30%	$48,530	$48,530	$126,178	$546,770
6	Columbia Southern Lateral TFC Hillburner/PRV	1330.41	NA	18	2	4	24	NA	$43,380	$178,253	$1,330	$222,964	15%	15%	30%	$33,445	$33,445	$86,956	$376,809

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
	to Tail																		
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	215.58	NA	18	2	4	24	NA	$7,029	$28,884	$216	$36,129	15%	15%	30%	$5,419	$5,419	$14,090	$61,058
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	76.82	NA	18	2	4	24	NA	$2,505	$10,292	$77	$12,874	15%	15%	30%	$1,931	$1,931	$5,021	$21,757
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	565.40	NA	18	2	4	24	NA	$18,436	$75,755	$565	$94,756	15%	15%	30%	$14,213	$14,213	$36,955	$160,138
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1079.96	NA	18	2	4	24	NA	$35,214	$144,697	$1,080	$180,991	15%	15%	30%	$27,149	$27,149	$70,587	$305,875
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1123.03	NA	18	2	4	24	NA	$36,618	$150,468	$1,123	$188,210	15%	15%	30%	$28,231	$28,231	$73,402	$318,074
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	695.59	NA	18	2	4	24	NA	$22,681	$93,198	$696	$116,575	15%	15%	30%	$17,486	$17,486	$45,464	$197,012
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1000.00	NA	15	3	3	21	NA	$29,655	$114,887	$1,000	$145,542	15%	15%	30%	$21,831	$21,831	$56,761	$245,966
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	715.99	NA	15	3	3	21	NA	$21,233	$82,258	$716	$104,206	15%	15%	30%	$15,631	$15,631	$40,640	$176,109
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	7.95	NA	15	3	3	21	NA	$236	$913	$8	$1,157	15%	15%	30%	$174	$174	$451	$1,955
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	143.85	NA	15	3	3	21	NA	$4,266	$16,526	$144	$20,936	15%	15%	30%	$3,140	$3,140	$8,165	$35,381
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	226.53	NA	15	3	3	21	NA	$6,718	$26,025	$227	$32,969	15%	15%	30%	$4,945	$4,945	$12,858	$55,718
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	457.16	NA	15	3	3	21	NA	$13,557	$52,522	$457	$66,536	15%	15%	30%	$9,980	$9,980	$25,949	$112,446
6	Columbia Southern Lateral TFC Hillburner/PRV	0.15	NA	15	3	3	21	NA	$4	$17	$0	$22	15%	15%	30%	$3	$3	$9	$37

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
	to Tail																		
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1.40	NA	15	3	3	21	NA	$41	$160	$1	$203	15%	15%	30%	$30	$30	$79	$343
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	2.19	NA	15	3	3	21	NA	$65	$252	$2	$319	15%	15%	30%	$48	$48	$125	$540
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	403.78	NA	15	3	3	21	NA	$11,974	$46,389	$404	$58,767	15%	15%	30%	$8,815	$8,815	$22,919	$99,316
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	117.74	NA	15	3	3	21	NA	$3,491	$13,526	$118	$17,135	15%	15%	30%	$2,570	$2,570	$6,683	$28,959
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	496.83	NA	15	3	3	21	NA	$14,734	$57,080	$497	$72,310	15%	15%	30%	$10,847	$10,847	$28,201	$122,204
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	2216.39	NA	15	3	3	21	NA	$65,728	$254,635	$2,216	$322,579	15%	15%	30%	$48,387	$48,387	$125,806	$545,158
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	694.12	NA	15	3	3	21	NA	$20,584	$79,746	$694	$101,024	15%	15%	30%	$15,154	$15,154	$39,399	$170,731
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1888.49	NA	15	3	3	21	NA	$56,004	$216,963	$1,888	$274,855	15%	15%	30%	$41,228	$41,228	$107,193	$464,504
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	2.83	NA	15	3	3	21	NA	$84	$326	$3	$413	15%	15%	30%	$62	$62	$161	$697
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1.99	NA	15	3	3	21	NA	$59	$229	$2	$290	15%	15%	30%	$44	$44	$113	$490
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	128.19	NA	15	3	3	21	NA	$3,801	$14,727	$128	$18,656	15%	15%	30%	$2,798	$2,798	$7,276	$31,529
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	31.46	NA	15	3	3	21	NA	$933	$3,615	$31	$4,579	15%	15%	30%	$687	$687	$1,786	$7,739
6	Columbia Southern Lateral TFC Hillburner/PRV	161.55	NA	15	3	3	21	NA	$4,791	$18,560	$162	$23,512	15%	15%	30%	$3,527	$3,527	$9,170	$39,735

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
	to Tail																		
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	566.40	NA	15	3	3	21	NA	$16,797	$65,072	$566	$82,436	15%	15%	30%	$12,365	$12,365	$32,150	$139,316
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	372.24	NA	15	3	3	21	NA	$11,039	$42,766	$372	$54,177	15%	15%	30%	$8,127	$8,127	$21,129	$91,559
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	492.30	NA	15	3	3	21	NA	$14,599	$56,559	$492	$71,650	15%	15%	30%	$10,748	$10,748	$27,944	$121,089
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	153.19	NA	15	3	3	21	NA	$4,543	$17,599	$153	$22,295	15%	15%	30%	$3,344	$3,344	$8,695	$37,679
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	417.72	NA	15	3	3	21	NA	$12,387	$47,990	$418	$60,795	15%	15%	30%	$9,119	$9,119	$23,710	$102,744
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	548.18	NA	15	3	3	21	NA	$16,256	$62,978	$548	$79,783	15%	15%	30%	$11,967	$11,967	$31,115	$134,833
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	820.10	NA	15	3	3	21	NA	$24,320	$94,219	$820	$119,360	15%	15%	30%	$17,904	$17,904	$46,550	$201,718
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	0.03	NA	15	3	3	21	NA	$1	$3	$0	$4	15%	15%	30%	$1	$1	$2	$7
6	Columbia Southern Lateral TFC to Hillburner/PRV	256.25	NA	20	4	4	26	NA	$8,791	$37,152	$256	$46,199	4%	12%	30%	$1,848	$5,544	$16,077	$69,668
6	Columbia Southern Lateral TFC to Hillburner/PRV	2777.79	NA	20	4	4	26	NA	$95,297	$402,735	$2,778	$500,809	4%	12%	30%	$20,032	$60,097	$174,282	$755,220
6	Columbia Southern Lateral TFC to Hillburner/PRV	30.32	NA	20	4	4	26	NA	$1,040	$4,396	$30	$5,466	4%	12%	30%	$219	$656	$1,902	$8,243
6	Columbia Southern Lateral TFC to Hillburner/PRV	1410.28	NA	20	4	4	26	NA	$48,382	$204,468	$1,410	$254,260	4%	12%	30%	$10,170	$30,511	$88,483	$383,424
6	Columbia Southern Lateral TFC to Hillburner/PRV	1368.31	NA	20	4	4	26	NA	$46,942	$198,382	$1,368	$246,693	4%	12%	30%	$9,868	$29,603	$85,849	$372,013
6	Columbia Southern Lateral TFC to Hillburner/PRV	1060.74	NA	20	4	4	26	NA	$36,390	$153,790	$1,061	$191,242	4%	12%	30%	$7,650	$22,949	$66,552	$288,392

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
6	Columbia Southern Lateral TFC to Hillburner/PRV	148.97	NA	20	4	4	26	NA	$5,111	$21,599	$149	$26,859	4%	12%	30%	$1,074	$3,223	$9,347	$40,503
6	Columbia Southern Lateral TFC to Hillburner/PRV	709.84	NA	20	4	4	26	NA	$24,352	$102,915	$710	$127,977	4%	12%	30%	$5,119	$15,357	$44,536	$192,989
6	Columbia Southern Lateral TFC to Hillburner/PRV	761.78	NA	20	4	4	26	NA	$26,134	$110,446	$762	$137,342	4%	12%	30%	$5,494	$16,481	$47,795	$207,111
6	Columbia Southern Lateral TFC to Hillburner/PRV	351.36	NA	20	4	4	26	NA	$12,054	$50,942	$351	$63,348	4%	12%	30%	$2,534	$7,602	$22,045	$95,528
6	Columbia Southern Lateral TFC to Hillburner/PRV	510.61	NA	20	4	4	26	NA	$17,517	$74,030	$511	$92,057	4%	12%	30%	$3,682	$11,047	$32,036	$138,822
6	Columbia Southern Lateral TFC to Hillburner/PRV	1028.09	NA	20	4	4	26	NA	$35,270	$149,056	$1,028	$185,354	4%	12%	30%	$7,414	$22,243	$64,503	$279,514
6	Columbia Southern Lateral TFC to Hillburner/PRV	39.28	NA	20	4	4	26	NA	$1,347	$5,694	$39	$7,081	4%	12%	30%	$283	$850	$2,464	$10,678
6	Columbia Southern Lateral TFC to Hillburner/PRV	5.83	NA	20	4	4	26	NA	$200	$845	$6	$1,051	4%	12%	30%	$42	$126	$366	$1,585
6	Columbia Southern Lateral TFC to Hillburner/PRV	1271.75	NA	20	4	4	26	NA	$43,629	$184,382	$1,272	$229,283	4%	12%	30%	$9,171	$27,514	$79,791	$345,759
6	Columbia Southern Lateral TFC to Hillburner/PRV	609.77	NA	20	4	4	26	NA	$20,919	$88,407	$610	$109,935	4%	12%	30%	$4,397	$13,192	$38,258	$165,783
6	Columbia Southern Lateral TFC to Hillburner/PRV	1592.94	NA	20	4	4	26	NA	$54,648	$230,950	$1,593	$287,192	4%	12%	30%	$11,488	$34,463	$99,943	$433,085
6	Columbia Southern Lateral TFC to Hillburner/PRV	840.68	NA	20	4	4	26	NA	$28,841	$121,885	$841	$151,566	4%	12%	30%	$6,063	$18,188	$52,745	$228,562
6	Columbia Southern Lateral TFC to Hillburner/PRV	6.32	NA	20	4	4	26	NA	$217	$916	$6	$1,139	4%	12%	30%	$46	$137	$396	$1,717
6	Columbia Southern Lateral TFC to Hillburner/PRV	NA	20	NA	NA	NA	NA	$20,000	NA	NA	NA	$20,000	4%	12%	30%	$800	$2,400	$6,960	$30,160
6	Conarn East	1.83	NA	5	1	1	10	NA	$37	$100	$2	$139	15%	15%	30%	$21	$21	$54	$235
6	Conarn East	787.59	NA	5	1	1	10	NA	$16,029	$43,076	$788	$59,893	15%	15%	30%	$8,984	$8,984	$23,358	$101,219
6	Conarn East	NA	2	NA	NA	NA	NA	$2,000	NA	NA	NA	$2,000	15%	15%	30%	$300	$300	$780	$3,380
6	Conarn Lateral	208.40	NA	5	1	1	10	NA	$4,241	$11,398	$208	$15,848	12%	12%	30%	$1,902	$1,902	$5,895	$25,547
6	Conarn Lateral	11.73	NA	5	1	1	10	NA	$239	$642	$12	$892	12%	12%	30%	$107	$107	$332	$1,438
6	Conarn Lateral	332.73	NA	5	1	1	10	NA	$6,772	$18,198	$333	$25,303	12%	12%	30%	$3,036	$3,036	$9,413	$40,789

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering , CM, Survey	CMGC	Contingency	Engineering , CM, Survey	CMGC	Contingency	Total Cost[11]
6	Conarn Lateral	678.84	NA	5	1	1	10	NA	$13,816	$37,128	$679	$51,623	12%	12%	30%	$6,195	$6,195	$19,204	$83,217
6	Conarn Lateral	1009.76	NA	5	1	1	10	NA	$20,551	$55,227	$1,010	$76,789	12%	12%	30%	$9,215	$9,215	$28,565	$123,783
6	Conarn Lateral	1079.23	NA	5	1	1	10	NA	$21,965	$59,027	$1,079	$82,071	12%	12%	30%	$9,849	$9,849	$30,531	$132,299
6	Conarn Lateral	670.58	NA	5	1	1	10	NA	$13,648	$36,676	$671	$50,995	12%	12%	30%	$6,119	$6,119	$18,970	$82,203
6	Conarn Lateral	149.21	NA	5	1	1	10	NA	$3,037	$8,161	$149	$11,347	12%	12%	30%	$1,362	$1,362	$4,221	$18,292
6	Conarn Lateral	19.18	NA	5	1	1	10	NA	$390	$1,049	$19	$1,459	12%	12%	30%	$175	$175	$543	$2,351
6	Conarn Lateral	844.00	NA	5	1	1	10	NA	$17,178	$46,161	$844	$64,183	12%	12%	30%	$7,702	$7,702	$23,876	$103,463
6	Conarn Lateral	0.02	NA	5	1	1	10	NA	$0	$1	$0	$2	12%	12%	30%	$0	$0	$1	$2
6	Conarn Lateral	0.25	NA	5	1	1	10	NA	$5	$14	$0	$19	12%	12%	30%	$2	$2	$7	$31
6	Conarn Lateral	5.88	NA	5	1	1	10	NA	$120	$322	$6	$447	12%	12%	30%	$54	$54	$166	$721
6	Conarn Lateral	1.49	NA	5	1	1	10	NA	$30	$81	$1	$113	12%	12%	30%	$14	$14	$42	$182
6	Hooker Creek Lateral	387.05	NA	5	1	1	10	NA	$7,877	$21,169	$387	$29,433	15%	15%	30%	$4,415	$4,415	$11,479	$49,742
6	Hooker Creek Lateral	1427.92	NA	5	1	1	10	NA	$29,062	$78,098	$1,428	$108,588	15%	15%	30%	$16,288	$16,288	$42,349	$183,514
6	Hooker Creek Lateral	965.74	NA	5	1	1	10	NA	$19,655	$52,820	$966	$73,441	15%	15%	30%	$11,016	$11,016	$28,642	$124,115
6	Hooker Creek Lateral	2.36	NA	5	1	1	10	NA	$48	$129	$2	$179	15%	15%	30%	$27	$27	$70	$303
6	Hooker Creek Lateral	6.32	NA	5	1	1	10	NA	$129	$346	$6	$481	15%	15%	30%	$72	$72	$188	$813
6	Hooker Creek Lateral	337.47	NA	5	1	1	10	NA	$6,868	$18,457	$337	$25,663	15%	15%	30%	$3,849	$3,849	$10,009	$43,371
6	Hooker Creek Lateral	463.38	NA	5	1	1	10	NA	$9,431	$25,344	$463	$35,238	15%	15%	30%	$5,286	$5,286	$13,743	$59,553
6	Hooker Creek Lateral	120.43	NA	5	1	1	10	NA	$2,451	$6,587	$120	$9,159	15%	15%	30%	$1,374	$1,374	$3,572	$15,478
6	Hooker Creek Lateral	1473.17	NA	5	1	1	10	NA	$29,983	$80,573	$1,473	$112,029	15%	15%	30%	$16,804	$16,804	$43,691	$189,328
6	Hooker Creek Lateral	499.16	NA	5	1	1	10	NA	$10,159	$27,301	$499	$37,959	15%	15%	30%	$5,694	$5,694	$14,804	$64,151
6	Hooker Creek Lateral	4.79	NA	5	1	1	10	NA	$98	$262	$5	$364	15%	15%	30%	$55	$55	$142	$616
6	Hooker Creek Lateral	505.80	NA	5	1	1	10	NA	$10,294	$27,664	$506	$38,465	15%	15%	30%	$5,770	$5,770	$15,001	$65,005
6	Hooker Creek Lateral	283.54	NA	5	1	1	10	NA	$5,771	$15,508	$284	$21,562	15%	15%	30%	$3,234	$3,234	$8,409	$36,440
6	Hooker Creek Lateral	137.15	NA	5	1	1	10	NA	$2,791	$7,501	$137	$10,429	15%	15%	30%	$1,564	$1,564	$4,067	$17,626
6	Hooker Creek Lateral	267.13	NA	5	1	1	10	NA	$5,437	$14,610	$267	$20,314	15%	15%	30%	$3,047	$3,047	$7,922	$34,331
6	Hooker Creek Lateral	NA	18	NA	NA	NA	NA	$18,000	NA	NA	NA	$18,000	15%	15%	30%	$2,700	$2,700	$7,020	$30,420
6	Jewett Lateral	1264.21	NA	5	1	1	10	NA	$25,730	$69,144	$1,264	$96,139	15%	15%	30%	$14,421	$14,421	$37,494	$162,474
6	Jewett Lateral	754.25	NA	5	1	1	10	NA	$15,351	$41,252	$754	$57,358	15%	15%	30%	$8,604	$8,604	$22,369	$96,934
6	Jewett Lateral	507.60	NA	5	1	1	10	NA	$10,331	$27,762	$508	$38,601	15%	15%	30%	$5,790	$5,790	$15,054	$65,235
6	Jewett Lateral	690.12	NA	5	1	1	10	NA	$14,046	$37,745	$690	$52,481	15%	15%	30%	$7,872	$7,872	$20,467	$88,692
6	Jewett Lateral	419.34	NA	5	1	1	10	NA	$8,535	$22,935	$419	$31,889	15%	15%	30%	$4,783	$4,783	$12,437	$53,892
6	Jewett Lateral	53.62	NA	5	1	1	10	NA	$1,091	$2,933	$54	$4,078	15%	15%	30%	$612	$612	$1,590	$6,891
6	Jewett Lateral	1463.33	NA	5	1	1	10	NA	$29,783	$80,035	$1,463	$111,281	15%	15%	30%	$16,692	$16,692	$43,399	$188,064
6	Jewett Lateral	2.76	NA	5	1	1	10	NA	$56	$151	$3	$210	15%	15%	30%	$32	$32	$82	$355
6	Jewett Lateral	195.26	NA	5	1	1	10	NA	$3,974	$10,679	$195	$14,849	15%	15%	30%	$2,227	$2,227	$5,791	$25,094
6	Jewett Lateral	207.80	NA	5	1	1	10	NA	$4,229	$11,365	$208	$15,802	15%	15%	30%	$2,370	$2,370	$6,163	$26,706
6	Jewett Lateral	1.44	NA	5	1	1	10	NA	$29	$79	$1	$109	15%	15%	30%	$16	$16	$43	$185

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6	Jewett Lateral	288.69	NA	5	1	1	10	NA	$5,876	$15,790	$289	$21,954	15%	15%	30%	$3,293	$3,293	$8,562	$37,102
6	Jewett Lateral	342.41	NA	5	1	1	10	NA	$6,969	$18,728	$342	$26,039	15%	15%	30%	$3,906	$3,906	$10,155	$44,006
6	Jewett Lateral	545.82	NA	5	1	1	10	NA	$11,109	$29,853	$546	$41,507	15%	15%	30%	$6,226	$6,226	$16,188	$70,147
6	Jewett Lateral	58.22	NA	5	1	1	10	NA	$1,185	$3,184	$58	$4,428	15%	15%	30%	$664	$664	$1,727	$7,483
6	Jewett Lateral	0.30	NA	5	1	1	10	NA	$6	$16	$0	$23	15%	15%	30%	$3	$3	$9	$38
6	Jewett Lateral	0.03	NA	5	1	1	10	NA	$1	$2	$0	$3	15%	15%	30%	$0	$0	$1	$4
6	Jewett Lateral	NA	19	NA	NA	NA	NA	$19,000	NA	NA	NA	$19,000	15%	15%	30%	$2,850	$2,850	$7,410	$32,110
6	North Columbia Southern East Lateral and Sublateral	39.16	NA	15	3	3	21	NA	$1,161	$4,499	$39	$5,699	15%	15%	30%	$855	$855	$2,223	$9,632
6	North Columbia Southern East Lateral and Sublateral	420.38	NA	15	3	3	21	NA	$12,466	$48,296	$420	$61,183	15%	15%	30%	$9,177	$9,177	$23,861	$103,399
6	North Columbia Southern East Lateral and Sublateral	909.05	NA	15	3	3	21	NA	$26,958	$104,438	$909	$132,306	15%	15%	30%	$19,846	$19,846	$51,599	$223,596
6	North Columbia Southern East Lateral and Sublateral	1566.85	NA	15	3	3	21	NA	$46,465	$180,011	$1,567	$228,043	15%	15%	30%	$34,206	$34,206	$88,937	$385,393
6	North Columbia Southern East Lateral and Sublateral	1.30	NA	15	3	3	21	NA	$39	$150	$1	$190	15%	15%	30%	$28	$28	$74	$321
6	North Columbia Southern East Lateral and Sublateral	1.11	NA	15	3	3	21	NA	$33	$128	$1	$162	15%	15%	30%	$24	$24	$63	$274
6	North Columbia Southern East Lateral and Sublateral	2694.50	NA	15	3	3	21	NA	$79,906	$309,563	$2,695	$392,164	15%	15%	30%	$58,825	$58,825	$152,944	$662,756
6	North Columbia Southern East Lateral and Sublateral	1419.21	NA	15	3	3	21	NA	$42,087	$163,049	$1,419	$206,555	15%	15%	30%	$30,983	$30,983	$80,556	$349,078
6	North Columbia Southern East Lateral and Sublateral	1207.21	NA	15	3	3	21	NA	$35,800	$138,692	$1,207	$175,699	15%	15%	30%	$26,355	$26,355	$68,523	$296,932
6	North Columbia Southern East Lateral and Sublateral	262.13	NA	15	3	3	21	NA	$7,773	$30,115	$262	$38,151	15%	15%	30%	$5,723	$5,723	$14,879	$64,475
6	North Columbia Southern East Lateral and Sublateral	12.55	NA	15	3	3	21	NA	$372	$1,442	$13	$1,827	15%	15%	30%	$274	$274	$712	$3,087
6	North Columbia Southern East Lateral and Sublateral	1025.50	NA	15	3	3	21	NA	$30,412	$117,817	$1,026	$149,254	15%	15%	30%	$22,388	$22,388	$58,209	$252,239
6	North Columbia Southern East Lateral and Sublateral	521.23	NA	15	3	3	21	NA	$15,457	$59,882	$521	$75,861	15%	15%	30%	$11,379	$11,379	$29,586	$128,205
6	North Columbia Southern East Lateral and	0.43	NA	15	3	3	21	NA	$13	$49	$0	$63	15%	15%	30%	$9	$9	$24	$106

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	Sublateral																		
6	North Columbia Southern East Lateral and Sublateral	344.38	NA	15	3	3	21	NA	$10,213	$39,565	$344	$50,122	15%	15%	30%	$7,518	$7,518	$19,547	$84,705
6	North Columbia Southern East Lateral and Sublateral	3.23	NA	15	3	3	21	NA	$96	$371	$3	$470	15%	15%	30%	$71	$71	$183	$795
6	North Columbia Southern East Lateral and Sublateral	441.51	NA	15	3	3	21	NA	$13,093	$50,724	$442	$64,259	15%	15%	30%	$9,639	$9,639	$25,061	$108,597
6	North Columbia Southern East Lateral and Sublateral	1691.22	NA	15	3	3	21	NA	$50,153	$194,299	$1,691	$246,144	15%	15%	30%	$36,922	$36,922	$95,996	$415,983
6	North Columbia Southern East Lateral and Sublateral	235.34	NA	15	3	3	21	NA	$6,979	$27,037	$235	$34,252	15%	15%	30%	$5,138	$5,138	$13,358	$57,885
6	North Columbia Southern East Lateral and Sublateral	513.85	NA	15	3	3	21	NA	$15,238	$59,034	$514	$74,786	15%	15%	30%	$11,218	$11,218	$29,167	$126,389
6	North Columbia Southern East Lateral and Sublateral	2275.77	NA	15	3	3	21	NA	$67,489	$261,457	$2,276	$331,221	15%	15%	30%	$49,683	$49,683	$129,176	$559,763
6	North Columbia Southern East Lateral and Sublateral	187.13	NA	15	3	3	21	NA	$5,549	$21,498	$187	$27,235	15%	15%	30%	$4,085	$4,085	$10,622	$46,027
6	North Columbia Southern East Lateral and Sublateral	772.24	NA	15	3	3	21	NA	$22,901	$88,721	$772	$112,394	15%	15%	30%	$16,859	$16,859	$43,834	$189,946
6	North Columbia Southern East Lateral and Sublateral	4.72	NA	15	3	3	21	NA	$140	$543	$5	$688	15%	15%	30%	$103	$103	$268	$1,162
6	North Columbia Southern East Lateral and Sublateral	1867.37	NA	15	3	3	21	NA	$55,377	$214,536	$1,867	$271,781	15%	15%	30%	$40,767	$40,767	$105,994	$459,309
6	North Columbia Southern East Lateral and Sublateral	2299.67	NA	15	3	3	21	NA	$68,197	$264,202	$2,300	$334,698	15%	15%	30%	$50,205	$50,205	$130,532	$565,640
6	North Columbia Southern East Lateral and Sublateral	17.27	NA	15	3	3	21	NA	$512	$1,985	$17	$2,514	15%	15%	30%	$377	$377	$981	$4,249
6	North Columbia Southern East Lateral and Sublateral	NA	11	NA	NA	NA	NA	$11,000	NA	NA	NA	$11,000	15%	15%	30%	$1,650	$1,650	$4,290	$18,590
6	North Columbia Southern West Lateral and Sublateral	426.03	NA	5	1	1	10	NA	$8,671	$23,301	$426	$32,398	6%	10%	30%	$1,944	$3,240	$11,274	$48,856
6	North Columbia Southern West Lateral and Sublateral	89.25	NA	5	1	1	10	NA	$1,816	$4,881	$89	$6,787	6%	10%	30%	$407	$679	$2,362	$10,235

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6	North Columbia Southern West Lateral and Sublateral	3.72	NA	5	1	1	10	NA	$76	$203	$4	$283	6%	10%	30%	$17	$28	$98	$427
6	North Columbia Southern West Lateral and Sublateral	874.53	NA	5	1	1	10	NA	$17,799	$47,831	$875	$66,504	6%	10%	30%	$3,990	$6,650	$23,143	$100,288
6	North Columbia Southern West Lateral and Sublateral	419.48	NA	5	1	1	10	NA	$8,537	$22,943	$419	$31,899	6%	10%	30%	$1,914	$3,190	$11,101	$48,104
6	North Columbia Southern West Lateral and Sublateral	8.37	NA	5	1	1	10	NA	$170	$458	$8	$636	6%	10%	30%	$38	$64	$221	$960
6	North Columbia Southern West Lateral and Sublateral	466.39	NA	5	1	1	10	NA	$9,492	$25,509	$466	$35,467	6%	10%	30%	$2,128	$3,547	$12,343	$53,485
6	North Columbia Southern West Lateral and Sublateral	410.37	NA	5	1	1	10	NA	$8,352	$22,444	$410	$31,207	6%	10%	30%	$1,872	$3,121	$10,860	$47,060
6	North Columbia Southern West Lateral and Sublateral	0.51	NA	5	1	1	10	NA	$10	$28	$1	$39	6%	10%	30%	$2	$4	$14	$59
6	North Columbia Southern West Lateral and Sublateral	1.17	NA	5	1	1	10	NA	$24	$64	$1	$89	6%	10%	30%	$5	$9	$31	$134
6	North Columbia Southern West Lateral and Sublateral	5.40	NA	5	1	1	10	NA	$110	$295	$5	$410	6%	10%	30%	$25	$41	$143	$619
6	North Columbia Southern West Lateral and Sublateral	1139.24	NA	5	1	1	10	NA	$23,187	$62,309	$1,139	$86,635	6%	10%	30%	$5,198	$8,664	$30,149	$130,646
6	North Columbia Southern West Lateral and Sublateral	4.28	NA	5	1	1	10	NA	$87	$234	$4	$325	6%	10%	30%	$20	$33	$113	$491
6	North Columbia Southern West Lateral and Sublateral	0.68	NA	5	1	1	10	NA	$14	$37	$1	$52	6%	10%	30%	$3	$5	$18	$78
6	North Columbia Southern West Lateral and Sublateral	5.12	NA	5	1	1	10	NA	$104	$280	$5	$389	6%	10%	30%	$23	$39	$136	$587
6	North Columbia Southern West Lateral and Sublateral	2.98	NA	5	1	1	10	NA	$61	$163	$3	$227	6%	10%	30%	$14	$23	$79	$342
6	North Columbia Southern West Lateral and Sublateral	511.58	NA	5	1	1	10	NA	$10,412	$27,980	$512	$38,904	6%	10%	30%	$2,334	$3,890	$13,539	$58,667
6	North Columbia Southern West Lateral and Sublateral	0.93	NA	5	1	1	10	NA	$19	$51	$1	$70	6%	10%	30%	$4	$7	$25	$106
6	North Columbia	639.39	NA	5	1	1	10	NA	$13,013	$34,970	$639	$48,623	6%	10%	30%	$2,917	$4,862	$16,921	$73,323

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
	Southern West Lateral and Sublateral																		
6	North Columbia Southern West Lateral and Sublateral	591.43	NA	5	1	1	10	NA	$12,037	$32,347	$591	$44,976	6%	10%	30%	$2,699	$4,498	$15,652	$67,824
6	North Columbia Southern West Lateral and Sublateral	415.24	NA	5	1	1	10	NA	$8,451	$22,711	$415	$31,578	6%	10%	30%	$1,895	$3,158	$10,989	$47,619
6	North Columbia Southern West Lateral and Sublateral	NA	23	NA	NA	NA	NA	$23,000	NA	NA	NA	$23,000	6%	10%	30%	$1,380	$2,300	$8,004	$34,684
6	North Hammond Lateral	NA	5	NA	NA	NA	NA	$5,000	NA	NA	NA	$5,000	15%	15%	30%	$750	$750	$1,950	$8,450
6	Phiffer Lateral	556.65	NA	5	1	1	10	NA	$11,329	$30,445	$557	$42,331	12%	12%	30%	$5,080	$5,080	$15,747	$68,237
6	Phiffer Lateral	367.40	NA	5	1	1	10	NA	$7,478	$20,094	$367	$27,939	12%	12%	30%	$3,353	$3,353	$10,393	$45,038
6	Phiffer Lateral	45.79	NA	5	1	1	10	NA	$932	$2,504	$46	$3,482	12%	12%	30%	$418	$418	$1,295	$5,613
6	Phiffer Lateral	351.08	NA	5	1	1	10	NA	$7,145	$19,202	$351	$26,698	12%	12%	30%	$3,204	$3,204	$9,932	$43,037
6	Phiffer Lateral	589.21	NA	5	1	1	10	NA	$11,992	$32,226	$589	$44,807	12%	12%	30%	$5,377	$5,377	$16,668	$72,230
6	Phiffer Lateral	434.27	NA	5	1	1	10	NA	$8,838	$23,752	$434	$33,024	12%	12%	30%	$3,963	$3,963	$12,285	$53,235
6	Phiffer Lateral	155.84	NA	5	1	1	10	NA	$3,172	$8,523	$156	$11,851	12%	12%	30%	$1,422	$1,422	$4,408	$19,103
6	Phiffer Lateral	418.10	NA	5	1	1	10	NA	$8,510	$22,868	$418	$31,795	12%	12%	30%	$3,815	$3,815	$11,828	$51,254
6	Phiffer Lateral	0.65	NA	5	1	1	10	NA	$13	$36	$1	$50	12%	12%	30%	$6	$6	$18	$80
6	Phiffer Lateral	NA	9	NA	NA	NA	NA	$9,000	NA	NA	NA	$9,000	12%	12%	30%	$1,080	$1,080	$3,348	$14,508
6	Putnam Lateral	1238.60	NA	5	1	1	10	NA	$25,209	$67,743	$1,239	$94,190	10%	12%	30%	$9,419	$11,303	$34,474	$149,386
6	Putnam Lateral	1339.18	NA	5	1	1	10	NA	$27,256	$73,245	$1,339	$101,840	10%	12%	30%	$10,184	$12,221	$37,273	$161,518
6	Putnam Lateral	36.24	NA	5	1	1	10	NA	$738	$1,982	$36	$2,756	10%	12%	30%	$276	$331	$1,009	$4,371
6	Putnam Lateral	423.19	NA	5	1	1	10	NA	$8,613	$23,145	$423	$32,182	10%	12%	30%	$3,218	$3,862	$11,778	$51,040
6	Putnam Lateral	2468.23	NA	5	1	1	10	NA	$50,235	$134,996	$2,468	$187,700	10%	12%	30%	$18,770	$22,524	$68,698	$297,692
6	Putnam Lateral	NA	5	NA	NA	NA	NA	$5,000	NA	NA	NA	$5,000	10%	12%	30%	$500	$600	$1,830	$7,930
6	West Branch Columbia Southern East	352.49	NA	5	1	1	10	NA	$7,174	$19,279	$352	$26,805	15%	15%	30%	$4,021	$4,021	$10,454	$45,301
6	West Branch Columbia Southern East	0.13	NA	5	1	1	10	NA	$3	$7	$0	$10	15%	15%	30%	$2	$2	$4	$17
6	West Branch Columbia Southern East	882.08	NA	5	1	1	10	NA	$17,953	$48,244	$882	$67,079	15%	15%	30%	$10,062	$10,062	$26,161	$113,363
6	West Branch Columbia Southern East	265.58	NA	5	1	1	10	NA	$5,405	$14,526	$266	$20,197	15%	15%	30%	$3,029	$3,029	$7,877	$34,132
6	West Branch Columbia Southern East	443.66	NA	5	1	1	10	NA	$9,030	$24,265	$444	$33,738	15%	15%	30%	$5,061	$5,061	$13,158	$57,018
6	West Branch Columbia Southern East	466.34	NA	5	1	1	10	NA	$9,491	$25,506	$466	$35,464	15%	15%	30%	$5,320	$5,320	$13,831	$59,933
6	West Branch Columbia Southern East	2014.62	NA	5	1	1	10	NA	$41,003	$110,187	$2,015	$153,204	15%	15%	30%	$22,981	$22,981	$59,750	$258,915
6	West Branch Columbia Southern East	91.41	NA	5	1	1	10	NA	$1,860	$4,999	$91	$6,951	15%	15%	30%	$1,043	$1,043	$2,711	$11,747

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
6	West Branch Columbia Southern East	326.84	NA	5	1	1	10	NA	$6,652	$17,876	$327	$24,855	15%	15%	30%	$3,728	$3,728	$9,693	$42,005
6	West Branch Columbia Southern East	396.91	NA	5	1	1	10	NA	$8,078	$21,709	$397	$30,184	15%	15%	30%	$4,528	$4,528	$11,772	$51,010
6	West Branch Columbia Southern East	432.18	NA	5	1	1	10	NA	$8,796	$23,638	$432	$32,866	15%	15%	30%	$4,930	$4,930	$12,818	$55,543
6	West Branch Columbia Southern East	502.21	NA	5	1	1	10	NA	$10,221	$27,468	$502	$38,191	15%	15%	30%	$5,729	$5,729	$14,895	$64,544
6	West Branch Columbia Southern East	312.65	NA	5	1	1	10	NA	$6,363	$17,100	$313	$23,776	15%	15%	30%	$3,566	$3,566	$9,273	$40,181
6	West Branch Columbia Southern East	4.09	NA	5	1	1	10	NA	$83	$223	$4	$311	15%	15%	30%	$47	$47	$121	$525
6	West Branch Columbia Southern East	4.60	NA	5	1	1	10	NA	$94	$252	$5	$350	15%	15%	30%	$52	$52	$136	$591
6	West Branch Columbia Southern East	NA	9	NA	NA	NA	NA	$9,000	NA	NA	NA	$9,000	15%	15%	30%	$1,350	$1,350	$3,510	$15,210
6	West Branch Columbia Southern East	NA	7	NA	NA	NA	NA	$7,000	NA	NA	NA	$7,000	15%	15%	30%	$1,050	$1,050	$2,730	$11,830
7	Flannery Ditch	32.03	NA	5	1	1	10	NA	$652	$1,752	$32	$2,436	15%	15%	30%	$365	$365	$950	$4,116
7	Flannery Ditch	1358.45	NA	5	1	1	10	NA	$27,648	$74,298	$1,358	$103,305	15%	15%	30%	$15,496	$15,496	$40,289	$174,585
7	Flannery Ditch	770.60	NA	5	1	1	10	NA	$15,684	$42,147	$771	$58,601	15%	15%	30%	$8,790	$8,790	$22,855	$99,036
7	Flannery Ditch	17.25	NA	5	1	1	10	NA	$351	$944	$17	$1,312	15%	15%	30%	$197	$197	$512	$2,217
7	Flannery Ditch	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	15%	30%	$600	$600	$1,560	$6,760
7	Gerking Lateral	NA	11	NA	NA	NA	NA	$11,000	NA	NA	NA	$11,000	10%	12%	30%	$1,100	$1,320	$4,026	$17,446
7	Hillburner Lateral	820.24	NA	5	1	1	10	NA	$16,694	$44,862	$820	$62,376	12%	12%	30%	$7,485	$7,485	$23,204	$100,550
7	Hillburner Lateral	19.98	NA	5	1	1	10	NA	$407	$1,093	$20	$1,519	12%	12%	30%	$182	$182	$565	$2,449
7	Hillburner Lateral	549.86	NA	5	1	1	10	NA	$11,191	$30,074	$550	$41,814	12%	12%	30%	$5,018	$5,018	$15,555	$67,405
7	Hillburner Lateral	589.69	NA	5	1	1	10	NA	$12,002	$32,252	$590	$44,844	12%	12%	30%	$5,381	$5,381	$16,682	$72,288
7	Hillburner Lateral	310.65	NA	5	1	1	10	NA	$6,323	$16,991	$311	$23,624	12%	12%	30%	$2,835	$2,835	$8,788	$38,082
7	Hillburner Lateral	458.95	NA	5	1	1	10	NA	$9,341	$25,102	$459	$34,902	12%	12%	30%	$4,188	$4,188	$12,983	$56,262
7	Hillburner Lateral	1.67	NA	5	1	1	10	NA	$34	$92	$2	$127	12%	12%	30%	$15	$15	$47	$205
7	Hillburner Lateral	305.83	NA	5	1	1	10	NA	$6,225	$16,727	$306	$23,258	12%	12%	30%	$2,791	$2,791	$8,652	$37,491
7	Hillburner Lateral	527.73	NA	5	1	1	10	NA	$10,741	$28,864	$528	$40,132	12%	12%	30%	$4,816	$4,816	$14,929	$64,693
7	Hillburner Lateral	3.91	NA	5	1	1	10	NA	$80	$214	$4	$297	12%	12%	30%	$36	$36	$111	$479
7	Hillburner Lateral	3.04	NA	5	1	1	10	NA	$62	$166	$3	$231	12%	12%	30%	$28	$28	$86	$373
7	Hillburner Lateral	704.17	NA	5	1	1	10	NA	$14,332	$38,513	$704	$53,549	12%	12%	30%	$6,426	$6,426	$19,920	$86,321
7	Hillburner Lateral	220.09	NA	5	1	1	10	NA	$4,479	$12,037	$220	$16,737	12%	12%	30%	$2,008	$2,008	$6,226	$26,980
7	Hillburner Lateral	6.72	NA	5	1	1	10	NA	$137	$367	$7	$511	12%	12%	30%	$61	$61	$190	$823

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Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[11]
7	Hillburner Lateral	124.02	NA	5	1	1	10	NA	$2,524	$6,783	$124	$9,431	12%	12%	30%	$1,132	$1,132	$3,508	$15,203
7	Hillburner Lateral	694.03	NA	5	1	1	10	NA	$14,125	$37,959	$694	$52,778	12%	12%	30%	$6,333	$6,333	$19,633	$85,078
7	Hillburner Lateral	2002.81	NA	5	1	1	10	NA	$40,763	$109,541	$2,003	$152,306	12%	12%	30%	$18,277	$18,277	$56,658	$245,517
7	Hillburner Lateral	1.56	NA	5	1	1	10	NA	$32	$85	$2	$118	12%	12%	30%	$14	$14	$44	$191
7	Hillburner Lateral	NA	17	NA	NA	NA	NA	$17,000	NA	NA	NA	$17,000	12%	12%	30%	$2,040	$2,040	$6,324	$27,404
7	Kickbush Lateral	NA	6	NA	NA	NA	NA	$6,000	NA	NA	NA	$6,000	15%	15%	30%	$900	$900	$2,340	$10,140
7	Tellin Lateral	210.97	NA	5	1	1	10	NA	$4,294	$11,539	$211	$16,043	15%	12%	30%	$2,407	$1,925	$6,113	$26,488
7	Tellin Lateral	2608.58	NA	5	1	1	10	NA	$53,091	$142,672	$2,609	$198,372	15%	12%	30%	$29,756	$23,805	$75,580	$327,513
7	Tellin Lateral	1118.27	NA	5	1	1	10	NA	$22,760	$61,162	$1,118	$85,040	15%	12%	30%	$12,756	$10,205	$32,400	$140,401
7	Tellin Lateral	1068.21	NA	5	1	1	10	NA	$21,741	$58,424	$1,068	$81,233	15%	12%	30%	$12,185	$9,748	$30,950	$134,116
7	Tellin Lateral	1288.48	NA	5	1	1	10	NA	$26,224	$70,472	$1,288	$97,984	15%	12%	30%	$14,698	$11,758	$37,332	$161,772
7	Tellin Lateral	36.90	NA	5	1	1	10	NA	$751	$2,018	$37	$2,806	15%	12%	30%	$421	$337	$1,069	$4,632
7	Tellin Lateral	6.61	NA	5	1	1	10	NA	$135	$362	$7	$503	15%	12%	30%	$75	$60	$192	$830
7	Tellin Lateral	525.21	NA	5	1	1	10	NA	$10,689	$28,725	$525	$39,940	15%	12%	30%	$5,991	$4,793	$15,217	$65,941
7	Tellin Lateral	1108.19	NA	5	1	1	10	NA	$22,555	$60,611	$1,108	$84,273	15%	12%	30%	$12,641	$10,113	$32,108	$139,135
7	Tellin Lateral	NA	9	NA	NA	NA	NA	$9,000	NA	NA	NA	$9,000	15%	12%	30%	$1,350	$1,080	$3,429	$14,859
7	West Branch Columbia Southern South	NA	11	NA	NA	NA	NA	$11,000	NA	NA	NA	$11,000	15%	15%	30%	$1,650	$1,650	$4,290	$18,590
																		Capital Costs	**$69,998,807**

D.4 Net Present Value of Eliminated Alternatives

This section presents the calculations used to estimate the net present value of the eliminated alternatives.

Discount Rate:	2.750%
Period of Analysis:	100

	Alternatives			
Project Groups	**HDPE Piping**	**PVC & HDPE Piping**	**Steel Piping**	**Groundwater and & HDPE Piping**
Design Life	100	33	50	50
Capital Costs				
1	$11,375,000	$11,375,000	$7,366,000	$11,375,000
2	$5,992,000	$5,934,000	$14,967,000	$5,992,000
3	$3,496,000	$3,178,000	$7,328,000	$3,496,000
4	$3,868,000	$3,677,000	$10,215,000	$3,868,000
5	$3,338,000	$3,427,000	$9,495,000	$4,439,000
6	$12,450,000	$11,486,000	$24,063,000	$4,365,000
7	$1,482,000	$1,560,000	$3,939,000	$2,167,000
Replacement Costs				
1	N/A	N/A	$2,386,000	N/A
2	N/A	$2,601,000	$4,848,000	N/A
3	N/A	$1,502,000	$2,374,000	N/A
4	N/A	$1,602,000	$3,309,000	N/A
5	N/A	$1,378,000	$3,076,000	$1,718,000
6	N/A	$5,229,000	$7,794,000	$1,689,000
7	N/A	$470,000	$1,276,000	N/A
Annual Operation and Maintenance Costs				
1	$25,000	$25,000	$25,000	$25,000
2	$157,000	$157,000	$157,000	$157,000
3	$47,000	$47,000	$47,000	$47,000
4	$114,000	$114,000	$114,000	$114,000
5	$104,000	$104,000	$104,000	$273,000
6	$167,000	$167,000	$167,000	$287,000
7	$66,000	$66,000	$66,000	$66,000
Total Percent Change in O&M:	-18%	-18%	-18%	17%
Total Net Present Value of O&M Costs				
1	$849,000	$849,000	$849,000	$849,000
2	$5,330,000	$5,330,000	$5,330,000	$5,330,000
3	$1,596,000	$1,596,000	$1,596,000	$1,596,000
4	$3,870,000	$3,870,000	$3,870,000	$3,870,000
5	$3,531,000	$3,531,000	$3,531,000	$9,269,000

6	$5,670,000	$5,670,000	$5,670,000	$9,744,000
7	$2,241,000	$2,241,000	$2,241,000	$2,241,000
Total Net Present Value of Project				
1	$12,224,000	$12,224,000	$10,601,000	$12,224,000
2	$11,322,000	$13,865,000	$25,145,000	$11,322,000
3	$5,092,000	$6,276,000	$11,298,000	$5,092,000
4	$7,738,000	$9,149,000	$17,394,000	$7,738,000
5	$6,869,000	$8,336,000	$16,102,000	$15,426,000
6	$18,120,000	$22,385,000	$37,527,000	$15,798,000
7	$3,723,000	$4,271,000	$7,456,000	$4,408,000

D.5 Hydrology Report

This reports provides a brief background of the current condition of the proposed project area and the potential effects to water resources from the piping of the Tumalo Irrigation District canal system. Project implementation consists of: (1) mobilizing and staging of construction equipment, (2) excavation of trenches, (3) placement and fusing of pipe, (4) compaction of backfill, and (5) restoration and reseeding of the disturbed areas.

The analysis herein will concentrate on the potential impact from the above construction and subsequent restoration activities to water resources.

The proposed action area is within the northern half of Deschutes County. The entire District is approximately 28,000 acres, and within that, there are 7,417 acres currently irrigated by 667 patrons. Of these 7,417 acres, 7,002 irrigated acres would be served by infrastructure included in the proposed action (TID 2017).

The area of potential effect for surface water include Crescent Lake, Crescent Creek, the Little Deschutes River, the Deschutes River, and Tumalo Creek. The upstream end of Lake Billy Chinook, at the confluence of the Deschutes, Crooked, and Metolius Rivers, serves as the downstream boundary of the area of potential effect. The area of potential effect for groundwater is limited to the upper Deschutes Basin.

Hydrologic Resources

The District's service area and the TID Irrigation Modernization Project are located in six subwatersheds: Buckhorn Canyon, Bull Creek, Lower Tumalo Creek, Laidlaw Butte-Deschutes River, Overturf Butte-Deschutes River, and Deep Canyon Dam-Deep Canyon, which cover a total of 169,251 acres. These six subwatersheds comprise the TID Watershed Planning Area. They are located within the Upper Deschutes watershed (HUC 17070301).

12-Digit Hydrologic Unit Code	Name	Area (acres)
170703010804	Buckhorn Canyon	13,809
170703010603	Bull Creek	32,153
170703010502	Lower Tumalo Creek	17,238
170703010802	Laidlaw Butte-Deschutes River	42,749
170703010406	Overturf Butte-Deschutes River	31,374
170703010604	Deep Canyon Dam-Deep Canyon	31,928
	Total	**169,251**

The Upper Deschutes watershed (HUC 17070301) covers 1.4 million acres, extending into three countries with 70 percent in the Deschutes County, 25 percent in Jefferson County, and 5 percent in Klamath County (NRCS 2005). The basin's western border is the crest of the Cascade Mountain Range. The southern border extends from the southern ridges that traverse along Odell Lake and follows a northeastern path along the summits of Royca Mountain, Davis Mountain, and Gilchrist Butte until reaching the confluence of the Deschutes and the Little Deschutes River. Here the Eastern border shifts east until reaching the northern flanks of the Newberry Caldera and directing north until the Crooked River. The northern border then traverses along the northern side of the Deschutes River with as little as a mile distance in some locations.

The basin's geology composition of porous volcanic rock and soil allows surface water to infiltrate into the subsurface and recharge groundwater aquifers (Gannet et al. 2001). This is one of the most significant traits of the watershed, establishing a profound connection between groundwater and surface water flow. Average annual runoff of $5.1x10^9$m is equivalent to about 0.19 meters over the entire basin with most of this water derived from the Cascade Range (O'Connor & Grant 2003).

The Watershed Planning Area is located in the rain shadow of the Cascade Mountain range. Orographic processes result in large amount of precipitation in the Cascades Range with levels exceeding 200 inches per year, mostly as snow. Precipitation rates diminish rapidly moving from west to east across the basin, with less than 10 inches per year received in the central part of the basin. The District's annual average precipitation is 10 to 14 inches, thus irrigation is essential to crop production, and TID irrigators rely on Crescent Lake and Tumalo Creek in order to receive adequate water supplies for their crops. The average high temperature for the month of July is 82 degrees Fahrenheit and average low temperature for the month of December is 23 degrees Fahrenheit. The average annual growing season is 120 days (TID 2016).

Future increases in temperature and changes in precipitation patterns could result in fundamental changes in the seasonal distribution of streamflow in the area and may have serious implications for natural resource managers and local farmers (Vano et al. 2015). Variable Infiltration Capacity (VIC) simulations show a substantial decrease in annual streamflow in response to increasing summer (April through September) warming where winter (October through March) warming stimulates greater streamflow immediately, which partly compensates for a subsequent decrease in summer streamflow that happens because less water is available (Das et al. 2011). Future projections exhibit a transition from snow to rain at intermediate and low elevations in the Cascade Range, causing earlier runoff and reduction in the pulse of runoff and groundwater recharge associated with spring snowmelt (Waibel 2010).

The District obtains water from Crescent Lake Reservoir and Tumalo Creek. Crescent Lake Reservoir, in the Cascade Range about 84 miles upstream from Bend on the Deschutes River, relies on annual snowmelt and precipitation for inflow. Water from Crescent Lake is released throughout the year, but during the irrigation season it is released as necessary to supply the District's water rights. The water is conveyed through Crescent Creek, the Little Deschutes River, and the Deschutes River to the District's BFC diversion in Bend where it enters a 5-mile-long pipeline completed in 2005. Diversion flow levels are operated by TID staff. In addition to stored water conveyance and diversion, the District also retains a 9.5 cfs live flow water right in the Deschutes River that is subject to diversion at its BFC intake.

The Tumalo Creek supply consists of streamflow generated by snow melt and precipitation conveyed through Tumalo Creek. Streamflow enters the District's Tumalo Feed Canal diversion structure on Tumalo Creek (RM 2.5) and enters a dual pipe conveyance system into the District. The TFC and the BFC diversions confluence in Tumalo, continuing as the TFC to supply the District.

The hydrology of Tumalo Creek is largely influenced by snowmelt and precipitation from its tributaries and groundwater discharge from springs. Tumalo Creek and its tributaries (Bottle Creek, Bridge Creek, Happy Valley Creek, Middle Fork, North Fork, Rock Creek, South Fork, and Spring Creek) are unusual in the area due to their response to rain-on-snow events, which result in large increases of streamflow. This is in part to the geography of the creek's basin which includes steep valley slopes. Streamflows typically peak at 200-300 cfs during the spring due to snow melt.

Impacts of historic changes to the Deschutes River and its tributaries' hydrographs due to decreased winter flows and increased summer flows discussed in the Plan-EA include diminished water and habitat quality. The Oregon Department of Environmental Quality (ODEQ) periodically prepares a list of all surface waters in the state considered impaired because they do not meet water quality standards under Section 303(d) of the Clean Water Act (33 USC 1251 et seq.). The Deschutes River and its tributaries in the study area is included on the most current list for temperature, DO, pH, sedimentation, turbidity, and/or Chlorophyll a.

Within the upper Deschutes Basin, precipitation in the Cascade Range provides 3,500 cfs of annual groundwater recharge. Inflows from outside the upper Deschutes provide an additional 850 cfs of recharge. Canal leakage across the region provides approximately 411 cfs of additional recharge based on 2008 data (Gannett et al. 2001, Gannett and Lite 2013). Subsequent canal lining and piping projects have further reduced canal leakage. Groundwater generally flows east and then north through the basin. Approximately half of this groundwater discharges into streams through springs along the edge of the Cascade Mountains. The remainder of this groundwater discharges into streams and rivers near the confluence of the Metolius, Deschutes, and Crooked Rivers.

Analysis Framework

The proposed action should have no adverse cumulative effects on water quality or quantity. Actions are limited to canals and laterals within the TID boundary with no return flows to river systems, thus limiting adverse effects to water quality. BMPs include proper erosion control. No new roads will be constructed within 300' of a stream thus reducing the impact of sedimentation and runoff to streams.

Measurable changes to streamflow are predicted to occur. When changes to streamflow occur, water yield is expected to occur as an increase in summer low flows for Tumalo Creek and winter low flows to Crescent Creek and subsequent waterbodies. Changes to streamflow are predicted to occur incrementally following completion of each project group of the HDPE Piping Alternative with a potential to allocate up to 48 cfs (approximately 18 cfs to Crescent Creek and 30 cfs to Tumalo Creek). Tables located in Appendix E quantify the effects the proposed action will have on streamflow within the area of potential effect.

Increasing streamflow has the potential to benefit water quality in streams and rivers within the area of potential effect which currently do not meet water quality standards under Section 303(d) of the Clean Water Act (33 U.S.C. 1251 et seq.). Increasing streamflows in Tumalo Creek would decrease water temperatures in the Deschutes River past the confluence (Park and Foged 2009; Mork 2016). This decrease in water temperature past the confluence would have an indirect effect on other water quality components including dissolved oxygen, pH, and chlorophyll a. Similar effects would occur as streamflows are increased past the Crescent Lake Dam. By not diverting the amount of water that is currently lost through seepage to the natural river systems would affect wetland and riparian areas within the area of potential effect, subsequently enhancing water quality.

No groundwater resources would be extracted or consumptively used as part of the proposed action; however, piping of irrigation canals and laterals may affect groundwater hydrology associated with canal leakage. Following construction, reduction in canal leakage is expected to result in reduced groundwater recharge during the irrigation season. A seepage loss assessment performed in 2016 calculated water loss at a rate of 48 cfs throughout the entire District (TID 2017). This estimate includes evaporation, so it is anticipated that the entire 48 cfs does not contribute to the aquifer. Extrapolating from prior study (Gannett and Lite 2013) data, the average relationship between canal recharge and groundwater levels in the central part of the Deschutes Basin is approximately 1 foot of groundwater elevation drop per 377,000 acre-feet of reduced canal recharge. HDPE Piping Alternative would reduce canal seepage, and associated groundwater recharge, by up to approximately 15,116 acre-feet annually in this part of the Deschutes Basin. On average, for this part of the Deschutes Basin, this decrease in recharge translates into a decreased groundwater elevation of approximately 0.040 feet annually. An important caveat is that localized effects on groundwater from implementation of the proposed project, would differ throughout the area of potential effect. Over the course of 50 years, this annual drop results in a cumulative decreased average groundwater elevation of 2 feet.

The proposed action should have substantial changes to hydrology within the District's canal and lateral systems. Eliminating seepage and evaporative losses through a piped and pressurized system could greatly increase conveyance efficiency while providing irrigators with pressurized water for on-farm use. Substantial benefits to irrigation water quality through piping of the canals and laterals would occur through the reduction of contaminants, such as herbicides and pesticides, from entering the water supply for TID's patrons.

Appendix E

Other Supporting Information

E.1 Intensity Threshold Table

This appendix section presents the intensity threshold table used to quantify effects to resources of concern as a result of the proposed action.

Table E-1. Intensity Threshold Table for the Tumalo Irrigation District – Irrigation Modernization Project.

	Intensity Threshold			
Resource	**Negligible**	**Minor**	**Moderate**	**Major**
Cultural Resources	No known, eligible resources are adversely affected or are at the lowest levels of detection or barely perceptible, and not measurable.	Affects a cultural site, structure or feature with little data potential. The historic context of the affected site(s) would be local. Not affect the contributing element of a property eligible for the National Register of Historic Places. Causes a slight change to a natural or physical ethnographic resource, if measurable and localized.	Affects a cultural site, structure or landscape with modest data potential of local, regional or state significance. Changes a contributing element but would not diminish resource integrity or jeopardize National Register eligibility. Localized and measurable change to a natural or physical ethnographic resource.	Affects a cultural site or landscape with high data potential of national context Diminishes the integrity of the resource to the extent that affects cannot be mitigated, would permanently impact the historic register eligibility of the resource, prevent a resource from meeting criteria for listing in a historic register, or reduce the ability of a cultural resource to convey its historic significance. Permanent severe change or exceptional benefit to

Resource	**Intensity Threshold**			
	Negligible	**Minor**	**Moderate**	**Major**
				a natural or physical ethnographic resource.
Geology and Soils	Project activities would not disturb soils or underlying geology.	Short-term erosion during construction at project and clearing sites on soils classified as not highly erodible. Short-term disturbance to the soil profile or underlying geology.	Short-term erosion during construction at project and clearing sites on soils classified as highly erodible. Short-term changes to previously undisturbed soil profiles or underlying geology.	Continued erosion after construction at project and clearing sites with soils classified as highly erodible, as defined by NRCS. Permanent changes to previously undisturbed soil profiles or underlying geology.
Fish and Aquatic Species	No discernable short or long-term impacts to fish life or habitat.	Changes in watershed conditions that cause minor change in existing hydrology or sediment functions. Direct or indirect habitat changes that result only in low, short-term change in risk to ESA-listed and other fish species at the	Changes in watershed conditions that cause moderate impairment to hydrology or sediment functions. Direct or indirect habitat changes that cause moderate, short or long-term change in risk to ESA-listed or other fish species at the	Changes in watershed conditions that cause high impairment to hydrology or sediment functions that affects population viability. When, through consultation, a proposed action would likely jeopardize a species’

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
		population or ESU scale.	population or ESU scale.	continued existence or destroy or adversely affect a species' critical habitat
Land Use	Existing land uses or ownership would continue as before.	A short-term change in or interruption to land use or access to existing land uses. A short-term or permanent change in landowner property (but very minor) use within an existing easement or where new right-of-way or easements are required.	A permanent change in land use that is compatible with existing land use. A permanent change to landowner property use within an existing easement. Permanently limited access to agricultural or timber production areas (stranded use). An increase in unauthorized land use or access that may or may not be compatible with existing land use. A short-term (more than one month at a time) change in or interruption to land use or access to existing land uses.	A permanent change resulting in a modification to greater than 50 percent of a tax lot. A new unauthorized land use or access that may or may not be compatible with existing land use.

Resource	Intensity Threshold Negligible	Minor	Moderate	Major
			A permanent change in land ownership.	
Public Safety	No change in risk to human health and safety.	Create a risk to health and safety that could largely be mitigated. Eliminate a known health and safety condition in localized areas	Create a known but short-term or infrequent health and safety condition. Eliminate a known health and safety condition on the study area level	Create a permanent and known health and safety condition. Eliminate a known health and safety condition on a regional level.
Recreation	No effect on the location, timing, or quality of recreation facilities and uses during and after construction.	Temporarily preclude or limit dispersed and dedicated recreational opportunities during off-peak use periods during project construction. Require relocation of dispersed recreational activities to an equal or better location after project construction. Expand to a limited degree existing	Temporarily preclude or limit dispersed and dedicated recreational opportunities during peak use periods during project construction. Create or encourage new unauthorized land uses along the right-of-way for recreational purposes, such as ATV use in unauthorized areas.	Obstruct legally existing or planned dispersed recreational uses after project construction. Alter or eliminate dedicated recreation opportunities after project construction. Create extensive new recreational opportunities or areas

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
		recreational areas or opportunities.	Create limited dispersed new recreational areas or opportunities.	
Socioeconomics	No reduction in the yield of agricultural products or timber, household income, or where project activities create an imperceptible change to the unemployment rate.	Little effect on the yield of agricultural products or timber. A 1/10 of 1 percent increase in the unemployment rate. A small change in farm household incomes.	A change to the yield of agricultural products or timber at the local level A moderate change in farm household incomes. A half percentage point increase to the rate of unemployment.	A change to the yield of agricultural products or timber at the regional or national level. A large change in farm household incomes. A full percentage point of change to the rate of unemployment.
Vegetation	Project activities would not affect vegetation or it is limited to small areas.	Effects would be localized on one or more species or populations. Any adverse effects can be effectively mitigated.	A large segment of one or more species populations show effects that are of importance, but relatively localized. Mitigation could be extensive, but likely effective.	Considerable effects on plant populations over large areas. Impact is severe or of exceptional benefit to native species. Extensive mitigation required offsetting

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
				adverse effects to native species, but success not assured.
Visual Resources	Project features are visually negligible or not visible.	Landscape is a designated scenic area and project features do not attract attention to the landscape. The majority of project features do not attract attention to the landscape. Short-term visual changes during project construction.	Landscape is a designated scenic area and some project features attract attention to the landscape. A majority of project features attract attention to the landscape.	Landscape is a designated scenic area and the majority of project features attract attention to the landscape. Project features create a disruptive change and dominate the landscape.
Water Resources	Project activities would not disturb or alter water quantity, water quality, groundwater quantity, and water rights.	*Surface Water Quantity:* Less than 10 percent change in volume of annual discharge in the study area. *Ground Water:* Long-term, less than 10 percent change in depth to	*Surface Water Quantity:* Greater than 10 percent and less than 20 percent change in volume of annual discharge in the study area. *Ground Water:* Short-term, greater than 10 percent change in depth to	*Surface Water Quantity:* Greater than 20 percent change in volume of annual discharge in the study area. *Ground Water:* Long-term, greater than 10 percent change in depth to

Resource	Intensity Threshold Negligible	Minor	Moderate	Major
		groundwater. *Water Rights:* Not Applicable; any change that is more than negligible would be considered moderate or major effect. *Water Quality:* Short-term measurable degradation to water quality in waterbodies that is unlikely to result in excursions to water quality standards on the Oregon's 303(d) list. Short-term measurable changes to water quality in waterbodies that are 303d listed.	groundwater. *Water Rights:* Short-term change in the availability of water to fulfill water rights. *Water Quality:* Permanent measurable changes to water quality in waterbodies that is unlikely to result in excursions to water quality standards on the Oregon's 303(d) list. Permanent measurable changes to water quality in waterbodies that are 303d listed.	groundwater. *Water Rights:* Permanent change in the availability of water to fulfill water rights. *Water Quality:* Permanent measurable changes to water quality in waterbodies that results in excursions to water quality standards on the Oregon's 303(d) list. Permanent measurable changes to the delisting of waterbodies that are 303d listed.
Wetland, Flood Plains, Riparian Zones	Doesn't alter wetlands or change the hydraulic capacity of	Alteration of non-jurisdictional wetland hydrology, vegetation, and/or soils changes water	Short-term alteration of jurisdictional wetland hydrology, vegetation, and/or soils that changes	Permanent alteration of jurisdictional wetland hydrology, vegetation, and/or soils that causes

Resource	Intensity Threshold			
	Negligible	Minor	Moderate	Major
	floodplains.	quality, hydrologic, and/or habitat functions. Altered hydraulic function or hydraulic capacity of floodplains to a degree that does not increase or decrease the potential for flooding and damage to personal property.	water quality, hydrologic, and/or habitat functions.	changes to water quality, hydrologic, and/or habitat functions. Altered hydraulic function or changes to hydraulic capacity of floodplains to a degree that changes the potential for flooding and damage to personal property.
Wildlife	Slight change in wildlife populations and/or habitats would not be of measurable to perceptible consequence.	Small local changes in wildlife populations or habitats would be of little consequence. Any adverse effects can be effectively mitigated.	Changes in wildlife populations or habitats would be of consequence, but relatively localized. Mitigation could be extensive but likely successful.	Considerable effects, possibly permanent, to native wildlife populations or habitats. Mitigation would be extensive, and success not assured.

Duration of Effects	
Temporary	Transitory effects which only occur over a period of days or months.
Short-term	Effects lasting 1-5 years.
Long-term	Effects last 5-20 years.
Permanent	Effects last more than 20 years.

E.2 Supporting Information for Fish and Aquatic Resources

This appendix section presenting supporting information providing details associated with Primary Constituent Elements for Oregon spotted frog and bull trout critical habitat.

Table E-2. Primary Constituent Elements for Oregon Spotted Frog Critical Habitat.

Primary Constituent Element Number	Habitat Description	Characteristics
PCE 1	Nonbreeding (N), Breeding (B), Rearing (R), and Overwintering Habitat (O). Ephemeral or permanent bodies of fresh water, including, but not limited to natural or manmade ponds, springs, lakes, slow-moving streams, or pools within or oxbows adjacent to streams, canals, and ditches.	Inundated for a minimum of 4 months per year (B, R) (timing varies by elevation but may begin as early as February and last as long as September);
		Inundated from October through March (O)
		If ephemeral, areas are hydrologically connected by surface water flow to a permanent water body (e.g., pools, springs, ponds, lakes, streams, canals, or ditches) (B, R);
		Shallow water areas (less than or equal to 30 centimeters (12 inches), or water of this depth over vegetation in deeper water (B, R);
		Total surface area with less than 50 percent vegetative cover (N);
		Gradual topographic gradient (less than 3 percent slope) from shallow water toward deeper, permanent water (B, R);
		Herbaceous wetland vegetation (i.e., emergent, submergent, and floating-leaved aquatic plants), or vegetation that can structurally mimic emergent wetland vegetation through manipulation (B, R);
		Shallow water areas with high solar exposure or low (short) canopy cover (B, R);

Primary Constituent Element Number	Habitat Description	Characteristics
		An absence or low density of nonnative predators (B, R, N)
PCE 2	Aquatic movement corridors. Ephemeral or permanent bodies of fresh water.	Less than or equal to 3.1 mi (5 km) linear distance from breeding areas
		Impediment free (including, but not limited to, hard barriers such as dams, impassable culverts, lack of water, or biological barriers such as abundant predators, or lack of refugia from predators).
PCE 3	Refugia Habitat	Nonbreeding, breeding, rearing, or overwintering habitat or aquatic movement corridors with habitat characteristics (e.g., dense vegetation and/or an abundance of woody debris) that provide refugia from predators (e.g., nonnative fish or bullfrogs).

Table E-3. Primary Constituent Elements for Bull Trout.

Primary Constituent Element Number	Habitat Description and Characteristics
PCE 1	Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.
PCE 2	Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.
PCE 3	An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

Primary Constituent Element Number	**Habitat Description and Characteristics**
PCE 4	Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.
PCE 5	Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.
PCE 6	In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.
PCE 7	A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.
PCE 8	Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
PCE 9	Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

E.3 Supporting Calculations for Geology and Soils

This appendix section presents supporting calculations used when evaluating effects of the proposed action with respect to geology and soil resources.

Table E-4. Detailed Calculations to Estimate Quantity of Soil Disturbed Under the Canal Lining Alternative.

Canal Top Width (ft)	Canal Bottom Width (ft)	Canal Length (ft)	Canal Volume Disturbed (cubic yards)	Berm Volume Disturbed (cubic yards)	Volume of Soil Disturbed (cubic yards)
5	1	126,482	3,829	37,476	41,306
12	4	107,260	33,960	31,781	65,741
15	3	82,183	22,394	24,350	46,745
18	2	17,358	4,651	5,143	9,794
20	4	14,781	7,160	4,380	11,540
28	4	14,277	10,510	4,230	14,740
				Total Volume of Soil Disturbed:	**189,865 cubic yards**

Table E-5. Detailed Calculations to Estimate Quantity of Soil Disturbed Under the HDPE Piping Alternative.

Diameter (ft)	Sum of Length (ft)	Excavation Width (ft)	Bedding Volume (CY)	Pipe Trench Volume Calcs		Canal Volume Calcs			Total Volume Disturbed (CY) ~excluding volume of pipe~
				Pipe Trench Depth	Pipe Trench Volume (CY)	Canal Top Width (ft)	Canal Bottom Width (ft)	Canal Volume (CY)	
0.50	122,101	4	7,914	0.3	3,957	1.7	1.0	3,040	14,023
0.67	31,969	4	2,171	0.3	1,241	2.3	1.3	1,415	4,413
0.83	21,442	4	1,522	0.4	1,052	2.8	1.7	1,483	3,624
1.00	29,216	4	2,164	0.5	1,739	3.4	2.0	2,909	5,963
1.17	14,721	4	1,136	0.6	1,034	3.9	2.3	1,995	3,582
1.33	24,323	4	1,952	0.7	1,974	4.5	2.7	4,306	6,974
1.50	16,635	5	1,386	0.8	1,535	5.1	3.0	3,727	5,560
1.67	2,434	5	210	0.8	252	5.6	3.3	673	939
2.00	15,179	5	1,405	1.0	1,928	6.8	4.0	6,046	7,613
2.17	12,617	5	1,207	1.1	1,754	7.3	4.3	5,898	7,137
2.33	6,207	5	613	1.2	939	7.9	4.7	3,365	3,934
2.50	4,971	6	506	1.3	814	8.4	5.0	3,094	3,510
2.67	5,410	6	568	1.3	954	9.0	5.3	3,831	4,234
2.83	6,850	6	740	1.4	1,297	9.6	5.7	5,476	5,913

Diameter (ft)	Sum of Length (ft)	Excavation Width (ft)	Bedding Volume (CY)	Pipe Trench Volume Calcs		Canal Volume Calcs			Total Volume Disturbed (CY) ~excluding volume of pipe~
				Pipe Trench Depth	Pipe Trench Volume (CY)	Canal Top Width (ft)	Canal Bottom Width (ft)	Canal Volume (CY)	
3.00	6,104	6	678	1.5	1,236	10.1	6.0	5,471	5,787
3.50	6,099	7	734	1.8	1,483	11.8	7.0	7,440	7,483
4.00	17,871	7	2,317	2.0	5,108	13.5	8.0	28,474	27,581
4.50	2,825	8	392	2.3	934	15.2	9.0	5,697	5,359
5.25	3,700	8	565	2.6	1,485	17.7	10.5	10,156	9,239
7.00	14,276	10	2,644	3.5	8,332	23.6	14.0	69,658	60,286
								Total	**193,154**

Note: Pipe length and diameter information from the TID 2017 SIP.

E.4 Supporting Calculations for Land Use

This appendix section presents supporting calculations used when evaluating effects of the proposed action with respect to land use.

Table E-6. Land Ownership in Tumalo Irrigation District.

Ownership	Percentage of Area	Acres
BEND METRO PARKS AND REC	1%	345
BLM	16%	4,466
DESCHUTES COUNTY	1%	181
OREGON PARKS AND REC	1%	178
PRIVATE	77%	21,530
STATE OF OR	4%	1,219
USFS	0%	45
Grand Total	**100%**	**27,964**

Note: Acreage data comes from the attribute table corresponding to Figure 3-13, which used GIS data from Deschutes County, BLM, USFS, and the FCA TID Boundary.

Table E-7. Land Zoning in Tumalo Irrigation District.

Zoning	Acres	Percentage of total area
EFUSC	3,625	13%
EFUTRB	13,975	50%
F1	1,322	5%

Zoning	**Acres**	**Percentage of total area**
F2	559	2%
FP	473	2%
MUA10	2,587	9%
OS&C	1,684	6%
PF	12	0%
RL	36	0%
RM	23	0%
RR10	1,031	4%
RS	554	2%
SM	1,547	6%
SR2-1/2	155	1%
TUC	51	0%
TUI	32	0%
TUR	77	0%
TUR5	129	0%
TURE	34	0%
UAR10	59	0%

Zoning	Acres	Percentage of total area
Grand Total	**27,964**	**100%**

Note: Acreage data comes from Deschutes County GIS data clipped to the TID Boundary provided by FCA.

Table E-8. Land Cover in Tumalo Irrigation District.

Land Cover Type	Acres	Percent of the total area
Barren Land	54	0%
Cultivated Crops	5,983	21%
Developed, High Intensity	2	0%
Developed, Low Intensity	792	3%
Developed, Medium Intensity	74	0%
Developed, Open Space	1,754	6%
Evergreen Forest	1,550	6%
Herbaceous	496	2%
Open Water	81	0%
Shrub/Scrub	17,076	61%
Woody Wetlands	103	0%
Grand Total	27,964	**100%**

Note: Acreage data comes from the 2011 National Land Cover Database GIS data clipped to the TID Boundary provided by FCA.

E.5 Supporting Calculations for Vegetation

This appendix section presents supporting calculations used when evaluating effects of the proposed action with respect to vegetation.

Table E-9. Calculations to Estimate Vegetation Disturbed by Construction.

System Element	Proposed Piping (ft)	Land affected on both sides of the canal (ft)	Additional affected land between canal affected area and maintenance road (ft)	Subtotal affected area (sq ft)
Canals	10,206	16	15	316,386
Laterals	354,746	10	8	6,385,428
System Element	**Units**	**Land affected width (ft)**	**Land affected length (ft)**	**Subtotal affected area**
Turnouts	662	10	30	198,600
Total (sq ft)				**6,900,414**
Total (acres)				**162**

Table E-10. Calculations to Estimate New Vegetation Area Created by the Conversion of Open Canals and Laterals to a Buried System.

Pipe Diameter (ft)	Sum of Length (ft)	Canal Top Width (ft)	Total Area Converted (sq ft)
0.50	122,101	1.7	206,191
0.67	31,969	2.3	71,982
0.83	21,442	2.8	60,349
1.00	29,216	3.4	98,673

Pipe Diameter (ft)	Sum of Length (ft)	Canal Top Width (ft)	Total Area Converted (sq ft)
1.17	14,721	3.9	58,005
1.33	24,323	4.5	109,532
1.50	16,635	5.1	84,273
1.67	2,434	5.6	13,702
2.00	15,179	6.8	102,531
2.17	12,617	7.3	92,327
2.33	6,207	7.9	48,913
2.50	4,971	8.4	41,973
2.67	5,410	9.0	48,729
2.83	6,850	9.6	65,550
3.00	6,104	10.1	61,850
3.50	6,099	11.8	72,093
4.00	17,871	13.5	241,431
4.50	2,825	15.2	42,941
5.25	3,700	17.7	65,610
7.00	14,276	23.6	337,504
		TOTAL	**1,924,159**

Note: Pipe length and diameter information from the TID 2017 SIP.

E.6 Supporting Calculations for Water Resources

This appendix section presents supporting calculations used when evaluating effects of the proposed action with respect to water resources.

Table E-11. ODFW Instream Water Rights for the Little Deschutes River, Crescent Creek, Deschutes River, and Tumalo Creek.

Source	From	To	Certificate	Priority Date	Instream Rates (cfs)											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Little Deschutes R	Crescent Creek	Mouth	73226	10/11/1990	200	200	236	240	240	200	126	74.5	92.2	116	164	196
Crescent Cr	Crescent Lake	Mouth	73234	10/11/1990	75	75	125	125	125	75	50	50	50	50	108	125
Deschutes R	Wickiup Reservoir	Little Deschutes	59776	11/3/1983	300	300	300	300	300	300	300	300	300	300	300	300
Deschutes R	Little Deschutes	Spring River	59777	11/3/1983	400	400	400	400	400	400	400	400	400	400	400	400
Deschutes R	Spring River	North Canal Dam	59778	11/3/1983	660	660	660	660	660	660	660	660	660	660	660	660
Deschutes R	North Canal Dam	Round Butte Reservoir	Pending	9/24/1990		250	250	250	250	250	250	250	250	250	250	250
Tumalo Cr	S. Fk Tumalo	Mouth	73222	10/11/1990	47	47	68.7	76.6	82	47	32	32	47	65.3	47	47

Tumalo Creek

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in Tumalo Creek. Data for historic stream flow represent the 1998 through 2016 water years. Data is sourced from OWRD Gauge No. 14073520.

Table E-12. Tumalo Creek - Historic Daily Average Stream Flow (cfs).

Month	Low Stream Flow (cfs) - 80% Exceedance	Lower Bar	Average Stream Flow (cfs) - 50% Exceedance	Upper Bar	High Stream Flow (cfs) - 20% Exceedance
Oct	45.0	10.0	55.0	13.0	68.0
Nov	52.0	12.0	64.0	12.0	76.0
Dec	53.0	12.0	65.0	22.0	87.0
Jan	57.0	11.0	68.0	18.0	86.0
Feb	58.6	10.4	69.0	17.4	86.4
Mar	52.0	14.0	66.0	22.8	88.8
Apr	11.0	20.5	31.5	45.7	77.2
May	11.0	19.5	30.5	48.5	79.0
Jun	19.0	45.0	64.0	64.0	128.0
Jul	7.4	7.6	15.0	25.4	40.4
Aug	7.1	4.9	12.0	4.0	16.0
Sep	5.8	6.2	12.0	5.0	17.0

Table E-13. Tumalo Creek - Future Daily Average Stream Flow (cfs) following the Canal Lining Alternative.

Month	Historic Daily Average Stream Flow (cfs)	Stream Flow Restored Through Project (cfs)	Future Daily Average Stream Flow instream (cfs)	ODFW Instream Water Right[1]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge[4]
Oct	55.0	10.8	65.8	65.3	0.2%
Nov	64.0	0.0	64.0	47.0	0.0%
Dec	65.0	0.0	65.0	47.0	0.0%
Jan	68.0	0.0	68.0	47.0	0.0%
Feb	69.0	0.0	69.0	47.0	0.0%
Mar	66.0	0.0	66.0	68.7	0.0%
Apr[2]	31.5	10.8	42.3	76.6	0.2%
May	30.5	14.5/26.8	45.0/57.3	82.0	0.2%/0.4%
Jun	64.0	26.8	90.8	47.0	0.4%
Jul	15.0	26.8	41.8	32.0	0.4%
Aug	12.0	26.8	38.8	32.0	0.4%
Sep[3]	12.0	26.8/14.5	38.8/26.5	47.0	0.4%/0.2%

Notes:

Season 1 (39.6%): April 1- April 30 and Oct. 1 - Oct. 31: 1 CFS to 80 AC
Season 2 (53%): May 1- May 14 and Sept. 15 - Sept 30: 1 CFS to 60 AC
Season 3 (100%): May 15 - Sept. 14: 1 CFS to 32.4 AC

1. ODFW instream Water Right #73222 Priority Date 10/11/90.
2. This month is separated between two irrigation seasons (Season 2/Season 3)
3. This month is separated between two irrigation seasons (Season 3/Season 2)
4. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs

Table E-14. Tumalo Creek - Future Daily Average Stream Flow (cfs) following the HDPE Pressurized Pipeline Alternative.

Month	Historic Daily Average Stream Flow (cfs)	Stream Flow Restored Through Project (cfs)	Future Daily Average Stream Flow (cfs)	ODFW Instream Water Right[1]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge[4]
Oct	55.0	12.1	67.1	65.3	0.2%
Nov	64.0	0.0	64.0	47.0	0.0%
Dec	65.0	0.0	65.0	47.0	0.0%
Jan	68.0	0.0	68.0	47.0	0.0%
Feb	69.0	0.0	69.0	47.0	0.0%
Mar	66.0	0.0	66.0	68.7	0.0%
Apr[2]	31.5	12.1	43.6	76.6	0.2%
May	30.5	16.1/29.8	46.6/60.3	82.0	0.3%/0.5%
Jun	64.0	29.8	93.8	47.0	0.5%
Jul	15.0	29.8	44.8	32.0	0.5%
Aug	12.0	29.8	41.8	32.0	0.5%
Sep[3]	12.0	29.8/16.1	41.8/28.1	47.0	0.5%/0.3%

Notes: Irrigation dates run from April 1 - October 31.
Season 1 (39.6%): April 1- April 30 and Oct. 1 - Oct. 31: 1 CFS to 80 AC
Season 2 (53%): May 1- May 14 and Sept. 15 - Sept 30: 1 CFS to 60 AC
Season 3 (100%): May 15 - Sept. 14: 1 CFS to 32.4 AC

1. ODFW instream Water Right #73222 Priority Date 10/11/90.
2. This month is separated between two irrigation seasons (Season 2/Season 3)
3. This month is separated between two irrigation seasons (Season 3/Season 2)
4. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs

Crescent Creek

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in Crescent Creek. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions following the Stipulated Settlement Agreement. Data is source from OWRD Gauge No. 14060000.

Table E-15. Crescent Creek – Historic and Modified Daily Average Stream Flow (cfs).

Month	Historic Low Stream Flow (cfs) - 80% Exceedance	Lower Bar	Historic Average Stream Flow (cfs) - 50% Exceedance	Upper Bar	Historic High Stream Flow (cfs) - 20% Exceedance	Modified Average Daily Stream Flow (cfs)
Oct	4.1	2.0	6.1	16.9	23.0	20.0
Nov	4.3	2.5	6.8	5.2	12.0	20.0
Dec	4.6	2.3	6.9	4.1	11.0	20.0
Jan	4.9	2.3	7.2	11.8	19.0	20.0
Feb	5.4	1.5	6.9	35.1	42.0	20.0
Mar	4.7	2.2	6.9	36.1	43.0	20.0
Apr	4.8	2.4	7.2	14.8	22.0	7.0
May	5.5	3.1	8.6	63.4	72.0	9.0
Jun	7.7	26.3	34.0	79.0	113.0	34.0
Jul	54.0	57.0	111.0	39.0	150.0	111.0
Aug	114.0	24.0	138.0	29.0	167.0	138.0
Sep	44.0	58.0	102.0	52.0	154.0	102.0

Table E-16. Crescent Creek - Future Daily Average Stream Flow (cfs) following the Canal Lining Alternative.

Month	Modified Daily Average Stream Flow	5 cfs Management Agreement	Stream Flow Restored Through Project (cfs)	Future Daily Average Stream Flow (cfs) [2]	ODFW Instream Water Right[1]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge [3]
Oct	20.0	5.0	16.4	21.4	50	0.3%
Nov	20.0	5.0	16.4	21.4	108.0	0.3%
Dec	20.0	5.0	16.4	21.4	125.0	0.3%
Jan	20.0	5.0	16.4	21.4	75.0	0.3%
Feb	20.0	5.0	16.4	21.4	75.0	0.3%
Mar	20.0	5.0	16.4	21.4	125.0	0.3%
Apr	7.0	5.0	16.4	28.4	125	0.3%
May	9.0	0.0	0.0	9.0	125.0	0.0%
Jun	34.0	0.0	0.0	34.0	75.0	0.0%
Jul	111.0	0.0	0.0	111.0	50.0	0.0%
Aug	138.0	0.0	0.0	138.0	50.0	0.0%
Sep	102.0	0.0	0.0	102.0	50.0	0.0%

Notes: Irrigation dates run from April 1 - October 31.
Season 1 (39.6%): April 1- April 30 and Oct. 1 - Oct. 31: 1 CFS to 80 AC
Season 2 (53%): May 1- May 14 and Sept. 15 - Sept 30: 1 CFS to 60 AC
Season 3 (100%): May 15 - Sept. 14: 1 CFS to 32.4 AC

1. ODFW instream Water Right #73234 Priority Date 10/11/90.
2. Assumes that restored stream flow extends from October 15 through April 15
3. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs

Table E-17. Crescent Creek - Future Daily Average Stream Flow (cfs) following the HDPE Pressurized Pipeline Alternative.

Month	Modified Daily Average Stream Flow	5 cfs Management Agreement	Stream Flow Restored Through Project (cfs)	Future Daily Average Stream Flow instream (cfs) [2]	ODFW Instream Water Right[1]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge [3]
Oct	20.0	5	18.2	23.2	50	0.3%
Nov	20.0	5	18.2	23.2	108	0.3%
Dec	20.0	5	18.2	23.2	125	0.3%
Jan	20.0	5	18.2	23.2	75	0.3%
Feb	20.0	5	18.2	23.2	75	0.3%
Mar	20.0	5	18.2	23.2	125	0.3%
April	7.0	5	18.2	30.2	125	0.3%
May	9.0	0	0.0	9.0	125	0.0%
Jun	34.0	0	0.0	34.0	75	0.0%
Jul	111.0	0	0.0	111.0	50	0.0%
Aug	138.0	0	0.0	138.0	50	0.0%
Sep	102.0	0	0.0	102.0	50	0.0%

Notes: Irrigation dates run from April 1 - October 31.
Season 1 (39.6%): April 1- April 30 and Oct. 1 - Oct. 31: 1 CFS to 80 AC
Season 2 (53%): May 1- May 14 and Sept. 15 - Sept 30: 1 CFS to 60 AC
Season 3 (100%): May 15 - Sept. 14: 1 CFS to 32.4 AC

1. ODFW instream Water Right #73234 Priority Date 10/11/90.
2. Assumes that restored stream flow extends from October 15 through April 15
3. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs

Little Deschutes River

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in the Little Deschutes River. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions following the Stipulated Settlement Agreement with the Center for Biological Diversity. Data is source from OWRD Gauge No. 1406300.

Table E-18. Little Deschutes River - Historic and Modified Daily Average Stream Flow (cfs).

Month	Historic Low Stream Flow (cfs) - 80% Exceedance	Lower Bar	Historic Average Stream Flow (cfs) - 50% Exceedance	Upper Bar	Historic High Stream Flow (cfs) - 20% Exceedance	Modified Daily Average Stream Flow (cfs)
Oct	40.0	18.0	58.0	38.2	96.2	76.2
Nov	57.0	19.0	76.0	37.0	113.0	94.2
Dec	62.0	28.0	90.0	78.0	168.0	108.2
Jan	71.0	47.0	118.0	92.0	210.0	136.2
Feb	72.0	54.0	126.0	92.0	218.0	144.2
Mar	100.0	62.0	162.0	118.6	280.6	180.2
Apr	136.0	92.0	228.0	131.2	359.2	246.2
May	149.0	91.0	240.0	241.0	481.0	240.0
Jun	94.8	68.2	163.0	153.0	316.0	163.0
Jul	102.0	31.0	133.0	50.0	183.0	133.0
Aug	114.0	26.0	140.0	48.0	188.0	140.0
Sep	79.0	39.0	118.0	63.0	181.0	118.0

Table E-19. Little Deschutes River - Future Daily Average Stream Flow (cfs) following the Canal Lining Alternative.

Month	Modified Daily Average Stream Flow	5 cfs Management Agreement	Stream Flow Restored Through Project (cfs)[2,3]	Future Daily Average Stream Flow instream (cfs)	ODFW Instream Water Right[1]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge[4]
Oct	76.2	5	14.9	77.9	116.0	0.2%
Nov	94.2	5	14.9	95.9	164.0	0.2%
Dec	108.2	5	14.9	109.9	196.0	0.2%
Jan	136.2	5	14.9	137.9	200.0	0.2%
Feb	144.2	5	14.9	145.9	200.0	0.2%
Mar	180.2	5	14.9	181.9	236.0	0.2%
Apr	246.2	5	14.9	247.9	240.0	0.2%
May	240.0	0	0.0	240.0	240.0	0.0%
Jun	163.0	0	0.0	163.0	200.0	0.0%
Jul	133.0	0	0.0	133.0	126.0	0.0%
Aug	140.0	0	0.0	140.0	74.5	0.0%
Sep	118.0	0	0.0	118.0	92.2	0.0%

Notes:
1. ODFW Instream Water Right #73226 Priority Date 10/11/90
2. Assumes that restored stream flow extends from October 15 through April 15
3. To account for channel losses, an 18 percent loss factor is used between Crescent Creek Gauging Station and the Benham Falls Gauging Station No. 14064500 on the Deschutes River. Therefore, an estimated 9 percent channel loss between Crescent Creek and the Little Deschutes River Gauging Station No. 14063000 is included above and the other 9 percent is included in the Benham Falls Future Average Stream Flow Chart.
4. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs.

Table E-20. Little Deschutes River - Future Daily Average Stream Flow (cfs) following the HDPE Pressurized Piping Alternative.

Month	Modified Daily Average Stream Flow	5 cfs Management Agreement	Stream Flow Restored Through Project (cfs)[2,3]	Future Daily Average Stream Flow instream (cfs)	ODFW Instream Water Right[1]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge[4]
Oct	76.2	5	21.1	84.1	200	0.4%
Nov	94.2	5	21.1	102.1	200	0.4%
Dec	108.2	5	21.1	116.1	236	0.4%
Jan	136.2	5	21.1	144.1	240	0.4%
Feb	144.2	5	21.1	152.1	240	0.4%
Mar	180.2	5	21.1	188.1	200	0.4%
Apr	246.2	5	21.1	254.1	126	0.4%
May	240.0	0	0.0	240.0	74.5	0.0%
Jun	163.0	0	0.0	163.0	92.2	0.0%
Jul	133.0	0	0.0	133.0	116	0.0%
Aug	140.0	0	0.0	140.0	164	0.0%
Sep	118.0	0	0.0	118.0	196	0.0%
Sep	118.0	0	0.0	118.0	92.2	0.0%

Notes:
1. ODFW Instream Water Right #73226 Priority Date 10/11/90
2. Assumes that restored stream flow extends from October 15 through April 15
3. To account for channel losses, an 18 percent loss factor is used between Crescent Creek Gauging Station and the Benham Falls Gauging Station No. 14064500 on the Deschutes River. Therefore, an estimated 9 percent channel loss between Crescent Creek and the Little Deschutes River Gauging Station No. 14063000 is included above and the other 9 percent is included in the Benham Falls Future Average Stream Flow Chart.
4. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs. Upper Deschutes River at Benham Falls

Upper Deschutes River at Benham Falls

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in the Upper Deschutes River at Benham Falls. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions following the Stipulated Settlement Agreement with the Center for Biological Diversity. Data is source from OWRD Gauge No. 14064500.

Table E-21. Deschutes River at Benham Falls - Historic and Modified Daily Average Stream Flow (cfs).

Month	Low Stream Flow (cfs) - 80% Exceedance	Lower Bar	Average Stream Flow (cfs) - 50% Exceedance	Upper Bar	High Stream Flow (cfs) - 20% Exceedance	Modified Daily Average Stream Flow (cfs)
Oct	499.0	347.0	846.0	454.0	1300.0	854.9
Nov	462.0	59.5	521.5	292.5	814.0	545.9
Dec	485.0	78.0	563.0	342.8	905.8	603.4
Jan	496.0	109.0	605.0	405.0	1010.0	643.9
Feb	518.0	92.5	610.5	505.5	1116.0	648.4
Mar	553.0	197.0	750.0	412.0	1162.0	804.4
Apr	877.8	372.2	1250.0	290.0	1540.0	1316.4
May	1550.0	260.0	1810.0	160.0	1970.0	1810.0
Jun	1660.0	210.0	1870.0	200.0	2070.0	1870.0
Jul	1850.0	130.0	1980.0	112.0	2092.0	1980.0
Aug	1798.0	102.0	1900.0	120.0	2020.0	1900.0
Sep	1420.0	250.0	1670.0	172.0	1842.0	1670.0

Table E-22. Deschutes River at Benham Falls - Future Daily Average Stream Flow (cfs) following the Canal Lining Alternative.

Month	Modified Daily Average Stream Flow	5 cfs Management Agreement (OWRD 2005)	Stream Flow Restored Through Project (cfs) [3,4]	Future Daily Average Stream Flow instream (cfs)	ODFW Instream Water Right[1] in the Deschutes River from the mouth of the Little Deschutes River to the confluence of Spring River	ODFW Instream Water Right[2] in the Deschutes River from the mouth of Spring River to the North Canal Dam at Bend	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge[5]
Oct	854.9	5	13.3	863.3	400.0	660.0	0.2%
Nov	545.9	5	13.3	538.8	400.0	660.0	0.2%
Dec	603.4	5	13.3	580.3	400.0	660.0	0.2%
Jan	643.9	5	13.3	622.3	400.0	660.0	0.2%
Feb	648.4	5	13.3	627.8	400.0	660.0	0.2%
Mar	804.4	5	13.3	767.3	400.0	660.0	0.2%
Apr	1316.4	5	13.3	1267.3	400.0	660.0	0.2%
May	1810.0	0	0.0	1810.0	400.0	660.0	0.0%
Jun	1870.0	0	0.0	1870.0	400.0	660.0	0.0%
Jul	1980.0	0	0.0	1980.0	400.0	660.0	0.0%
Aug	1900.0	0	0.0	1900.0	400.0	660.0	0.0%
Sep	1670.0	0	0.0	1670.0	400.0	660.0	0.0%

Notes:
1. ODFW Instream Water Right #59777 Priority Date 11/03/83.
2. ODFW Instream Water Right #59778 Priority Date 11/03/83.
3. Assumes that restored stream flow extends from October 15 through April 15.
4. To account for channel losses, an 18 percent loss factor is used between Crescent Creek Gauging Station and the City of Bend.
5. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs.

Table E-23. Deschutes River at Benham Falls - Future Daily Average Stream Flow (cfs) following the HDPE Pressurized Piping Alternative.

Month	Modified Daily Average Stream Flow	5 cfs Management Agreement (OWRD 2005)	Stream Flow Restored Through Project (cfs) [3,4]	Future Daily Average Stream Flow instream (cfs)	ODFW Instream Water Right[1] in the Deschutes River from the mouth of the Little Deschutes River to the confluence of Spring River	ODFW Instream Water Right[2] in the Deschutes River from the mouth of Spring River to the North Canal Dam at Bend	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge[5]
Oct	854.9	5	14.8	864.8	400.0	660.0	0.2%
Nov	545.9	5	14.8	540.3	400.0	660.0	0.2%
Dec	603.4	5	14.8	581.8	400.0	660.0	0.2%
Jan	643.9	5	14.8	623.8	400.0	660.0	0.2%
Feb	648.4	5	14.8	629.3	400.0	660.0	0.2%
Mar	804.4	5	14.8	768.8	400.0	660.0	0.2%
April	1316.4	5	14.8	1268.8	400.0	660.0	0.2%
May	1810.0	0	0.0	1810.0	400.0	660.0	0.0%
Jun	1870.0	0	0.0	1870.0	400.0	660.0	0.0%
Jul	1980.0	0	0.0	1980.0	400.0	660.0	0.0%
Aug	1900.0	0	0.0	1900.0	400.0	660.0	0.0%
Sep	1670.0	0	0.0	1670.0	400.0	660.0	0.0%

Notes:
1. ODFW Instream Water Right #59777 Priority Date 11/03/83.
2. ODFW Instream Water Right #59778 Priority Date 11/03/83.
3. Assumes that restored stream flow extends from October 15 through April 15.
4. To account for channel losses, an 18 percent loss factor is used between Crescent Creek Gauging Station and the City of Bend.
5. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs.

Upper Deschutes River at Bend, Below North Canal Dam

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in the Upper Deschutes River at Bend, below North Canal Dam. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions following the Stipulated Settlement Agreement with the Center for Biological Diversity. Data is sourced from OWRD Gauge No. 14070500.

Table E-24. Upper Deschutes River Below North Canal Dam - Historic and Modified Daily Average Stream Flow (cfs).

Month	Historic Low Stream Flow (cfs) - 80% Exceedance	Lower Bar	Historic Average Stream Flow (cfs) - 50% Exceedance	Upper Bar	Historic High Stream Flow (cfs) - 20% Exceedance	Modified Average Daily Stream Flow (cfs)
Oct	72	231	303	224	527.00	318.3
Nov	333	118	451	211	661.60	466.3
Dec	400	112	512	287	798.80	527.3
Jan	389	133	522	311	832.80	536.8
Feb	401	127	529	463	991.00	543.8
Mar	452	203	655	423	1078.00	670.3
Apr	50	125	175	447	622.20	190.3
May	37	49	86	65	151	85.9
Jun	35	51	86	59	145	86.0
Jul	32	47	79	57	136	79.0
Aug	33	46	79	57	136	79.0
Sep	35	52	87	54	141	87.0

Table E-25. Upper Deschutes River Below North Canal Dam - Future Daily Average Stream Flow (cfs) following the Canal Lining Alternative.

Month	Modified Daily Average Stream Flow	5 cfs Management Agreement (OWRD 2005)	Stream Flow Restored Through Project (cfs)[2,3]	Future Daily Average Stream Flow instream (cfs)	ODFW Instream Water Right[1]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge[4]
Oct	318.3	5	12.5	374.3	250	0.2%
Nov	466.3	5	12.5	531.3	250	0.2%
Dec	527.3	5	12.5	593.3	250	0.2%
Jan	536.8	5	12.5	602.8	250	0.2%
Feb	543.8	5	12.5	612.8	250	0.2%
Mar	670.3	5	12.5	740.3	250	0.2%
Apr	190.3	5	12.5	257.3	250	0.2%
May	85.9	0	0.0	132.5/146.2	250	0.3%/0.5%
Jun	86.0	0	0.0	117.5	250	0.0%
Jul	79.0	0	0.0	109.5	250	0.0%
Aug	79.0	0	0.0	143.0	250	0.0%
Sep	87.0	0	0.0	128.8/115.1	250	0.5%/0.3%

Notes:
1. ODFW Pending Instream Water Right Priority Date 09/24/1990
2. Assumes that restored stream flow extends from October 15 through April 15
3. To account for channel losses, a 7 percent loss factor is used between Benham Falls Gauging Station and the City of Bend at North Canal Dam.
4. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs.

Table E-26. Upper Deschutes River Below North Canal Dam - Future Daily Average Stream Flow (cfs) following the HDPE Pressurized Pipeline Alternative.

Month	Modified Daily Average Stream Flow	5 cfs Management Agreement (OWRD 2005)	Stream Flow Restored Through Project (cfs)[2,3]	Future Daily Average Stream Flow instream (cfs)	ODFW Instream Water Right[1]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge[4]
Oct	318.3	5	13.9	375.7	250	0.2%
Nov	466.3	5	13.9	532.7	250	0.2%
Dec	527.3	5	13.9	594.7	250	0.2%
Jan	536.8	5	13.9	607.2	250	0.2%
Feb	543.8	5	13.9	615.2	250	0.2%
Mar	670.3	5	13.9	738.7	250	0.2%
Apr	190.3	5	13.9	224.2	250	0.2%
May	85.9	0	0.0	132.5/146.2	250	0.3%/0.5%
Jun	86.0	0	0.0	150.0	250	0.0%
Jul	79.0	0	0.0	94.0	250	0.0%
Aug	79.0	0	0.0	91.0	250	0.0%
Sep	87.0	0	0.0	128.8/115.1	250	0.5%/0.3%

Notes:
1. ODFW Pending Instream Water Right Priority Date 09/24/1990
2. Assumes that restored stream flow extends from October 15 through April 15
3. To account for channel losses, a 7 percent loss factor is used between Benham Falls Gauging Station and the City of Bend at North Canal Dam.
4. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs.

Deschutes River Downstream Tumalo Creek Confluence

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in the Deschutes River past the Tumalo Creek confluence. There is no OWRD stream gage near the confluence, therefore, data was extrapolated using the historic daily average stream flow from OWRD Gauge No. 14073520 below the TFC diversion and the historic daily average stream flow from OWRD Gauge No. 14070500 below North Canal Dam.

Table E-27. Deschutes River Downstream of the Tumalo Creek Confluence - Historic and Modified Daily Average Stream Flow (cfs).

Month	Historic Daily Average Stream Flow (cfs) Downstream from North Canal Dam	Historic Daily Average Stream Flow (cfs) Downstream from TFC Diversion	Estimated Historic Daily Average Stream Flow (cfs) Downstream from Tumalo Creek Confluence
Oct	303	55	358
Nov	451	64	515
Dec	512	65	577
Jan	522	68	590
Feb	529	69	598
Mar	655	66	721
Apr	175	31.5	207
May	86	30.5	116
Jun	86	64	150
Jul	79	15	94
Aug	32.0	42.5	74.5
Sep	34.0	52.5	86.5

Table E-28. Deschutes River Downstream of the Tumalo Creek Confluence - Future Daily Average Stream Flow (cfs) following the Canal Lining Alternative.

Month	Historic Daily Average Stream Flow (cfs)[3]	5 cfs Management Agreement (OWRD 2005)	Stream Flow Restored Through Project (cfs)[1]	Future Daily Average Stream Flow (cfs)	ODFW Instream Water Right[2]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge[4]
Oct[2]	358.0	5	23.4	385.2	250	0.4%
Nov	515.0	5	12.5	531.3	250	0.2%
Dec	577.0	5	12.5	593.3	250	0.2%
Jan	589.5	5	12.5	605.8	250	0.2%
Feb	597.5	5	12.5	613.8	250	0.2%
Mar	721.0	5	12.5	737.3	250	0.2%
Apr[2]	206.5	5	23.4	233.7	250	0.4%
May	116.4	0	14.5/26.8	130.9/143.2	250	0.2%/0.4%
Jun	150.0	0	26.8	176.8	250	0.4%
Jul	94.0	0	26.8	120.8	250	0.4%
Aug	91.0	0	26.8	117.8	250	0.4%
Sep	99.0	0	26.8/14.5	125.8/113.5	250	0.4%/0.2%

Notes:
1. Assumes that restored stream flow from the Upper Deschutes extends from October 15 through April 15 and that restored stream flow from Tumalo Creek extends from April 15 through October 15.
2. Pending ODFW instream Water Right with Priority Date 9/24/1990.
3. Takes into account historic stream flow in Tumalo Creek and historic stream flow in the Deschutes River.
4. According to “Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow” by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs.

Table E-29. Deschutes River Downstream of the Tumalo Creek Confluence - Future Daily Average Stream Flow (cfs) following the HDPE Pressurized Pipeline Alternative.

Month	Modified Daily Average Stream Flow (cfs)[3]	5 cfs Management Agreement (OWRD 2005)	Stream Flow Restored Through Project (cfs)[1]	Future Daily Average Stream Flow (cfs)	ODFW Instream Water Right[2]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge[4]
Oct[2]	358.0	5	26.0	387.8	250	0.4%
Nov	515.0	5	13.9	532.7	250	0.2%
Dec	577.0	5	13.9	594.7	250	0.2%
Jan	589.5	5	13.9	607.2	250	0.2%
Feb	597.5	5	13.9	615.2	250	0.2%
Mar	721.0	5	13.9	738.7	250	0.2%
Apr[2]	206.5	5	26.0	236.3	250	0.4%
May	116.4	0	16.1/29.8	132.5/146.2	250	0.3%/0.5%
Jun	150.0	0	29.8	179.8	250	0.5%
Jul	94.0	0	29.8	123.8	250	0.5%
Aug	91.0	0	29.8	120.8	250	0.5%
Sep	99.0	0	29.8/16.1	128.8/115.1	250	0.5%/0.3%

Notes:
1. Assumes that restored stream flow from the Upper Deschutes extends from October 15 through April 15 and that restored stream flow from Tumalo Creek extends from April 15 through October 15.
2. Pending ODFW instream Water Right with Priority Date 9/24/1990.
3. Takes into account historic stream flow in Tumalo Creek and historic stream flow in the Deschutes River.
4. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs.

E.7 Allocation of Conserved Water Program

This appendix section presents information on the State of Oregon's Allocation of Conserved Water Program. Oregon Revised Statutes 537.455-500 authorize this program. Per OWRD (2017),

> The Allocation of Conserved Water Program allows a water user who conserves water to use a portion of the conserved water on additional lands, lease or sell the water, or dedicate the water to instream use. Use of this program is voluntary and provides benefits to both water right holders and instream values.
>
> The statutes authorizing the program were originally passed by the Legislative Assembly in 1987. The primary intent of the law is to promote the efficient use of water to satisfy current and future needs--both out-of-stream and instream. The statute defines conservation as "the reduction of the amount of water diverted to satisfy an existing beneficial use achieved either by improving the technology or method for diverting, transporting, applying or recovering the water or by implementing other approved conservation measures."
>
> In the absence of Department approval of an allocation of conserved water, water users who make the necessary investments to improve their water use efficiency are not allowed to use the conserved water to meet new needs; instead any unused water remains in the stream where it is available for the next appropriator. In exchange for granting the user the right to "spread" a portion of the conserved water to new uses, the law requires allocation of a portion to the state for instream use.
>
> After mitigating the effects on any other water rights, the Water Resources Commission allocates 25 percent of the conserved water to the state (for an instream water right) and 75 percent to the applicant, unless more than 25 percent of the project costs come from federal or state non-reimbursable sources or the applicant proposes a higher allocation to the state. A new water right certificate is issued with the original priority date reflecting the reduced quantity of water being used with the improved technology. A certicate[sic] is issued for the state's instream water right, and, if requested, a certificate is issued for the applicant´s portion of the conserved water. The priority dates for the state's instream certificate and the applicant's portion of conserved water must be the same date and will be either the same date as the original water right or one minute[sic] junior to the original right.

Section 2.2.1 of the draft Plan-EA describes the District's intention to restore 100 percent of the water conserved through this project instream. The District has already received approval from OWRD for Conserved Water Application #37 (CW-37). CW-37 would permanently protect 100 percent of the water conserved from Project Group 1, piping the Tumalo Feed Canal. As part of the proposed action, the District would apply to use the Conserved Water Program for the remaining project groups not included in the existing CW-37. The District has previously used Conserved Water Application #9 for water conserved through other piping projects.

References

Oregon Water Resources Department (OWRD). (2017). *Allocation of Conserved Water*. Retrieved from: http://www.oregon.gov/owrd/pages/mgmt_conserved_water.aspx. Accessed November 10, 2017.

E.8 Prehistoric and Historical Background

This appendix section presents information on the prehistoric and historical background of the project area. The information comes from a 2006 survey and report on the Tumalo Feed Canal (Stuemke 2006).

Prehistoric Background

"The general sequence of cultural development of the Northern Great Basin and central Oregon has recently been revised to reflect research conducted in the region over the past 75 years. The University of Oregon's Northern Great Basin field school has contributed to a better understanding of cultural land use through the Fort Rock Basin Prehistoric Project (1989-1999) and the Northern Great Basin Prehistory project (1999- present) (Aikens et al. 2011). Given this greater body of data, the Great Basin region's prehistory has been divided into named time periods that track cultural change and social patterns as well as reflecting important climatic shifts that influence environmental change and resource use. These new time periods overlap the previously used paradigms and are more succinct."

Paisley Period (>15,700 to 12,900 years ago)

"The time period's beginning is tentative and is based on recovered human DNA in dried feces found in Paisley and radiocarbon dating and obsidian hydration data obtained from the region. This period incorporates pre-Clovis time approximately 13,000 years ago. Food resources included the utilization of now extinct Pleistocene animals, camel and horse, and other species that have lived on to present. Artifacts recovered from the period include flake stone tools of obsidian and chert, bone, and wooden tools."

Fort Rock Period (12,900 to 9000 years ago)

"Important sites associated with the Fort Rock period are represented by caves located near marshes around the Fort Rock and Sumer Lake basin which were occupied during the late fall and winter. Sites excavated at Paulina Lake, Buffalo Flat Bunny Pits, the Tucker site, and Harney Basin sites like Catlow and Roaring Springs caves provide a comprehensive picture of spring, summer, and early fall seasonal resource utilization. Subsistence relied on a broad range of food items including large mammals such as horse, camel and other now extinct fauna. Seasonal rounds for resource exploitation are assumed to have ranged over long distances. Winter sites appear to have been centered on caves and rock shelters near lowland lakes and marshes. Artifact assemblages include a wide range of artifacts including Western Stemmed point styles, as well as, lanceolate and leaf shaped points, and bifacially modified tools including cores, blanks, knives, crescents and drills. Large unifacially modified basalt scrapers, gravers and edge modified are also represented in the archaeological record."

Lunette Period (9,000 – 6,000 years ago)

"This period begins well before the eruption of Mt. Mazama 7,600 years ago. This period is characterized by increased temperatures and aridity. The middle of this period coincides with the rise in lake and marsh levels following the Mazama eruption which suggests an interval of a cooler climate. Drought conditions later returned and continued until 6,000 years ago. During this period human population numbers are believed to have declined and were generally more mobile. Most archaeological sites from this period have been difficult to identify. Sites have been interpreted to be temporary hunting and foraging camps located near intermittent/seasonal lakes and ponds. Artifacts in the archaeological record include leaf shaped projectile points, large well shaped scrapers and tiny engravers. Ground stone artifacts are common but not well shaped. Leaf shaped projectile points continued to flourish following the Mazama eruption and Northern-side Notched points appear. Fort Rock style sandals are replaced by Multiple and Spiral Weft sandals. Decorated twinned basketry appears as part of the perishable artifact assemblage."

Bergen Period (6,000 – 3,000 years ago)

"During this period temperature was moderate and precipitation increased, represented by an interval of fluctuating cool-wet and warm-wet climate. These changes increased the biotic productivity of lowland lakes and marshes. The hallmark of this period was the construction of houses and large volume storage pits representative of stable settlements. A wide variety of resources including small mammals, waterfowl, and fish remains have been found at seasonal village locations. Trade was represented by the presence of abalone shell from the Pacific Coast and olivella shell beads from the Channel Islands in Southern California. Artistically embellished artifacts including beads, carved and ground bone tools, pipes, mauls and stone balls represents resource redistribution and increased social interaction."

Boulder Village Period (3,000 – Historic Contact)

"This period is named for a large aggregation of boulder-outlined house structures in the southeast Fort Rock Basin and known for residential site seasonal collection and storage of root crops. Marsh, lake and riverine resources were important to native populations in the northern Great Basin. These resources were harvested from seasonal villages. Winter pit house villages featured stone house rings built along marsh edges."

Euro-American History

"The first Euro-American forays into the Central Oregon area can be attributed to the Hudson Bay Company's expedition by Peter Skene Ogden in 1825-1826, Nathaniel Wyeth in 1834-1835, the John C. Fremont expedition to California in 1843, and lieutenant Henry Abbot's Pacific Railroad Survey in 1855. The explorations represent several different objectives and provide a glimpse of the environment in close proximity to the project area."

"Early immigration to Oregon began as early as the 1840s and generally followed the Oregon Trail to the Willamette Valley. The first historical use of the area [Central Oregon] is primarily related to grazing of cattle, sheep and horses, and ranching activities. One good example of this is associated with George Millican who drove cattle and horses from the Willamette Valley to the high desert east of Bend where he established the small community of Millican. Large bands of sheep were introduced in the 1880s resulting in range wars between cattlemen and shepherds which continued until the early 1900s. Congress passed legislation in 1902 to create forest reserves on land held by the federal government due in part to environmental degradation caused by overgrazing. This created an allotment system which ended the indiscriminant grazing on public lands and putting an end to the range wars so prevalent through central Oregon."

References

Stuemke, S. (2006). *Tumalo Irrigation District Tumalo Feed Canal: Phase I Field Survey and Section 106 Evaluation, Deschutes County, Oregon*. Report SES 2006-002 prepared for David Evans and Associates, Inc. on behalf of the Tumalo Irrigation District.