Appendix A

Comments and Responses

To be included in the final environmental assessment.

Appendix B

Project Maps

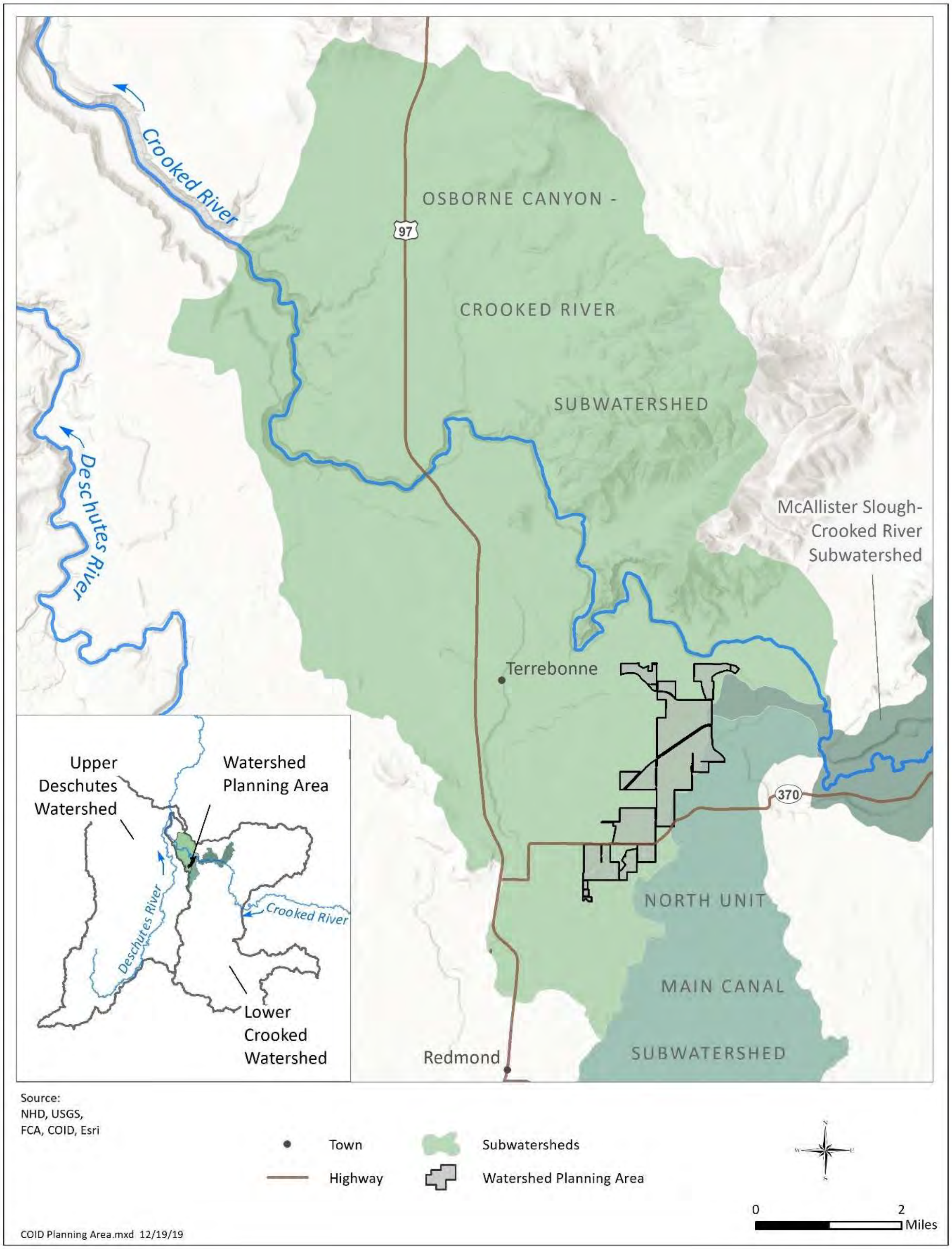

Figure B-1. The Central Oregon Irrigation District Watershed Planning Area.

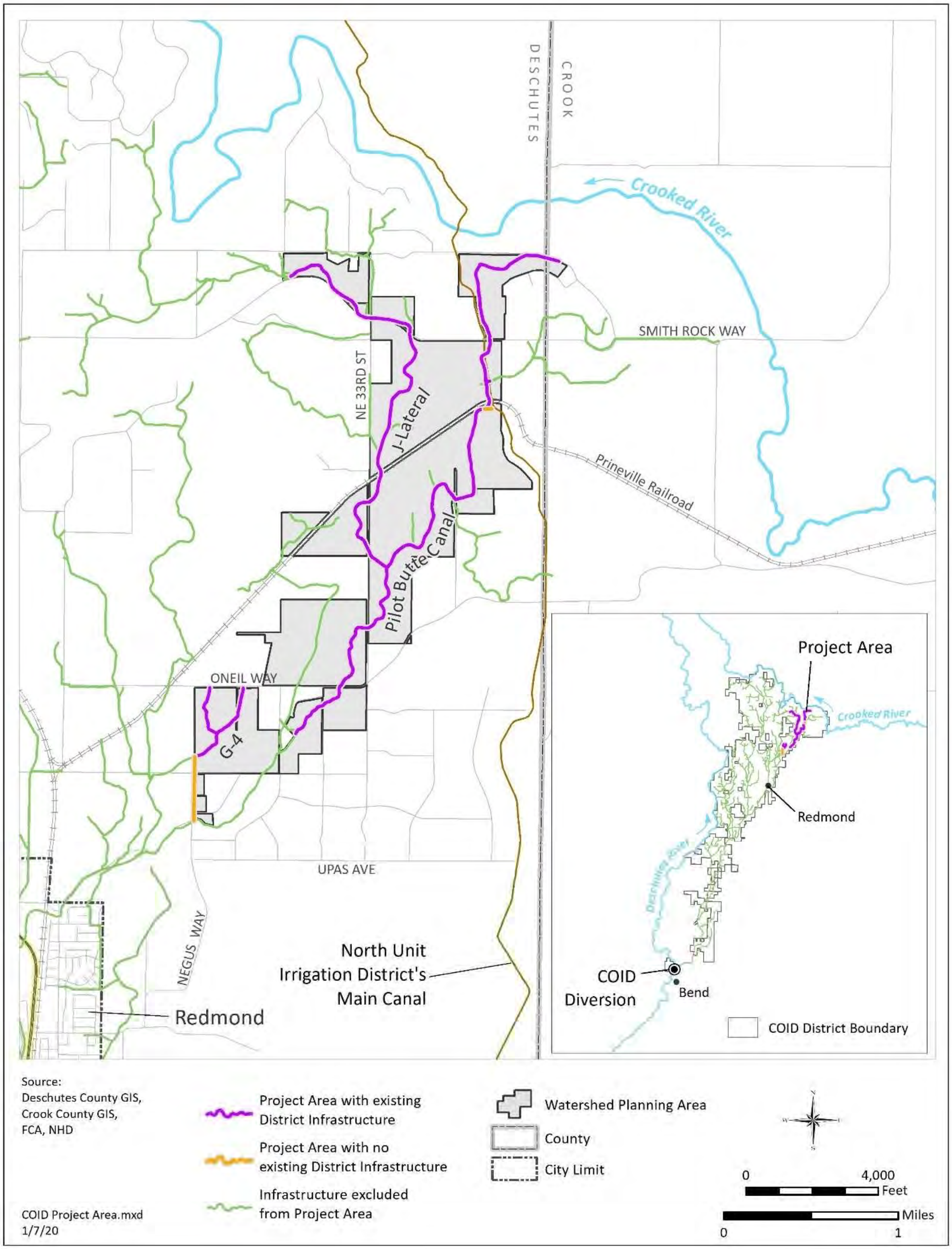

Figure B-2. The Central Oregon Irrigation District Infrastructure Modernization Project Area.

Appendix C

Supporting Maps

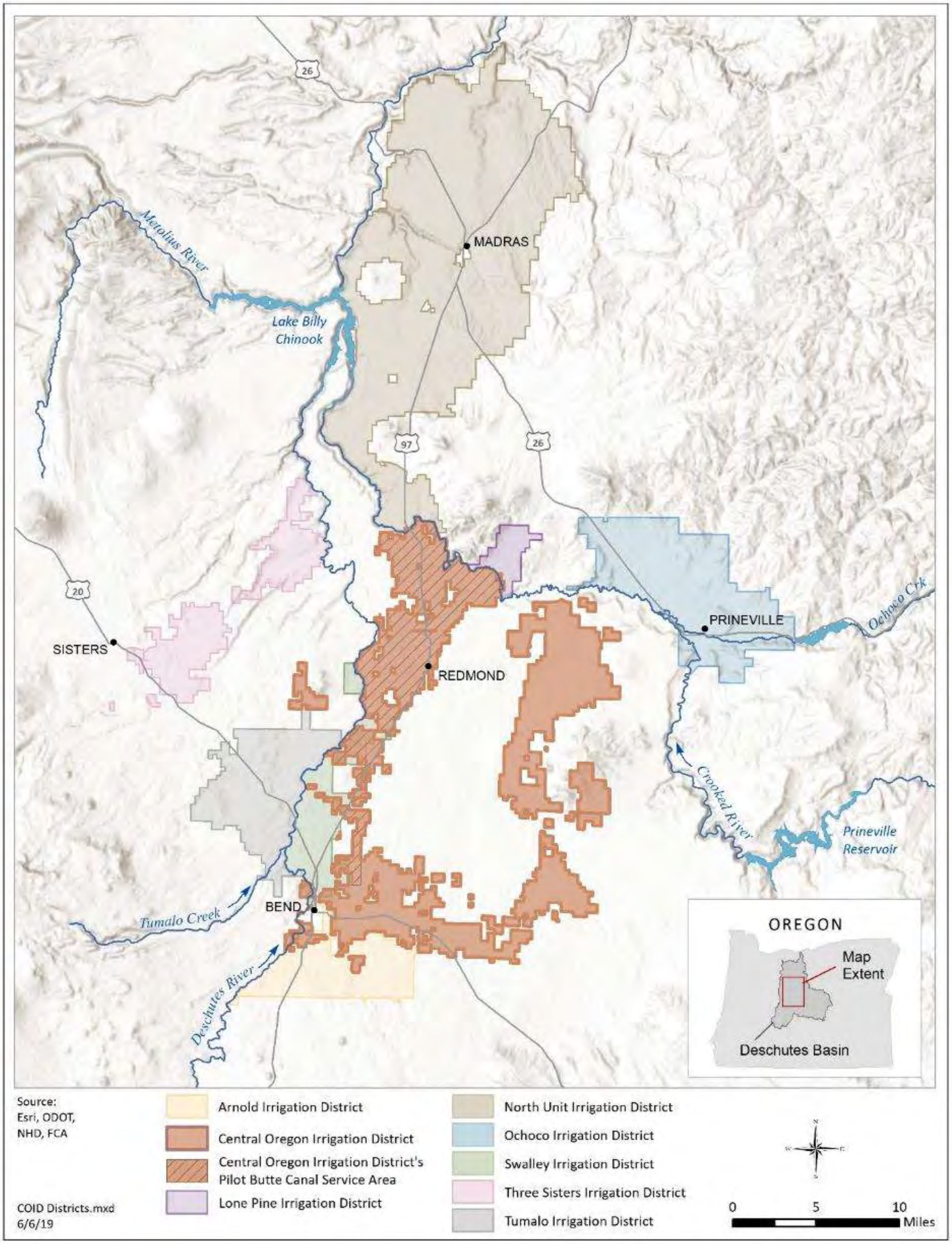

Figure C-1. Irrigation Districts within the Deschutes Basin.

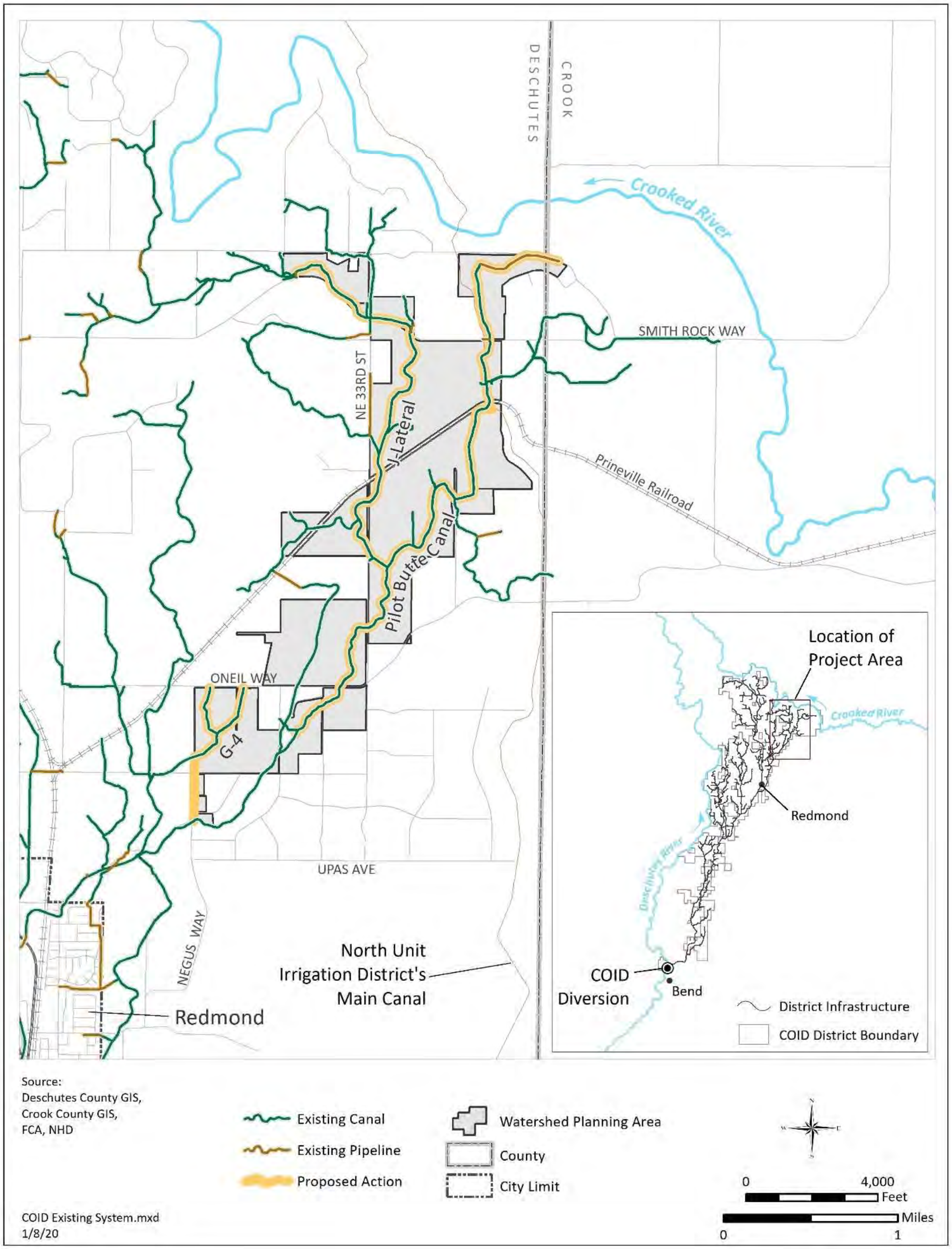

Figure C-2. Central Oregon Irrigation District current infrastructure.

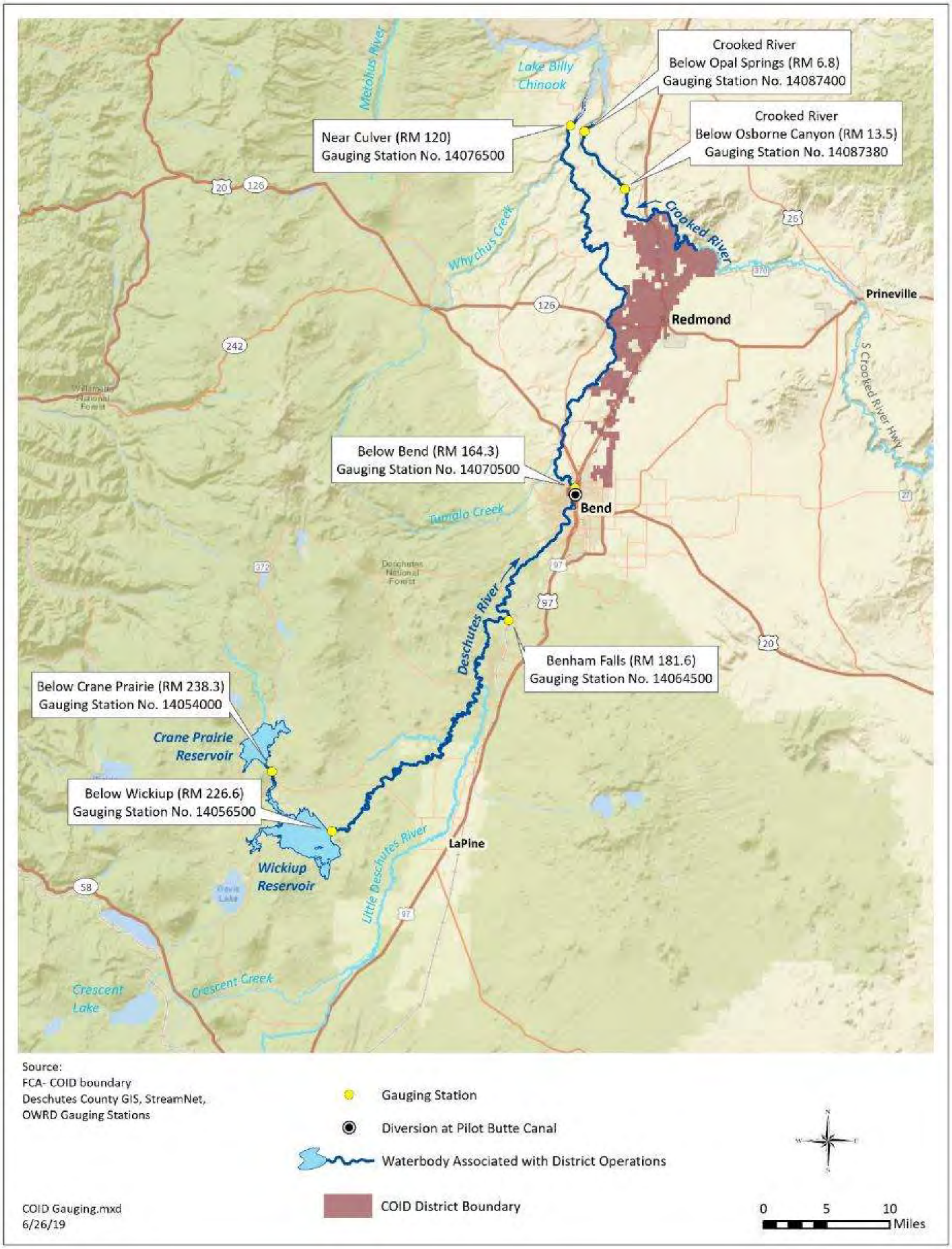

Figure C-3. Waterbodies and gauging stations associated with District operations.

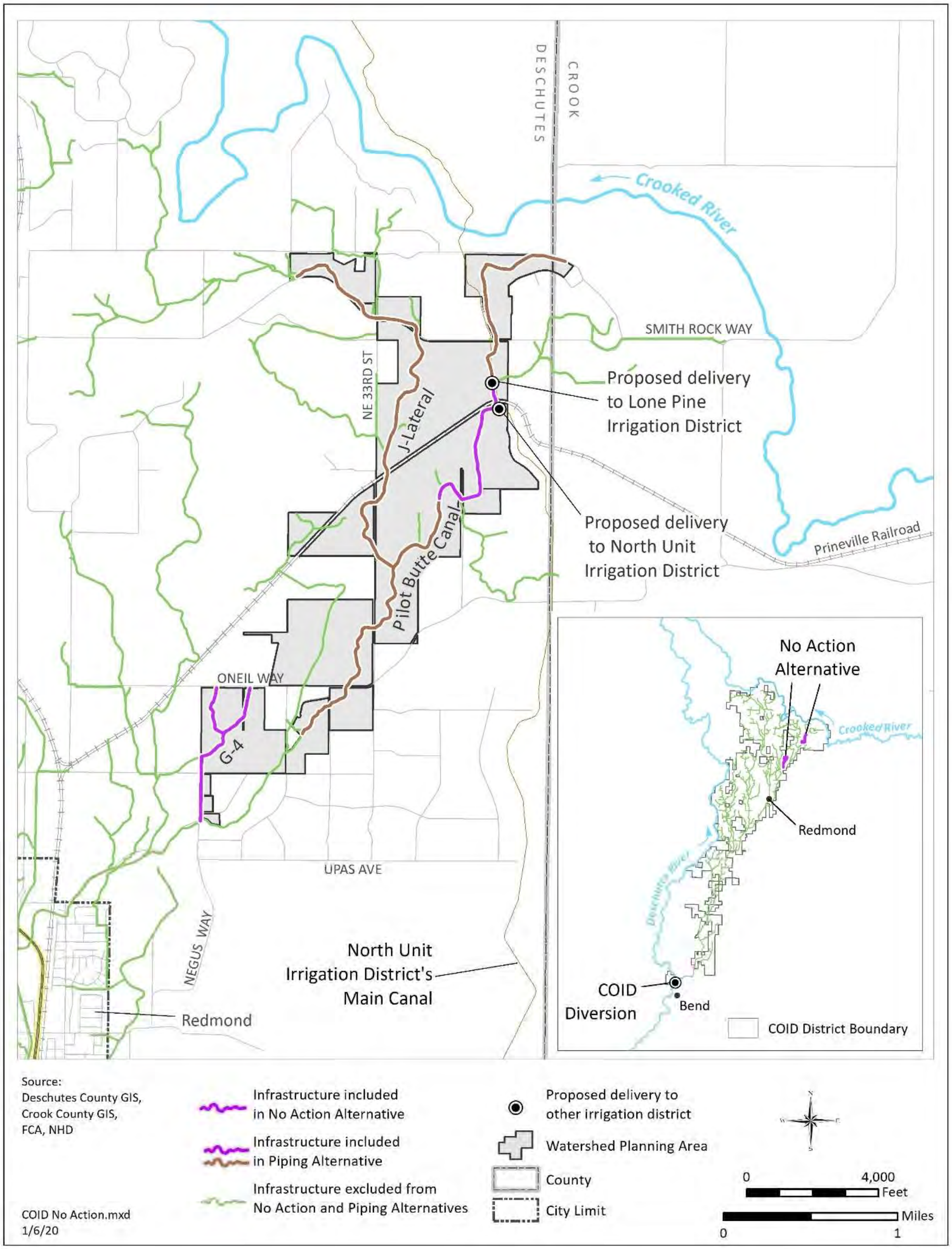

Figure C-4. Central Oregon Irrigation District No Action Alternative.

Appendix D

Investigations and Analysis Reports

D.1 National Economic Development Analysis

Highland Economics LLC

National Economic Development Analysis

Barbara Wyse and Winston Oakley
12/27/2019

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Introduction

This appendix outlines the costs and benefits of the Piping Alternative and the No Action Alternative. The Piping Alternative represents the future with federal funding through PL 83-566. The No Action Alternative represents the future if the District does not receive federal funding through PL 83-566. Because the District plans to pipe some of its irrigation canals, even in the absence of federal funding through PL 83-566, the No Action Alternative includes benefits and costs that differ from the current (referred to as Baseline) conditions. Therefore, this National Economic Development (NED) analysis is divided into three sections. The first section focuses on the Piping Alternative and how costs and benefits change from current Baseline conditions. The second section discusses the costs and benefits under the No Action Alternative, compared to the Baseline conditions. The third section presents the analysis of the benefits and costs of the Piping Alternative over the No Action Alternative.

1 Piping Alternative

1.1 Costs of the Piping Alternative

This section evaluates the costs and benefits of the Piping Alternative over the Baseline conditions. The analysis uses NRCS guidelines for evaluating 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 2019 dollars and have been discounted and amortized to average annualized values using the 2019 federal water resources planning rate of 2.75 percent.

1.1.1 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.

1.1.1.1 Funding

PL 83-566 funds would cover $29,003,000 or 69% of the project cost. COID would be required to fund $13,303,000 or 31% of the project. COID would cover their funding through a combination of sources including grants, partnerships, and loans. COID would be pursuing loan funding through the Oregon Department of Environmental Quality's Clean Water State Revolving Fund. COID 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.

1.1.1.2 Evaluation Unit

The proposed project is grouped into two project groups. 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.

1.1.1.3 Project Implementation Timeline

Based on conversations with the District manager and staff, if PL 83-566 funds are made available, it is likely that construction would be completed over approximately four years, with approximately one project group constructed every two years. For all project groups, the analysis assumes that full benefits would be realized the year after construction is completed (i.e., 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). Table A summarizes the approximate construction timeline and the breakdown of funding for construction.

Table A. Construction Timeline and Installation Costs by Funding Source for the Piping Alternative, Deschutes Watershed, Oregon, 2019$[1].

Construction Year	Works of Improvement	Public Law 83-566 Funds	Other, Non-Federal Funds	Total Construction Costs
0	Project Group 1	$28,481,000	$10,207,000	$38,688,000
2	Project Group 2	$522,000	$3,096,000	$3,618,000
Total Project		**$29,003,000**	**$13,303,000**	**$42,306,000**

1/ Price Base: 2019 dollars. Prepared December 2019

1.1.1.4 Analysis Period

The analysis period for each project group is defined as 102 years since the installation period is two years for each project group and 100 years is the expected project life of buried HDPE pipe. Across the two project groups, the analysis period is 104 years (Year 0 to Year 103). Construction and installation of Project Group 1 is assumed to occur in Year 0 with project life from Year 2 through Year 101, and Project Group 2 would have a project life from Year 4 through Year 103. While over half of the total project length would be piped using HDPE pipe, the remaining project length, consisting of large diameter pipe, would be piped with fiberglass-reinforced, steel, or HDPE pipe. Steel and fiberglass pipe can have a useful life of less than 100 years. The potential costs to replace large diameter pipe, depending on what material would be chosen, are described in Section 1.1.4.3.

1.1.1.5 Project Purpose

The purpose of the project as identified in the Plan-EA is to improve water conservation, water delivery reliability, and public safety on up to approximately 7.9 miles of District-owned canals and laterals. The project is multipurpose, that is, it provides multiple benefits. Because no project cost items serve a single purpose separately, this analysis does not allocate costs or benefits by purpose.

1.1.2 Proposed Project Costs

Table 8-1 (NWPM 506.11, Economic Table 1) and Table 8-2 (NWPM 506.12, Economic Table 2) in Section 8 of the Plan-EA summarize installation costs, distribution of costs, and total annual average costs for the Piping Alternative. Table B below summarizes the annualized costs over the Baseline. Table C and Table D present other direct costs associated with piping. The subsections provide details on the derivation of the values in the tables.

Average annual costs include those associated with installation and other direct costs. There are three primary types of other direct costs: increased pumping costs from increased depth to groundwater due to reduced recharge; the costs to replace large diameter piping; and the potential reduction in aesthetic values to area residents due to the removal of canals. Of these, only the aesthetic costs are not quantified in this analysis due to a lack of available quantitative information. Based on COID's past experience of piping irrigation canals, the District expects cost savings, not cost increases, for infrastructure maintenance, repair, and replacement of the Piping Alternative (Clark, 2018).

Two categories, energy use and carbon emissions, are counted as a cost or benefit depending on whether their values increase or decrease as a result of the Piping Alternative. For example, because the Piping Alternative is expected to increase costs associated with carbon emissions, carbon emissions are considered another direct cost in this section.

Table B. Estimated Average Annual Costs for Piping Alternative above the Baseline, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Project Outlays (Amortization of Installation Cost)	Other Direct Costs [2]	Total
Project Group 1	$1,124,000	$127,000	$1,251,000
Project Group 2	$100,000	$1,000	$101,000
Total	**$1,224,000**	**$128,000**	**$1,352,000**

Note: Totals may not sum due to rounding. Prepared December 2019

1/Price base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

2/Other direct costs include the uncompensated economic losses due to changes in resource use or associated with installation, operation, or replacement of project structures. Other direct costs are presented for fiberglass pipe replacement and increased pumping costs elsewhere in the basin from reduced groundwater recharge (i.e., seepage from unlined canals). This does not include operations, maintenance, and repair costs because these decline under the Piping Alternative, so these are presented as a benefit. Because carbon emissions in Project Group 1 increase under the Piping Alternative, the cost of carbon emissions is included as another direct cost for Project Group 1 (carbon emissions do not substantially change for Project Group 2).

1.1.3 Project Installation Costs

According to estimates by Black Rock Consulting, Inc. and KPFF Consulting Engineers[1], the cost of piping and associated turnouts is projected to be approximately $37,591,000. See Appendix D.5 for detailed cost derivation by pipe size, cost category, etc. All values in this analysis are presented in 2019-dollar values and rounded to the nearest $1,000.

Adding three percent for project administration from COID and NRCS, between six and eight percent for technical assistance from NRCS[2], and permitting costs, the total cost for the Piping

[1] Project costs for Project Group 1 were provided by Black Rock Consulting, Inc. and project costs for Project Group 2 were provided by KPFF Consulting Engineers.

[2] Six percent technical assistance was applied to Project Group 1 and eight percent was applied to Project Group 2.

Alternative is estimated at $42,306,000. The average annual cost by project group is shown in Table B with total average annual costs of $1,352,000 for the Piping Alternative (assuming piping projects are completed in the order shown in Table D).

1.1.4 Other Direct Costs

1.1.4.1 Groundwater Recharge Costs

Water seepage 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 U.S. 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 from the period 1997 to 2008 (Gannett & Lite, 2013).

The study indicated 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 found that approximately 10 percent of this decline in groundwater level is due to canal lining and piping during this period, or approximately 0.5 to 1.4 feet. This was modeled as the result of reducing the recharge from irrigation canal leakage by 58,000 acre-feet annually. This NED analysis uses this data to first estimate the effect of reduced irrigation canal seepage on groundwater levels from the Piping Alternative. The analysis then uses these data to roughly approximate the change in the cost of pumping for all groundwater users in the Deschutes Basin due to the Piping Alternative.

Assuming a uniform increase in canal lining/piping over this timeframe, in 1997 the decreased canal seepage was 4,833 acre-feet; rising each year by another 4,833 acre-feet until the reduced canal seepage in 2008 was 58,000 acre-feet. Cumulatively, this represents 377,000 acre-feet of reduced recharge from canals during this period. The USGS study found 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 acre-feet of reduced canal recharge, though local effects may vary widely.

The Piping Alternative would reduce canal seepage, and associated groundwater recharge, by up to approximately 10,281 acre-feet annually in this part of the Deschutes Basin, once all project groups are complete[3]. On average, for this part of the central basin, this translates into a decreased groundwater elevation of approximately 0.027 feet annually (based on information presented above that a one-foot groundwater elevation drop is expected to result from reduced recharge of 377,000 acre-feet, so the corresponding drop from 10,281 acre-feet is 0.027 foot since 10,281 acre-feet divided by 377,000 acre-feet is 0.027). An important caveat is that localized effects of the Piping Alternative on groundwater 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 2.72 feet (note that this drop in pumping elevation would have small

[3] The decrease in groundwater recharge includes the loss of canal seepage from the piping of COID's system as well as the loss of seepage from North Unit Irrigation District's Main Canal (North Unit would proportionally decrease the water passed through their Main Canal relative to the water that is saved and passed to them through COID).

effects on pumping costs, but would not be expected to result in the need to drill deeper wells or replace pumps at a faster rate).

This analysis combines the 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. The USGS report identified approximately 25,000 acre-feet per year of groundwater pumping for public supply and about 25,000 acre-feet per year of groundwater pumping for irrigation use. A 2017 study by GSI Water Solutions, Inc. on future groundwater use indicated that demand for irrigation groundwater in the basin would increase by 2,643 acre-feet from 2016 to 2035, and by a further 1,728 acre-feet between 2036 and 2065 (Sussman, McMurtrey, & Grigsby, 2017).[4] The same study found that demand for public supply groundwater use would increase by approximately 10,590 acre-feet from 2016 to 2035 and by a further 6,438 between 2036 and 2065.[5] We adopt these projections to model the amount of groundwater pumping in the Deschutes Basin in future years, assuming that growth happens linearly during the time periods. We further assume that growth in pumping after 2065 would occur at the same rate as from 2036 to 2065. Given these assumptions, total groundwater pumping over 104 years may rise to over 87,000 acre-feet annually (with about 33,000 acre-feet going to irrigation and roughly 55,000 acre-feet dedicated to the public water supply).

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 $0.0601 per kilowatt-hour (kWh) under Schedule 28 (Pacific Power, 2019). Farmers who use electricity to irrigate fall under Central Electric Cooperative's Schedule C, which charges a rate of $0.0512 per kWh; this analysis assumes this rate is the marginal cost to farmers for pumping groundwater.

Even without the Piping Alternative, groundwater levels would still decline. The USGS study noted 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 1 foot per year, which we assume would continue in absence of the Piping Alternative. 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). Under Baseline conditions, we assume a current average groundwater pumping depth in the central Deschutes Basin of 500 feet; assuming a 1-foot drop in groundwater depth each year over 100 years, groundwater depths would be approximately 600 feet. Over the course of 100

[4] This estimate combines the use categories of irrigation, agriculture, and nurseries. The projected demand from 2036-2065 was based on municipal demand of 300 gallons per capita per day. In a previous version of the analysis, we used a different study to project future groundwater use in the Deschutes Basin. This study found that public groundwater 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). Because this study was more than 10 years old, and because the study from GSI Water Solutions was written in the last two years, we chose to update the analysis to incorporate the more recent estimates.

[5] This estimate combines the use categories of municipal, domestic, commercial, storage, and industrial. The projected demand from 2036- 2065 was based on municipal demand of 300 gallons per capita per day.

years, the Piping Alternative would result in a pumping depth of approximately 603.0 feet, or an increased depth to groundwater of 3.0 feet compared to Baseline conditions.

Applying the electricity prices, assuming a pump irrigation efficiency of 70 percent,6 and using the volume of pumping and pumping depths shown in Table C, the total cost of groundwater pumping under Baseline conditions is projected to grow from around $2.2 million in Year 1 to $4.4 million in Year 103.

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

Year	Volume Pumped (acre-feet per year)	Average Depth to Groundwater (feet)	
		Baseline Conditions	Piping Alternative (NED Alternative)
1	54,000	501	501.0
10	60,000	510	510.3
20	65,000	520	520.6
30	67,000	530	530.9
40	70,000	540	541.2
50	73,000	550	551.5
60	75,000	560	561.8
70	78,000	570	572.1
80	81,000	580	582.4
90	84,000	590	592.7
100	86,000	600	603.0

Prepared December 2019

The increased depth to groundwater due to reduced recharge results in higher pumping costs in the Piping Alternative. The increased cost to groundwater pumpers over the 100-year-analysis period rises 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 the installation of Project Group 1, the groundwater elevation may decline 0.024 feet in Year 2, rising up to a 2.4-foot decline by Year 100 (0.024 multiplied by 100), with associated costs rising from approximately $105 to $17,000. In total, after discounting and amortizing these costs across all project groups, the estimated total annual average cost across 104 years is $5,000 per year for the Piping Alternative (see Table D).

[6] As assumed in the Central Oregon Irrigation District On-Farm Water Conservation Report completed by Black Rock Consulting, Inc. and Farmers Conservation Alliance in 2018.

Table D. Other Direct Costs of Reduced Recharge under Piping Alternative, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Water Conservation (cfs)	Water Conservation (acre-feet/year)	Change in Groundwater Depth (feet/year)	Annual Average Cost
Project Group 1	27.91	8,907	0.024	$4,000
Project Group 2	4.31	1,374	0.004	$1,000
Total	**32.2**	**10,281**	**0.027**	**$5,000**

Note: Totals may not sum due to rounding. Prepared December 2019
[1]/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

1.1.4.2 Booster Pump Costs

In order to pressurize the piped conveyance system on the G-4 Lateral (included in Project Group 1), the District plans to install a booster pump station as part of the Piping Alternative. This station would require additional energy, estimated at 193,285 kWh per year (Alliance, 2019). The pump station would provide pressure to all the patrons served by the G-4 Lateral. The cost of the energy use was valued based on Central Electric Cooperative's tariff under Schedule C (Agricultural Irrigation), which is $0.0512 per kWh.

In addition to the marginal cost of electricity, Central Electric Cooperative imposes a demand charge and a facilities charge. Assuming a 60-hp pump requiring a 45-kW connection for seven months out of the year, these charges would total approximately $3,000 annually. The booster pump is expected to have a useful life of 25 years, after which it would need to be replaced at a cost of approximately $50,000 (the cost of the initial pump installation). Accordingly, we model the pump's replacement three times during the study period (Years 27, 52, and 77). When the $50,000-replacement cost in each of these years is discounted and amortized, the total annual NED replacement cost is approximately $1,000. Following a 2016 NRCS publication, we estimate that annual maintenance costs on the pump are around 1 percent of its purchase price, or in this case, around $500 per year (Natural Resources Conservation Services, 2016). Table E. outlines the energy costs for the pump station by Project Group as well as the expected operation, maintenance, and replacement (OMR) costs. When discounted and amortized, the total costs of the booster pump station are roughly $14,000 per year.

Table E. Annual Booster Pump Costs of Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Total Annual Booster Pump Energy Demands (kWh)	Undiscounted Annual Booster Pump Energy Costs Under Piping (kWh)	Undiscounted Annual Booster Pump O&M Costs Under Piping (kWh)	Discounted and Amortized Annual Cost of Booster Pump Replacement	Average Annual NED Cost for Booster Pump (Discounted and Amortized)
Project Group 1	193,285	$10,000	$4,000	$1,000	$14,000
Project Group 2	0	$0	$0	$0	$0
Total	**193,285**	**$10,000**	**$4,000**	**$1,000**	**$14,000**

1/ Price base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent. Prepared December 2019

1.1.4.3 Pipe Replacement

The Piping Alternative would require large diameter pipe (102 and 108 inches) for approximately 34 percent of the project length, totaling approximately 2.7 miles of pipe. The material for this large diameter pipe is still being decided (see Section 5.3.2 in the Plan-EA for further discussion). Unlike the HDPE pipe used for the smaller diameter pipes, this large diameter pipe, depending on the material selected, may potentially have a shorter lifespan. The materials being considered, such as fiberglass pipe or steel pipe, conservatively have an expected life of 50 years, and so if these materials were selected the pipe would have to be replaced during the period of this analysis (Crew, Black Rock Consulting, 2018). Experts estimate that around 25 percent of the total pipe would need to be replaced in Year 50 and the remaining 75 percent would need to be replaced in Year 75 (Crew, Black Rock Consulting, 2018). We assume that these costs are incurred 50 years after the construction of each project group and the cost to replace the pipe is the same as the cost to install it.[7] Table F shows the costs of replacing pipe under the Piping Alternative.

Table F. Other Direct Costs of Large Diameter Pipe Replacement under the Piping Alternative, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Feet of Large Diameter Pipe Replaced	Total Cost	Annual Average NED Cost
Project Group 1	14,300	$23,792,000	$108,000
Project Group 2	0	$0	$0
Total	**14,300**	**$23,792,000**	**$108,000**

Note: Totals may not sum due to rounding. Prepared December 2019

1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

1.1.4.4 Carbon Costs

Changes in energy use also produce changes in carbon dioxide emissions from power generation. Every MWh of reduced on-farm energy use is estimated to translate into an estimated reduction of

7 The costs of large diameter pipe were estimated based on 30% engineering design by KPFF Consulting Engineers and costed based on material quotes provided in September 2019.

0.7521 metric tons (Mt) of carbon emissions, and the same amount of emissions is added for each MWh of increased energy use.[8] The Piping Alternative would decrease some carbon emissions (from eliminating some pumping energy use in the District) and increase other emissions (by increasing basin-wide pumping as a result of lower groundwater levels). Accordingly, compared to Baseline conditions, the annual energy savings would reduce CO_2 emissions by approximately 79 Mt (approximately 106 MWh multiplied by 0.7521), while energy use increases associated with lower groundwater levels and power for a new booster would increase emissions, leading to a net annual increase of 184 Mt (see Table G). In Project Group 1, emissions increase steadily after completion, due mainly to the booster pump. In Project Group 2, there is a net decrease in emissions early on as pressurization eliminates emissions from electricity, and later there is a net increase when declining groundwater levels cause electricity demand (and associated emissions) to outweigh pressurization benefits.

Table G. Annual Average Carbon Emissions (Mt) by Project Group, Deschutes Watershed, Oregon.

Works of Improvement	Baseline Conditions		Piping Alternative (NED Alternative)		
	Average Annual Carbon Emissions, Basin-wide Pumping	Annual Carbon Emissions, COID Patron Pumping	Average Annual Carbon Emissions, Basin-wide Pumping	Annual Carbon Emissions, COID Patron Pumping	Net Annual Carbon Increase (Compared to Baseline)
Project Group 1	N/A	156	N/A	314	185
Project Group 2	N/A	58	N/A	57	-1
Total	**44,341**	**214**	**44,525**	**397**	**184**

Prepared December 2019

Note: These values show an average annual increase over 104 years. Carbon emissions rise over time because groundwater pumping volume increases throughout the basin over time, and the depth to groundwater also rises over time due to reduced recharge from canals.

To value the reduced carbon emissions, this analysis uses an estimate of the social cost of carbon (SCC), which is the estimated total cost to society of emitting carbon related to the expected damages associated with future climate change. There are many estimates of the SCC, and the estimates vary based on what types of damages are included, the discount rate chosen, the geographic area under consideration (such as global damages versus U.S. domestic damages), and the projected level of global warming and associated damages. SCC damage values used by federal agencies have varied over the years.

[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 used), such that 100 percent of energy use reduction and green energy production result in reduced fossil fuel powered generation. Furthermore, this estimate assumes 0.7521 metric tons of carbon emitted from 1 MWh of fossil-fuel powered electricity generation based on 1) the current proportion of fuel sources–oil, natural gas, and coal–for fossil-fuel powered electrical power generation in the West, and 2) the associated metric tons of CO_2 produced per MWh powered by each fossil fuel source, as reported by the Energy Information Administration.

At first, federal agencies developed and applied their own estimates. Then, the Office of Management and Budget convened an Interagency Working Group (IWG) on the Social Costs of Greenhouse Gases, which developed a set of SCC estimates that could be used across federal agencies. In the year 2020 (the closest estimate available for the current year), the IWG estimate for SCC was estimated to be approximately $51.20 per Mt (2019 dollars) (Interagency Working Group on Social Cost of Greenhouse Gases, 2013).[9] However, in 2017, Executive Order 13783 disbanded the IWG, indicated that IWG estimates were not representative of government policy, and removed the requirement for a harmonized federal policy for SCC estimates in regulatory analysis. Since this time, the Environmental Protection Agency (EPA) and other federal agencies have developed interim alternative estimates of the SCC, largely relying on the methodology used by the IWG, but using different discount rates and focusing on direct damages projected to occur within the borders of the United States. For example, the EPA developed interim SCC values for the *Regulatory Impact Analysis for the Repeal of the Clean Power Plan, and the Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units* published in June of 2019 (Environmental Protection Agency, 2019). As these interim EPA SCC estimates are indicative of current federal agency policy on SCC applications for federal cost benefit analysis, they are employed in this analysis.

This analysis uses the EPA interim value of the SCC for 2020, based on a 3-percent discount rate, $7 per metric ton of carbon. We apply this value to the net change in carbon emissions each year throughout the project life to estimate the change in carbon emissions from the Piping Alternative. Because there is a net increase in carbon emissions, this represents a cost. As shown in Table H, when discounted and annualized, the value of net increase in carbon emissions is $1,000.

[9] We adjusted the original cost of $42 in 2007 dollars to 2019 dollars using the Consumer Price Index.

Table H. Annual Increased Average Carbon Costs of Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Annual Avoided Emissions (Reduced COID Patron Energy Use, Mt Carbon)	Average Annual Increased Emissions (from Reduced Recharge and Booster Pump Power, Mt Carbon)[2]	Net Average Increased Emissions	Average Annual NED Costs (Social Cost of Carbon)[3]
Project Group 1	62	247	185	$1,000
Project Group 2	17	16	-1	$0
Total	**79**	**263**	**184**	**$1,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 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. Added to this increase is the estimated energy required to power the booster pump. The average annual energy use increase elsewhere in the basin represents the average change in energy use across the 100 project years for each project group.
3/Note that the average annual NED benefits differ from the change in tons of carbon emitted multiplied by the $7 value per Mt of carbon. The increased emissions rise through time (and are thus highest at later periods when the values are most discounted, while the decreased carbon emissions are the same through time).

1.1.4.5 Change in Aesthetics and Associated Property/Recreation Values

The project is located in a rural area with only a limited number of residents that have a direct view of the canal from their house. 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.

The potential aesthetic cost to residential landowners 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 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,[10] this analysis does not quantify the potential change in

[10] Note that increased agricultural production value, due to a more reliable water supply to COID 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 COID) is largely the same (there may be some residents in the area who benefit from canal views who are not patrons of COID).

aesthetic values of the proposed project. There are no recreational opportunities in the project area, therefore, there would be no effect to recreation values.

1.2 Benefits of the Piping Alternative

Table I compares the project benefits (over Baseline conditions)[11] to the annual average project costs presented in Table B. The remainder of this section provides details on these project benefits. As the No Action differs from the Baseline (under the No Action COID would pipe 2.3 miles over four years), Section 2.2 presents the benefits of the No Action Alternative, while Section 3.2 identifies the NED benefits of the Piping Alternative over and above the No Action Alternative.

Table I presents on-site damage reduction benefits that would accrue to agriculture and the local rural community, including reduced power costs. Table I also presents off-site quantified benefits, which includes the value of reduced carbon emissions and the value of enhanced fish and wildlife habitat. Other benefits not included in the analysis, which may result indirectly from the Piping Alternative, include increased agricultural yields and the potential for increased on-farm investments in irrigation efficiency (as patrons have more funds due to 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 fishing and wildlife viewing) from improved species populations, it is not clear how recreation may be affected. 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 Piping Alternative may be both positive and adverse (depending on flow timing and magnitude), with no indication of whether there may be net benefits or net costs to recreation (Tamashiro, 2017; Smith, 2017; Houle, 2017; Krein, 2017; Renton, 2017; Brown, 2017). As such, this analysis assumes no net impact on recreation.

[11] The Baseline conditions represent the current state of energy use, O&M, etc. within COID.

Table I. Comparison of Average Annual NED Benefits and Costs of the Piping Alternative Compared to Baseline Conditions, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Agriculture-Related			Non-Agricultural		Average Annual Benefits	Average Annual Cost [2]	Benefit –Cost Ratio
	Reduced O&M	Pumping Cost Savings	NUID Ag Benefits	Instream Flow Value	Oregon Spotted Frog			
Project Group 1	$3,000	$16,000	$335,000	$594,000	$533,000	$1,481,000	$1,251,000	1.18
Project Group 2	$1,000	$1,000	$49,000	$87,000	$77,000	$215,000	$101,000	2.13
Total	**$4,000**	**$17,000**	**$384,000**	**$681,000**	**$610,000**	**$1,696,000**	**$1,352,000**	**1.25**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.
2/From Table B

1.2.1 Benefits Considered and Included in Analysis

1.2.1.1 Agricultural Damage Reduction Benefit

Under the Piping Alternative, North Unit Irrigation District (NUID) would gain an estimated 888 acre-feet of water annually due to reduced seepage losses in the North Unit Main Canal, resulting from a change in diversion associated with the COID piping project (See Section 6.9 in the Plan-EA for further information) (Farmers Conservation Alliance, 2019). The increase in water available to NUID is expected to reduce the agricultural damages associated with water shortages experienced currently in NUID.

North Unit Irrigation District has historically experienced water shortages, during which water supply is less than total water demand in the district (Britton, 2019). Since the adoption of the 2016 Settlement Agreement, which includes provisions for irrigation districts in Central Oregon to increase instream flows to support the Oregon Spotted Frog (which reduces water availability for irrigation), water supply reliability to NUID irrigators has been further decreased. While there have been just a few years since the Settlement Agreement, and water year type and market conditions also affect acreage planted in any given year, Figure A shows that the average fallowed acreage in NUID increased from the 2009-2015 period to the 2016-2018 period.

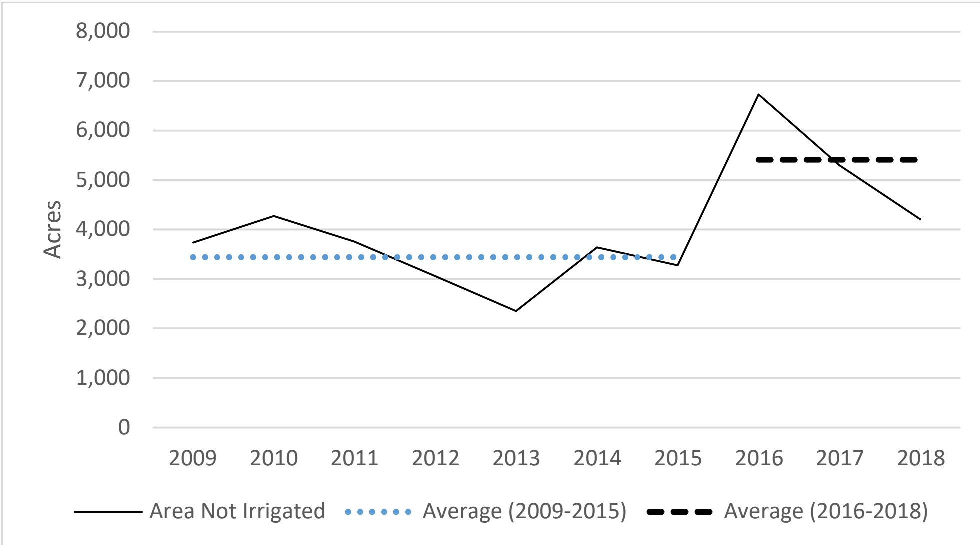

Figure A: North Unit Irrigation District agricultural area not irrigated[12].

Based on these data, this analysis assumes that the 888 acre-feet of additional water made available to NUID would reduce the agricultural damages arising from water supply shortages in NUID. To estimate the value of reduced damages, we used published Oregon State University and Washington State University crop budgets to estimate the net revenues of agricultural production in NUID from two key crops: alfalfa hay and carrot seed. Alfalfa hay represents all hay/grain crops, while carrot seed represents all specialty crops (including peppermint, grass seed, vegetables, and nursery crops). These crop budgets are provided in Section 4.1 of the NED, with detailed explanation of the methods used to update revenues and costs to 2019-dollar values. We assume that all types of crops would benefit from increased water supplies from the Piping Alternative that are reliable in every type of water year, as farmers in NUID are concerned about the effect of long-term reduced water supply availability on their ability to maintain all types of acreage, including specialty crop acreage (Harris, 2019). The water provided by the Piping Alternative would be available in every type of water year, and water of this type would influence long-term, overall cropping pattern decisions.

Results from the net return analysis in Section 4.1 indicate that alfalfa hay provides an annualized average net return of about $160 per acre per year, while carrot seed provides roughly $2,680 per acre per year. Based on crop water use requirements from the Bureau of Reclamation Madras Agrimet Weather Station (AgriMet, 2019), alfalfa requires about 3 acre-feet of water per acre and carrot seed requires 1 acre-foot per acre. Thus, the net returns to water applied to alfalfa are about $53 per acre-foot ($160 per acre divided by 3 acre-feet of water use per acre) and the net returns for water applied to carrot seed are around $2,680 per acre-foot. Combining data on historic cropping pattern in NUID and water use by crop type from the Madras Agrimet Station indicates that alfalfa/grain crops typically use about 85 percent of the water in NUID, while specialty crops use about 15 percent of the water. Applying these water use percentages to the value per acre-foot for each crop type results in a weighted average value of $447 per acre-foot of water.[13] We use this amount to estimate the damage-avoidance benefit of each acre-foot of water going to NUID under the Piping Alternative.

[12] Source: North Unit Crop Mix Acreage, 2009 to 2018, Electronic document sent to Winston Oakley, Economist, Highland Economics from Mylen Bohle, Oregon State University Extension, on November 11, 2018.

[13] Specifically: $447/acre-foot = 85% X $53/acre-foot + 15% X $2,680/acre-foot.

Under the Piping Alternative, approximately 888 acre-feet of water would be passed to NUID each year. This volume of water valued at $447 per acre-foot results in a total annual agricultural damage reduction value of about $397,000. When discounted and annualized, the value of the Piping Alternative in avoiding agricultural damages in NUID totals $384,000 (as shown in Table J).

Table J. Avoided Damages to NUID Agriculture Resulting from Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2019$ [1].

Project Group	Water Conservation Under Piping Alternative (acre-feet/year)	Undiscounted Annual Benefits of Additional Instream Flow	Annualized Average Net Benefits of Piping Alternative above Baseline
Project Group 1	770	$344,000	$335,000
Project Group 2	118	$53,000	$49,000
Total	**888**	**$397,000**	**$384,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

1.2.1.2 District Operations and Maintenance Cost Savings Benefit

From 2013 to 2017, annual operation and maintenance (O&M) costs for COID averaged roughly $1.65 million per year, which includes maintenance of equipment, buildings, and irrigation systems; supplies; payroll expenses; and administrative expenses (Clark, 2018).[14] As the District maintains 475 miles of canals, the O&M costs average roughly $3,477 per mile. It is expected that these costs would continue in the future under Baseline conditions. The District expects O&M costs to fall by 15 percent for canals converted to pipe, or roughly $520 ($3,477 multiplied by 15 percent) (Clark, 2018). Implementing the Piping Alternative would result in approximately 7.9 miles of piped canals, which is expected to reduce costs by roughly $4,000 per year ($4,000 per year of discounted, annualized NED savings) as a result of reduced maintenance expenses (Table K). Although not quantified in this analysis, there are also additional benefits to Oregon Department of Transportation because of decreased maintenance and inspection of road crossings. Similarly, there would also be potential benefits and a decrease in operation and maintenance costs for NUID, due to the decrease in flow through their Main Canal (see Section 6.9.2.1 in the Plan-EA for more information). This benefit was also not quantified.

14 The costs were adjusted for inflation from $1.60 million in 2017 dollars using the Consumer Price Index.

Table K. Annual Reduced Operation and Maintenance Costs to COID of Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Mileage Piped	Undiscounted Annual O&M Cost Under Baseline Conditions	Undiscounted Annual O&M Costs Under Piping Alternative	Discounted Annualized Benefit (Cost Reduction)
Project Group 1	5.1	$1,036,000	$1,033,000	$3,000
Project Group 2	2.8	$565,000	$564,000	$1,000
Total	**7.9**	**$1,601,000**	**$1,597,000**	**$4,000**

Note: Totals may not sum due to rounding. Prepared December 2019
[1/]Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

1.2.1.3 Patron Irrigation Pumping Cost Savings

Compared to Baseline conditions, it is estimated that the system improvements associated with the Piping Alternative would result in a net energy savings of 105,523 kWh per year, since it is much more efficient for patrons to receive pressurized water than to pressurize it themselves.[15] This energy cost savings is evaluated using Central Electric Cooperative's Schedule C rate for irrigation pumping: $0.0512 per kWh (Central Electric Cooperative, Inc., 2019). Table L presents the energy use under Baseline conditions and displays the savings to COID patrons for each project group under the Piping Alternative. Once all project groups are complete, the average annual NED savings to COID patrons would be approximately $5,000 each year.

[15] This is a based on an FCA analysis of COID data on energy savings.

Table L. Annual Increased Average Energy Cost Savings to COID Patrons of Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Annual Energy Use Under Baseline Conditions (kWh)	Annual Energy Use Under HDPE Piping Alternative (kWh)	Reduced Annual Energy Use (kWh)[2]	Undiscounted Annual Energy Cost Savings	Average Annual Discounted NED Benefits (Avoided Energy Costs)
Project Group 1	206,944	123,951	82,993	$4,000	$4,000
Project Group 2	76,945	54,415	22,530	$1,000	$1,000
Total	**283,889**	**178,366**	**105,523**	**$5,000**	**$5,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.
2/As estimated by Farmers Conservation Alliance (Alliance, 2019)

Because the Piping Alternative would include the installation of a booster pump at the G-4 lateral, it would eliminate the need for District patrons on that lateral to maintain irrigation pumps. Of the estimated 12 pumps being used by COID patrons on the G-4 lateral, 12 are projected to be eliminated as a result of the Piping Alternative. Pumps incur annual maintenance costs, service charges from power providers, and require replacement at the end of their useful life. Avoiding these costs would represent a benefit to District patrons.

Under Schedule C, the Central Electric Cooperative charges $5.29 per KW per month and $32.30 per month from April to October (Central Electric Cooperative, Inc., 2019). For this analysis, we used an average pump size of 10 horsepower (hp), requiring a 7.5-kW power connection. At this size, service charges for power would cost approximately $504 per year. A 10-hp pump typically requires roughly $550 worth of repairs every four years, for an average annual maintenance cost of $138 (Mark, 2019; Scarborough, 2019). A 10-hp pump typically has a 10-year useful life and costs approximately $3,000 (Haun, 2019; Fey, 2019). Amortizing these replacement costs results in an annualized replacement cost of $347. Summing the service charges, maintenance costs, and annualized replacement costs results in a total estimated annual cost of $989 to own and operate an irrigation pump, which this analysis uses to estimate the annual benefit of each pump eliminated in the study area as a result of the Piping Alternative. The table below outlines these cost-saving benefits. When discounted and amortized, roughly $12,000 per year would be saved on pump operation, maintenance, and replacement (OMR) costs.

Table M. Annual Estimated Cost Savings from Eliminated Irrigation Pumps under the Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Pumps Eliminated Under Piping Alternative	Undiscounted Annual OMR Costs Avoided by Piping Alternative	Average Annual NED Benefit (Avoided OMR Cost, Discounted and Amortized)
Project Group 1	12	$12,000	$12,000
Project Group 2	0	$0	$0
Total	**12**	**$12,000**	**$12,000**

[1]/ Price base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent. Prepared December 2019

1.2.1.4 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. This analysis focuses on the value of instream flow, as the conserved water from the Piping Alternative would be used to augment instream flows. However, this analysis also presents the value of water to agriculture as the Piping Alternative also enhances water supply reliability to the District.

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, similar to the data on costs of water conservation projects and may significantly underestimate the full value of instream flow augmentation. Data on water right transactions in the Deschutes Basin were not available for this study. However, prices of water rights are often based on the value of water to agriculture (as agriculture is the most common seller of water rights for environmental or other water uses). We therefore present market information on the value of water rights to irrigators in COID, as this indicates the 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/acre-foot/year, such that this enhanced instream flow is estimated to have a value of approximately $704,000 per year once all project groups are complete under the Piping Alternative (because of the timing, on an average annualized basis the NED benefit is roughly $681,000 as presented in Table O). As most water right transactions for environmental purchases are to enhance fish habitat, this value is expected to be a conservative proxy for the value to the public of enhanced fish habitat and fish populations. The full measure of the economic benefit of enhanced instream flow is the benefit to the public of enhanced fish and wildlife populations, water quality, ecosystem function, etc. Based on the fact that instream flow purchases are typically focused on fish habitat, we also include a separate value for other environmental benefits in the next section, notably Oregon Spotted Frog (OSF) habitat improvement.

Values published in the economic literature are often quite high for enhancements to trout and other fish and wildlife populations (see Table N), like those that would benefit from the instream flows provided by the Piping Alternative. As quantitative information on how instream flows would 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 estimated in this section using the prices of water from transactions in the Western United States (the next section below also separately considers the value of preserving the threatened OSF). Transaction values 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. Table O shows the estimated average annual benefits of enhanced instream flow for the Piping Alternative.

Table N. Studies and Values Used to Estimate the Value of Fish Enhancement.

Author(s)	Study Year	Original Value Per Household (Dollar Year)	Value Per Household Adjusted to 2019 dollars	Restoration Location	Fish Enhancement	Survey Respondents
Bell, Huppert, & Johnson	2003	\$24 - \$122 (2000\$)	\$36 - \$179	Coastal WA and OR	Annual willingness to pay (WTP) per household to increase local Coho salmon populations by 100%	Households in Grays Harbor, WA; Willapa Bay, WA; Coos Bay, OR; Tillamook Bay, OR; Yaquina Bay, OR
Olsen, Richards, & Scott	1991	\$43 (2006\$)	\$54	Columbia River Basin	Annual WTP per household to increase salmon and steelhead population by 100%	Pacific Northwest households that never fish
Loomis	1996	\$59 - \$73 (1994\$)	\$101 - \$125	Elwha River, Olympic Peninsula, WA	Annual WTP per household to restore a salmon and steelhead population in its historic habitat on the Elwha River	Households in Clallam County, WA; WA state; U.S.
Layton, Brown, & Plummer	1999	\$119 - \$250 (1998\$)	\$185 - \$388	Eastern WA and Columbia River; Western WA and Puget Sound	Annual WTP per household to increase migratory fish populations by 50%	Households in WA state

Prepared April 2019

Sources: (Bell, Huppert, & Johnson, 2003); (Loomis J. , 1996); (Layton, Brown, & Plummer, 2001); (Olsen, Richards, & Scott, 1991) as cited in (Richardson & Loomis, 2009).

Table O. Annual Estimated Instream Flow Value of Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2019$ [1].

Project Group	Water Conservation Under Piping Alternative (acre-feet/year)	Undiscounted Annual Benefits of Additional Instream Flow	Annualized Average Net Benefits of Piping Alternative above Baseline
Project Group 1	8,137	$610,000	$594,000
Project Group 2	1,255	$94,000	$87,000
Total	**9,392**	**$704,000**	**$681,000**

Note: Totals may not sum due to rounding. Prepared December 2019
[1/]Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

This value of $75 per acre-foot per year is based on the following information (see Table P):

1. Prices paid for water by environmental buyers throughout the Western United States: In the period 2000 to 2009, the purchase price of environmental water varied from just over $0 to nearly $1,676 per acre-foot per year, with an average permanent sale transaction price of $166 per acre-foot per year. Among 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 acre-foot 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 COID: Depending on the method used, this is estimated at $40 to $120 per acre-foot per year (for an average value of water to agriculture of approximately $80 per acre-foot). 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 would determine agricultural sellers' willingness to accept a price for water), and because conserved water avoids potential future reductions in COID's deliveries.

Table P. Value per acre-foot per Year of Water (Market Prices and Value to Agriculture), Deschutes Watershed, Oregon, 2019$.

Type of Value	Low Value	High Value	Median Value	Average Value
Permanent water right transactions in Western U.S., 2000 to 2009 (*Converted to Annual Values*)	~$0	$1,676	~$75	$166
Value of water to COID irrigators (*Income Capitalization Approach and Sales Price of Water in Ag to Ag Transfers, Converted to Annual Values*)	$40	$120	N/A	~$80

1.2.1.4.1 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 flows 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 acre-feet 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 $105,000 to approximately $344,000 per cubic foot per second (cfs) conserved; this may equate to roughly $300 to $1,000 per acre-foot conserved.

Water rights can be purchased or leased in Oregon. It is important to note that the value paid per acre-foot 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 period between 1995 and 1999, six transactions of water right purchases averaged $362 per acre-foot in Oregon, while five water right leases averaged $115 per acre-foot per year. The paper also shows lease and purchase price by environmental use, including for riparian areas, wetlands, recreation, and instream flow. For instream flows, the average purchase price across 18 transactions per acre-foot was $1,121, while across 35 lease transactions the annual price was $68 per acre-foot.

The Bren School of Environmental Science and Management at the University of California, Santa Barbara, maintains a database of water transfers in the Western United States, and distinguishes between the terms of the transaction (i.e., sale or lease) and the 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 shown below in Figures B and C show more recent (from 2000 to 2009) sales and leases of water rights by environmental buyers on a price per acre-foot 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 1-year leases typically fall below $800 per acre-foot per year (with several transactions showing prices rising over a $1,000 per acre-foot per year). Among 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 acre-foot per year. However, it is also important to note that the amount paid per acre-foot tends to decline with an increase in water volume traded; weighing the purchase price by the water volume sold decreases the average permanent sale transaction price to $20 per acre-foot per year.

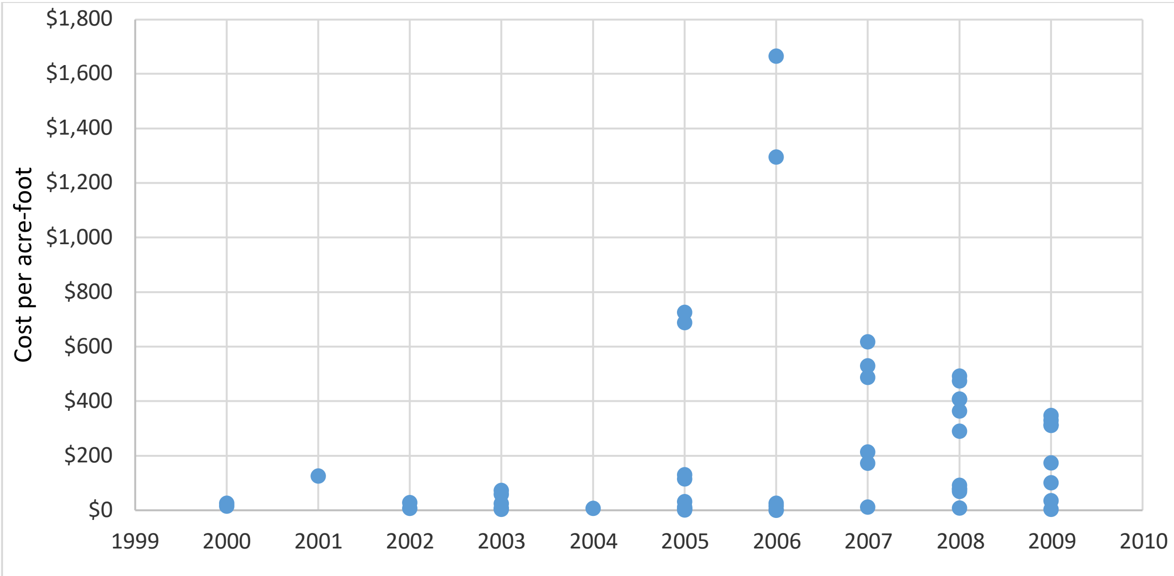

Figure B: Western water right purchases for environmental purposes, 2000 to 2009, price paid per acre-foot per year[16].

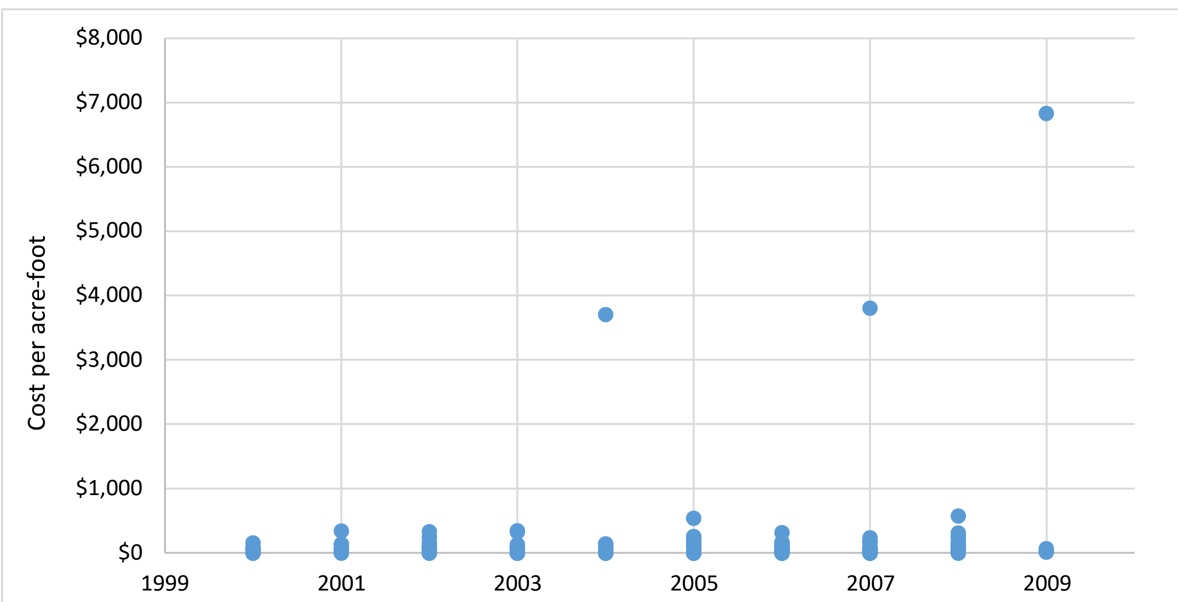

Figure C: One-year water leases for environmental purposes, price paid per acre-foot in western United States.

16 Note that dollar per acre-foot purchase prices were amortized using a 2.75-percent interest rate and a 100-year period to derive dollar per acre-foot per year values.

1.2.1.4.2 CURRENT AND POTENTIAL FUTURE WATER RIGHT PURCHASE VALUES IN THE SURROUNDING AREA

The District is currently undergoing discussions with their Board about how water is valued in District sales, as it is not accurately represented in current sale costs. However, to provide a reference for the value of water based on purchases in neighboring districts, water rights sold from one irrigator to another within Tumalo Irrigation District (which is also located in Deschutes County and has a similar crop mixture of predominantly forage crops) have typically had a purchase price between $5,030 to $7,550 per acre (Rieck, Tumalo Irrigation District Manager, 2017).[17] These values are very similar to values provided by area real estate agents regarding the increased value of property with irrigation water rights, with all else equal. Assuming the certificated rate of 5.45 acre-feet per year delivered on average to acreage in the District, this equates to approximately $923 to $1,385 per acre-foot ($5,030 to $7,550 per acre divided by 5.45 acre-feet per acre delivery), or a value of approximately $30 to $40 per acre-foot per year.

Prices paid for the limited number of agricultural water right sales may not reflect the average value of water to irrigators in COID and the cost of acquiring water in the future. The value of water to irrigators in COID (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 acre-foot in the limited number of current COID water transactions is lower than the value derived from the effect on on-farm income of changes in access to irrigation water (income capitalization approach), which indicates that changes in farm water supply affects farm income by approximately $100 per acre-foot per year.[18]

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 the region are not commercial farms or are not farming all 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 $30 to $40 per acre-foot, if instream flow buyers were to purchase water rights, then as more water rights were acquired, the cost per acre-foot would likely rise to the level as derived through the income capitalization approach.

1.2.1.5 Value of Supporting the Oregon Spotted Frog Habitat

In many river systems, organizations that are leasing and purchasing water rights to restore instream flows are focused on the enhancement of fish populations. As such, water right transaction values for instream flow purchases presented in the above section may represent the value of the instream habitat enhancement for fish but may not include the value associated with conservation of other species, such as amphibians. In the Deschutes River, restoration of flows would benefit not only fish species but would also benefit and help recover the Deschutes River populations of the threatened Oregon Spotted Frog (OSF) and enhance water quality. In this section, we describe the potential

[17] These values have been adjusted for inflation to 2019 dollars using the Consumer Price Index.

[18] We based this estimate on an analysis of the net returns of water for grass hay. An agricultural expert in the area estimated that reducing applied water by 1 acre-foot would decrease grass hay yields by approximately 0.5 tons per acre (Bohle, 2018). Assuming that each ton of grass hay generates $200 in revenue after harvest costs are subtracted, an acre-foot of water is worth approximately $100 to growers (Painter, 2015; NASS, 2017). However, given the existing full water supply at COID, we do not assume any change in yield would accrue to District patrons under the Piping Alternative.

additional value of OSF conservation, based on values from the literature regarding ecosystem and species conservation.

Long-term viability of the Deschutes populations of OSF is threatened by the Deschutes River's highly modified hydrologic regime. High summer flows, rapid flow fluctuation in the fall and spring, and current low wintertime flows are incongruent with the needs of the OSF lifecycle (Reclamation 2017). The USFWS believes that for long-term species preservation, increased wintertime flows are necessary in the Deschutes River (the Proposed Action would increase wintertime streamflow by up to 30.3 cfs). Although OSF and its habitat needs are still under scientific investigation, USFWS currently considers that 400 cfs is the minimum target winter instream flow in the upper Deschutes River necessary for beginning OSF recovery (Moran & O'Reilly, 2018). With restoration of streamflow and habitat on the Deschutes, the target flow may change as biologists monitor how the ecosystem and the OSF adjust to changes in flow management.

The economic value of conserving amphibian populations, and the OSF in particular, may stem from many types of benefits to society provided by these species. As summarized in Table Q, social and economic benefits of OSF preservation may include enhanced cultural values, recreational values, educational values, public health values, environmental quality values, and intrinsic species existence values (i.e., the value to people of preserving the species, apart from any use of the species). Pertinent to potential medical and ecological values, researchers have identified that the OSF may have an antimicrobial chemical in its skin secretions that provides resistance to a fatal amphibian disease (chytridiomycosis) that is causing declines in many amphibian populations (Conlon, et al., 2013).

Table Q: Sources of Economic Value from Amphibian Conservation.

Source of Value	Description
Cultural Value	Frogs have cultural value that is evident in their symbolism and use in literature, music, art, and jewelry.
Recreational Value	Wildlife viewing of frogs can enhance recreational value, while intact amphibian natural areas and wetlands can also enhance recreational value by providing aesthetically pleasing and diverse recreational environments.
Educational Value	Frogs provide an opportunity for research and education for ecology, biology, anatomy, and physiology.
Mosquito Control (Human Health, Well Being)	Amphibians reduce mosquito and other pest populations through predation and competition, which can provide social and economic values by reducing a nuisance as well as provide public health benefits by reducing risk of mosquito-borne illnesses (thereby improving quality of life and reducing medical costs).
Pharmaceutical Drug Development (Human Health Value)	Amphibians produce chemicals for a variety of purposes and these chemicals can provide the basis for new drugs.
Other Medical Advances (Human Health Value)	Amphibians' ability to regenerate limbs and tails may increase knowledge about physiology and lead to human medical advances.
Environmental Quality Value	Amphibians improve soil structure and fertility through soil furrowing, decomposition, and nutrient cycling.
Species Existence Value	In addition to, and separate from their values for the above uses, preservation of frog populations provides intrinsic value to people related to enjoyment of knowing the species exists and the moral/ethical values associated with the conservation of the species for others, including future generations.

Source: (Hocking & Babbitt, 2013) Prepared December 2019

1.2.1.5.1 *VALUE PER HOUSEHOLD*

In terms of specific dollar values for the OSF, numerous studies are available in the economic literature that estimate the willingness to pay for individual species conservation. People's values for species conservation may arise from personal use (i.e., enjoying seeing the species and/or its habitat), personal beliefs and moral ethics (i.e., believing protecting a species and its habitat is the right thing to do), altruism (i.e., believing a resource should be protected so that others can use it or benefit from it), and/or a desire to bequest the resource (i.e., believing a resource should be protected for future generations). The most common way to measure value to people of species conservation is through surveys in which people are asked about their willingness to pay to protect a species. These surveys are highly challenging to develop and implement well, and results from different surveys aiming to measure similar changes in resources can be highly variable.

While results are varied, several reviews of these types of survey studies have found that people's willingness to pay (i.e., the value they hold) for species conservation typically depends most heavily on the following factors:

- The type of species being conserved (in general, the larger and more iconic or charismatic the species, the higher the value, with species such as marine mammals tending to have the highest values);
- People's knowledge of the species (the more knowledge people have regarding the species, the higher the conservation value);
- The usefulness of the species to people, the level of threat and species population size (the smaller and more endangered the species population, the higher the value);
- Whether the respondent is a visitor or a resident (recreational or tourist visitors tend to have higher values than residents); and
- Survey design (Loomis & White, 1996; Mahoney, 2009; Martin-Lopez, Montes, & Benayas, 2008; Amuakwa-Mensah, Barenbold, & Riemer, 2018).

As noted above, values, particularly for iconic mammals, can be quite high. For example, household willingness to pay for enhancing or preserving a species such as elk, moose, or humpback whales have been estimated to average over $150 per household per year. Values for less iconic, non-mammal species, however, are more pertinent to the OSF. Preservation of non-mammal species that are much less iconic are often valued by U.S. households in the range of $15 to $35, or more, per household per year[19] (Loomis & White, 1996; Martin-Lopez, Montes, & Benayas, 2008). For example, the Palouse giant earthworm has been estimated to be valued at approximately $20 per year per household in eastern Washington State, while the Riverside fairy shrimp has been estimated to be valued at approximately $35 per household per year by households in Orange County, California (Stanley, 2005; Decker & Watson, 2016). These two species may be similar to the OSF in that they are not iconic, but may be symbols of preservation of a particular ecosystem.

While the literature does not include willingness-to-pay surveys specific to the Deschutes Basin, watershed and habitat protection are important to basin residents. A 2009 survey of 400 randomly selected Deschutes County voters highlights this (The Trust for Public Land, 2010). In terms of conservation projects, the top five ranking project types, all with 79 percent or more of Deschutes County respondents indicating an importance level of extremely important or very important, are: 1) protecting water quality in rivers, creeks, and streams; 2) protecting and improving drinking water quality; 3) protecting wildlife habitat; 4) protecting natural areas; and 5) protecting natural watersheds. These priorities ranked more highly than protecting forests, protecting farmland, planting more trees, and improving recreational access and recreational amenities. Furthermore, the survey findings illustrate that natural environment and recreational opportunities are integral to the county's quality of life (The Trust for Public Land, 2010). In response to questions regarding the county's quality of life, the most commonly cited contributors to a high quality of life were regarding the natural environment, including outdoor recreation, open space, and natural areas.

Specific to values for OSF conservation in the Deschutes Basin, because the species is not a large mammal, its value to people would tend to be less. On the other hand, several factors would tend to increase its value to households in the Deschutes Basin: 1) many people know about the species, and its conservation has come to represent, to many people, the restoration of the Deschutes River ecosystem, 2) the OSF species population is threatened, and researchers have identified that the

[19] Surveys that are conducted in other countries, including developing countries with lower incomes, often find lower willingness-to-pay values for species conservation. In general, willingness to pay for conservation increases with higher household income. For this reason, we focus on studies conducted in the U.S. and Canada.

Deschutes population of OSF is genetically distinct from other OSF populations (Moran & Monje, 2016)[20], such that the population size of the genetically distinct species benefiting from increased wintertime Deschutes River flows is quite small, and 3) there are many visitors to the Deschutes Basin, and visitors tend to have relatively higher values (compared to local residents) for preservations of ecosystems and species in the areas they visit.

As instream flow augmentation in the Deschutes aids not just the OSF but also improves ecological function and enhances habitat for other species, it is useful to consider studies that estimate value of local habitat restoration and species preservation more generally (Hodgson, 2018). As cited above, Orange County residents were estimated to value fairy shrimp recovery at $35 per household per year and $78 per household per year for preservation of all local endangered species (Stanley, 2005).[21] Perhaps more pertinent, a study identifying the value of preserving one or multiple little-known fish species in Ontario, Canada found that some improvement in the population of a single, little-known riverine species (channel darter) was valued at $10 per household per year, while conservation of three, little-known riverine species (channel darter, eastern sand darter, and the spotted sucker) would increase the value to $69 per household per year (Rudd, Andres, & Kilfoil, 2016). The same study found that a conservation action resulting in a large improvement to the channel darter population was valued at $22 per household per year while a large improvement to the three species populations resulted in a value of $83 per household per year.[22] In other words, in both studies, preserving a single species was valued at approximately $10 to $35, while preserving habitat for a broader range of species was valued at $69 to $86 per household. As shown in Table R, the highest values in the Ontario, Canada study were found to be associated with water quality, which would also be improved in the Deschutes Basin due to the Piping Alternative.

Table R. Economic Values (2019 values) for Little-Known Ontario, Canada Aquatic Species at Risk.

Type of Benefit	Some Improvement	Large Improvement
1 Riverine Species (Channel Darter)	$10	$22
3 Riverine Species (Channel Darter, Eastern Sand Darter, Spotted Sucker)	$69	$83
Water Quality Index	$91	$113

Source: (Rudd, Andres, & Kilfoil, 2016) Prepared December 2019

[20] In terms of its uniqueness, the OSF is found in Oregon, Washington, and California, but the OSF populations in the Deschutes Basin have been found to be genetically distinct. In fact, even within the Deschutes Basin, evidence indicates that there are numerous genetically distinct populations of OSF due to the large distances between OSF habitat sites and the relatively limited travel distances of the frog (Loomis, Quattlebaum, Brown, & Alexander, 2003). While Deschutes OSF is still considered the same species as OSF located elsewhere, its genetic uniqueness adds to the biological and potentially economic value of its continued survival.

[21] The original study cited values of $25.83 and $55.22 in 2001 dollars, which were converted into annual 2019 dollars in this study.

[22] The original study cited values of $9.45, $64.23, $20.59, and $77.50 in 2011 Canadian dollars. We converted these to 2011 USD using an exchange rate of 0.9567 and adjusted the resulting value for inflation to 2019 dollars using the Consumer Price Index (a factor of 1.124).

The instream flow value of $75 per acre-foot per year described in the previous section translates into approximately $37 per Deschutes County household per year of conservation value.[23] Including a value of $35 per household per year for OSF habitat in addition to the instream flow values cited above provides a cumulative value per household of instream flow augmentation/habitat conservation value of $72 per Deschutes County household. This appears reasonable based on the literature addressing the value of single species conservation compared to multiple species conservation and improvements to an aquatic ecosystem.

1.2.1.5.2 NUMBER OF RESIDENT AND TOURIST HOUSEHOLDS HOLDING VALUE FOR OSF AND DESCHUTES BASIN HABITAT CONSERVATION

Based on U.S. Census data, the population of Deschutes County in 2017 was 186,875 people. Using the Census 2010 average household size of 2.44 translates to approximately 76,600 households. In addition to local households, there may be many households residing outside of Deschutes County that may value the preservation of the OSF and Deschutes Basin habitat. Some studies have found that households throughout the nation, located far from a wildlife habitat area, may value species preservation efforts (Loomis J. , An Empirical Comparison of Economic versus Political Jurisdictions, 2000). Additionally, as noted above, visitors to an area, particularly tourists participating in outdoor recreation, may have even higher species preservation values than residents. As such, we apply the estimated OSF species conservation value not only to Deschutes County households, but also to the estimated number of households who are tourists in Deschutes County each year that participate in outdoor recreation activities. Based on overnight visitation data (Longwoods International , 2017) and tourism expenditure data in Central Oregon (Dean Runyan Associates, 2018), we estimate that there are 102,000 households who visit Deschutes County each year with the main trip purpose being outdoor recreation. We focus on these visitor households as many of the surveys of visitor willingness to pay for conservation have been at outdoor recreation sites.[24] In sum, we estimate that approximately 178,600 households (76,600 resident households and 102,000 visitor

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23 Based on U.S. Census data, the population of Deschutes County in 2017 was 186,875 people, which using the Census 2010 average household size of 2.44 translates to approximately 76,600 households. The Proposed Action would increase instream flows by 37,750 acre-feet annually. As such, using $75 acre-foot per year value, the average estimated value on a per household basis translates to $37 per year ($75 x 37,750 / 76,600 = $37/household).

24 A tourism study by Longwoods Travel estimated that there were 4.5 million overnight person trips (a person trip is a trip of any length taken by one person) to Central Oregon in 2017. The Central Oregon region includes Deschutes, Jefferson, Crooked, and South Wasco counties. We use the proportion of visitor spending in each county to estimate the percent of the overnight person trips occurring to Deschutes County. According to the Oregon Travel Impacts report prepared for the Oregon Tourism Commission, 82 percent of 2017 visitor spending in Central Oregon occurs in Deschutes County. (Total estimated spending in Central Oregon is $776.6 million, of which $640.2 million, or 82 percent, is estimated to occur in Deschutes County.) Assuming 82 percent of Central Oregon overnight visits are in Deschutes County, there were approximately 3.71 million overnight person visits in 2017 in Deschutes County. The Longwoods Travel survey indicated that the average household size of overnight visitors to Central Oregon is approximately 2.87 people, which translates to approximately 1.293 million households with overnight trips to Central Oregon. The survey also indicates that approximately 62 percent of households had visited Central Oregon in the previous 12-month period. We assume that these households with previous visits to the region had visited, on average, three times per year. This translates to an average visitation rate of 2.24 across all households with overnight visits, for an estimated 577,000 separate households visiting Deschutes County. Of all visitors, the survey indicates that approximately 57 percent are tourists (i.e., not traveling for business or visiting family or friends). Of these, approximately 31 percent have outdoor recreation as the primary purpose of their visit. As such, we estimate approximately 102,000 households take at least one overnight tourist trip to Deschutes County annually with the primary purpose of their trip being outdoor recreation.

households) may value OSF habitat conservation in the Deschutes Basin. This represents approximately seven percent of Oregon households.

1.2.1.5.3 ESTIMATED OSF CONSERVATION VALUE OF COID FLOW AUGMENTATION

While there are numerous factors that create uncertainty in estimating the value of OSF habitat conservation[25], the economic literature supports the notion that habitat conservation through flow augmentation in the Deschutes likely exceeds the instream flow values cited in the previous section that are based on market transaction data. Based on the species and habitat conservation literature as a whole, we find it reasonable that this additional value for OSF conservation may be approximately $35 per household per year. While people throughout Oregon and beyond may value OSF habitat conservation, we conservatively apply this value to the 76,600 Deschutes County households and approximately 102,000 tourism households who visit the County annually for the primary purpose of outdoor recreation, for a total of 178,600 households. In sum, this translates into an estimated value of Deschutes OSF preservation of approximately $6.25 million per year.

As discussed above, for OSF preservation, flow augmentation is needed to increase wintertime flows from the current 100 cfs to approximately 400 cfs, or an increase of 300 cfs. After being passed water saved by the COID project, NUID in turn would contribute 30.3 cfs to wintertime flows, or 9.81 percent of the additional flow anticipated to be required for OSF conservation. We thus apportion 10.10 percent of the estimated value of $6.25 million for OSF conservation to the COID Proposed Project, or $631,000 per year ($610,000 annualized net benefit as shown in Table S).

Table S. Value of Supporting OSF Habitat under the Piping Alternative, Deschutes Watershed, Oregon, 2019$.

Project Group	Water Conservation Under Piping Alternative (cfs)	Undiscounted Annual Benefits	Annualized Average Net Benefits[1]
Project Group 1	26.3	$548,000	$533,000
Project Group 2	4.0	$83,000	$77,000
Total	**30.4**	**$631,000**	**$610,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

1.2.2 Benefits Considered but Not Included in Analysis

1.2.2.1 Public Safety Avoided Costs

Piping irrigation water removes the hazard of drownings in canals, as well as eliminates the potential for earthen canals to fail, causing potential damages to downstream property and lives. While COID canal failure is very possible, 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, the 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

25 Including, first and foremost, the uncertainty in applying values from other contexts and species to the OSF, as well as the challenge in interpreting results from previous studies given the diversity of values found and the high sensitivity of findings to study design and implementation methods.

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 three drownings over the last 21 years (1996 through 2016), or 0.143 deaths per year during this period. As the population in Central Oregon continues to grow and areas surrounding irrigation canals continue to urbanize, the risk to public safety would increase.

The Piping Alternative would pipe open canals in COID's system. This section qualitatively discusses the potential magnitude of the public safety benefit of piping the 7.9 miles in COID. The analysis presents some information on the potential public safety hazard of the existing unlined irrigation canals in COID proposed for piping (based on the recent history of drownings and the mileage of exposed canals).

1.2.2.1.1 Level of Public Safety Hazard

This analysis estimates the public safety hazard of unlined canals in COID based on past drownings in unlined canals in Central Oregon. Based on data from the Oregon Water Resources Department (OWRD) 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 show that approximately 209 miles have been piped. Assuming piping occurred uniformly across the 21-year period from 1996 to 2016, approximately 9.9 miles were piped each year, leaving approximately 973 miles unpiped on an average annual basis during this period. Given that an average of 0.143 drowning deaths occurred annually during this period (three deaths over 21 years as described above), 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 20 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 Baseline conditions, COID would continue to have approximately 7.9 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 COID carry a risk of 0.0012 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	**1,072.0**

Note: Totals may not sum due to rounding. Prepared December 2019
Source: Oregon Water Resources Department, database maintained and provided by Jonathon LaMarche on March 9, 2017.

2 No Action Alternative

2.1 Costs of the No Action Alternative

This section outlines the costs and benefits of the No Action Alternative in comparison to Baseline conditions. Under the No Action Alternative COID would pipe 2.3 miles of their system over four years. This alternative assumes that COID could receive approximately $3 million per year over the four years. In the next section, these costs and benefits of the No Action are compared to the costs and benefits of the Piping Alternative to show the incremental NED benefits of the proposed project. Many of the assumptions described in the first section also apply to the No Action Alternative and are not duplicated here. Instead, this section describes the results of applying the same analysis to piping under the No Action Alternative.

2.1.1 Analysis Parameters

2.1.1.1 Funding

In the absence of the Piping Alternative, the District intends to continue piping the COID system, with a focus on piping Project Group 1. The District would seek funding, as it traditionally has, from grants and loans; it is not expected that federal funds would be used to support the piping.

2.1.1.2 Evaluation Unit

The same project groups used to analyze the Piping Alternative are used for the No Action Alternative.

2.1.1.3 Project Implementation Timeline

Under the No Action Alternative, the District expects to pipe about 2.3 miles of Project Group 1 over the next four years. At completion, this would represent 29 percent of the length piped under the Piping Alternative. This analysis assumes the piping construction would occur linearly over this time period, and the benefits of piping would begin the year after each section is finished. Table U displays the installation costs of piping under the No Action Alternative.

Table U. Construction Timeline and Installation Costs by Funding Source for the No Action Alternative, Deschutes Watershed, Oregon, 2019$[1].

Construction Year	Works of Improvement	Public Law 83-566 Funds	Other, Non-Federal Funds	Total Installation Costs
0 - 4	Project Group 1	$0	$12,720,000	$12,720,000
N/A	Project Group 2	$0	$0	$0
Total Project		**$0**	**$12,720,000**	**$12,720,000**

[1/]Price Base: 2019 dollars. Prepared December 2019

2.1.1.4 Analysis Period

The analysis period for the No Action Alternative is the same as the Piping Alternative.

2.1.2 Piping Costs

Table V shows the distribution of installation costs associated with piping under the No Action Alternative. Because the District expects to cover all piping costs without federal funding (as shown in Table U), we have omitted the columns for "PL 83-566 Funds" and only "Other Funds" are shown. Table W presents the annualized costs of installation and other direct costs associated with piping, which includes increased pumping costs from increased depth to groundwater due to reduced recharge and the costs to replace fiberglass piping.

Table V. Estimated Cost Distribution of No Action Alternative - Water Resource Project Measures, Deschutes Watershed, Oregon, 2019$ [1,2].

Works of Improvement	Installation Cost - Other Funds			Total Installation Costs
Piping	Construction	Engineering	Project Admin[3]	
Project Group 1	$11,641,000	$359,000	$720,000	$12,720,000
Project Group 2	$0	$0	$0	$0
Total Costs	**$11,641,000**	**$359,000**	**$720,000**	**$12,720,000**

Note: Totals may not sum due to rounding. Prepared December 2019

1/Price base: 2019 dollars.

2/Project cost as identified in by KPFF Consulting Engineers in 2019, including additional percent project administration and technical assistance costs.

3/Project Admin includes project administration, technical assistance costs, and permitting costs.

Table W. Estimated Average Annual NED Costs for No Action Alternative, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Project Outlays (Amortization of Installation Cost)	Other Direct Costs [2]	Total
Project Group 1	$360,000	$61,000	$421,000
Project Group 2	$0	$0	$0
Total	**$360,000**	**$61,000**	**$421,000**

Note: Totals may not sum due to rounding. Prepared December 2019

1/Price base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

2/Other direct costs include the uncompensated economic losses due to changes in resource use or associated with installation, operation, or replacement of project structures. Other direct costs are presented for fiberglass pipe replacement, costs of the booster pump, and increased pumping costs elsewhere in the basin from reduced groundwater recharge (i.e., seepage from unlined canals). This does not include operations, maintenance, and repair costs because these decline under the Piping Alternative, so these are presented as a benefit.

2.1.3 Project Installation Costs

Based on FCA's analysis of estimates by Black Rock Consulting, the total cost for installing piping under the No Action Alternative is projected at $12,720,000 (Table V). Of this, project administration is estimated at three percent of construction and engineering costs, as are permitting costs. When spread evenly across four years of construction, the total cost converts to a discounted annual average cost of $360,000 (Table W).

2.1.4 Other Direct Costs

2.1.4.1 Groundwater Recharge Costs

The No Action Alternative would impact groundwater for the same reasons as the described in the Piping Alternative (Section 1.1.4.1) and under the same Baseline conditions. However, the No Action Alternative would only reduce associated groundwater recharge by up to approximately 1,235 acre-feet annually in this part of the Deschutes Basin[26].

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

Year	Volume Pumped (acre-feet per year)	Average Depth to Groundwater (feet)	
		Baseline Conditions	No Action Alternative
1	54,000	501	501.0
10	60,000	510	510.0
20	65,000	520	520.0
30	67,000	530	530.1
40	70,000	540	540.1
50	73,000	550	550.2
60	75,000	560	560.2
70	78,000	570	570.2
80	81,000	580	580.3
90	84,000	590	590.3
100	86,000	600	600.3

Prepared December 2019

Table X compares the estimated depth to groundwater under Baseline conditions to those under the No Action Alternative. Piping under the No Action Alternative is expected to increase groundwater depth by 0.001 feet in Year 1, rising to 0.33 feet in Year 100. The decline in the groundwater level is expected to increase total pumping costs by $4 in Year 1 and increase to $2,400 in Year 103. After discounting and amortizing these costs, the estimated annual average cost is $1,000 (as shown in Table Y).

26 The decrease in groundwater recharge includes the loss of canal seepage from the piping of COID's system as well as the loss of seepage from North Unit Irrigation District's Main Canal (North Unit would proportionally decrease the water passed through their Main Canal to the water that is saved and passed to them through COID).

Table Y. Other Direct Costs of Reduced Recharge under No Action Alternative, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Water Conservation (cfs)	Water Conservation (acre-feet/year)	Change in Groundwater Depth (feet/year)	Annual Average NED Cost
Project Group 1	3.9	1,253	0.003	$1,000
Project Group 2	0.0	-	0.000	$0
Total	**3.9**	**1,253**	**0.003**	**$1,000**

Note: Totals may not sum due to rounding. Prepared December 2019
[1]/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

2.1.4.2 Booster Pump Costs

Under the No Action Alternative, the District would install a booster pump on the G-4 lateral as it also plans to do under the Piping Alternative (Section 1.1.4.2); therefore, there would be the same associated energy and OMR costs. However, due to discounting and the slightly later construction schedule, the annualized present value of the energy and maintenance costs would be slightly lower under the No Action Alternative. In total, it is expected that the total additional annualized costs of the booster pump under the No Action Alternative would be approximately $13,000.

Table Z. Annual Booster Pump Energy Costs of No Action Alternative by Project Group, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Total Annual Booster Pump Energy Demands (kWh)	Undiscounted Annual Booster Pump Energy Costs Under Piping (kWh)	Undiscounted Annual Booster Pump O&M Costs Under Piping (kWh)	Discounted and Amortized Annual Cost of Booster Pump Replacement	Average Annual NED Cost for Booster Pump (Discounted and Amortized)
Project Group 1	193,285	$10,000	$4,000	$1,000	$13,000
Project Group 2	0	$0	$0	$0	$0
Total	**193,285**	**$10,000**	**$4,000**	**$1,000**	**$13,000**

[1]/ Price base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent. Prepared December 2019

2.1.4.3 Pipe Replacement

Piping under the No Action Alternative would require approximately 0.87 miles of large diameter (102 inch) piping, representing roughly 38 percent of the total length piped. This pipe would cost around $11,631,000 to procure and install, which is the amount we use to represent the full cost of replacing the pipe. We assume that the total length of large-diameter piping would be spread evenly throughout the four years of construction under the No Action Alternative (i.e., piping about $3 million dollars of pipe per year). Using the same replacement schedule described in the Piping Scenario (25 percent replaced 50 years after initial installation and 75 percent replaced 75 years after initial installation), the annual average costs to replace fiberglass pipe are $45,000 as shown in Table AA.

Table AA. Other Direct Costs of Large Diameter Pipe Replacement under the No Action Alternative, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Feet of Pipe Replaced	Undiscounted Replacement Cost	Annual Average NED Replacement Cost
Project Group 1	4,579	$11,631,000	$45,000
Project Group 2	0	$0	$0
Total	**4,579**	**$11,631,000**	**$45,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

2.1.4.4 Carbon Costs

The 80.8 MWh of reduced energy demand would help to avoid 61 Mt of carbon emissions each year once the four years of piping is complete. This would be offset by an average of 144 Mt of carbon per year that would be added as a result of booster pump energy use and declining groundwater levels under the No Action Alternative, resulting in an average net decrease of about 84 Mt annually (as shown in Table BB).

Table BB. Annual Average Carbon Emissions (Mt) of No Action Alternative by Project Group, Deschutes Watershed, Oregon.

Works of Improvement	Baseline Conditions		No Action Alternative		
	Average Annual Carbon Emissions, Basin-wide Pumping	Annual Carbon Emissions, COID Patron Pumping	Average Annual Carbon Emissions, Basin-wide Pumping	Annual Carbon Emissions, COID Patron Pumping	Net Annual Carbon Increase (Compared to No Action)
Project Group 1	N/A	156	N/A	239	84
Project Group 2	N/A	58	N/A	58	0
Total	**44,341**	**214**	**44,425**	**297**	**84**

Note: Totals may not sum due to rounding. Prepared December 2019
1/ These values show an average annual increase over 104 years. Carbon emissions rise over time because groundwater pumping volume increases throughout the basin over time, and the depth to groundwater also rises over time due to reduced recharge from canals.

Table CC. Annual Average Carbon Cost Savings of No Action Alternative by Project Group, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Annual Avoided Emissions (Reduced COID Patron Energy Use, Mt Carbon)	Average Annual Increased Emissions (from Reduced Recharge, Mt Carbon)[2]	Net Average Increased Emissions	Average Annual Costs (Social Cost of Carbon)[3]
Project Group 1	61	144	84	$1,000
Project Group 2	0	0	0	0
Total	**61**	**144**	**84**	**$1,000**

Note: Totals may not sum due to rounding. Prepared December 2019

1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

2/Additional energy use elsewhere rises over 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 differ from the change in tons of carbon emitted multiplied by the $7 value per Mt of carbon. The increased emissions rise over time (and are thus highest at later periods when the values are most discounted, while the decreased carbon emissions are the same over time).

2.1.4.5 Change in Aesthetics and Associated Property/Recreation Values

The types of changes to aesthetics, property values, and recreation values are expected to be similar under the No Action Alternative as under the Piping Alternative. However, because the length of piping is less, the magnitude of the impacts is expected to be less and isolated to the area of Project Group 1 (north of Redmond).

2.2 Benefits of the No Action Alternative

This section outlines the benefits of the No Action Alternative.

2.2.1 Benefits Considered and Included in Analysis

2.2.1.1 Agricultural Damage Reduction Benefit

Under the No Action Alternative, NUID would gain an estimated 108 acre-feet of water annually due to reduced seepage losses in the North Unit Main Canal, resulting from a change in diversion associated with the COID piping project (Farmers Conservation Alliance, 2019). Similar to the Piping Alternative, this increased water availability is expected to reduce the agricultural damages associated with water shortages experienced currently in NUID.

Using the same methods as described in Section 1.2.1.1, this analysis estimates the value of additional water to NUID agriculture to be approximately $447 per acre-foot. Accordingly, the additional 108 acre-feet of water expected to reach NUID each year under the No Action Alternative is estimated to have an undiscounted annual benefit of roughly $48,000. As shown in Table DD, when discounted and amortized, the benefit of additional water to NUID agriculture would be approximately $47,000 annually.

Table DD. Avoided Damages to NUID Agriculture Resulting from No Action Alternative by Project Group, Deschutes Watershed, Oregon, 2019$ 1.

Project Group	Water Conservation Under Piping Alternative (acre-feet/year)	Undiscounted Annual Benefits of Additional Instream Flow	Annualized Average Net Benefits of Piping Alternative above Baseline
Project Group 1	108	$48,000	$47,000
Project Group 2	0	$0	$0
Total	**108**	**$48,000**	**$47,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

2.2.1.2 Operations and Maintenance Cost Savings Benefit

Because the District plans to pipe part of Project Group 1 under the No Alternative, there would also be O&M cost savings under the No Action Alternative. Piping 2.3 miles in Project Group 1 would result in savings of roughly $1,000 each year. Table EE shows the O&M costs under both scenarios and the savings associated with the Piping Alternative.

Table EE. Annual Reduced Operation and Maintenance Costs to COID of No Action Alternative by Project Group, Deschutes Watershed, Oregon, 2019$1.

Works of Improvement	Mileage Piped	Discounted Annualized Benefit of No Action (O&M Cost Reduction)
Project Group 1	2.3	$1,000
Project Group 2	0.0	$0
Total	**2.3**	**$1,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

2.2.1.3 Patron Irrigation Pumping Cost Savings

As in the Piping Alternative, piping under the No Action Alternative would result in energy savings by avoiding pumping. Using the same assumptions that were used for the Piping Alternative, the No Action Alternative piping would save roughly 80,867 kWh per year. At a rate of $0.0512 per kWh, these savings would be worth about $4,000 per year. After accounting for the construction timeline and discounting the values, the energy saved from piping under the No Action Alternative is worth an annual average of $4,000 (shown in Table FF).

The No Action Alternative, similar to the Piping Alternative, would also include the installation of a booster pump at the G-4 lateral and would eliminate the need for District patrons on that lateral to maintain irrigation pumps. Using the same assumptions as in the Piping Alternative, this would result in an annual average savings to patrons of $11,000 (shown in Table GG).[27] Avoiding these costs would represent a benefit to District patrons.

Table FF. Annual Increased Average Energy Cost Savings to COID Patrons of No Action Alternative by Project Group, Deschutes Watershed, Oregon, 2019$1.

Works of Improvement	Annual Energy Use Under Baseline Conditions (kWh)	Annual Energy Use After Piping Under No Action Alternative (kWh)	Reduced Annual Energy Use (kWh)2	Undiscounted Annual Energy Cost Savings	Average Annual Benefits (Avoided Energy Costs)
Project Group 1	206,944	126,077	80,867	$5,000	$4,000
Project Group 2	76,945	76,945	0	$0	$0
Total	**283,889**	**203,022**	**80,867**	**$5,000**	**$4,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

Table GG. Annual Estimated Cost Savings from Eliminated Irrigation Pumps under the No Action Alternative by Project Group, Deschutes Watershed, Oregon, 2019$1.

Works of Improvement	Pumps Eliminated Under Piping Alternative	Undiscounted Annual OMR Costs Avoided by Piping Alternative	Average Annual NED Benefit (Avoided OMR Cost, Discounted and Amortized)
Project Group 1	12	$12,000	$11,000
Project Group 2	0	$0	$0
Total	**12**	**$12,000**	**$11,000**

1/ Price base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent. Prepared December 2019

2.2.1.4 Value of Conserved Water

The No Action Alternative would conserve approximately 1,145 acre-feet of water, and similar to the Piping Alternative, the District intends to pass the water to NUID, which would release the same volume of water instream from Wickiup Reservoir during the non-irrigation season. Accordingly, we model the benefits associated with instream flow under the No Action Alternative using the same value ($75/ acre-foot) as in the Piping Alternative. The 3.7 cfs released during the non-irrigation season would bring benefits of roughly $86,000 annually, which, when discounted and annualized, are worth roughly $83,000 (see Table HH below).

27 Due to discounting and the later construction timeline under the No Action Alternative, the present value of benefits is slightly lower than under the Piping Alternative.

Table HH. Annual Estimated Instream Flow Value of No Action Alternative by Project Group, Deschutes Watershed, Oregon, 2019$[1].

Project Group	Water Conservation Under No Action Alternative (acre-feet/year)	Undiscounted Annual Benefits of Additional Instream Flow	Annualized Average Net Benefits of No Action Alternative over Baseline
Project Group 1	1,145	$86,000	$83,000
Project Group 2	0	$0	$0
Total	**1,145**	**$86,000**	**$83,000**

Note: Totals may not sum due to rounding. Prepared December 2019
[1/]Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

2.2.1.5 Value of Supporting the Oregon Spotted Frog Habitat

Similar to instream flow, because the water conserved under the No Action Alternative would be put back instream, there would be additional support to the OSF, which would bring benefits. As explained in Section 1.2.1.5, the 3.7 cfs protected instream under the No Action Alternative would supply 1.2 percent of total instream flow needed to support the OSF, and therefore provide 1.2 percent of the total estimated value of supporting the OSF ($6.25 million), or $77,000 annually. When discounted and annualized, these benefits are worth roughly $74,000 above the Baseline scenario (as shown in Table II).

Table II. Value of Supporting OSF Habitat under the No Action Alternative, Deschutes Watershed, Oregon, 2019$.

Project Group	Water Conservation Under Piping Alternative (cfs)	Undiscounted Annual Benefits	Annualized Average Net Benefits[1]
Project Group 1	3.7	$77,000	$74,000
Project Group 2	0.0	$0	$0
Total	**3.7**	**$77,000**	**$74,000**

Note: Totals may not sum due to rounding. Prepared December 2019
[1/]Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

2.2.2 Benefits Considered but Not Included in Analysis

2.2.2.1 Public Safety Avoided Costs

Piping 2.3 miles under the No Action Alternative would likely bring the same types of public safety benefits as described in Section 1.2.2.1 above, but only within the area of Project Group 1. However, as with the Piping Alternative, we do not model these benefits under the No Action Alternative.

3 NED Benefits and Costs

This section compares the benefits and costs of the Piping Alternative described in Section 1 to the benefits and costs of the No Action Alternative outlined in Section 0. Specifically, this section provides the estimated benefits and costs of the Piping Alternative that exceed those in the No Action Alternative. This comparison provides the NED benefits and costs of the Piping Alternative.

3.1 NED Costs

3.1.1 Project Costs

Table 8-5 (NWPM 506.18, Economic Table 4) in the Plan-EA summarizes the annualized costs described in this section, showing the annualized installation costs of the Piping Alternative over the No Action Alternative costs, as well as the difference in other direct costs associated with each alternative. Table 8-5 displays the difference between Table B and Table W. Additionally, because energy costs are higher for Project Group 1 (see Section 3.2.1.3) and carbon emissions increase for both project groups (see Section 3.1.3.4), those cost increases are included as other direct costs in Table 8-5 in the Plan-EA. In total, the annualized costs of the Piping Alternative exceed those of the No Action Alternative by $931,000. The total costs in this table are weighed against the total NED benefits in Table 8-6 in the Plan-EA.

3.1.2 Project Installation Costs

Table JJ shows the installation costs of the Piping Alternative that exceed the installation costs of the No Action Alternative. Under the Piping Alternative, federal funding would total $29.0 million, compared to $0 under the No Action Alternative. Non-federal funding (District funding) when comparing the Piping Alterative over the No Action Alternative would total $583,000. However, if the project was implemented it would still require $13. 3 million of match funding (Table A).

Table JJ. Installation Costs for the Piping Alternative Over the No Action Alternative, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Total Installation Costs
Project Group 1	$25,968,000
Project Group 2	$3,618,000
Total Project	**$29,586,000**

1/Price Base: 2019 dollars. Prepared December 2019

3.1.3 Other Direct Costs

3.1.3.1 Groundwater Recharge Costs

As shown in Table KK, in Year 100 the groundwater level is expected to decline about 2.7 feet more under the Piping Alternative than under the No Action Alternative. Table LL combines information from Table D and Table Y, and shows that the additional decrease in groundwater levels under the Piping Alternative would increase energy costs by an annual average of $4,000 over the No Action Alternative.

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

Year	Volume Pumped (acre-feet per year)	Average Depth to Groundwater (feet)		
		Baseline Conditions	No Action Alternative	Piping Alternative
1	51,000	501.0	501.0	501.0
10	64,000	510.0	510.0	510.3
20	82,000	520.0	520.0	520.6
30	105,000	530.0	530.1	530.9
40	134,000	540.0	540.1	541.2
50	172,000	550.0	550.1	551.5
60	220,000	560.0	560.2	561.8
70	282,000	570.0	570.2	572.1
80	360,000	580.0	580.2	582.4
90	461,000	590.0	590.2	592.7
100	591,000	600.0	600.3	603.0

Prepared December 2019

Table LL. Other Direct Costs of Reduced Groundwater Recharge under the Pressurized Piping and No Action Alternatives, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	No Action Alternative		Piping Alternative		
	Change in Groundwater Depth (feet/year)	Discounted Annual Average Cost	Change in Groundwater Depth (feet/year)	Discounted Annual Average Cost	Discounted Average Annual NED Costs over No Action Alternative
Project Group 1	0.003	$1,000	0.024	$4,000	$3,000
Project Group 2	0.000	$0	0.004	$1,000	$1,000
Total	**0.003**	**$1,000**	**0.027**	**$5,000**	**$4,000**

Note: Totals may not sum due to rounding. Prepared December 2019

1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

3.1.3.2 Booster Pump Costs

Under both the No Action Alternative and the Piping Alternative, the District would be installing a booster pump on the G-4 lateral with the same (undiscounted) costs (see Sections 1.1.4.2 and 2.1.4.2). However, due to discounting and the slightly later construction schedule of the No Action Alternative, the discounted and annualized costs of the booster pump are slightly higher under the

Piping Alternative, however due to rounding the difference does not show in the table. The costs of the two scenarios are summarized in Table MM.

Table MM. Annual Booster Pump Costs of No Action Alternative Compared to Piping Alternative, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	No Action Alternative Booster Pump Cost (Discounted and Amortized)	Piping Alternative Booster Pump Cost (Discounted and Amortized)	Average Annual NED Booster Pump Cost (Piping Alt. over No Action Alt.)
Project Group 1	$14,000	$14,000	$0
Project Group 2	$0	$0	$0
Total	**$14,000**	**$14,000**	**$0**

[1]/ Price base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent. Prepared December 2019

3.1.3.3 Pipe Replacement

The Piping Alternative would install approximately 1.8 more miles of large diameter pipe than the No Action Alternative and would therefore entail higher replacement costs. Combining information from Table F and Table AA, Table NN shows the additional annualized costs of replacing large diameter pipe under the Piping Alternative.

Table NN. Other Direct Costs of Large Diameter Pipe Replacement under the Pressurized Piping and No Action Alternatives, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	No Action Alternative		Piping Alternative		
	Miles of Large Diameter Pipe Installed	Discounted Annual Average Cost	Miles of Large Diameter Pipe Installed	Discounted Annual Average Cost	Discounted Annual Average NED Cost over the No Action Alternative
Project Group 1	0.9	$45,000	2.7	$108,000	$63,000
Project Group 2	0	$0	0	$0	$0
Total	**0.9**	**$45,000**	**2.7**	**$108,000**	**$63,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

3.1.3.4 Carbon Costs

Carbon emissions (and costs) increase under both the Piping Alternative and the No Action Alterative. Table OO combines information on carbon emissions from Table G and Table BB to show the carbon costs of the Piping Alternative compared to the costs of the No Action Alternative. Due to rounding, on an annualized basis, the value of increased carbon emissions under the Piping Alternative is the same those under the No Action Alternative.

Table OO. Annual Increased Average Carbon Costs of Piping Alternative and the No Action Alternative, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	No Action Alternative		Piping Alternative		
	Net Average Increased Emissions (Mt)	Discounted Annualized Increased Costs	Net Average Increased Emissions (Mt)	Discounted Annualized Increased Costs	Annualized Value of Carbon Increases Over the No Action Alternative
Project Group 1	84	$1,000	185	$1,000	$0
Project Group 2	0	$0	-1	$0	$0
Total	**84**	**$1,000**	**184**	**$1,000**	**$0**

Prepared December 2019

3.1.3.5 Change in Aesthetics and Associated Property/Recreation Values

Because the length of piping under the No Action Alternative is shorter than under the Piping Alternative, the magnitude of the impacts described in Section 1.1.4.5 is expected to be higher under the Piping Alternative. However, as we do not quantify these impacts, we do not present the incremental costs of the Piping Alternative over the No Action Alternative.

3.2 NED Benefits

Table 8-6 (NWPM 506.20, Economic Table 5a) in the Plan-EA summarizes annual average NED project benefits of the Piping Alternative that exceed the benefits under the No Action Alternative. Table 8-7 (NWPM 506.21, Economic Table 6) in the Plan-EA compares annual NED benefits and costs of the Piping Alternative over those in the No Action Alternative.

3.2.1 Benefits Considered and Included in Analysis

3.2.1.1 Agricultural Damage Reduction Benefit

As discussed in Sections 1.2.1.1 and 2.2.1.1, NUID would experience reduced agricultural damage due to increases in available water for irrigation under both the No Action and Piping Alternatives. Table PP summarizes the benefits shown in Table J (for the Piping Alternative) and Table DD (for the No Action Alternative). The benefits of reduced agricultural damage under the Piping Alternative outweigh the benefits under the No Action Alternative, resulting in a NED benefit of $337,000.

Table PP. Avoided Damages to NUID Agriculture Resulting from No Action Alternative and Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2019$ [1].

Project Group	Annualized Average Net Benefits of No Action Alternative above Baseline	Annualized Average Net Benefits of Piping Alternative above Baseline	Annualized Average Net Benefits of Piping Alternative above No Action Alternative
Project Group 1	$47,000	$335,000	$288,000

Project Group 2	$0	$49,000	$49,000
Total	**$47,000**	**$384,000**	**$337,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

3.2.1.2 Operations and Maintenance Cost Savings Benefit

Table QQ compares the O&M cost savings of the Piping Alternative (also shown in Table K) that exceed the cost savings under the No Action Alternative (also shown in Table EE). As the table indicates, the Piping Alternative would result in additional annualized benefits of $3,000.

Table QQ. Annual Reduced Operation and Maintenance Costs to COID of Piping Alternative and No Action Alternative by Project Group, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	No Action Alternative		Piping Alternative		
	Mileage Piped	Discounted Annualized Benefit (Cost Savings)	Mileage Piped	Discounted Annualized Benefit (Cost Savings)	Discounted Annualized Benefit Over the No Action Alternative
Project Group 1	2.3	$1,000	5.1	$3,000	$2,000
Project Group 2	0.0	$0	2.8	$1,000	$1,000
Total	**2.3**	**$1,000**	**7.9**	**$4,000**	**$3,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

3.2.1.3 Patron Irrigation Pumping Cost Savings

Table RR compares the energy cost savings of the Piping Alternative (shown in Table L) to the savings of the No Action Alternative (shown in Table FF). In Project Group 1, the energy savings under the No Action Alternative equal the savings under the Piping Alternative, causing the NED benefits to be zero. However, in Project Group 2, the benefits under the Piping Alternative exceed those under the No Action Alternative. In total, the additional energy savings under the Piping Alternative results in an annualized benefit of $1,000 above the No Action Alternative, as shown in Table RR.

Table SS compares the cost savings from eliminating pumps under the Piping Alternative (shown in Table M) to the savings of the No Action Alternative (shown in Table GG). Although the G-4 Lateral would be piped under both alternatives, because the G-4 would be piped at a later time under the No Action Alternative, the NED benefits under the Piping Alternative would be approximately $1,000 higher than under the No Action Alternative.

Table RR. Annual Increased Average Energy Cost Savings to COID Patrons of Piping Alternative Compared to the No Action Alternative, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Discounted Annual Costs Savings Under No Action Alternative	Discounted Annual Cost Savings Under the Piping Alternative	Discounted Average Annual NED Benefits of the Piping Alternative Over the No Action Alternative
Project Group 1	$4,000	$4,000	$0
Project Group 2	$0	$1,000	$1,000
Total	**$4,000**	**$5,000**	**$1,000**

Note: Totals may not sum due to rounding. Prepared December 2019
[1/]Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

Table SS. Annual Estimated Cost Savings from Eliminated Irrigation Pumps Under the Piping Alternative Compared to the No Action Alternative, Deschutes Watershed, Oregon, 2019$[1].

Works of Improvement	Discounted Annual Costs Savings Under No Action Alternative	Discounted Annual Cost Savings Under the Piping Alternative	Discounted Average Annual NED Benefits of the Piping Alternative Over the No Action Alternative
Project Group 1	$11,000	$12,000	$1,000
Project Group 2	$0	$0	$0
Total	**$11,000**	**$12,000**	**$1,000**

Note: Totals may not sum due to rounding. Prepared December 2019
[1/]Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

3.2.1.4 Value of Conserved Water

Table TT combines the results of Table O and Table HH to compare the instream flow benefits of the Piping Alternative to the No Action Alternative. On annualized basis, the Piping Alternative generates $598,000 more than the No Action Alternative.

Table TT. Annual Increased Instream Flow Value of Piping Alternative Compared to the No Action Alternative, Deschutes Watershed, Oregon, 2019$1.

Works of Improvement	Discounted Annual Instream Flow Value Under No Action Alternative	Discounted Annual Instream Flow Value Under the Piping Alternative	Discounted Average Annual NED Benefits of the Piping Alternative Over the No Action Alternative
Project Group 1	$83,000	$594,000	$511,000
Project Group 2	$0	$87,000	$87,000
Total	**$83,000**	**$681,000**	**$598,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

3.2.1.5 Value of Supporting the Oregon Spotted Frog Habitat

Table UU uses information from Table S and Table II to compare the benefits of supporting the OSF under the Piping Alternative and the No Action Alternative. As shown in the last column, compared to the No Action Alternative, the Piping Alternative generates an additional $536,000 on an annualized basis.

Table UU. Annual Increased OSF Support Value of Piping Alternative Compared to the No Action Alternative, Deschutes Watershed, Oregon, 2019$1.

Works of Improvement	Discounted Annual OSF Support Value Under No Action Alternative	Discounted Annual OSF Support Value Under the Piping Alternative	Discounted Average Annual NED Benefits of the Piping Alternative Over the No Action Alternative
Project Group 1	$74,000	$533,000	$459,000
Project Group 2	$0	$77,000	$77,000
Total	**$74,000**	**$610,000**	**$536,000**

Note: Totals may not sum due to rounding. Prepared December 2019
1/Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

3.2.2 Incremental Analysis

The 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. In engineering the design of the system, the District and Black Rock Consulting mapped and collected digital elevation data along the entire delivery system. The District determined that the system needed to be able to deliver seven gallons per minute per acre served. The system also needed to be able to handle an upper limit of nine gallons per minute per acre served. In addition to evaluating the system based on COID water rights and demand, the system was also evaluated to include water to be passed through to Lone Pine Irrigation District (this is part of their current operations) as well as passing 200 CFS to NUID. The District used these data to create a hydraulic model that determined pipe sizes for each pipeline (canal or lateral to be piped) in the system.

Table VV shows the incremental analysis of the project groups.

Table VV. Incremental Analysis of Annual NED Costs and Benefits Under the Piping Alternative for Central Oregon Irrigation District 2017 Watershed Plan, Deschutes Watershed, Oregon, 2019$[1].

Groups	Total Costs	Incremental Costs	Total Benefits	Incremental Benefits	Net Benefits
1	$830,000		$1,261,000		$431,000
1,2	$931,000	$101,000	$1,476,000	$215,000	$545,000

Note: Totals may not sum due to rounding Prepared December 2019
[1/]Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.

4 NED Appendix

4.1 NED Crop Enterprise Budgets

This section presents the crop enterprise budgets used in estimating agricultural NED benefits under the Piping Alternative resulting from reduced damages associated with reducing water shortages in NUID. Enterprise budgets aim to reflect costs and returns under best management practices for production in the region, but do not necessarily represent conditions of any particular farm. We used crop budgets for carrot seed and alfalfa hay developed, respectively, by Oregon State University (OSU) and Washington State University (WSU), and then adjusted values in these budgets to account for changes in prices through time and local conditions in NUID. As the most recent alfalfa hay budget for the Deschutes River Basin is from 1995, we used a more recent 2012 WSU budget developed for agricultural land in the Columbia Basin as we expect this to provide a more accurate representation of production practices and costs in the Deschutes Basin than the available OSU budget. Alfalfa budgets represent all hay and grain crops in NUID, while carrot budget represents all high value, specialty crops in NUID including peppermint, nursery, grass seed, vegetables, and all vegetable seed.

Because alfalfa hay is a perennial crop, we used the three WSU enterprise budgets that represent the costs and returns during the three stages of the crop's stand life. These consist of a budget for the stand establishment (Year 0, which is the fall establishment period), a budget for the first year of production (Year 1), and a budget for the remaining years of production (Year 2-6). We use the budgets to estimate the net benefits of piping (reduced water shortages) for agricultural production in NUID (in NED Section 1.2.1.1). The following two sections outline the data and assumptions used in adjusting the Oregon State and Washington State carrot seed and alfalfa hay budgets. Table 1 summarizes the net returns to carrot seed and alfalfa hay, as modeled in the enterprise budgets. For alfalfa, the annualized value is calculated using the same 2.75-percent discount rate as the rest of the analysis.

Table 1. Summarized Net Returns to Crops.

Production Year	Duration (Years)	Carrot Seed	Alfalfa Hay
Year 0	0.25	N/A	-$570
Year 1	1	$2,682	$453
Year 2-6	5	N/A	$235
Annualized, average value		$2,682	$159

4.2 Carrot Seed Enterprise Budget

The carrot seed enterprise budget (presented in full below) is an enterprise budget for carrot seeds developed by OSU in 2010 to represent the costs and benefits of producing carrot seeds in Central Oregon (Butler & Weber, 2010). We updated the costs and revenues presented in the budgets to account for changing values over time and to reflect values specific to NUID.

4.2.1 Modeled Farm and Equipment

The farm modeled in the original OSU budget is 600 acres total, of which 40 acres is dedicated to carrot seed. The budgets are based on producing hybrid carrot seed under drip irrigation. Power equipment units used in production include a combine, ATV, three two-wheel-drive tractors, one four-wheel-drive tractor, and a tractor with a loader. The implements and equipment include a swather, bedder bar, carrot roller, chisel, cultimulcher, cultipacker, disk, flail mower, flamer, flex harrow, land leveler, mint planter, mint rake, paper roller, pasture harrow, precision planter, roller, rolling cultivator, row sprayer, and tool bar with shovels.

4.2.1.1 Input Costs

All costs are adjusted from the original values in the OSU budget. Wherever possible, we adopted area-specific values, which was the case for fuel prices and irrigation charges. NUID charges a flat rate of $180 per account and $72 per acre up to the allotted amount of water (North Unit Irrigation District, 2018; North Unit Irrigation District, 2019). As the irrigated parcel size in NUID is 55 acres, the flat rate is divided by 55 to derive the per-acre cost of the flat irrigation fee. For land costs, we use the average cost to rent irrigated cropland in Oregon: $150 per acre (NASS, 2019).

For costs that did not have area-specific values, we adjusted the value in the original budget using the national Producer Price Indices (PPI) produced by the National Agricultural Statistics Services (NASS), which are published for a variety of farm expenses (NASS, 2019). For example, there are prices indices for fertilizer, herbicides, supplies, tractors, custom work, as well as one for the farm sector in general. The PPI cost adjustments range from an 11-percent decrease in the price of fertilizer to a 30-percent increase in the cost of machinery.

4.2.1.2 Labor Costs

For general farm labor, we use the average wage rate for farmworkers in the Central Oregon non-metropolitan area.[28] For equipment operator labor, we use the mean hourly wage rate for this occupation in Oregon.[29] In both cases, we adjust the average wage rate up by 20 percent to account for non-wage employment costs, such as health care and insurance. This results in total labor costs of $16.14 and $21.65 per hour for laborers and equipment operators, respectively.

4.2.1.3 Revenues

To estimate the gross revenues of carrot seeds under full irrigation, we use the yield from the original OSU carrot seed budget (400 pounds per acre) because it is specific to Central Oregon and reflects the likely yield under drip irrigation (and thus matches the costs of production modeled in the published enterprise budget). We use the average price per pound received by farmers for carrot seed in Central Oregon from 2014 to 2018, according to data from Central Oregon Seeds: $16.44 (Weber, 2019).

[28] This is the average wage for the Farmworkers and Laborers, Crop, Nursery, and Greenhouse occupation (45-2092) in the Central Oregon non-metropolitan area according the Bureau of Labor Statistics Occupational Employment Statistics data in May 2018. We adjust wage for inflation to 2019 dollars using the Consumer Price Index.

[29] This is the average wage for the Agricultural Equipment Operators (45-2091) in Oregon according the Bureau of Labor Statistics Occupational Employment Statistics data in May 2018. We adjust wage for inflation to 2019 dollars using the Consumer Price Index.

4.2.2 Modeled Farm and Equipment

Table 2 below presents the carrot seed enterprise budget used to estimate the net returns to specialty crops in NUID.

Table 2. Carrot Seed Enterprise Budget.

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Carrot seeds	400.0	lbs	$16.44	$6,575.20
VARIABLE COSTS				
Insecticides	1.0	acre	$194.64	$194.64
Herbicides	1.0	acre	$251.75	$251.75
Fungicides	1.0	acre	$175.65	$175.65
Fertilizer	1.0	acre	$97.63	$97.63
Other	1.0	acre	$178.53	$178.53
Custom applications	1.0	acre	$164.67	$164.67
Rentals	1.0	acre	$295.25	$295.25
Seed	1.0	acre	$31.64	$31.64
Water	1.0	ac-in	$72.00	$72.00
Irrigation lot charge	1.0	acre	$3.29	$3.29
Install drip irrigation	1.0	acre	$366.11	$366.11
Hand Labor	6.7	hours	$16.14	$108.61
Irrigation labor	10.0	hours	$16.14	$161.71
Operator labor	11.5	hours	$21.65	$249.37
Roguing labor	20.0	hours	$16.14	$322.77
Diesel fuel	27.6	gal	$3.29	$90.87
Gasoline	4.7	gal	$2.47	$11.53
Repair & maintenance	1.0	acre	$155.87	$155.87
Interest on operating capital	1.0	acre	$112.09	$112.09
Total variable costs				$3,043.99
FIXED COSTS				
Implements	1.0	ac	$104.08	$104.08
Tractors	1.0	ac	$207.41	$207.41
Self-propelled equipment	1.0	ac	$219.77	$219.77
Trucks	1.0	ac	$14.47	$14.47
Pickup & miscellaneous equipment	1.0	ac	$81.84	$81.84
Land cost	1.0	ac	$150.00	$150.00
Irrigation systems	1.0	ac	$71.45	$71.45
Total fixed costs				$849.02
Total costs				$3,893.00
NET RETURNS PER ACRE				**$2,682.20**

4.3 Alfalfa Hay Enterprise Budgets

The alfalfa hay enterprise budgets were based on 2012 budgets developed by WSU for establishing and producing alfalfa hay in the Washington Columbia Basin (Norberg & Neibergs, 2012). We selected these budgets as the basis for NUID crop production costs because they are the most recent crop budgets developed for alfalfa production in a region proximate to Central Oregon.

As in the carrot seed budgets, we updated the costs presented in the original budgets to account for changing values over time and to reflect conditions specific to NUID. Returns to alfalfa hay were based on reported hay yields in Jefferson County and the 2019 state-level normalized average price for alfalfa hay in Oregon (Economic Research Service, USDA, 2019). We developed three hay budgets in total: a budget for the stand establishment (Year 0, shown in Table 3), a budget for the first year of production (Year 1, shown in Table 4), and a budget for the remaining years of full production (Year 2-6, shown in Table 5).

4.3.1 Modeled Farm

The farm modeled in the original WSU budget was meant to represent typical per-acre costs of alfalfa production under best management practices. The modeled farm is 120 acres. The hay field is seeded in the fall following a grain crop such as wheat or barley and is harvested using one-ton bales beginning the following spring. Other than labor for irrigation, all labor is provided by hiring custom work (includes harvest, fertilizer application, and herbicide application). Irrigation is delivered by a center pivot. The alfalfa is assumed to have a stand life of seven years.

4.3.1.1 Input Costs

All costs are adjusted from the original values in the WSU budget. As with the carrot seed budgets, we used area-specific values for fuel prices, irrigation charges, and land costs. Irrigation charges are the same as those presented in the carrot seed budget. The original WSU budget did not include the costs of land; however, we added it to the budget used in this analysis using the same value as was used in the carrot seed budget ($150 per acre). This cost was included in the years after establishment, but because about three-quarters of the establishment year is used to support a different crop (i.e., the grain crop), we only assign one-fourth of the land costs to alfalfa in the establishment year (to represent the fall season establishment). For costs that did not have area-specific values, we adjusted the value in the original budget using the same PPIs as were used in the carrot seed budgets.

4.3.1.2 Labor Costs

Because most of the labor is provided by custom work, the only direct labor costs are for an agricultural equipment operator to move the center pivots. The per hour total labor costs for this equipment operator are the same as the per hour equipment operator costs presented in the carrot seed budget ($21.65 per hour). For swathing and raking, we assume three cuttings per year. The WSU budget assumed a yield of 8 tons per acre and we conservatively use a yield of 5.4 tons per acre based on published NASS yield estimates for Jefferson County. For other labor and fertilizer, we adjusted the costs proportionally to the change in yield from the original budget (i.e., if yield falls by 10 percent, the amount of labor or fertilizer needed also falls by 10 percent). To the extent that costs fall more than this, our results would under-estimate benefits (and vice versa).

4.3.1.3 Revenues

To estimate the gross revenues of alfalfa hay, we use the average yields in Jefferson County from 2013 to 2017 according USDA NASS data: 5.4 tons per acre (NASS, 2019).[30] To estimate the gross revenues per ton, we use the normalized average price per ton for alfalfa hay in Oregon reported by the Economic Research Service of USDA: $193.20 per ton (Economic Research Service, USDA, 2019).

4.3.2 Alfalfa hay Enterprise Budget Tables

The tables below present the three alfalfa hay enterprise budgets used to estimate the net returns to hay/grain crops in NUID: one budget for the establishment year (Table 3), one budget modeling returns for the first year of production (Table 4), and one budget modeling costs and returns for the remaining production years (Years 2-6; Table 5).

[30] We excluded yield data from 2018 because that was a low water year and would not be representative of alfalfa hay under full irrigation.

Table 3. Alfalfa Hay Enterprise Budget – Establishment Year (Year 0).

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Alfalfa hay	0.0	ton	$193.20	$0.00
VARIABLE COSTS				
Seed	20.0	lb.	$4.46	$89.21
Custom - seeding	1.0	acre	$11.57	$11.57
Dry Nitrogen	0.0	lb.	$0.34	$0.00
Dry Phosphate	92.0	lb.	$0.58	$53.23
Dry Potash	140.0	lb.	$0.41	$57.60
Dry Sulfur	25.0	lb.	$0.20	$4.89
Zinc	5.0	lb.	$1.98	$9.91
Boron	2.0	lb.	$4.47	$8.94
Custom Application	1.0	acre	$9.90	$9.90
Herbicide - Raptor	6.0	oz.	$6.43	$38.57
Custom - herbicide application	1.0	acre	$10.31	$10.31
Soil Test	1.0	acre	$0.33	$0.33
Custom - Disc & Pack (2x)	1.0	acre	$55.00	$55.00
Irrigation - power	1.0	acre	$72.00	$72.00
Irrigation - water access	1.0	acre	$3.29	$3.29
Irrigation - repairs	0.4	acre	$16.53	$5.95
Irrigation - labor	0.2	acre	$21.65	$3.90
Fuel	2.5	gallon	$2.47	$6.18
Lubricants	1.0	acre	$1.36	$1.36
Machinery repairs	1.0	acre	$2.47	$2.47
Machinery labor	0.25	acre	$21.65	$5.41
Overhead	1.0	acre	$25.58	$25.58
Operating interest	1.0	acre	$15.05	$15.05
Total variable costs				$490.64
FIXED COSTS				
Machinery depreciation	1.0	acre	$7.36	$7.36
Machinery interest	1.0	acre	$5.07	$5.07
Machinery insurance, taxes, housing, license	1.0	acre	$2.11	$2.11
Management (5% of total cost)	1.0	acre	$27	$27.13
Land cost	1.0	acre	$37.50	$37.50
Total fixed costs				$79.19
Total costs				$569.83
NET RETURNS PER ACRE				**-$569.83**

Table 4. Alfalfa Hay Enterprise Budget (Year 1).

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Alfalfa hay	5.4	ton	$193.20	$1,043.28
VARIABLE COSTS				
Dry Nitrogen	0.0	lb.	$0.34	$0.00
Dry Phosphate	0.0	lb.	$0.58	$0.00
Dry Potash	0.0	lb.	$0.41	$0.00
Dry Sulfur	0.0	lb.	$0.20	$0.00
Custom - Swath	3.0	acre	$22.00	$66.00
Custom - Rake	3.0	acre	$11.00	$33.00
Custom - Bail	5.4	ton	$18.70	$100.98
Custom - Haul & Stack	5.4	ton	$9.90	$53.46
Custom - Tarping	5.4	ton	$5.50	$29.70
Irrigation - power	1.0	acre	$72.00	$72.00
Irrigation - water access	1.0	acre	$3.29	$3.29
Irrigation - repairs	1.0	acre	$16.53	$16.53
Irrigation - labor	0.5	acre	$21.65	$10.82
Gopher control	1.0	acre	$5.58	$5.58
Fuel	2.3	gallon	$2.47	$5.63
Lubricants	1.0	acre	$0.89	$0.89
Machinery repairs	1.0	acre	$1.98	$1.98
Haystack Insurance	5.4	ton	$1.88	$10.15
Overhead	1.0	acre	$28.12	$28.12
Operating interest	1.0	acre	$23.16	$23.16
Total variable costs				$461.35
FIXED COSTS				
Machinery depreciation	1.0	acre	$6.31	$6.31
Machinery interest	1.0	acre	$3.68	$3.68
Machinery insurance, taxes, housing, license	1.0	acre	$2.62	$2.62
Management (5% of total cost)	1.0	acre	$28.12	$28.12
Land cost	1.0	acre	$150.00	$150.00
Total fixed costs				$190.73
Total costs				$652.08
NET RETURNS PER ACRE				**$391.20**

Table 5. Alfalfa Hay Enterprise Budget (Years 2-6).

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Alfalfa hay	5.4	ton	$193.20	$1,043.28
VARIABLE COSTS				
Dry Nitrogen	0.0	lb.	$0.34	$0.00
Dry Phosphate	62.1	lb.	$0.58	$35.93
Dry Potash	94.5	lb.	$0.41	$38.88
Dry Sulfur	16.9	lb.	$0.20	$3.30
Zinc	3.4	lb.	$1.98	$6.69
Boron	1.4	lb.	$4.47	$6.03
Custom Application	1.0	acre	$9.90	$9.90
Soil Test	1.0	acre	$0.33	$0.33
Herbicide	1.4	lb.	$19.14	$25.84
Custom Application	1.0	acre	$9.90	$9.90
Custom - Swath	3.0	acre	$22.00	$66.00
Custom - Rake	3.0	acre	$11.00	$33.00
Custom - Bail	5.4	ton	$18.70	$100.98
Custom - Haul & Stack	5.4	ton	$9.90	$53.46
Custom - Tarping	5.4	ton	$5.50	$29.70
Irrigation - power	1.0	acre	$72.00	$72.00
Irrigation - water access	1.0	acre	$3.29	$3.29
Irrigation - repairs	1.0	acre	$16.53	$16.53
Irrigation - labor	0.5	acre	$21.65	$10.82
Haystack insurance	5.4	ton	$2.20	$11.89
Gopher control	1.0	acre	$5.58	$5.58
Fuel	2.3	gallon	$2.47	$5.63
Lubricants	1.0	acre	$0.89	$0.89
Machinery repairs	1.0	acre	$1.98	$1.98
Overhead	1.0	acre	$42.33	$42.33
Operating interest	1.0	acre	$16.25	$16.25
Total variable costs				$607.13
FIXED COSTS				
Machinery depreciation	1.0	acre	$6.31	$6.31
Machinery interest	1.0	acre	$3.68	$3.68
Machinery insurance, taxes, housing, license	1.0	acre	$2.62	$2.62
Management (5% of total cost)	1.0	acre	$38.49	$38.49
Land cost	1.0	acre	$150.00	$150.00
Total fixed costs				$201.10
Total costs				$808.23
NET RETURNS PER ACRE				**$235.05**

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D.2 Alternatives Considered during Formulation

This section presents the alternatives considered in the formulation phase.

During the formulation phase, alternatives were evaluated based on meeting both NEPA and environmental review requirements specific to NRCS federal investments in water resources projects (1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, herein P&G). According to NEPA, agencies shall rigorously explore and objectively evaluate all reasonable alternatives (40 CFR 1502.14). According to P&G, alternative plans, including the NED plan, should be formulated in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability (P&G 1.6.2c).

1. Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. This may require relating the plan to other types of public or private plans if the other plans are crucial to realization of the contributions to the objective.
2. Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.
3. Efficiency is the extent to which an alternative plan is the most cost effective by means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.
4. Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies.

Alternatives that were eliminated during formulation are identified in Table D-1 and further discussed below.

Table D-1. Alternatives Considered During the Formulation Phase.

Alternative	Which criteria in the P&G[1] does the alternative achieve?				Selected for Further Evaluation
	Completeness	Effectiveness	Efficiency	Acceptability	
Conversion to Dryland Farming			X		
Fallowing Farm Fields			X		
Voluntary Duty Reduction			X		
Exclusive or Partial Use of Groundwater					
On-Farm Efficiency Upgrades		X		X	X

Alternative	Which criteria in the P&G[1] does the alternative achieve?				Selected for Further Evaluation
	Completeness	Effectiveness	Efficiency	Acceptability	
Canal Lining	X	X		X	X
Piping Private Laterals		X		X	X
Piping District Infrastructure with Steel	X	X		X	X
Piping District Infrastructure with PVC and HDPE	X	X	X	X	X
No Action (Future without Project)			X		X
Piping and Pressurization Alternative	X	X	X	X	X

Notes:
[1]/ Source: USDA 2013, 1.6.2c

D.2.1 Conversion to Dryland Farming

This method of farming uses no irrigation and drought-resistant crops and practices to conserve moisture. The lack of rainfall throughout the growing season coupled with hot temperatures, desiccating winds, as well as generally shallow and well to excessively drained soils with low storage potentials, makes dryland farming infeasible within the District (Daly et al 1994; Gannett et al 2001). Furthermore, in dryland farming systems where rainfall is approximately 12 inches per year (like COID) a fallow every other year is necessary (Golden and Aylward 2006; Granatstein 1992). In the project area, production would substantially decrease if dryland farming were implemented. Furthermore, COID lacks the statutory authority to force COID patrons to begin dryland farming. Therefore, carrying out this alternative would be logistically complex.

Conversion to dryland farming was eliminated from further evaluation because it would not meet the project purpose; its effectiveness would be uncertain since conversion to dryland farming would be voluntary; and it would not be acceptable because it is inconsistent with public policy supporting and maintaining existing agricultural land use.

D.2.2 Fallowing Farm Fields

Fallowing farm fields includes permanently transferring or temporarily leasing water rights from irrigated lands or otherwise not using water rights appurtenant to irrigated lands. Fallowing farm fields would use less irrigation water within the District and would therefore allow more water to be kept instream for fish, wildlife, and habitat. This water would be legally protected instream if the patrons' chose to lease or transfer their associated water rights instream. The District lacks the statutory authority or responsibility to carry out, operate and maintain fallowing farm fields by COID patrons. Therefore, carrying out this alternative would be logistically complex.

Fallowing farm fields was eliminated from further evaluation because: it would not meet the project purpose; its effectiveness would be uncertain since fallowing fields would be voluntary; and it would not be acceptable because it is inconsistent with public policy supporting and maintaining existing agricultural land use.

D.2.3 Voluntary Duty Reduction

Voluntary duty reduction refers to patrons voluntarily accepting less than their full water delivery rate from the District. A reduction in duty could mean the District diverts less water, which would leave more water instream.

Because this alternative would be voluntary and at the discretion of individual landowners, there would be no certainty that water would be saved and that streamflow would be restored. Furthermore, COID lacks the statutory authority or responsibility to carry out, operate and maintain voluntary duty reduction by its patrons. Therefore, carrying out this alternative would be logistically complex.

Voluntary duty reduction was eliminated from further evaluation because: it would not meet the project purpose; and its effectiveness would be uncertain since reducing ones duty would be voluntary.

D.2.4 Exclusive or Partial Use of Groundwater

The exclusive or partial conversion from surface water sourced to groundwater-sourced irrigation was initially considered as a possible alternative. To use groundwater in the Deschutes Basin, the District would have to apply for groundwater rights under OWRD's Deschutes Basin Groundwater Mitigation (DBGM) program pursuant to OAR 690-505-0500. The DBGM program is part of OWRD's goal to limit groundwater use by imposing restrictions to new users obtaining groundwater rights. Under the DBGM program, only 32.98 cfs is available for the whole Deschutes Basin, and it is unlikely the District could obtain rights to all the remaining water (S Henderson, personal communication, August 14, 2017). Given only 32.98 cfs is available under this program, the District's exclusive use of groundwater to entirely replace their use of surface water is not feasible.

The partial use of groundwater for irrigation would have logistical and legal constraints. The District and patrons could use their surface water rights for groundwater mitigation credits[31] required by the DBGM program, however, the District would need the authority from each patron to convert surface rights to groundwater rights; there would be no guarantee of gaining this approval from patrons. Converting from surface water rights to groundwater rights would also affect the seniority and, therefore, the reliability of the District's water rights. The District currently has senior surface water rights that minimize the chance of being impacted during drought years; however, new groundwater rights would be junior (dated the year of the application and construction) and could be subject to curtailment in the future.

[31] COID would not create groundwater mitigation credits under either the No Action or the Piping Alternative analyzed in this Plan-EA.

Additionally, the District lacks the statutory authority or responsibility to carry out, operate and maintain groundwater wells on private lands owned by COID patrons. Therefore, carrying out this alternative would be logistically complex. The partial use of groundwater was eliminated from further evaluation because it would not meet the project purpose; its effectiveness would be uncertain since conversion to groundwater would be voluntary; inefficiencies associated with logistical and legal constraints obtaining groundwater rights; and low acceptability since converting to groundwater rights would result in junior water rights.

D.2.5 References

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D.3 Capital Costs for the Eliminated Alternatives

This section presents dimensions and capital costs for canal lining.

D.3.1 Canal Lining Alternative

The capital cost of the Canal Lining Alternative was estimated by calculating the length of geotextile membrane in existing open canals, assuming an anchor of membrane extending 7 feet on either side. The membrane would be covered by a 1-inch layer of shotcrete (fine-aggregate concrete sprayed in place). This estimate also includes fencing along both sides of the canal, and safety ladders every 750 feet in channels deeper than 2.5 feet. Costs related to earthwork and labor are estimated by a construction cost multiplier of 2. Turnouts were estimated using the same assumptions as the piping alternative. The cross-section dimensions for lining the canals was calculated for each corresponding pipe diameter size using transects on a digital elevation model.

Table D-2. Canal Lining Alternative Costs

Area	Feature	Diameter (in)	Quantity	Units	Cross-section to be lined (ft.)	Channel Width (ft.)	Geomembrane total ($)	Shotcrete total ($)	Fencing total ($)	Ladder total ($)	Subtotal
Project Group 1											
PBC	LINING	108	7,650	Ft	37.8	35.1	$336,881	$1,590,771	$104,958	$5,100	$4,075,422
PBC	LINING	102	6,650	Ft	33.6	31.9	$269,341	$1,230,742	$91,238	$4,433	$3,191,507
PBC	LINING	48	860	Ft	25.9	23.5	$29,153	$122,414	$11,799	$573	$327,879
L Lateral	LINING	48	20	Ft	25.9	23.5	$678	$2,847	$274	$13	$7,625
J Lateral	LINING	32	5,077	Ft	25.3	24.0	$161,141	$707,595	$69,656	$3,385	$1,883,553
L Lateral	LINING	24	150	Ft	23.8	22.6	$4,561	$19,612	$2,058	$100	$52,661
G-4 Lateral	LINING	12	1,980	Ft	12.7	11.8	$41,634	$138,719	$27,166	$0	$415,039
G-4 Lateral	LINING	8	2,900	Ft	12.3	11.6	$59,895	$196,158	$39,788	$0	$591,683

G-4 Lateral	LINING	4	1,628	Ft	10.7	10.5	$31,414	$95,819	$22,336	$0	$299,139
PBC	Mobilization & SUPPORT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$594,788
PBC	STRUCTURES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$500,000
PBC	TURNOUTS	N/A	15	Unit	N/A	N/A	N/A	N/A	N/A	N/A	$247,000
J Lateral	TURNOUTS	N/A	4	Unit	N/A	N/A	N/A	N/A	N/A	N/A	$41,000
G-4 Lateral	TURNOUTS	N/A	12	Unit	N/A	N/A	N/A	N/A	N/A	N/A	$33,225
L Lateral	TURNOUTS	N/A	1	Unit	N/A	N/A	N/A	N/A	N/A	N/A	$4,000
Project Group 2											
PBC D/S L Lateral	INTAKE STRUCTURE	N/A	1	Unit	N/A	N/A	N/A	N/A	N/A	N/A	$150,000
J Lateral	LINING	32	1,410	Ft	25.3	24.0	$44,753	$196,515	$19,345	$940	$523,106
J Lateral	LINING	32	3,073	Ft	25.3	24.0	$97,535	$428,292	$42,162	$2,049	$1,140,075
J Lateral	LINING	32	3,669	Ft	25.3	24.0	$116,452	$511,358	$50,339	$2,446	$1,361,189
J Lateral	LINING	24	186	Ft	23.8	22.6	$5,655	$24,318	$2,552	$124	$65,299
PBC D/S L Lateral	LINING	12	1,400	Ft	12.7	11.8	$29,439	$98,084	$19,208	$0	$293,462
PBC D/S L Lateral	LINING	8	2,374	Ft	12.3	11.6	$49,032	$160,579	$32,571	$0	$484,364
PBC D/S L Lateral	LINING	8	2,558	Ft	12.3	11.6	$52,832	$173,025	$35,096	$0	$521,905
PBC D/S L Lateral	RAILROAD CROSSING	N/A	1	Unit	N/A	N/A	N/A	N/A	N/A	N/A	$50,000

PBC D/S L Lateral	ROAD XING (MAJOR)	N/A	2	Unit	N/A	N/A	N/A	N/A	N/A	N/A	$150,000
PBC D/S L Lateral	ROAD XING (MINOR)	N/A	2	Unit	N/A	N/A	N/A	N/A	N/A	N/A	$90,000
PBC D/S L Lateral	TURNOUT	N/A	10	Unit	N/A	N/A	N/A	N/A	N/A	N/A	$80,000
								Subtotal			**$17,174,000**
								Engineering, Construction Management, Survey (5% Project Group 1, 10% Project Group 2)			**$1,104,000**
								Construction Management / General Contractor (8% Project Group 1, 15% Project Group 2)			**$1,718,000**
								Contingency (30% both project groups)			**$5,152,000**
								TOTAL			**$25,148,000**

Totals are rounded to nearest $1000.

D.4 Net Present Value of Alternatives and Other Piping Materials Considered

This section presents the calculations used to estimate the net present value of the Preferred Alternative, eliminated alternatives, and other piping materials considered.

Discount Rate: 2.75%, **Period of Analysis**: 100 years

Table D-3. Net Present Value of the Preferred Alternative and the Eliminated Alternatives.

Project Group	Alternatives and Other Piping Materials Considered			
	HDPE Piping	**PVC Piping**	**Steel Piping**	**Canal Lining**
Design Life (years)	100	33	50	33
Capital Costs				
1	$34,417,000	$34,929,000	$36,392,000	$17,538,000
2	$3,143,000	$3,469,000	$5,337,000	$7,610,000
Net Present Value of Replacement Costs[1]				
1	$3,221,000	$3,776,000	$3,884,000	$11,154,000
2	N/A	$756,000	$877,000	$4,893,000
Annual Operation and Maintenance Costs				
1	$15,000	$15,000	$15,000	$21,000
2	$8,000	$8,000	$8,000	$12,000
Total Percent Change in O&M:	-15%	-15%	-15%	25%
Total Net Present Value of O&M Costs				
1	$509,000	$509,000	$509,000	$713,000
2	$272,000	$272,000	$272,000	$407,000
Total Net Present Value of Project				
Total:	**$41,562,000**	**$43,711,000**	**$47,271,000**	**$42,315,000**

Notes:
[1] For PVC pipe, 33% of the pipe was replaced at 33 years and 67% replaced at 66 years. For steel pipe, 25% was replaced at 50 years and 75% replaced at 75 years. For canal lining, 100% was replaced at both 33 years and 66 years.

D.5 Piping Alternative Costs

This section presents dimensions and capital costs for the Piping Alternative. The Piping Alternative was priced using HDPE pipe for small diameter pipe, which was at the time of this analysis considered the most cost-effective material and is identified as the Preferred Alternative. The material for large diameter pipe (102 and 108 inch) is still in the process of being selected. The cost below represents an average cost of HDPE, fiberglass, and steel (three different materials being considered at this time). This section also includes a discussion of other piping materials that were considered for the Piping Alternative.

D.5.1 Preferred Alternative Costs

Table D-4. Preferred Alternative Costs.

Project Group	Area	Feature	Diameter (in)	Length (ft.)	Qty	$/Unit	Total Cost
1	PBC	EARTHWORK	N/A	N/A	N/A	N/A	$7,645,500
1	PBC	CROSSINGS (SPECIAL PIPE CONDITIONS)	N/A	N/A	N/A	N/A	$42,500
1	PBC	PIPE LINE APPURTENANCES	N/A	N/A	N/A	N/A	$525,000
1	PBC	PRESSURE REDUCTION	N/A	N/A	1	N/A	$ 650,000
1	PBC	TURNOUTS	N/A	N/A	15	N/A	$247,000
1	PBC	MAIN PIPELINE	48	860		$225	$193,500
1	PBC	MAIN PIPELINE	102	6,650		$875	$5,818,750
1	PBC	MAIN PIPELINE	108	7,650		$925	$7,076,250
1	PBC	MAIN PIPELINE Bend Fittings	N/A	N/A	54	$29,500	$1,593,000
1	PBC	CONTINGENCY (10%)	N/A	N/A	N/A	N/A	$2,379,150
1	PBC	CMGC (8%)	N/A	N/A	N/A	N/A	$1,903,320
1	PBC	ECMS (5%)	N/A	N/A	N/A	N/A	$1,189,575
1	PBC	MOBILIZATION & SUPPORT	N/A	N/A	N/A	N/A	$594,788
1	PBC	DEMOLITION	N/A	N/A	N/A	N/A	$530,000
1	PBC	SURFACE RESTORATION	N/A	N/A	N/A	N/A	$942,500
1	PBC	STRUCTURES	N/A	N/A	N/A	N/A	$500,000
1	PBC	CONTINGENCY (10%)	N/A	N/A	N/A	N/A	$256,729
1	PBC	CMGC (8%)	N/A	N/A	N/A	N/A	$205,383
1	PBC	ECMS (5%)	N/A	N/A	N/A	N/A	$128,364
1	J Lateral	DEMOLITION & EARTHWORK	N/A	N/A	N/A	N/A	$107,500
1	J Lateral	PIPE LINE APPURTENANCES	N/A	N/A	N/A	N/A	$8,000
1	J Lateral	CROSSINGS (SPECIAL PIPE CONDITIONS)	N/A	N/A	N/A	N/A	$10,000
1	J Lateral	SURFACE RESTORATION	N/A	N/A	N/A	N/A	$198,000

Project Group	Area	Feature	Diameter (in)	Length (ft.)	Qty	$/Unit	Total Cost
1	J Lateral	TURNOUTS	N/A	N/A	N/A	N/A	$41,000
1	J Lateral	MAIN PIPELINE	30	5,077	N/A	$125	$634,625
1	J Lateral	MAIN PIPELINE Bend Fittings	N/A	N/A	10	$1,500	$15,000
1	J Lateral	CONTINGENCY (10%)	N/A	N/A	N/A	N/A	$101,413
1	J Lateral	CMGC (8%)	N/A	N/A	N/A	N/A	$81,130
1	J Lateral	ECMS (5%)	N/A	N/A	N/A	N/A	$50,706
1	G-4 Lateral	MAIN PIPELINE	4	1,628	N/A	$25	$30,525
1	G-4 Lateral	MAIN PIPELINE	8	2,900	N/A	$40	$87,000
1	G-4 Lateral	MAIN PIPELINE	10	1,980	N/A	$50	$74,250
1	G-4 Lateral	TURNOUTS	N/A	N/A	12	N/A	$33,225
1	G-4 Lateral	PUMP STATION	N/A	N/A	N/A	N/A	$75,000
1	G-4 Lateral	CONTINGENCY (10%)	N/A	N/A	N/A	N/A	$30,000
1	G-4 Lateral	CMGC (8%)	N/A	N/A	N/A	N/A	$24,000
1	G-4 Lateral	ECMS (5%)	N/A	N/A	N/A	N/A	$15,000
1	L Lateral	DEMOLITION & EARTHWORK	N/A	N/A	N/A	N/A	$22,500
1	L Lateral	MAIN PIPELINE	24	N/A	N/A	N/A	$22,500
1	L Lateral	MAIN PIPELINE	48	N/A	N/A	N/A	$7,000
1	L Lateral	MAIN PIPELINE Bend Fittings	N/A	N/A	6	N/A	$8,000
1	L Lateral	PIPE LINE APPURTENANCES	N/A	N/A	N/A	N/A	$4,500
1	L Lateral	CROSSINGS (SPECIAL PIPE CONDITIONS)	N/A	N/A		N/A	$240,000
1	L Lateral	TURNOUTS	N/A	N/A	1	N/A	$4,000
1	L Lateral	CONTINGENCY (10%)	N/A	N/A	N/A	N/A	$30,850
1	L Lateral	CMGC (8%)	N/A	N/A	N/A	N/A	$24,680
1	L Lateral	ECMS (5%)	N/A	N/A	N/A	N/A	$15,425
2	J Lateral	MAIN PIPELINE	32	3,669	N/A	$ 212	$776,225
2	J Lateral	MAIN PIPELINE	30	1,410	N/A	$ 186	$262,243
2	J Lateral	MAIN PIPELINE	30	3,073	N/A	$152	$466,279
2	J Lateral	MAIN PIPELINE	24	186	N/A	$ 97	$18,058
2	J Lateral	CONTINGENCY (5%)	N/A	N/A	N/A	N/A	$95,175
2	J Lateral	CMGC (15%)	N/A	N/A	N/A	N/A	$228,421
2	J Lateral	ECMS (10%)	N/A	N/A	N/A	N/A	$152,280
2	PBC D/S L Lateral	MAIN PIPELINE	10	1,400	N/A	$24	$33,449
2	PBC D/S L Lateral	MAIN PIPELINE	8	2,374	N/A	$15	$36,507
2	PBC D/S L Lateral	MAIN PIPELINE	8	2,558	N/A	$17	$43,220
2	PBC D/S L Lateral	PRV STATION	N/A	N/A	1	$250,000	$250,000

Project Group	Area	Feature	Diameter (in)	Length (ft.)	Qty	$/Unit	Total Cost
2	PBC D/S L Lateral	ROAD XING (MAJOR)	N/A	N/A	2	$75,000	$150,000
2	PBC D/S L Lateral	ROAD XING (MINOR)	N/A	N/A	2	$45,000	$90,000
2	PBC D/S L Lateral	ENERGY DISS. TEMP	N/A	N/A	1	$12,000	$12,000
2	PBC D/S L Lateral	RAILROAD CROSSING	N/A	N/A	1	$50,000	$50,000
2	PBC D/S L Lateral	INTAKE STRUCTURE	N/A	N/A	1	$150,000	$150,000
2	PBC D/S L Lateral	TURNOUT	N/A	N/A	10	$8,000	$80,000
2	PBC D/S L Lateral	CONTINGENCY (5%)	N/A	N/A	N/A	N/A	$55,949
2	PBC D/S L Lateral	CMGC (15%)	N/A	N/A	N/A	N/A	$134,276
2	PBC D/S L Lateral	ECMS (10%)	N/A	N/A	N/A	N/A	$89,518
						Total	**$37,590,737**

D.5.2 Other Piping Materials Considered

In addition to HDPE, using steel or polyvinyl chloride (PVC) was also explored for the smaller diameter pipes. A cost analysis was completed for each material. The same costs were used for the large diameter pipes (102 and 108 inch) across all the cost analyses and a design life of 50 years was used for the large diameter pipes. Earthwork, turnouts, and other non-pipe costs were also kept constant for the PVC and steel analysis. The lengths, diameters, and range of pressure ratings used for these piping alternatives were estimated based on the engineering analysis completed in the District's SIP. Annual operating costs and material design life were also taken into consideration. Annual operating costs were estimated based on COID's current operating budget and with an assumption that equipment, maintenance, and labor costs would decrease 15 percent because a fully piped system would reduce the need to inspect, repair, remove obstructions, and make manual adjustments to the system.

For piping with steel, diameters up to 48 inches would use steel. Assuming a design life of 50 years, capital costs, replacement costs, and annual O&M costs are $40,785,000 for Project Group 1 and $6,486,000 for Project Group 2 over 100 years (2019 dollars).

For piping with PVC, diameters up to 48 inches would use PVC. Assuming a design life of 33 years for PVC, the estimated capital costs, replacement costs, and annual O&M costs are $39,214,000 for Project Group 1 and $4,497,000 for Project Group 2 over 100 years (2019 dollars).

See the tables below for steel and PVC cost details and pipe specifications.

D.4.2.1 Steel Piping

The lengths, diameters, and range of pressure ratings used for this alternative were estimated based on the engineering analysis completed in the District's SIP. Spiral welded steel was selected that conforms to requirements of the American Water Works Association C200 standard. This pipe was selected because it is considered an industry consensus standard and is a prominent guide for the manufacture of steel pipe for water and wastewater applications in North America (Bambie and Keil 2013). Steel pipe typically has a design life of 50 years under irrigation water delivery applications. Unlike HDPE, steel pipe cannot be shaped to conform into canal alignments; therefore, elbows would be required. The cost of elbow fittings was estimated by assuming one elbow every 100 feet at a cost of $100 per 1 inch of pipe diameter. Turnouts and PRV stations use the same costs as the Preferred Alternative. These costs are based upon actual installed costs for turnouts and PRV stations in Central Oregon. The table below shows the pipe lengths and diameters; for other features such as turnouts, PRV stations, or earthwork, see the Preferred Alternative Costs above.

Table D-5. Steel Piping Costs.

Project Group	Area	Feature	Diameter (in)	Length (ft.)	Pipe $/Foot	Elbow qty	Subtotal
1	G-4 Lateral	Steel Pipe	4	1,628	$33	16	$66,945
1	G-4 Lateral	Steel Pipe	8	2,900	$68	29	$244,906
1	G-4 Lateral	Steel Pipe	10	1,980	$86	20	$210,107
1	L Lateral	Steel Pipe	24	150	$210	2	$38,665
1	J Lateral	Steel Pipe	30	5,077	$263	51	$1,638,656
1	PBC	Steel Pipe	48	860	$422	9	$445,258
1	L Lateral	Steel Pipe	48	20	$422	1	$10,355
2	PBC D/S L Lateral	Steel Pipe	8	2,374	$68	24	$200,485
2	PBC D/S L Lateral	Steel Pipe	8	2,558	$68	26	$216,024
2	PBC D/S L Lateral	Steel Pipe	10	1,400	$86	14	$148,561
2	J Lateral	Steel Pipe	24	186	$210	2	$47,945
2	J Lateral	Steel Pipe	30	1,410	$263	14	$455,092
2	J Lateral	Steel Pipe	30	3,073	$263	31	$991,843
2	J Lateral	Steel Pipe	32	3,669	$280	37	$1,263,696
Subtotal							$5,979,000
Other costs (earthwork, turnouts, PRV stations, etc. – same as the Preferred Alternative)							$27,714,000
Engineering, Construction Management, Survey (5% Project Group 1, 10% Project Group 2)							$1,890,000
Construction Management / General Contractor (8% Project Group 1, 15% Project Group 2)							$2,983,000
Contingency (10% Project Group 1, 5% Project Group 2)							$3,164,000
Total							**$41,730,000**

Totals are rounded to nearest $1000.

D.4.2.2 PVC Piping

The lengths, diameters, and range of pressure ratings used for this alternative were estimated based on the engineering analysis completed in the District's SIP. Under the PVC piping alternative, PVC would be used for diameters up to 48 inches.

The lifespan of a piping system depends on many different factors. Proper installation and operation of the piping system are key to achieving a long service life. Assuming a piping system is ideally installed and operated, the main factor affecting the pipe's service life is the number and magnitude of surge/water hammer events the system experiences. Surge/water hammer events are caused by valve operations, changing irrigation demand in the system, pump startup and shutdown, quick hydropower turbine shutdowns due to power failures, and any other factors causing fast changes in the piping system flow rate (B. Cronin, personal communication, July 27, 2018).

USDA-NRCS's practice standard lifespan for irrigation pipeline is 20 years (NRCS n.d.). This lifespan is based on long-term experience with primarily PVC pipe irrigation system installations (B. Cronin, personal communication, July 27, 2018). The Plastics Pipe Institute's online software indicates that with the average number of surge/water hammer events expected in a pipeline network, the lifespan of a typical 24-inch, 125 psi pressure rated PVC pipe would 14 years with a safety factor of two (Plastics Pipe Institute 2015). PVC is also more prone to failure under freezing conditions and the COID system is used to deliver water several times during the winter for livestock. During these periods, the PVC pipe system would be more likely to freeze and potentially rupture and fail. PVC piping has been installed in irrigation districts in the Deschutes Basin and experienced premature failure, especially in Districts where stock water is delivered during the winter (M. Thalacker, personal communication, November 8, 2017). Considering all the information above, a PVC design life of 33 years was assumed for purposes of this analysis.

Unlike HDPE, PVC pipe cannot be shaped to conform into canal alignments; therefore, elbows would be required. The cost of elbow fittings was estimated by assuming one elbow every 100 feet at a cost of $100 per 1 inch of pipe diameter. To account for additional PVC costs such as fittings and bends in the system, an additional 5 percent cost was added. Turnouts and PRV stations use the same costs as the Preferred Alternative. These costs are based upon actual installed costs for turnouts and PRV stations in Central Oregon. The table below shows the pipe lengths and diameters; for other features such as turnouts, PRV stations, or earthwork, see the Preferred Alternative Costs above.

Table D-6. PVC Piping Costs.

Project Group	Area	Feature	Diameter (in)	Length (ft.)	Pipe $/Foot	Elbow qty	Subtotal
1	G-4 Lateral	PVC Pipe	4	1,628	$4	16	$20,171
1	G-4 Lateral	PVC Pipe	8	2,900	$13	29	$89,523
1	G-4 Lateral	PVC Pipe	10	1,980	$20	20	$83,576
1	L Lateral	PVC Pipe	24	150	$70	2	$18,617
1	J Lateral	PVC Pipe	30	5,077	$109	51	$902,513
1	PBC	PVC Pipe	48	860	$284	9	$343,321

Project Group	Area	Feature	Diameter (in)	Length (ft.)	Pipe $/Foot	Elbow qty	Subtotal
1	L Lateral	PVC Pipe	48	20	$284	1	$7,984
2	PBC D/S L Lateral	PVC Pipe	8	2,374	$13	24	$73,285
2	PBC D/S L Lateral	PVC Pipe	8	2,558	$13	26	$78,965
2	PBC D/S L Lateral	PVC Pipe	10	1,400	$20	14	$59,094
2	J Lateral	PVC Pipe	24	186	$70	2	$23,084
2	J Lateral	PVC Pipe	30	1,410	$109	14	$250,649
2	J Lateral	PVC Pipe	30	3,073	$109	31	$546,272
2	J Lateral	PVC Pipe	32	3,669	$158	37	$855,013
Subtotal							$3,352,000
Other costs (earthwork, turnouts, PRV stations, etc – same as the Preferred Alternative)							$27,714,000
Engineering, Construction Management, Survey (5% Project Group 1, 10% Project Group 2)							$1,687,000
Construction Management / General Contractor (8% Project Group 1, 15% Project Group 2)							$2,672,000
Contingency (10% Project Group 1, 5% Project Group 2)							$2,973,000
Total							**$38,398,000**

Totals are rounded to nearest $1000.

D.5.3 Other Materials References

Bambie, J. and B. Keil. 2013. *Revision of AWWA C200 Steel Water Pipe Manufacturing Standard: Consensus-Based Changes Mark Significant Improvements*. Northwest Pipe Company. Vancouver, Washington.

Cronin, Bill (NRCS). 2018. Personal communication (email) with Alexis Vaivoda (FCA). July 27, 2018.

Plastics Pipe Institute. 2015. Pipeline Analysis & Calculation Environment online tool. Website: http://ppipace.com. Accessed July 25, 2018.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). n.d. National Conservation Practice Standards. Website: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1076947.pdf. Accessed July 25, 2018.

Thalacker, Marc (Three Sisters Irrigation District). 2017. Personal communication (email) with Mattie Bossler (FCA). November 8, 2017.

Appendix E

Other Supporting Information

E.4 Intensity Threshold Table

This 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 Central Oregon Irrigation District – Irrigation Modernization Project.

	Intensity Threshold			
Resource	**Negligible**	**Minor**	**Moderate**	**Major**
Cultural Resources	No above or underground cultural resources are adversely affected.	Affects a cultural resource that does not have local, regional or state significance. The historic context of the affected site(s) is 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 resource with modest 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 resource with high 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 reduces the ability of a cultural resource to convey its historic significance. Permanent severe change or exceptional benefit to a natural or physical ethnographic resource.
Fish and Aquatic Species	No discernable short- or long-term impacts to fish populations or aquatic habitat.	Changes in watershed conditions that may cause non-measurable degradation to aquatic habitat. Direct or indirect habitat changes that result only in non-measurable,	Changes in watershed conditions that cause measurable degradation to aquatic habitat. Direct or indirect habitat changes that cause measurable, short- or long-term	Changes in watershed conditions that cause high impairment to aquatic habitat that affects population viability.

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
		short-term change in risk to ESA-listed or other fish populations.	change in risk to ESA-listed or other fish populations.	The proposed action would likely jeopardize a species' continued existence or destroy or adversely affect a species' critical habitat.
Soils	Project activities would not disturb soils.	Short-term erosion during construction at project and clearing sites that would be mitigated through BMPs. Changes to primarily previously disturbed soil profiles.	Short-term erosion during construction at project and clearing sites that could not be mitigated. Changes to primarily undisturbed soil profiles.	Continued erosion during and after construction at project and clearing sites. Permanent changes to undisturbed soil profiles.
Land Use	Existing land uses or ownership would continue as before. A short-term change or interruption to land use or access to existing land uses.	Land use changes that are consistent with existing ownership, easements, or right-of-way.	Land use changes that are inconsistent with existing ownership, easements, or right-of-way but are compatible to adjacent.	A new unauthorized land use or access that is not compatible with adjacent land use.
Public Safety	No increase in risk to human health and safety.	Any risks to public health and safety created by the project would be eliminated through mitigation.	Any risks to public health and safety created by the project would be eliminated through mitigation, but would require a short-term behavioral change by the public or present a temporary inconvenience.	Create a permanent and known health and safety risk.
Recreation	No effect on the location, timing, or quality of recreation facilities and uses during and after construction.	Temporarily preclude or limit recreational opportunities during off-peak use periods during project construction.	Temporarily preclude or limit recreational opportunities during peak use periods during project construction. Permanent elimination of dispersed recreational activities without a	Permanently obstruct, alter, or eliminate legally existing or planned recreational uses. .

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
		Long-term relocation of dispersed recreational activities to an equal or better location after project construction.	designated relocation or replacement area.	
Socioeconomics	No reduction in the yield of agricultural products or timber. Non-measurable change to income and/or employment levels.	Measurable, but short term, reduction to yield of agricultural products or timber. Temporary reduction to income and/or local employment levels.	Long-term reduction in the yield of agricultural products or timber on the scale of individual farms. Short-term reduction to income and/or local employment levels.	Long-term reduction in the yield of agricultural products or timber on a district wide scale. Long-term reduction to income and/or regional employment levels.
Vegetation	Project activities would not affect vegetation or it is limited to small areas.	Most effects would be localized and/or temporary. While individual plants could be affected, there would be no effects on a population scale. Any permanent effects would not be widespread nor affect sensitive species or populations.	A large proportion of one or more populations are affected but relatively localized and could be mitigated. Any effects to sensitive species could be mitigated.	Considerable effects on plant populations over large areas. Extensive mitigation required offsetting adverse effects to sensitive species, but success not assured.
Visual Resources	Project features are visually negligible or not visible.	The majority of project features do not attract attention to the landscape. Short-term visual changes during project construction.	A 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, or groundwater quantity.	*Surface Water Quantity:* Temporary change in quantity away from the natural or target hydrograph.	*Surface Water Quantity:* Permanent change in water quantity that is measurable and that is counter to the natural or target hydrograph, that does	*Surface Water Quantity:* Permanent change in water quantity that is measurable and that is counter to the natural or target hydrograph,

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
		Water Quality: Short-term or non-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. *Groundwater:* Long-term less than 10 percent change in volume of annual discharge in the area affected by District operations.	not affect other water users or 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. *Groundwater:* Long-term greater than 10 percent but less than 20 percent change in volume of annual discharge in the area affected by District operations.	that affects other water users and 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. *Groundwater:* Long-term greater than 20 percent change in volume of annual discharge in the area affected by District operations.
Wetland, Floodplains, Riparian Zones	Does not alter wetlands or riparian areas or change the hydraulic capacity of floodplains.	Degradation of non-jurisdictional wetlands. Project does not increase the potential for flooding and damage to personal property.	Mitigated degradation of jurisdictional wetlands. Increase to the potential for flooding and damage to personal property that can be permitted and mitigated.	Permanent, non-mitigated degradation of jurisdictional wetlands. Increase to the potential for flooding and damage to personal property that cannot be mitigated.

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
Wildlife	Degradation to wildlife habitat with no effect on populations	Degradation and recovery of wildlife populations and/or their habitats would be short-term.	Degradation and recovery of wildlife populations and/or their habitats would be long-term but would not affect the viability of any population. Habitat availability would continue to be adequate.	Long-term degradation to wildlife populations or habitats that would affect the viability of a population. Inadequate habitat availability.
Wild and Scenic Rivers	No effects to the resources determining the designation of Wild and Scenic Rivers.	Any effects to resources would be compatible with the designation of the Wild and Scenic River reaches.	An effect to resources that would be incompatible with the designation but could be mitigated.	Effects to resources that would change the designation of a Wild and Scenic River reach.

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 lasting greater than 5 years.

E.5 Cultural Resource Agreements

This section provides the Memorandum of Agreement between COID, Reclamation, and the Oregon State Historic Preservation Office and the Unanticipated Discovery Plan for Cultural Resources.

MEMORANDUM OF AGREEMENT
No. R14MA13733
AMONG
THE U.S. BUREAU OF RECLAMATION,
THE OREGON STATE HISTORIC PRESERVATION OFFICE
AND
CENTRAL OREGON IRRIGATION DISTRICT

For
Piping of a Segment of the I-Lateral

ALFALFA VICINITY, DESCHUTES COUNTY, OREGON

This Memorandum of Agreement (MOA) is entered into by Bureau of Reclamation, Columbia-Cascades Area Office (Reclamation), the Oregon State Historic Preservation Office (SHPO) and the Central Oregon Irrigation District (District) to define their respective roles in mitigation efforts related to the piping of the I-Lateral of the Central Oregon Irrigation District System (System). This MOA outlines separate, but related mitigation for the current undertaking (subterranean piping of a Segment of I-Lateral) and the proposed future piping of the remainder of the canals, laterals, sub-lateral and ditches within the District. This MOA replaces MOA No. R12MA13723 thereby canceling it in its entirety.

1. Background
The District is located in Deschutes County. The District provides irrigation water within the Central Oregon Tri-county area with 43,000 acres delivered to water users in the vicinity of Bend, Alfalfa, Powell Butte, Redmond, and Terrebonne, within the upper Deschutes River basin.

A. I-Lateral Piping

Under the current undertaking, the District intends to protect and improve water quality and improve water delivery by converting approximately 4,800 feet of open ditch laterals within the I-Lateral of the System to pipe, in T17S R14E Sections 25, 26 and 36.

The District has been awarded a grant through Reclamation's WaterSMART Program to perform the work. Because Reclamation-administered Federal funds will be involved in this project, the Section 106 process of the National Historic Preservation Act was applied to identify affected historic properties.

Pursuant to Section 106 of the National Historic Preservation Act (NHPA), the District has documented the extent of the Lateral within the current undertaking's Area of Potential Effects for historic and archaeological resources to standards acceptable to Reclamation and SHPO.

Reclamation, in consultation with SHPO, determined that replacement of the open I-Lateral with the pipe will have an adverse effect upon the historic integrity of the Lateral. Reclamation notified the Advisory Council on Historic Preservation (Council) of the adverse effect on the I-Lateral pursuant to the Code of Federal Regulations (CFR) 36 CFR Section 800.6(a)(1), and in a letter dated September 17, 2012, the Council indicated that their participation is not needed in the consultation for resolution of adverse effects from this undertaking.

Specific mitigation strategies designed to address the adverse effect of this undertaking are identified below, in section 3.A.

B. Future Piping of Canals, Laterals, sub-Laterals, and Ditches
Through discussions between Reclamation, SHPO, and the District related to future project planning and the stated intentions of the District, a proposal to programmatically mitigate for future adverse effects related to the future piping of canals, laterals, sub-laterals, and ditches throughout the District has been developed. This MOA is intended to provide mitigation for such future piping efforts.

Specific mitigation strategies designed to address the adverse effects of these future undertakings are identified below, in section 3.B.

C. Interim Management
Until the Programmatic Agreement is signed and in place, all consultation regarding non-Federal undertakings will be reviewed by SHPO under standard State review practices, as defined in Oregon State Regulations (ORS) 358.653.

This MOA is entered into under the authority of the National Historic Preservation Act of 1966 as amended, as specified in the regulations in 36 CFR 800, and specifically in Section 6(c) – Resolution of Adverse Effects without the Council.

2. Purpose and Applicability

This MOA will serve to define the necessary actions for documentation of the System in its current state, define in more detail the historical significance, contextual setting, character-defining characteristics and the contributing properties within the System, and set the parameters by which future actions to pipe the System can be accomplished. This MOA will reduce the need to consult with the SHPO on a case-by-case basis when qualifying future activities (defined as subterranean piping of canals, laterals, sub-laterals, and ditches) take place on the System, and provides for a schedule that allows the SHPO to be updated on implemented actions.

This MOA does not apply to projects affecting any feature or element that is or may be individually eligible for listing in the National Register of Historic Places. Federal undertakings that affect these elements of the District will continue to be reviewed under standard Section 106 review processes (36 CFR 800). Non-Federal projects will continue to be reviewed under ORS 358.653.

3. Implementing Actions

A. Piping of I-Lateral
The SHPO, Reclamation, and the District agree that the current undertaking, consisting of the subterranean piping of approximately 4,800 feet of the I-Lateral, currently an open-ditch structure, represents an adverse effect to the National Register-eligible District water conveyance system. In order to mitigate that adverse effect, the following shall be implemented:

1. Reclamation will:

(a) Consult with the proper interested parties, such as the Council, SHPO, and the Confederated Tribes of the Warm Springs Reservation.
(b) Ensure that mitigation efforts defined in this MOA as part of the current undertaking (identified below, Section 3.A.2) are completed to the standards set forth below.

2. The District will:

(a) Perform or cause to be performed the Historic Documentation of the System:

- Following all applicable guidance provided by the National Park Service and SHPO, the District will conduct a historic properties inventory of the entirety of the District facilities and infrastructure related to water conveyance (i.e., not to include district offices and equipment/vehicle maintenance or storage facilities). This inventory will document all water-conveyance system buildings and structures, provide locational information (in GIS format, using lines to represent canals, etc., and points or polygons, as appropriate, to represent features) for all water conveyance-related buildings and structures, as well as associated features. The inventory will meet the requirements set forth for Reconnaissance Level Surveys, as defined in the document, "Guidelines for Historic Resource Surveys in Oregon." Prior to initiation of the survey, a written, detailed survey design will be submitted to SHPO for review and concurrence.
- This inventory will be completed and submitted to Reclamation and SHPO for draft review within three (3) years of the date of the final signature on the document. Comments and revision requests from Reclamation and/or SHPO will be addressed, and a final version of the inventory will be submitted within one (1) year of the receipt of such comments.

B. Future Piping of Canals, Laterals, sub-Laterals, and Ditches Elsewhere Within the District
SHPO, Reclamation, and the District understand that it is the intention of the District to convert significant portions of the system of open canals, laterals, sub-laterals and ditches within the District to a subterranean, piped system. In order to mitigate for future adverse effects that would arise from these efforts, Reclamation, SHPO and the District have agreed to mitigate programmatically through the following measures in order to reduce time, effort, and resources required to conduct standard Section 106 and/or ORS 358.653 consultation:

1. Develop a Programmatic Agreement (PA)

(a) Reclamation, SHPO, and the District shall enter into a PA to allow for the more efficient fulfillment of the entity's obligations under Section 106 of the National Historic Preservation Act, as amended, and Oregon Revised Statute 358.653, as applicable.

(b) All parties shall use the Multiple Property Document (see Section 3.B.2., below) to identify contributing segments of the canal system to be managed under the PA and any subsequent documents created as part of the process. The PA will include, at minimum:

- A list of routine maintenance and minor construction activities and actions that do not adversely affect the historic resource and that are exempt from regular review by SHPO;
- A provision to address emergency situations where catastrophic breach of the canal or other unforeseen event or eminent threat endangers human life or property. Such a provision shall allow the District to act on the immediate situation without consultation and address compliance with applicable cultural resource laws in consultation with appropriate federal agencies and stakeholders within 30 days of the incident.
- An inadvertent discovery clause, which will outline procedures to be followed when unknown, unanticipated cultural resources are discovered due to District activities;
- A description of annual reporting requirements and timetable for reporting activities undertaken by the District where the provisions of the PA were applied;

- A defined effective period of ten (10) years with provisions for the document to be reviewed at five years from last date of signature, amended as necessary, and the effective period continued, based on consultation. If appropriate, the effective period can be extended for an additional ten (10) years (with an additional five-year review), subject to the agreement of Reclamation, SHPO, and the District.

(c) The PA may also include a probability model for subsurface archaeological sites, cultural resource treatment plans, and preservation plans, as agreed to by the signing Parties.

(d) Reclamation, SHPO, and the District, as well as any other interested, consulting parties, will be signatories to the PA.

(e) Until the PA is signed and in place, all consultation regarding future federal undertakings (those not covered under Stipulation A) affecting the District water conveyance system will be reviewed by Reclamation and SHPO under standard Section 106 review practices, as defined in 36 CFR 800.

2. Develop Multiple Property Document (MPD)

(a) Following all applicable guidance provided by the National Park Service and SHPO for the preparation of MPDs, the District will edit the MPD, *Historic Agricultural Resources in Central Oregon,* which is currently in draft form, as prepared by Claeyssens and Tomlinson (2006) under a previous Reclamation water conservation grant. The MPD will be prepared sufficiently such that subsequent Irrigation Districts are able to add their district-specific contexts and registration requirements. The MPD elements will be based on the results of the Reconnaissance Level Survey inventory created as a result of Stipulation A.2. (above). The MPD elements to be developed include:

1. General framework for the functioning of the MPD, once registered, including Sections A through D (complete), Sections E-I such that deal specifically with the District, but that includes general introductions, contexts, and registration requirements that will be applicable across all irrigation districts included in the final MPD;
2. Establishment of the various historic contexts pertaining to the history and significance of the District. The historic context(s) will be based on historical research, and supported by historical documents and images;
3. Development of associated property types and general and type-specific registration requirements through which identified elements of the system can be evaluated for eligibility (including consideration of significance and integrity) for inclusion in the NRHP through the framework of the MPD; and
4. A GIS-based map of the entire system identifying the location, extent, and features of the District, and any other necessary appendices, shall be included. The map should identify elements and sections of the System as either contributing or non-contributing to the District as a comprehensive historic resource.

(b) The draft MPD (including all GIS information) will be submitted to Reclamation and SHPO for review and comment within three (3) years of the date of the final signature of this MOA. Draft MPD and nomination materials will be submitted to Reclamation and SHPO for review by SHPO and the Oregon State Advisory Committee on Historic

Preservation (SACHP). The District will address any SHPO and SACHP comments prior to forwarding the document to the National Park Service for final consideration.

3. Preservation and Interpretation

(a) Following completion of the draft MPD elements described above (Stipulation B.2.a-b), the District, in consultation with Reclamation and the SHPO, shall select appropriate, contributing segments to be listed in the National Register of Historic Places through the MPD. These segments will be selected based on the following criteria:

1. The segments will be high-integrity, substantial, contributing segments (minimally, one substantial segment each in the Pilot Butte Canal and the Central Oregon Canal) to the overall eligible District;
2. The segment should include a variety of features, such that it well-represents the function and appearance of the water conveyance system, as it appeared as an intact system;
3. The segment should be of sufficient length that on-site interpretation (see Stipulation B.3 (b), below) can be achieved in an attractive, well-organized fashion, without crowding or overwhelming the resource itself.

(b) Once selected, the identified segment will be cleaned, repaired, and returned to working condition in a way that meets the Secretary of the Interior's Standards for the Treatment of Historic Properties, and the immediate vicinity prepared such that it creates a welcoming, attractive environment for the public visitation and interpretation of the resource.

(c) The interpretation of the resource will be achieved through the use of static or active displays that relate the history, function, and significance of the Central Oregon Irrigation District water conveyance system. Such displays will be presented in a format that is weather- and vandal-resistant, attractive, and engaging. Draft content and layout of the interpretive display(s) will be submitted to Reclamation and SHPO for review and comment, and if any revisions are requested, revised versions will be submitted for a second review prior to fabrication. Upon acceptance of the draft content by Reclamation and SHPO, the District will cause the interpretive display to be constructed.

(d) Once constructed, the interpretive site and displays must be maintained by the District in an attractive and functioning condition.

4. Completion of this MOA

The terms of this MOA will be considered to be completed when the above implementing actions (A-B) have been completed to the satisfaction of Reclamation and SHPO. Upon completion of the implementing actions, all adverse effects resulting from subterranean piping of *all canals, laterals, sub-laterals, and ditches will be considered to be fully mitigated*, and may proceed without Section 106 or ORS 358.653 (as appropriate) consultation with Reclamation or SHPO.

5. Period of Performance

This MOA shall become effective on the date of the last signature hereto and extend three years after the date of the last signature. The MOA will also be considered terminated once all stipulations are complete, or five years after the date of the last signature on this MOA. Any party may terminate this MOA by providing 30 days written notice to the other party(ies). Any party may formally request modification of the MOA by providing a written request to the other party(ies).

If this MOA is terminated prior to completion of the above stipulations, then all projects undertaken from the date of the final signature not covered by the PA (should it be in effect) on this MOA must be reviewed under standard review practices under Section 106 of the National Historic Preservation Act, or under ORS 358.653, as appropriate.

6. Modifications

Reclamation, SHPO or the District may formally request modification of this MOA. Modifications shall be made by mutual consent of Reclamation, SHPO and the District by the issuance of a written modification to this MOA, signed and dated by all parties prior to any changes being performed.

7. Principal Contacts

The principal contacts for this MOA are:

For Reclamation:

Chris Horting-Jones
Archeologist
1375 SE Wilson Ave. #100
Bend, OR 97701
Phone (541) 389-6541
Fax (541)-389-6394
Email: chortingjones@usbr.gov

For the District:

Laura Wollam
Grant Specialist
Central Oregon Irrigation District
1055 SW Lake Ct.
Redmond, OR 97756
Phone (541) 504-7577
Fax (541) 548-0243
Email: lauraw@coid.org

For SHPO:

Jason Allen
Historic Preservation Specialist
State Historic Preservation Office
Oregon Parks and Recreation Department
725 Summer St. NE, Suite C
Salem, OR 97301-1266
Phone (503) 986-0579
Fax (503) 986-0793
Email: Jason.Allen@state.or.us

8. General Provisions

a. Reclamation's responsibility for ensuring completion of consultation with SHPO for future undertakings identified in Section 3.B. is limited only to those that qualify as Federal undertakings. Projects identified in Section 3.B. that do not qualify as Federal undertakings are subject to review by the SHPO under ORS 358.653, and the responsibility for consultation and completion will rest with the District.

b. Completion of the mitigation stipulations will be considered to satisfy the requirements for mitigation of adverse effects for a previous undertaking (Pilot Butte Canal Juniper Ridge Piping Project Phase 2 [SHPO Case# 10-1873]) that has not yet been mitigated as of the date of the final signature on this MOA.

c. This MOA is neither a fiscal nor a funds-obligating document for Reclamation. Any endeavor or transfer of anything of value involving reimbursement or contribution of funds between the parties of this MOA will be handled in accordance with applicable laws, regulations, and procedures including those for Government procurement and printing. Such endeavors will be outlined in separate agreements that shall be made in writing by representatives of the parties and shall be independently authorized by appropriate statutory authority. This MOA does not provide such authority.

d. Nothing herein shall be construed to obligate Reclamation to expend or involve the United States of America in any contract or other obligation for the future payment of money in excess of the appropriations authorized by law and administratively allocated for the purposes and projects contemplated hereunder.

e. No member of or delegate to Congress, or resident Commissioner, shall be admitted to any share or part of the MOA or to any benefit that may arise out of it.

f. Any information furnished to Reclamation, under this MOA, is subject to the Freedom of Information Act (5 U.S.C. 552).

g. All parties to this MOA agree to comply with all Federal statutes relating to nondiscrimination, including but not limited to: Title VII of the Civil Rights Act of 1964, as amended, which prohibits discrimination on the basis of race, color, religion, sex, or national origin; Title IX of the Education amendments of 1972, as amended, which prohibits discrimination on the basis of sex; the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act of 1990, as amended, which prohibit discrimination on the basis of disability; the Age Discrimination in Employment Act of 1967, as amended, which prohibits discrimination based on age against those who are at least 40 years of age; and the Equal Pay Act of 1963.

9. Signatures

Reclamation, SHPO and the District will abide by the terms and provisions expressed or referenced herein.

BUREAU OF RECLAMATION

by: ______________________ DATE: 2/12/14

Gerry Kelso, Manager
Columbia-Cascades Area Office

MOA #R14MA13733 Page 7

OREGON STATE HISTORIC PRESERVATION OFFICE

BY: ______________________ DATE: 2-26-14

Roger Roper
Deputy State Historic Preservation Officer

CENTRAL OREGON IRRIGATION DISTRICT

BY: ______________________ DATE: 11/Feb 2014

Steven Johnson
Secretary-Manager

~~ **End of Document** ~~

POST-REVIEW DISCOVERY PLAN FOR UNANTICIPATED CULTURAL RESOURCES

Central Oregon Irrigation District

Agreement No. R19MA13745
(BFO U19-05.19.001)

5

Inadvertent or Unanticipated Discovery Plan for Cultural Resources

Central Oregon Irrigation District

Introduction

This Inadvertent Discovery Plan is a component of the Programmatic Agreement between the Bureau of Reclamation, Oregon State Historic Preservation Officer and Central Oregon Irrigation District, regarding Compliance with Section 106 of the National Historic Preservation Act for Improvement, Operation, and Maintenance of the Central Oregon Irrigation District System of Canals, Laterals, and Associated Irrigation Features and Facilities. It is to be utilized by the Central Oregon Irrigation District (COID) on projects funded, either partially or in full, by the Bureau of Reclamation and any other federal agency, and which will result in ground disturbance with the potential for exposure of cultural materials, including human remains.

The following paragraphs outline the steps to be taken in the event that cultural materials are found during project activities (such as pipeline installation and canal realignment) within district boundaries on lands owned by or held as easement by COID. A copy of this IDP will be provided to all contractors and sub-contractors working on COID projects as funded by any federal agency.

For purposes of this document, ***Project Manager*** refers to a COID employee who is overseeing project implementation. ***Reclamation Contact*** refers to the individual employed by Reclamation who is considered the Grants Specialist and regularly communicates with COID's ***Project Manager.***

Protocol for coordination in the event of an inadvertent discovery: In the event of an inadvertent discovery of possible cultural materials, including human remains:

- **All work will stop immediately in the vicinity of the find.** A 30-meter buffer should be placed around the discovery with work being able to proceed outside of this buffered area unless additional cultural materials are encountered.

- The area will be secured and protected.

- The *Project Manager*, as designated by COID, and the *lead federal agency contact* will be notified. The *Project Manager* will immediately notify the State Historic Preservation Office (SHPO) and Reclamation's archaeologist. If possible human remains are encountered, the Oregon State Police, Commission on Indian Services (CIS), SHPO, appropriate Tribes, and Reclamation's archaeologist will also be notified.

  This contact list will need to be updated as necessary to reflect current contact names and phone numbers.

Agreement No. R19MA13745
(BFO U19-05.19.001) 6

Contact Agency	Contact Name	Phone number
Oregon State Police (OSP)	Chris Allori	503-731-4717
Commission on Indian Services (CIS)	Danny Santos	503- 986-1067
Appropriate Tribes	As designated by CIS	
SHPO	Dennis Griffin	503-986-0674
	John Pouley	503-986-0675
	Jamie French	503-986-0729
Reclamation Contact	Leah Meeks, GOTR	208-378-5025 work
Reclamation Archaeologist	Chris Horting-Jones	541-389-6541 ext 236 541-410-9895 cell
COID Project Manager	Kelly O'Rourke	541-548-6467

- No work may resume until a professional archaeologist is able to assess the discovery and consultation with the SHPO and Reclamation has occurred.

- If human remains are encountered, they will not be disturbed in any way. *911 will not be called*. No one will speak with the media. The location will be secureed. No photos will be taken. The location will be secured and work will not resume in the area of discovery until all parties involved agree upon a course of action.

- A professional archaeologist may be needed to assess the discovery and they, working in tandem with Reclamation's archaeologist, will consult with SHPO and appropriate Tribal Governments to determine an appropriate course of action.

- Archaeological excavations may be required. This is handled on a case-by-case basis by Reclamation's archaeologist and Reclamation Contact, the professional archaeologist and Project Manager, in consultation with SHPO and appropriate Tribes.

When to stop work:

Construction work may uncover previously unidentified Native American or Euro-American artifacts. This may occur for a variety of reasons, but may be associated with deeply buried cultural material, access restrictions during project development, or if the area contains impervious surfaces throughout most of the project area which would have prevented standard archaeological site discovery methods.

Work must stop when the following types of artifacts and/or features are encountered:

Native American artifacts may include (but are not limited to):
- Flaked stone tools (arrowheads, knives scrapers etc.);
- Waste flakes that resulted from the construction of flaked stone tools;
- Ground stone tools such as mortars and pestles;
- Layers (strata) of discolored earth resulting from fire hearths - may be black, red or mottled brown and often contain discolored cracked rocks or dark soil with broken shell;
- Human remains;
- Structural remains - wooden beams, post holes, fish weirs.

Euro-American artifacts may include (but are not limited to):

- Glass (from bottles, vessels, windows etc.);
- Ceramic (from dinnerware, vessels etc.);
- Metal (nails, drink/food cans, tobacco tins, industrial parts etc.);
- Building materials (bricks, shingles etc.);
- Building remains (foundations, architectural components etc.);
- Old Wooden Posts, pilings, or planks (these may be encountered above or below water);
- Remains of ships or sea-going vessels, marine hardware etc.;
- Old farm equipment may indicate historic resources in the area;
- Even what looks to be old garbage could very well be an important archaeological resource;

When in doubt, call it in!

Proceeding with Construction

- Construction can proceed only after the proper archaeological inspections have occurred and environmental clearances are obtained. This requires close coordination with SHPO and the Tribes.

- After an inadvertent discovery, some areas may be specified for close monitoring or 'no work zones.' Any such areas will be identified by the professional archaeologist and Reclamation's archaeologist to the *Project Manager*, and appropriate contractor personnel.

- In coordination with the SHPO, the *Project Manager* will verify these identified areas and ensure that the areas are clearly demarcated in the field, as needed.

E.6 Historical Background

This section provides information on the federal Carey Desert Lands Act of 1894 and irrigation development in Central Oregon.

At the turn of the twentieth century, Central Oregon, known then as the Deschutes country, was one of the most remote regions in the nation. Settlers were enticed with opportunities to capitalize on the Deschutes River, promising lands for agriculture, and immense pine forests. Two major factors contributed to the settlement and agricultural development of Central Oregon: the arrival in 1900 of the Columbia Southern railroad, and the State of Oregon's acceptance in 1901 of the 1894 federal Carey Act which encouraged states to pursue development of arid lands (NPS 2015). In exchange for up to 1 million acres of federal land, states made up to 160 acres available to settlers who agreed to improve and cultivate the land. The Carey Act enabled states to issue irrigation contracts to private developers who were expected to design and build irrigation projects, as well as recruit settlers to farm the new areas. The State would issue a water right to the private developer for a particular project, but the State would not be responsible for financing or construction. If an irrigation project failed, the State reassigned the contract to another development company. While limited irrigation in Central Oregon had begun before these changes, the Carey Act helped spur the creation of more irrigation companies and investment in large-scale irrigation projects (NPS 2017).

References

U.S. Department of the Interior, National Park Service (NPS). 2015. National Register of Historic Places Registration Form, Pilot Butte Canal Historic District (Cooley Road-Yeoman Road Segment). Retrieved from: https://www.nps.gov/nr/feature/places/pdfs/15001052.pdf. Accessed September 7, 2017.

U.S. Department of the Interior, National Park Service (NPS). 2017. National Register of Historic Places Registration Form, Pilot Butte Canal: Downtown Redmond Segment Historic District. Retrieved from: http://www.oregon.gov/oprd/HCD/NATREG/docs/national_register_recent/OR_DeschutesCo_PilotButteDowntownRedmondSegment.pdf. Accessed September 7, 2017.

E.7 Consultation Letters

USDA United States Department of Agriculture | Forest Service | Deschutes National Forest | 63095 Deschutes Market Road
Bend, OR 97701
541-383-5300

File Code: 2500
Date: August 15, 2017

Margi Hoffmann
Community Relations Director
11 Third Street, Suite 101
Hood River, Oregon 97031

Dear Ms. Hoffmann:

The Deschutes National Forest (DNF) attended the public open house presentation by Central Oregon Irrigation District on July 10, 2017, and has reviewed the conservation measures proposed for funding by Tumalo and Swalley Irrigation districts available at www.oregonwatershedplans.org. The DNF would like to submit this letter in support of the proposed watershed plans and conservation measures put forth by all three Irrigation Districts. The improved irrigation infrastructure that would come through these proposed projects to conserve water, reduce energy consumption, increase irrigation delivery efficiency, improve public safety, and benefit instream habitat for aquatic species (both ESA listed and non-listed species) represents a concerted effort on the part of the Irrigation Districts to advance water conservation efforts throughout the Deschutes River Basin that aims to provide a more equitable distribution of water to rivers, farms and municipalities, as well as to install the infrastructure needed to respond to future water conservation/distribution pressures that may arise with a growing central Oregon population and climate change.

Much of the Deschutes River above Bend, Tumalo Creek, and Crescent Creek flows through National Forest System lands. As the steward of these lands, the DNF has long been involved in a collaborative effort to address issues with the functioning condition of physical and ecological processes in these rivers and streams as it relates to regulated flow for irrigation. These proposed conservation measures will help to trend instream flow regimes toward a condition that will help to facilitate the passive and active restoration of these processes, and the functioning condition of an important part of the central Oregon landscape that is managed for public benefit.

The DNF understands that the proposed conservation measures are another step toward improving upon the conservation of water resources in central Oregon, and looks forward to continuing to work in partnership with the Irrigation Districts to further this cause into the future.

Sincerely,

JOHN ALLEN
Forest Supervisor

Caring for the Land and Serving People

Printed on Recycled Paper

Oregon

Kate Brown, Governor

Department of Environmental Quality
Eastern Region Bend Office
475 NE Bellevue Drive, Suite 110
Bend, OR 97701
(541) 388-6146
FAX (541) 388-8283
TTY 711

Date: July 21, 2017

To: Margi Hoffman, Community Relations Director, Farmers Conservation Alliance

From: Eric Nigg, Water Quality Manager

Subject: Preliminary Investigative Report for the Central Oregon Irrigation District (COID) Irrigation Modernization Project (June 29, 2017)

The Oregon Department of Environmental Quality was asked to review the above referenced report and provide comments on our anticipated regulatory authority over the project through our rules or through implementation of the Federal Clean Water Act (CWA). In addition, we are providing comments on water quality topics discussed in the report in hopes that this information can be used to inform the Watershed Plan that will be drafted as part of the NEPA process.

At this point in time, we believe that DEQ might have regulatory authority over the proposed project in the areas listed below. The degree of our involvement in the first two areas will be determined by the type of permit (if any) required by the U.S. Army Corp of Engineers and the amount of ground disturbing activities, which will likely be determined on a case-by-case basis.

Section 401 Removal and Fill Certification. Section 401 of the CWA gives states and tribes the authority to issue state water quality certifications for projects that require a federal license or permit that may result in a discharge to waters of the US. The certification may condition a permit to ensure the discharge will comply with applicable provisions of the CWA, including state water quality standards. Oregon's water quality standards specify the designated use of a waterbody (e.g., for water supply or recreation), pollutant limits necessary to protect the designated use (in the form of numeric or narrative criteria), and policies to ensure that existing water uses will not be degraded by pollutant discharges. The federal permit or license cannot be issued until a 401 Water Quality Certificate is received.

DEQ works closely with the U.S. Army Corps of Engineers (USACE). The USACE determines whether a project will be reviewed under an Individual or Nationwide Permit. ***Individual Permits*** are for projects that have more than minimal impacts and have both general and project-specific conditions to ensure that the project can meet State water quality standards. ***Nationwide Permits*** are for projects that are expected to have minimal impacts. More information can be found on DEQ's website: http://www.oregon.gov/deq/wq/wqpermits/Pages/Section-401.aspx.

Construction Stormwater Permits. Construction Stormwater Permits. National Pollutant Discharge Elimination System (NPDES) general permits are required for construction activities including clearing, grading, excavation, materials or equipment staging and stockpiling that will disturb one or more acres of land and that may result in a discharge to waters of the state. They also apply to construction activities that will disturb less than one acre that are part of a common plan of development or sale, if the larger common plan of development or sale will ultimately disturb one acre or more. More information can be found on DEQ's website: http://www.oregon.gov/deq/wq/wqpermits/Pages/Stormwater-Construction.aspx

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Section 401 Hydropower Certification. DEQ issues 401 certifications for hydroelectric projects and the Federal Energy Regulatory Commission administers the federal licensing process. The water quality certification typically includes operating conditions designed to ensure project operations will not violate water quality standards.

Section 3.2 of the COID report and the Appendix describes the hydroelectric power potential associated with piping. If built, it appears that these would be in-conduit hydroelectric facilities. As such, they would likely have no impacts to water quality and not require 401 hydropower certification from DEQ.

Total Maximum Daily Loads. As identified in the COID Report, there are a number of 303(d) listed water bodies in the project area. Once a water body has been identified as water quality limited, the CWA requires the establishment of a pollutant total maximum daily load (TMDL) for that water body. TMDLs are assessments that determine the maximum amount of pollutant that can be present in a water body while meeting water quality standards. The loading capacity is allocated to point, nonpoint, and future sources of pollution.

TMDLs are implemented via water quality management plans, which include the designation of local management agencies (DMAs) who have legal authority over a sector or source of contributing pollutants. DMAs are required to develop TMDL Implementation Plans which describes the management activities they will implement to meet their responsibilities under the TMDL. DEQ has named irrigation districts as DMAs in basins where we have determined that the laterals, canals and/or dams operated by the district contribute to the delivery of nonpoint sources of pollution, such as bacteria, heat or nutrients, to 303(d) listed water bodies. DEQ has not named irrigation districts as DMAs due to the water quality impacts associated with reduced flows below diversions, although restoration of flows is encouraged in the TMDL analysis. More information on TMDLs can be found on DEQ's website: http://www.oregon.gov/deq/wq/tmdls/Pages/default.aspx

TMDLs have not yet been completed anywhere in the Deschutes Basin. At this point, we are in the process of developing TMDLs in the project area to address the 303(d) listings for dissolved oxygen, pH and chlorophyll-*a*. We expect to begin a stakeholder involvement process for this effort sometime in 2018 and COID will be invited to participate. At this point we do not know whether or not COID will be named as a DMA and what TMDL implementation responsibilities they might have.

Comments on Specific Sections of the Preliminary Report

1. **Section 2.3**. The report for the equivalent Swalley Irrigation District project includes a discussion of possible mitigation needed for the loss of historic canals or other cultural resources, as well as other possible impacts of the project. Why is this not an issue for the COID project?
2. **Section 3.1.1**. The first sentence states that streams in the project area do not meet water quality standards for *salmon and trout*. While it is true that salmon and trout are two of the beneficial uses protected by the state standards, there are other beneficial uses protected by these standards as well. A list of all of the beneficial uses in the Deschutes Basin can be found at the following location on DEQ's website: http://www.deq.state.or.us/wq/rules/div041/dbutables/table130a.pdf.
3. **Section 3.1.3**. The third paragraph in this section references Figure 3-2, showing COID's two diversions. This Figure was not included in the document.
4. **Section 3.2**. (a) The first bulleted item in this section lists improved stream flows and water quality within the Deschutes River from Crane Prairie Reservoir to Lake Billy Chinook. Does this include improved water quality with the reservoirs as well as the river? (b) What is the anticipated timing for the water quality improvements? There are water quality impairments during both the summer and

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fall/winter/spring seasons in different parts of the project area. (c)This section states that stream flow benefits would be realized by allocating saved water instream through the Conserved Water Program. How much water is COID agreeing to protect and during what times of year?

5. **Section 5.2.** (a) This section largely describes the details of COID's Pilot Butte canal system. It would be helpful to have a better description of the Central Oregon canal system included as well. (b) This section mentions that there are seven patrons currently served from individual diversions. Yet the map in Figure 3.0.1 in the Appendix shows 12 diversions associated with the COID system. It would be helpful to have this inconsistency corrected or explained. (c) Are there any discharges to natural water bodies as part of the COID system? This would be helpful to know in terms of evaluating potential water quality impacts of proposed activities.
6. **Section 5.6.3.** (a) The first sentence lists dissolved oxygen and temperature as parameters that can be exacerbated by low flows. pH levels can also be exacerbated by low flows. (b) There are not 303(d) listings for *E. coli* on the Deschutes River. There are *E. coli* listings on the Crooked River. Because COID system is connected to the Crooked River, will this project also be evaluating impacts on the Crooked River? If so, it would be helpful to have that more clearly stated in the document. (c) The 303(d) listing for "aquatic weeds" should be "aquatic weeds or algae". The listing is based on the presence of harmful algal blooms in the reservoirs. (d) The last sentence of this paragraph is incorrect. The Deschutes River is included on the 303(d) list for flow modification and/or habitat modification. These are Category 4C listings, which indicates that the impairment is not caused by a pollutant therefore a TMDL is not needed. The other impairments described in this paragraph are Category 5 listings, which indicates that a TMDL is required to address the listing. Given that flow and habitat modifications are 303(d) listings, and both are parameters that could be affected by water management, would it be helpful to add sub-sections for these parameters to Section 5.6.3? (e) For each of the water quality parameters listed in this section, it would be helpful to have a description of how this parameter would be affected by changes in stream flow or reservoir storage. This information could be used to support the claims of improved water quality that would be realized through implementation of the project.
7. **Section 5.6.3.1.** (a) In addition to affecting fish, elevated stream temperatures can also affect other aquatic life. (b) The temperature criterion that applies throughout the project area is 18.0 degrees Celsius (64.4 degrees Fahrenheit), which is designed to protect salmon and trout rearing and migration. There is an additional criterion that currently applies in the Deschutes River above Wickiup Reservoir, designed to protect bull trout spawning and juvenile rearing. This criterion is 12.0 degrees Celsius (53.6 degrees Fahrenheit).
8. **Section 5.6.3.2.** (a) The "non-spawning" criterion which applies on the Deschutes River in the project area is the criterion to protect cold-water aquatic life (rather than cool-water or warm-water).
9. **Section 5.6.3.3.** (a) The description of factors affecting pH is not accurate. We would suggest a further review of reference material on this topic. One possible source would be DEQ's issue paper on the topic, available at the following location on DEQ's website: http://www.deq.state.or.us/wq/standards/docs/19921994wqStandardsReview.pdf. (b) The pH listings for the Deschutes River in the project area occur year-round (both the summer and fall/winter/spring seasons).
10. **Section 5.6.3.6.** As referenced above, this parameter should be "Aquatic Weeds or Algae". Wickiup and Crane Prairie Reservoirs have both had health advisories issued by the Oregon Harmful Algae Bloom Surveillance (HABS) program based on algal cell counts or toxicity levels associated with cyanobacteria.
11. **Section 5.7.** The first paragraph in this section discusses the fish screen on the Pilot Butte Canal diversion. Do the Central Oregon diversion and the single farm diversions have screens as well?
12. **Section 7.3.1.** The bullets under #1 describe how habitat and water quality could be enhanced in the river through selection of this alternative. Does this apply to the reservoirs as well? A different set of

water quality conditions exist in the reservoirs and they may respond differently than the river to changes in water management. Similarly, water quality impairments are different in different parts of the river at different times of year. For example, low flows below Wickiup in the winter and low flows below Bend in the summer may both degrade water quality. How will this alternative increase habitat and water quality conditions at both locations and times of year?

We thank you for the opportunity to review the preliminary document and to provide comments. We also look forward to assisting with funding of the project through our Clean Water State Revolving Loan Fund program. Please feel free to contact me or Bonnie Lamb if you have any questions. I can be reached at (541) 633-2035 or nigg.eric@deq.state.or.us and Bonnie can be reached at (541) 633-2027 or lamb.bonnie@deq.state.or.us.

ec: Kelly Hill, DEQ Regional Solutions Liaison
Bonnie Lamb, DEQ Basin Coordinator

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Bend Field Office
63095 Deschutes Market Road
Bend, Oregon 97701
Phone: (541) 383-7146 FAX: (541) 383-7638

July 24, 2017

Memorandum

To: Assistant State Conservationist, NCRS – Watershed Resources and Planning, Portland, Oregon

From: Field Supervisor, Bend Field Office, Bend, Oregon

Subject: Deschutes Basin Board of Control and Natural Resource Conservation Service, Scoping Comments

Thank you for the opportunity to provide recommendations and input during your National Environmental Policy Act (NEPA) scoping process for the Irrigation Modernization Project. The U.S. Fish and Wildlife Service (Service) supports this proposal and is eager to see the resulting conserved water returned to the Deschutes River.

The Service has been leading a large scale, conservation planning effort for water management that will benefit threatened and endangered species in the Deschutes River Basin in Central Oregon. This effort has spanned many years and has involved eight Central Oregon irrigation districts (constituting the Deschutes Basin Board of Control), the City of Prineville (collectively the Applicants), as well as other stakeholders and interested parties. The goal of this planning effort is to develop an Endangered Species Act (ESA) habitat conservation plan (HCP) under section 10(a)(1)(B) of the ESA that provides non-Federal parties the opportunity to conserve the ecosystems upon which listed species depend, ultimately contributing to their recovery.

The Deschutes Basin HCP has been in development for a number of years. The Applicant's goal is to complete the planning process in 2019. The goal of the Deschutes Basin HCP is to manage water in the Deschutes Basin in a manner that addresses the long-term certainty for water users but provides necessary water for species covered by the plan (Oregon spotted frog (*Rana pretiosa*), bull trout (*Salvelinus confluentus*), and steelhead (*Oncorhynchus mykiss*), sockeye salmon (*Oncorhynchus nerka*) and spring Chinook salmon (*Oncorhynchus tshawytscha*)). The Applicant's conservation approach is to modernize their existing irrigation infrastructure, and return the conserved water back in-stream to support the conservation of the covered species.

Currently, low flows in the Deschutes River Basin result in a myriad of impacts to fish and wildlife resources. Water management that alters water levels has reduced habitat suitability for the Oregon spotted frog, and increased flows are necessary to meet the life history demands of this species. Further, low flows impact water quality in the Deschutes River by exacerbating temperature and dissolved oxygen problems. Water quality often dictates the spread and extent of invasive aquatic species (plants and wildlife), and these problems interact synergistically to degrade wildlife habitat within and around the Deschutes River

Current proposed piping projects within Central Oregon Irrigation District (COID), Swalley Irrigation District (SID), and Tumalo Irrigation District (TID) could potentially conserve approximately 72,284 acre feet of water (Newton and Perle 2006). This would amount to approximately 195 cubic feet per second (cfs) in the river per irrigation season (180 days). These conservation opportunities are the very approach that the Habitat Conservation Plan envisions to restore the necessary flows in the Deschutes River.

We look forward to coordinating with you throughout the scoping process and during the development of the EA. We will provide input as needed during the formulation of your draft document. If you have any questions or if we can be of any assistance, please contact Emily Weidner or myself at 541-383-7146.

Literature Cited

Newton, D., and M. Perle. 2006. Irrigation district water efficiency cost analysis and prioritization. DWS Final Report, Newton Consultants, Redmond, Oregon.

E.8 Supporting Information for Land Use

This section presents supporting information for the land use section.

Table E-2. Project Area Length Crossing Land Use Classes.

Land Use	Percent of the Project Area Length	Project Area Length Crossing each Land Use Class (miles)
Agriculture	36%	2.8
Non-cultivated lands[1]	51%	4.0
Developed Use[2]	14%	1.1
Total	**100%**	**7.9**

Source: Yang et al. 2018.
Notes: [1] Shrub/scrub, woody wetlands. [2] Low intensity development, developed open space

References

Yang, L., Jin, S., Danielson, P., Homer, C., Gass, L., Case, A., Costello, C., Dewitz, J., Fry, J., Funk, M., Grannemann, B., Rigge, M. and G. Xian. 2018. A New Generation of the United States National Land Cover Database: Requirements, Research Priorities, Design, and Implementation Strategies, p. 108–123.

E.9 Supporting Information for Vegetation

This section presents supporting information for the vegetation section.

E.9.1 Common Vegetation

Table E-3. Common Vegetation within the Project Area.

Vegetation Species	Scientific Name
Big sagebrush	*Artemisia tridentate*
Bitterbrush	*Pseudoroegneria spicata*
Black cottonwood	*Populus balsamifera*
Bulrush	*Scirpus spp.*
Idaho fescue	*Festuca idahoensis*
Low sagebrush	*Artemisia arbuscula*
Ponderosa pine	*Pinus ponderosa*
Rabbit brush	*Ericameria nauseosa*
Sandberg bluegrass	*Poa sandbergii*
Western juniper	*Juniperus occidentalis*

Source: Hartzell- Hill personal communication July 18, 2017.

E.9.2 Common and Noxious Weeds

The Deschutes County Noxious Weed Policy and Classification System designates three weed categories. “A” designated weeds are of highest priority for control and are subject to intensive eradication, containment, or control measures using county resources. “B” designated weeds have a limited distribution; intensive containment control and monitoring by landowners is required, and support from the County is provided when resources allow. “C” designated weeds are the lowest priority for control. They have a widespread distribution; landowner control and monitoring is recommended (Deschutes County 2017). The following table lists the noxious weeds and corresponding classifications known to occur in the project area.

Table E-4. Noxious Weeds Occurring in the Project Area.

Vegetation Species	Scientific Name	Deschutes County Noxious Weed Rating
Bull thistle	*Cirsium vulgare*	C
Cheatgrass	*Bromus tectorum*	C
Common mullein	*Verbascum thapsus*	C
Diffuse knapweed	*Centaurea diffusa*	B
Kochia	*Kochia scoparia*	B
Poison hemlock	*Conium maculatum*	B
Russian thistle	*Salsola spp.*	B
Spotted knapweed	*Centaurea stoebe*	B
Yellow flag iris	*Iris pseudacorus*	B
Yellow floating heart	*Nymphoides peltata*	A
Water hemlock	*Cicuta douglasii*	N/A[1]

Notes:
[1] Not applicable (N/A) because water hemlock is not classified as a noxious weed. However, it is present throughout the project area.
Source: Hartzell- Hill personal communication July 18, 2017

References

Deschutes County. 2017. Deschutes County Noxious Weed List. Retrieved from: https://www.deschutes.org/sites/default/files/fileattachments/road/page/567/deschutes_county_weed_list_updated_2017.pdf. Accessed August 28, 2017.

Hartzell-Hill, Jenny (COID Executive Assistant). 2017. Personal communication (email) with Raija Bushnell (FCA). July 18.

E.10 Supporting Calculations for Water Resources

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

Table E-5. Monthly Instream Flow Targets for the Deschutes River and Crooked River.

Source	From	To	Certificate	Priority Date	Instream Rates (cfs)											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Deschutes R	Crane Prairie Reservoir	Wickiup Reservoir	73233	10/11/1990	130	130	130	130	130	130	130	130	130	130	130	130
Deschutes R	Wickiup Reservoir	Little Deschutes River	59776	11/3/1983	300	300	300	300	300	300	300	300	300	300	300	300
Deschutes R	Little Deschutes River	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	Lake Billy Chinook	70695	Pending	250	250	250	250	250	250	250	250	250	250	250	250
Crooked R	Bowman Dam	Lake Billy Chinook	70354	Pending	75	75/ 150	225	225	225	150	75	75	75	75	75	75

E.10.1 Upper Deschutes River, Below Wickiup Reservoir

This subsection presents supporting calculations used when evaluating effects of the Proposed Action with respect to water resources in the Deschutes River below Wickiup Reservoir.

Table E-6. Upper Deschutes River Daily Average Streamflow below Wickiup Reservoir prior to the 2016 Settlement Agreement.

Month	Low Streamflow (cfs) - 80% Exceedance	Lower Bar	Average Streamflow (cfs) - 50% Exceedance	Upper Bar	High Streamfllow (cfs) - 20% Exceedance
October	35	260	295	506	801
November	26	11	37	227	264
December	26	12	38	234	272
January	27	16	43	268	311
February	29	15	44	406	450
March	30	121	151	313	464
April	284	282	565.5	250	815
May	823	277	1100	240	1340
December	1040	280	1320	190	1510
July	1330	140	1470	152	1622
August	1260	160	1420	100	1520
September	946	209	1155	185	1340

Note: Streamflow in the Deschutes River downstream from Wickiup Reservoir at Oregon Water Resources Department Gauge No. 14056500 from the 1985 through 2015 water years.

Table E-7. Upper Deschutes River Daily Average Streamflow below Wickiup Reservoir following the 2016 Settlement Agreement.

Month	Low Streamflow (cfs) - 80% Exceedance	Lower Bar	Average Streamflow (cfs) - 50% Exceedance	Upper Bar	High Streamfllow (cfs) - 20% Exceedance
October	107	9	116	477	592
November	119	6	125	54	178
December	103	48	151	44	195
January	104	51	155	47	202
February	103	48	151	50	201
March	99	95	194	140	334
April	601	23	624	9	633
May	760	425	1185	155	1340
June	937	373	1310	162	1472
July	1430	100	1530	130	1660
August	1500	30	1530	48	1578
September	864	256	1120	194	1314

Note: Streamflow in the Deschutes River downstream from Wickiup Reservoir at Oregon Water Resources Department Gauge No. 14056500 from the October 2016 through September 2018 water years.

Table E-8. Deschutes River Post-Project Streamflow below Wickiup Reservoir.

Month	Pre-Project Average Daily Average Streamflow (cfs) [1]	Streamflow Restored Through Project (cfs)	Post-Project Average Daily Average Streamflow (cfs)[1]	ODFW Instream Water Right[2] in the Deschutes River from Wickiup Reservoir to the mouth of the Little Deschutes River	Post-Project Percentage Increase in Average Streamflow
October	116	0	116	300	0%
November	125	30.32	155	300	24%
December	151	30.32	181	300	20%
January	155	30.32	185	300	20%
February	151	30.32	181	300	20%
March	194	30.32	224	300	16%
April	624	0	624	300	0%
May	1185	0	1185	300	0%
June	1310	0	1310	300	0%
July	1530	0	1530	300	0%
August	1530	0	1530	300	0%
September	1120	0	1120	300	0%

Notes
[1] Uses streamflow data following the 2016 Settlement Agreement. 2. Certificate No. 59776.

E.10.2 Upper Deschutes River at Benham Falls

This 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.

Table E-9. Upper Deschutes River Daily Average Streamflow at Benham Falls prior to the 2016 Settlement Agreement.

Month	Low Streamflow (cfs) - 80% Exceedance	Lower Bar	Average Streamflow (cfs) - 50% Exceedance	Upper Bar	High Streamflow (cfs) - 20% Exceedance
October	511	369	880	440	1320
November	466	62	528	287	814
December	486	92	578	328	906
January	493	127	620	323	943
February	518	106	624	536	1160
March	553	212	765	466	1230
April	878	382	1260	290	1550
May	1570	260	1830	150	1980
June	1660	230	1890	200	2090
July	1850	140	1990	120	2110
August	1798	112	1910	120	2030
September	1428	252	1680	170	1850

Note: Streamflow in the Deschutes River at Benham Falls at Oregon Water Resources Department Gauge No. 14064500 vary within and between years. Data represent the 1985 through 2015 water years.

Table E-10. Upper Deschutes River Daily Average Streamflow at Benham Falls following to the 2016 Settlement Agreement.

Month	Low Streamflow (cfs) - 80% Exceedance	Lower Bar	Average Streamflow (cfs) - 50% Exceedance	Upper Bar	High Streamflow (cfs) - 20% Exceedance
October	614	38	653	418	1070
November	595	31	626	68	693
December	571	69	640	66	706
January	572	91	663	83	746
February	665	57	722	28	749
March	705	57	762	195	956
April	1130	345	1475	55	1530
May	1640	70	1710	288	1998
June	1688	137	1825	75	1900
July	1950	45	1995	105	2100
August	1890	35	1925	95	2020
September	1320	230	1550	206	1756

Note: Streamflow in the Deschutes River at Benham Falls at Oregon Water Resources Department Gauge No. 14064500 vary within and between years. Data represent the October 2016 through September 2018 water years.

Table E-11. Upper Deschutes River Post-Project Streamflow at Benham Falls.

Month	Pre-Project Average Daily Average Streamflow (cfs)[1]	Streamflow Restored Through Project (cfs)[2]	Post-Project Average Daily Average Streamflow (cfs)[1,2]	ODFW Instream Water Right[3] in the Deschutes River from the mouth of the Little Deschutes River to the confluence of Spring River	ODFW Instream Water Right[4] in the Deschutes River from the mouth of Spring River to the North Canal Dam at Bend	Post-Project Percentage Increase in Average Streamflow
October	653	0.00	653	400	660	0%
November	626	26.53	652	400	660	4%
December	640	26.53	667	400	660	4%
January	663	26.53	690	400	660	4%
February	722	26.53	748	400	660	4%
March	762	26.53	788	400	660	3%
April	1475	0.00	1475	400	660	0%
May	1710	0.00	1710	400	660	0%
June	1825	0.00	1825	400	660	0%
July	1995	0.00	1995	400	660	0%
August	1925	0.00	1925	400	660	0%
September	1680	0.00	1680	400	660	0%

Notes:
[1] Uses streamflow data following the 2016 Settlement Agreement.
[2] To account for channel losses, a 12.5 percent loss factor is used between Wickiup Reservoir and Benham Falls.

E.10.3 Middle Deschutes River at Bend, Below North Canal Dam

This subsection presents supporting calculations used when evaluating effects of the Proposed Action with respect to water resources in the Middle Deschutes River at Bend, below North Canal Dam.

Table E-12. Middle Deschutes River Daily Average Streamflow at Bend – Below North Canal Dam prior to the 2016 Settlement Agreement.

Month	Low Streamflow (cfs) - 80% Exceedance	Lower Bar	Average Streamflow (cfs) - 50% Exceedance	Upper Bar	High Streamflow (cfs) - 20% Exceedance
October	66	221	287	237	523
November	332	119	451	190	641
December	397	105	503	282	784
January	386	132	518	268	785
February	398	126	524	446	970
March	446	195	641	470	1110
April	48	128	176	475	651
May	36	50	86	76	162
June	34	51	85	61	146
July	32	47	79	57	136
August	32	46	78	58	136
September	34	52	86	56	142

Note: Streamflow in the Deschutes River downstream from the City of Bend at Oregon Water Resources Department Gauge No. 14070500 from the 1985 through 2015 water years.

Table E-13. Middle Deschutes River Daily Average Streamflow at Bend – Below North Canal Dam following the 2016 Settlement Agreement.

Month	Low Streamflow (cfs) - 80% Exceedance	Lower Bar	Average Streamflow (cfs) - 50% Exceedance	Upper Bar	High Streamflow (cfs) - 20% Exceedance
October	82	447	528	45	573
November	515	49	564	44	607
December	500	81	581	71	652
January	487	12	499	179	677
February	509	117	626	42	667
March	607	61	668	184	851
April	163	328	491	234	725
May	95	20	116	15	131
June	122	9	131	4	135
July	128	5	133	3	136
August	122	9	131	3	134
September	91	42	133	18	151

Note: Streamflow in the Deschutes River downstream from the City of Bend at Oregon Water Resources Department Gauge No. 14070500 from the October 2016 through September 2018 water years.

Table E-14. Middle Deschutes River Post-Project Streamflow at Bend - Below North Canal Dam.

Month	Pre-Project Average Daily Average Streamflow (cfs) [1]	Streamflow Restored Through Project (cfs)[2]	Post-Project Average Daily Average Streamflow (cfs)[1,2]	Pending ODFW Instream Water Right[3] in the Middle Deschutes River downstream from North Canal Dam	Post-Project Percentage Increase in Average Streamflow
October	528	0.00	528	250	0%
November	564	24.67	588	250	4%
December	581	24.67	606	250	4%
January	499	24.67	523	250	5%
February	626	24.67	650	250	4%
March	668	24.67	692	250	4%
April	491	0.00	491	250	0%
May	116	0.00	116	250	0%
June	131	0.00	131	250	0%
July	133	0.00	133	250	0%
August	131	0.00	131	250	0%
September	86	0.00	86	250	0%

Notes
1/ Uses streamflow data following the 2016 Settlement Agreement.
2/ To account for channel losses, a 12.5 percent loss factor between Wickiup Reservoir and Benham Falls and an additional 7 percent loss factor between Benham Falls Gauging Station and the City of Bend are used.

E.10.4 Crooked River Below Osborne Canyon

This subsection presents supporting calculations used when evaluating effects of the Proposed Action with respect to water resources in the Crooked River below Osborne Canyon.

Table E-15. Crooked River Pre-Project Daily Average Streamflow Below Osborne Canyon.

Month	Low Streamflow (cfs) - 80% Exceedance	Lower Bar	Average Streamflow (cfs) - 50% Exceedance	Upper Bar	High Streamflow (cfs) - 20% Exceedance
October	208	31	239	55	294
November	186	17	203	33	236
December	173	19	192	44	236
January	180	40	220	220	440
February	191	42	233	291	524
March	200	68	268	804	1072
April	269	304	573	1079	1652
May	150	164	314	515	829
June	136	66	202	177	378
July	114	29	143	41	184
August	124	32	156	33	189
September	166	56	222	56	278

Note: Streamflow in Crooked River at Oregon Water Resources Department Gauge No. 14087380 from the 2003 through 2018 water years.

E.10.5 Crooked River Below Opal Springs

This subsection presents supporting calculations used when evaluating effects of the Proposed Action with respect to water resources in the Crooked River below Opal Springs.

Table E-16. Crooked River Pre-Project Daily Average Streamflow Below Opal Springs.

Month	Low Streamflow (cfs) - 80% Exceedance	Lower Bar	Average Streamflow (cfs) - 50% Exceedance	Upper Bar	High Streamflow (cfs) - 20% Exceedance
October	1330	40	1370	70	1440
November	1310	30	1340	30	1370
December	1300	30	1330	30	1360
January	1300	40	1340	250	1590
February	1310	50	1360	320	1680
March	1320	80	1400	840	2240
April	1400	325	1725	1105	2830
May	1260	220	1480	540	2020
June	1260	75	1335	195	1530
July	1240	20	1260	60	1320
August	1240	30	1270	50	1320
September	1280	70	1350	70	1420

Note: Streamflow in Crooked River at Oregon Water Resources Department Gauge No. 14087400 from the 2003 through 2018 water years.

E.11 Supporting Information for Water Resources

This section presents information regarding the Revised 1938 Inter-District Agreement.

E.11.1 Reservoir Storage Allocation Agreement

This section presents the 2019 Amendment to the Arnold Irrigation District, Central Oregon Irrigation District, and Lone Pine Irrigation District Reservoir Storage Allocation Agreement.

2019 AMENDMENT TO

AID-COID-LPID RESERVOIR STORAGE ALLOCATION AGREEMENT

THIS 2019 AMENDMENT TO AID-COID-LPID RESERVOIR STORAGE ALLOCATION AGREEMENT ("2019 Amendment to AID-COID-LPID RSAA") is made this 2nd day of December 2019, by and between the Arnold Irrigation District ("AID"), the Central Oregon Irrigation District ("COID"), and the Lone Pine Irrigation District ("LPID") (collectively "the Districts"), all of which are irrigation districts operating pursuant to the provisions of Oregon Revised Statutes Chapter 545.

RECITALS

A. In 2017, the Districts entered into a Reservoir Storage Allocation Agreement ("RSAA"), attached hereto and incorporated herein, as Exhibit A.

B. At the time of the RSAA, the Districts anticipated the issuance of an interim biological opinion and incidental take statement from the U.S. Fish and Wildlife Service ("USFWS") that would result in coverage under the Endangered Species Act ("ESA") through July 31, 2019, at which time, the Districts anticipated a Habitat Conservation Plan ("HCP") would be completed and approved by USFWS, resulting in the issuance of long-term incidental take permits. While an interim biological opinion and incidental take statement were issued and are currently in effect through July 31, 2019, it is anticipated that it will take additional time beyond July 31, 2019 to complete and receive approval for the proposed HCP, and for the Districts to receive long-term incidental take permits. USFWS recently received approval from the U.S. Department of Interior for additional time to complete an environmental impact statement pursuant to the National Environmental Policy Act ("NEPA") as part of its evaluation of the proposed HCP. The Districts understand that the U.S. Bureau of Reclamation is currently consulting with USFWS, which will result in a supplemental biological opinion that extends the current incidental take statement through December 31, 2020, which will allow additional time for the NEPA evaluation to be completed, the HCP to be fully considered, and if approved, long-term incidental take permits to be issued.

C. With certain modifications as set forth below in this 2019 Amendment to AID-COID-LPID RSAA, the Districts wish to continue to operate under the RSAA for the period between the effective date of this 2019 Amendment to AID-COID-LPID RSAA and the eventual date the HCP is approved and long-term incidental take permits are issued. As such, the Districts hereby affirm their desire to work together to manage the currently available supply of water to mitigate the impacts of the ESA.

Therefore, AID, COID, and LPID now seek to amend the RSAA as follows:

1. The introductory statement following the term "AGREEMENT" is deleted in its entirety and replaced with the following:

"In recognition of the mutual benefits to be derived from this Agreement, the Districts agree as follows for the 2019 and 2020 irrigation seasons:"

Page 1 2019 AMENDMENT TO AID-COID-LPID RSAA (6/9/2019 version)

2. Sections 2 through 6 of the RSAA are deleted in their entirety and replaced with the following:

"2. The provisions of this Agreement shall terminate on the earlier of December 31, 2020 or the date the HCP is approved and incidental take permits are issued by USFWS, unless extended by the written mutual agreement of the Districts."

"3. NUID will make available up to 12,000 acre-feet of its Wickiup storage at the commencement of the irrigation season for use by AID and LPID. The specific amount of Wickiup stored water to be made available to AID and LPID will be determined by the amount of stored water in Crane Prairie that is available to "pay back" NUID later in the season, and this amount will be the difference between the highest elevation reached at the end of the fill season and the lowest elevation to which the reservoir can be drawn down consistent with the interim Biological Opinion and interim incidental take authorization issued by the USFWS. In terms of accounting, each acre foot of water released by NUID from Wickiup storage for use by AID and/or LPID will be "paid back" to NUID by AID and/or LPID from Crane Prairie in the same season.

"4. Of the available water described in Section 3 above, LPID would receive the first 5,000 acre feet out of Wickiup. AID will receive the available water up to 5,000 acre feet after LPID receives its 5,000 acre feet. If there is water available in excess of 10,000 acre feet, and up to 12,000 acre feet, it would be divided equally between LPID and AID.

"5. AID may annually make up to 1,000 AF of its unused stored water available to Tumalo Irrigation District ("TID") in exchange for TID storage in Crescent Lake.

"6 Of the available stored water that is credited to any district pursuant to Sections 3, 4 and 5 above, the other districts (including AID, COID, LPID, and NUID) may request from the credited district the use of any available unused storage water in the current irrigation season without charge, approval of which shall not be unreasonably withheld."

3. All other provisions of the RSAA remain in full force and effect.

THIS 2019 AMENDMENT TO AID-COID-LPID RESERV0IR STORAGE ALLOCATION AGREEMENT is effective as of the date set forth above.

Arnold Irrigation District ("AID")

By: [signature] Date: 12-10-19
Its Board President

By: [signature] Date: 12/10/19
Its Board Secretary

Central Oregon Irrigation District ("COID")

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By: [signature] Date: 12-2-19
Its Board President

By: [signature] Date: 12.2.19
Its Board Secretary

Lone Pine Irrigation District ("LPID")

By: Jerry C. Smith Date: 12-11-19
Its Board President

By: [signature] Date: 12-11-19
Its Board Secretary

The following entity acknowledges and agrees to Paragraph 2 above:

North Unit Irrigation District ("NUID")

By: Morton Richards Date: 12-2-19
Its Board President

By: [signature] Date: 12/2/19
Its Board Secretary

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E.11.2 Agreement for Provision of Irrigation Water

This section presents the Agreement for Provision of Irrigation Water between Central Oregon Irrigation District and North Unit Irrigation District.

AGREEMENT FOR PROVISION OF IRRIGATION WATER

THIS AGREEMENT is made this _____ day of _______ 2017, by and between the Central Oregon Irrigation District ("COID"), and the North Unit Irrigation District ("NUID"), and collectively ("the Districts"), both of which are irrigation districts operating pursuant to the provisions of Oregon Revised Statutes Chapter 545.

RECITALS

A. In 2015, the U.S. Fish and Wildlife Service ("USFWS") listed the Oregon spotted frog as a threatened species under the provisions of the Endangered Species Act.

B. The Districts hold water rights for the storage of water in reservoirs located near the headwaters of the Deschutes River in the State of Oregon, including Crane Prairie Reservoir and Wickiup Reservoir. The Districts' ability to store and deliver water for irrigation from said reservoirs has been severely restricted as a result of recent litigation by environmental groups against the Districts and the U.S. Bureau of Reclamation ("USBR") involving the Endangered Species Act and the Oregon spotted frog. This litigation resulted in a settlement agreement, which requires water previously stored and delivered by the Districts to be dedicated to Oregon spotted frog purposes. In addition, the settlement agreement requires that USBR consult with USFWS, which is anticipated to result in a biological opinion and incidental take statement by July 31, 2017. The settlement agreement also anticipates the completion of a Habitat Conservation Plan ("HCP") by July 31, 2019. The implementation of the settlement agreement, biological opinion, and HCP will severely limit the 50,000 acre-feet of water rights for storage and use of water from Crane Prairie Reservoir and the 200,000 acre-feet of water rights for storage and use of water from Wickiup Reservoir.

C. A significant portion of the stored water that is unavailable to the Districts for the reasons described above can be replaced with water conserved through piping of canals in COID and potentially by combining the diversions from the Deschutes River of NUID and COID into a single piped conveyance structure. In addition to conserving substantial amounts of water, piping of COID's canals and other conveyance structures will result in COID's ability to deliver water under pressure to its members, relieving individual members of the need to use on-farm pumps, and allow COID to generate hydroelectric power.

D. The Districts desire to work together to manage the currently available supply of water to mitigate the impacts of the Endangered Species Act, and to conserve water to replace the stored water made unavailable as a result of the Endangered Species Act.

Therefore, COID and NUID agree as follows:

AGREEMENT

1. COMMUNICATION AND COOPERATION.

1.1 The Districts agree to implement the Short Term Agreement made by and between them dated October 6, 2016, which provides for cooperation in the use of the available supply of water during the period from the date of the Short Term Agreement to July 31, 2017.

AGREEMENT FOR PROVISION OF IRRIGATION WATER - 1 (6/23/2017 version)

1.2 The Districts shall coordinate the release of water from storage and diversion of water for beneficial use. Each District shall provide notice to the other District not less than 24 hours prior to any effective change in releases from the reservoirs with the goals of maintaining minimum flows in the Deschutes River required for Oregon spotted frog habitat (as set forth in the settlement agreement described in Recital B above, and as may be required by the biological opinion and HCP referenced in Recital B above) and to deliver and divert all water available in the Deschutes River for irrigation at the Districts' respective diversion points.

1.3 The Districts shall work side by side in identifying and obtaining funding for conservation projects likely to produce conserved water for the use and benefit of the Districts.

1.4 The Districts agree that in the event that either District has a concern about the other District's use and management of irrigation water, it shall address the concerns directly to the other District and, thereafter, work with the other District to resolve the concern. Both Districts shall refrain from making disparaging public comments about the use and management of water in the Deschutes Basin by the other District and its water users.

2. WATER SUPPLY.

2.1 The terms of this section 2. Water Supply are intended to address some of the water deficiencies resulting from inability to store water as described in the Recitals above for the period of time from the date of this Agreement until the HCP is approved by USFWS and the Districts' ability to store and deliver water as provided for in the HCP is known. The Districts anticipate that pursuant to requirements set forth in the HCP, Crane Prairie Reservoir could eventually be fully dedicated to Oregon spotted frog purposes, and if so, operation of Crane Prairie and Wickiup Reservoirs, the terms of the 1938 Agreement between the Districts for the operation of the reservoirs, and the terms of this section 2 will be adjusted. Therefore, the provisions of this section 2 shall terminate on the earlier of July 31, 2019 or the time the HCP is approved by USFWS, unless extended by the written mutual agreement of the Districts.

2.2 COID shall provide or facilitate a temporary water transfer program for the partial or full idling of land and the transfer of irrigation water from land in COID made available through land idling or conservation practices from COID water users to NUID. The amount of water that may be made available through the program shall not exceed the amount of water appurtenant to 2,000 acres of land in COID and may be furthered limited by COID as reasonably necessary to retain sufficient irrigated land on each of COID's canals and laterals to provide the necessary rate of flow to serve the remaining irrigated land on those canals or laterals. The Districts shall seek to identify the least costly process for making the temporary transfers. NUID will pay the actual cost of the transfer, plus an amount equal to the COID's annual operating and maintenance charges applicable to the land from which the water is transferred.

2.3 As the water level in Wickiup Reservoir drops each year, COID shall release from Crane Prairie Reservoir and store in Wickiup Reservoir not less than 5,000 acre-feet and not more than 12,000 acre-feet of water for use by COID, Arnold Irrigation District ("AID"), and Lone Pine Irrigation District ("LPID") during that year. COID, AID, and LPID may use not more than 5,000 acre-feet of water from Wickiup Reservoir each year before July 1. COID, AID, and LPID may use the water released from Crane Prairie Reservoir and stored in Wickiup

Reservoir in excess of 5,000 acre feet after July 1, but limited to the quantity of water that has been stored in Wickiup Reservoir that year for their use. NUID agrees to direct the Watermaster to release said stored water from Wickiup Reservoir at such times and in such quantities as COID may request. Any portion of such water stored in Wickiup Reservoir in a given year not released from Wickiup Reservoir for COID, AID, and LPID's use prior to October 31 in that same year shall become stored water available for NUID's use, whether for winter instream flow requirements at the WICO gage or for NUID irrigation demand in the following year.

2.4 The Districts may undertake to make available for COID's use water released from storage during the early shoulder season, which is defined to mean the period of the irrigation season between April 1 and May 1, to supplement COID's diversion rights from the Deschutes River during that time period. In exchange, COID, subject to the requirements of Oregon water law and the rights of other water users, will make available to NUID water from the Deschutes River that is in excess of COID's demand during the months of July and August. There will be no payment by one District to the other for water made available pursuant to this subparagraph, as the Districts' intent is to fully utilize the water available from the Deschutes River for diversion and use by the Districts' members to the greatest extent possible.

2.5 If hydrologic conditions, such as a dry year, substantially impact the water available for storage and use, the Districts agree to meet and adjust the terms of this section 2.

3. CONSERVATION PROJECTS AND USE OF CONSERVED WATER.

3.1 COID has made preliminary studies of opportunities within its delivery system for conservation projects, such as piping of canals and other portions of the delivery system. An Executive Summary of the Preliminary System Improvement Plan was published September 19, 2016.

3.2 The Districts agree to work together to identify and obtain third-party funding for said conservation projects. COID shall retain sole authority for determining the order of priority of construction of said conservation projects and shall be solely liable for the cost of the projects that is not paid by third parties.

3.3 Many of the conservation projects provide the opportunity for the generation of hydroelectric energy. COID may incorporate hydropower components in any of said projects, and shall be solely responsible for negotiating power sales agreements, licenses, leases, or other types of agreements for the construction, operation, and maintenance of those hydropower projects, and COID shall be entitled to receive and retain all revenue generated by those projects.

3.4 To the extent that improvements made in the COID delivery system result in conservation of water that is then available for use by COID, COID agrees that NUID shall have the first option to receive 90 percent of the net conserved water. The term "net conserved water" means the amount of water actually conserved and made available based on engineering studies conducted after the project is completed (which includes completed phases of larger projects, when conserved water from such phases is available and susceptible to transfer and use by NUID), reduced by the amount of water that must be transferred instream pursuant to Oregon law. COID may retain the remaining 10 percent of the net conserved water for use by COID members, other districts, or for other purposes. NUID shall pay to COID annually an amount equal to the same rate per acre charged by COID to its members, as determined by it pursuant to ORS 545.484. Said annual charges shall be due and payable to COID on the same dates as applicable to its members. The number of acres that NUID shall pay said charges for shall be equal to the amount of water in acre-feet provided by COID to NUID, divided by 4.0. NUID shall also pay one "account fee" annually to COID. It is the Districts' intent that the provision of said water by COID to NUID shall continue for so long as NUID is able to make beneficial use of the water for irrigation of land in NUID. COID will install measuring devices at each point where water is delivered from COID's conveyance system into NUID's conveyance system and shall provide daily flow rates from each such measuring device to NUID. Water shall be provided at a rate of 1/40th cubic foot per second for each acre of land in NUID irrigated with the water provided by COID. The Districts shall cooperate and work with each other to comply with any applicable regulations for the delivery of this water to NUID.

3.5 The Districts shall cooperate and work with each other to cause the conserved water transferred instream to be credited toward obligations imposed on the Districts to provide water instream for endangered species, and as mitigation credits for the City of Bend and other municipalities or entities that require mitigation credits. If it is beneficial to the Districts, the conserved water may also be used for instream flow in the Crooked River. NUID shall be solely responsible for the cost of compliance with regulations and permitting necessary to accomplish the provisions of this paragraph.

4. OTHER JOINT PROJECTS.

4.1 The Districts agree to work with other districts that divert water from the Deschutes River to establish a central water management office or entity with the goal of minimizing loss of water and maximizing utilization of the available water supply.

4.2 The Districts agree to work together to investigate the opportunity to obtain ownership of the North Canal Diversion Dam and to develop an operations and maintenance plan for the dam should one or more of the Districts obtain ownership of the dam.

4.3 The Districts agree that they shall cooperate in investigation of the potential to combine their facilities that divert water from the Deschutes River into a single diversion and piped conveyance structure.

5. GENERAL PROVISIONS.

5.1. Binding Effect. This Agreement is binding on and inures to the benefit of the Districts and their respective heirs, personal representatives, successors, and assigns.

5.2 Assignment. Neither this Agreement nor any of the rights, interests, or obligations under this Agreement may be assigned by any party without the prior written consent of the other District, which consent will not be unreasonably withheld.

5.3 No Third-Party Beneficiaries. Nothing in this Agreement, express or implied, is intended or may be construed to confer on any person, other than the parties to this Agreement, any right, remedy, or claim under or with respect to this Agreement.

5.4 Notices. All notices and other communications under this Agreement must be in writing and will be deemed to have been given if delivered personally, sent by facsimile (with confirmation), mailed by certified mail, or delivered by an overnight delivery service (with confirmation) to the Districts at the following addresses or facsimile numbers (or at such other address or facsimile number as a District may designate by like notice to the other District):

To: North Unit Irrigation District
Attention: Mike Britton, Manager
2024 NW Beach Street
Madras OR 97741
Facsimile No.: 541.475.3905

To: Central Oregon Irrigation District
Attention: Craig Horrell, Manager
1055 SW Lake Court
Redmond OR 97756
Facsimile No.: 541.548.0243

Any notice or other communication will be deemed to be given (a) on the date of personal delivery, (b) at the expiration of the fifth day after the date of deposit in the United States mail, or (c) on the date of confirmed delivery by facsimile or overnight delivery service.

5.5 Amendments. This Agreement may be amended only by an instrument in writing executed by all the parties, which writing must refer to this Agreement.

5.6 Construction. The captions used in this Agreement are provided for convenience only and will not affect the meaning or interpretation of any provision of this Agreement. All references in this Agreement to "Section" or "Sections" without additional identification refer to the Section or Sections of this Agreement. All words used in this Agreement will be construed to be of such gender or number as the circumstances require. Whenever the words "include" or "including" are used in this Agreement, they will be deemed to be followed by the words "without limitation."

5.7 Counterparts. This Agreement may be executed in counterparts, each of which will be considered an original and all of which together will constitute one and the same agreement.

5.8 Facsimile Signatures. Facsimile transmission of any signed original document, and retransmission of any signed facsimile transmission, will be the same as delivery of an original. At the request of any District, the Districts will confirm facsimile transmitted signatures by signing an original document.

5.9 Further Assurances. Each party agrees to execute and deliver such other documents and to do and perform such other acts and things as any other party may reasonably request to carry out the intent and accomplish the purposes of this Agreement.

5.10 Time of Essence. Time is of the essence with respect to all dates and time periods set forth or referred to in this Agreement.

5.11 Expenses. Except as otherwise expressly provided in this Agreement, each party to this Agreement will bear its own expenses in connection with the preparation, execution, and performance of this Agreement and the transactions contemplated by this Agreement.

5.12 Waiver. Any provision or condition of this Agreement may be waived at any time, in writing, by the party entitled to the benefit of such provision or condition. Waiver of any breach of any provision will not be a waiver of any succeeding breach of the provision or a waiver of the provision itself or any other provision.

5.13 Governing Law. This Agreement will be governed by and construed in accordance with the laws of the state of Oregon, without regard to conflict-of-laws principles.

5.14 Attorney Fees. If any arbitration, suit, or action is instituted to interpret or enforce the provisions of this Agreement, to rescind this Agreement, or otherwise with respect to the subject matter of this Agreement, the party prevailing on an issue will be entitled to recover with respect to such issue, in addition to costs, reasonable attorney fees incurred in the preparation, prosecution, or defense of such arbitration, suit, or action as determined by the arbitrator or trial court, and, if any appeal is taken from such decision, reasonable attorney fees as determined on appeal.

5.15 Injunctive and Other Equitable Relief. The Districts agree that the remedy at law for any breach or threatened breach by a party may, by its nature, be inadequate, and that in addition to damages, the other District will be entitled to a restraining order, temporary and permanent injunctive relief, specific performance, and other appropriate equitable relief, without showing or proving that any monetary damage has been sustained.

5.16 Venue. Any action or proceeding seeking to enforce any provision of this Agreement or based on any right arising out of this Agreement must be brought against any of the Districts in Deschutes County Circuit Court or Jefferson County Circuit Court of the State of Oregon or, subject to applicable jurisdictional requirements, in the United States District Court for the District of Oregon, and each of the Districts consents to the jurisdiction of such courts (and of the appropriate appellate courts) in any such action or proceeding and waives any objection to such venue.

5.17 Severability. If any provision of this Agreement is deemed to be invalid or unenforceable in any respect for any reason, the validity and enforceability of such provision in any other respect and of the remaining provisions of this Agreement will not be impaired in any way.

5.18 Entire Agreement. This Agreement (including the documents and instruments referred to in this Agreement) constitutes the entire agreement and understanding of the Districts with respect to the subject matter of this Agreement and supersedes all prior understandings and agreements, whether written or oral, between the Districts with respect to such subject matter.

THIS AGREEMENT is effective as of the date set forth above.

Central Oregon Irrigation District ("COID")

By: ______________________________ Date: ______________
Its Board President

By: ______________________________ Date: ______________
Its Board Secretary

North Unit Irrigation District ("NUID")

By: ______________________________ Date: ______________
Its Board President

By: ______________________________ Date: ______________
Its Board Secretary

AGREEMENT FOR PROVISION OF IRRIGATION WATER - 7 (6/23/2017 version)

E.12 Supporting Information for Fish and Aquatic Resources

This section presents the Primary Constituent Elements for Oregon spotted frog and bull trout critical habitat.

Table E-17. 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-18. 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 nonnnative 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.

Table E-19. Fish Species within Areas Potentially Affected by the Central Oregon Irrigation District – Infrastructure Modernization Project.

Fish Species	Scientific Name	Presence in Deschutes[1] and Crooked Rivers[2]		Origin
		Deschutes	Crooked	
Black crappie	*Pomoxis nigromaculatus*	No	Yes	introduced
Bluegill	*Lepomis macrochirus*	No	Yes	introduced
Bridgelip sucker	*Catastomus columbianus*	Yes	Yes	indigenous
Brook trout	*Salvelinus fontinalis*	Yes	No	introduced
Brown bullhead catfish	*Ictalurus nebulosus*	Yes	Yes	introduced
Brown trout	*Salmo trutta*	Yes	No	introduced
Bull trout	*Salvelinus confluentus*	Yes	Yes	indigenous
Chinook salmon	*Oncorhynchus tshawyscha*	Yes	Yes	indigenous
Chiselmouth	*Acrocheilus alutaceus*	Yes	Yes	indigenous
Dace species	*Rhinichthys spp.*	Yes	Yes	indigenous
Largemouth bass	*Micropterus salmoides*	No	Yes	introduced
Largescale sucker	*Catastomus macrocheilus*	Yes	Yes	indigenous
Mountain whitefish	*Prosopium williamsoni*	Yes	Yes	indigenous
Northern pike minnow	*Ptychocheilus oregonensis*	Yes	Yes	indigenous
Rainbow trout	*Oncorhynchus mykiss*	Yes	Yes	introduced
Redband trout	*Oncorhynchus mykiss*	Yes	Yes	indigenous
Sculpin species	*Cottus spp.*	Yes	Yes	indigenous
Smallmouth bass	*Micropterus dolomieu*	No	Yes	introduced
Sockeye salmon/kokanee	*Oncorhynchus nerka*	Yes	No	indigenous
Summer steelhead	*Oncorhynchus mykiss*	Yes	Yes	indigenous
Three-spined stickleback	*Gasterosteus aculeatus*	Yes	Yes	introduced
Tui chub	*Gila (Siphateles) bicolor*	Yes	No	introduced

Notes:
[1] Deschutes River from: Wickiup Reservoir (RM 226.8) to North Canal Dam (RM 164.8), North Canal Dam (RM 164.8) to Lake Billy Chinook (RM 120)
[2] Crooked River (RM 27.7) to mouth
Source: Adapted from: Starcevich 2016

References

Starcevich, S. 2016. Technical Report Oregon Department of Fish and Wildlife. 2014 Deschutes River Fisheries Monitoring Report: Occupancy and Closed-Capture Modeling of Salmonids Using Boat Electrofishing in the Middle and Upper Deschutes River.

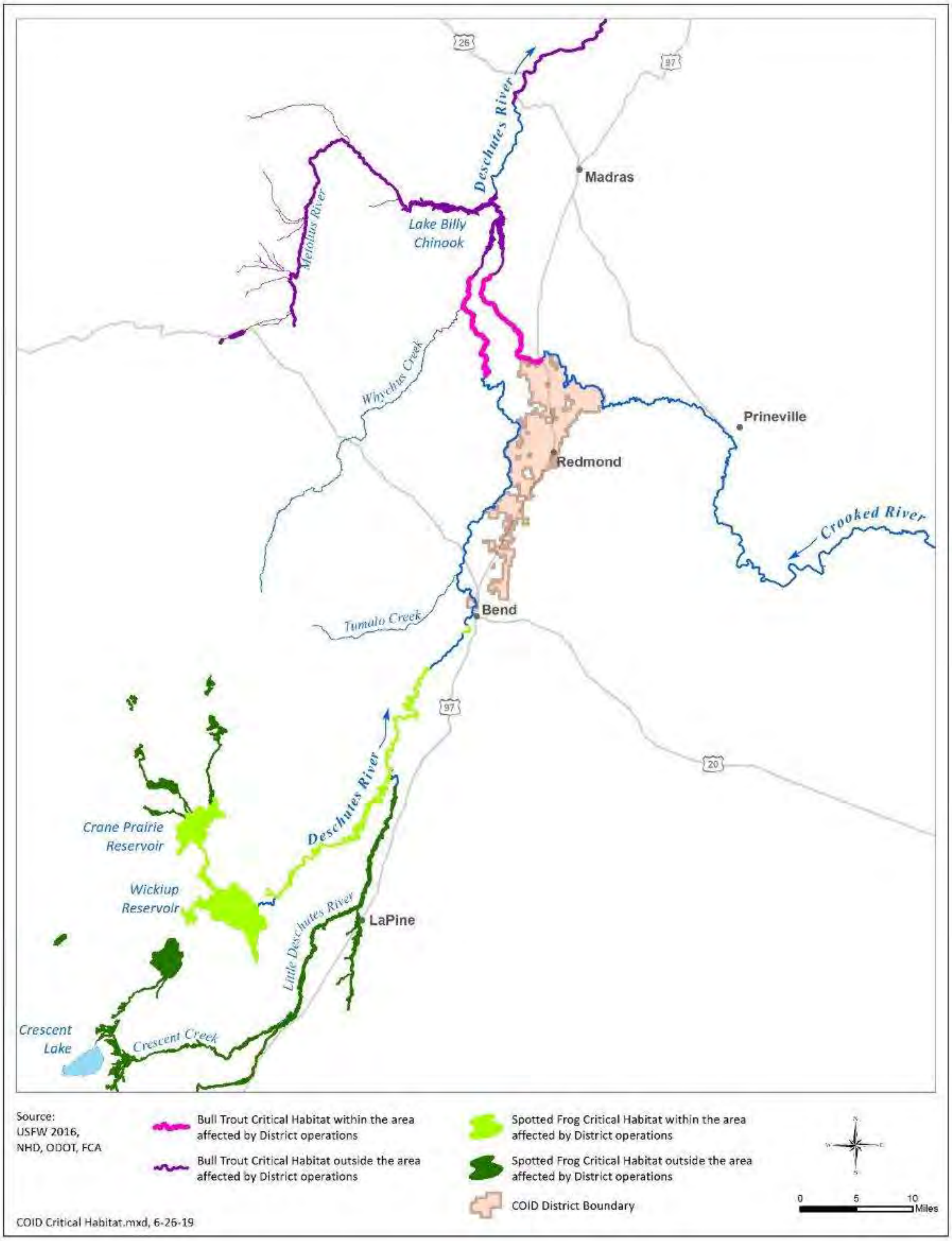


Figure E-1. Bull trout and Oregon spotted frog critical habitat within and outside the area affected by District operations.

Figure E-2. Steelhead non-essential experimental population within and outside of area affected by District operations.

E.13 Supporting Information for Wetlands and Riparian Areas

This section presents supporting information for the wetland and riparian areas section.

E.13.1 NRCS Letter regarding Jennifer Moffitt's Wetland Inventory Review

USDA

United States Department of Agriculture

Natural Resources Conservation Service
625 SE Salmon Ave, Suite 4
Redmond, OR 97756

Telephone: (541) 699-3181 http:www.or.nrcs.usda.gov Jennifer.Moffitt@usda.gov

Date: 10/25/2019

Subject: Wetland Inventory Review for COID Project – PBC-47 and PBC-49

To: Kevin Conroy, ASTC-FO Deschutes/High Desert

The National Wetlands Inventory (NWI) has identified two "Freshwater Emergent Wetlands" that would be crossed by a project being proposed by Central Oregon Irrigation District (COID). The District visited the two sites and documented their findings: one site was an irrigation pond the other was irrigated pasture.

I have conducted an informal off-site wetland inventory of the two areas and agree with COID that these are artificial wetlands.

The areas being reviewed are located on a large lava plateau that sits above the adjacent river systems – the Crooked and Deschutes Rivers. The plateau is the result of large basalt flows that has been overlain with volcanic ash from Mt. Mazama. The soils mapped for the area do not describe a water table within 60 inches of the soil surface, and none are classified as hydric. See attached soil report.

While imagery analysis of the area shows wetland signatures in the areas identified by the NWI, they are coincident with irrigation ditches and canals, and all wetland signatures for the area are consistent with field boundaries.

Please feel free to contact me if you need further information, or if a field visit is necessary to further document this inventory.

Sincerely,

JENNIFER MOFFITT Digitally signed by JENNIFER MOFFITT
Date: 2019.10.25 14:44:31 -07'00'

Jennifer Moffitt
USDA-NRCS Resource Soil Scientist

Enclosure: Web soil Survey Report for PBC-47 and PBC-49

cc: Lars Santana, District Conservationist

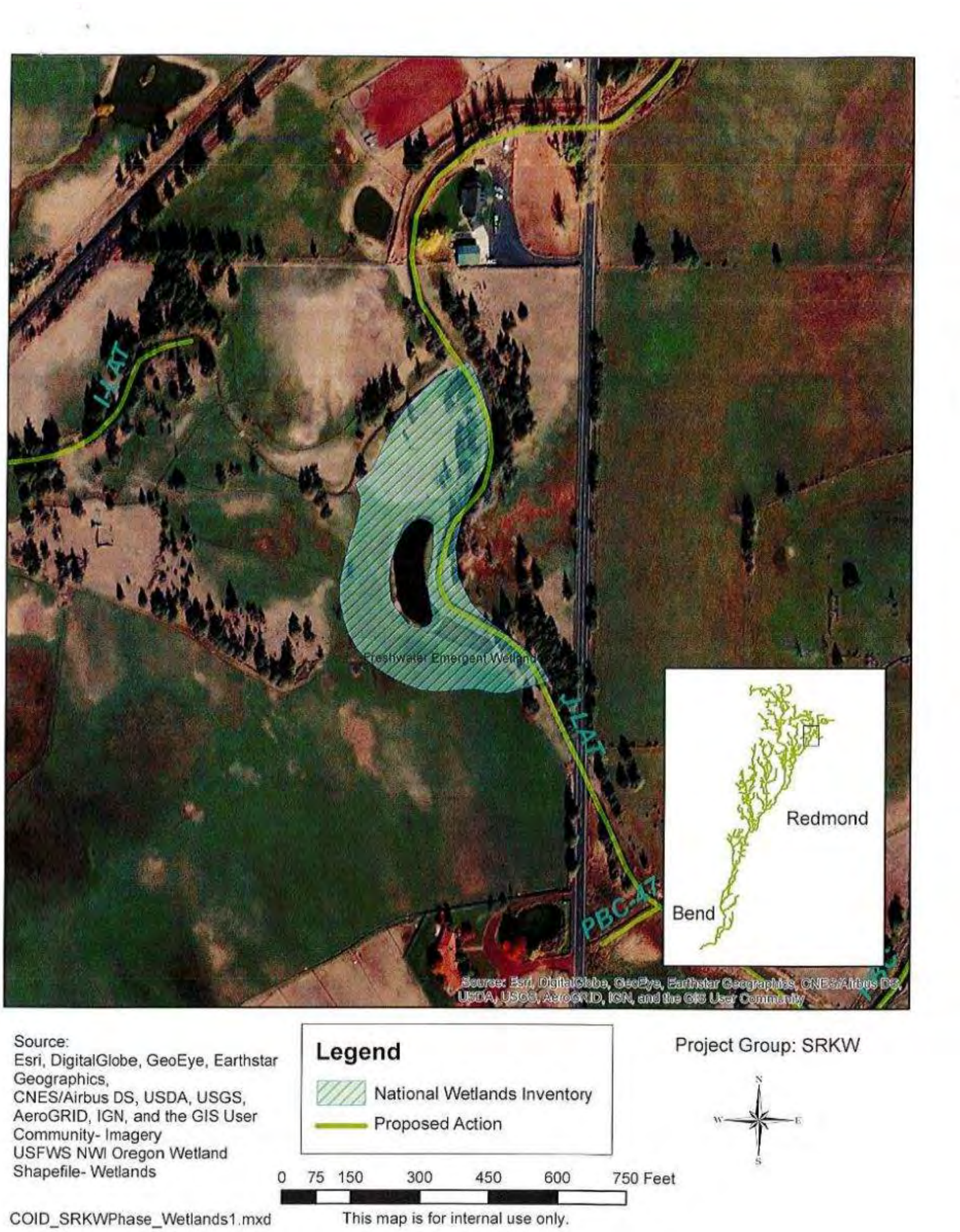
Natural Resources Conservation Service
An Equal Opportunity Provider, Employer, and Lender

E.13.2 Resources from COID's On-Site Wetlands Visit to Site PBC-49

PBC-49 Wetland Inventory

- Site visit 10/16/19. COID shut down canal 10/10/19. System is de-watered.
- Property is flood irrigated from private irrigation ditch system surrounding property.
- Irrigation water floods across land from surrounding private ditches and migrates to the lowest point that is completed covered by the wetland polygon. Also seepage from private irrigation ditch located between the irrigation east boundary and the PBC-49 lateral.
- Vegetation is pasture grass which is grazed. Cattle recently removed from property; hoof imprints and manure scattered across entire area.
- Oblong pond on southeast boundary of wetland polygon is used for livestock watering.

E.13.3 Resources from COID's On-Site Wetlands Visit to Site J Lateral



PBC 47 Wetland Inventory

- Site visit 10/16/19. COID shut down canal 10/10/19. System is de-watered.
- Pond is filled for livestock watering and not used for irrigation.
- Pond has a high berm around it.
- Property is flood-irrigated out of a private ditch system, not directly from the main lateral.
- North 1/3 of area is dry with sparse vegetation.
- Land bordering west side of pond is in a low trough (base of the berm). Irrigation water floods across surrounding land and migrates to the lowest point in the trough (lower 2/3 of wetland designation). Vegetation in the lower 2/3 is pasture grass and is consumed by livestock.

E.14 Supporting information for Wildlife Resources

This section presents supporting information for the wildlife resources section.

Table E-20. Wildlife Species Likely to Occur within the Project Area.

Wildlife Species	Scientific Name
Bats	*Vespertilionidae* spp.
Coyote	*Canis latrans*
Desert horned lizard	*Phrynosoma platyrhinos*
Golden mantled ground squirrels	*Spermophilus lateralis*
Mule deer	*Odocoileus hemionus*
Northern flicker	*Colaptes auratus*
Osprey	*Pandion haliaetus*
Pygmy rabbits	*Brachylagus idahoensis*

Wildlife Species	Scientific Name
Pygmy short-horned lizards	*Phrynosoma douglasii*
Raccoon	*Sciurus griseus*
Red-tailed hawks	*Buteo jamaicensis*
Rufous hummingbird	*Selasphorus rufus*
Turkey vulture	*Cathartes aura*
Western gray squirrels	*Procyon lotor*
Western rattlesnake	*Crotalus viridus*
Western skink	*Eumeces skiltonianus*
Yellow pine chipmunk	*Eutamias amoenus*

Notes:
[1] This is only a partial list of migratory birds that potentially occur within the project area.
Source: USFWS 2019

Table E-21. Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species Potentially Occurring within the Project Area.[1]

MBTA Species	Scientific Name
Brewer's sparrow	*Spizella breweri*
Calliope hummingbird	*Stellula calliope*
Cassin's finch	*Carpodacus cassinii*
Eared grebe	*Podiceps nigricollis*
Flammulated owl	*Otus flammeolus*
Fox sparrow	*Passerella iliaca*
Green-tailed towhee	*Pipilo chlorurus*
Lewis's woodpecker	*Melanerpes lewis*
Loggerhead shrike	*Lanius ludovicianus*
Long-billed curlew	*Numenius americanus*
Olive-sided flycatcher	*Cantopus cooperi*

MBTA Species	Scientific Name
Peregrine falcon	*Falco peregrinus*
Pinyon jay	*Gymnorhinus cyanocephalus*
Rufous hummingbird	*Selasphorus rufus*
Sage thrasher	*Oreoscoptes montanus*
Short-eared owl	*Asio flammeus*
Swainson's hawk	*Buteo swainsoni*
Western grebe	*Aechmophorus occidentalis*
White-headed woodpecker	*Picoides albolavatus*
Williamson's sapsucker	*Sphyrapicus thyroidus*
Willow flycatcher	*Empidonax traillii*

Notes:
[1] This is only a partial list of migratory birds that potentially occur within the project area.
Source: USFWS 2019

References

U.S. Fish and Wildlife Service (USFWS). 2019. IPaC ECOS (Environmental Conservation Online System). Retrieved from: https://ecos.fws.gov/ipac/. Accessed June 3, 2019.

E.15 Wild and Scenic Outstandingly Remarkable Values

This section presents supporting information associated with Outstandingly Remarkable Values identified for the upper and middle Deschutes River and the lower Crooked River.

Table E-22. Outstandingly Remarkable Values for the Upper Deschutes River.

Outstandingly Remarkable Value (ORV)	Outstandingly Remarkable Value Description
Vegetative	Aquatic, riparian, and upland vegetation is a significant element of all other river values. The vegetating resource is an Outstandingly Remarkable Value in Segments 3[1] and 4[2] because of *Artemesia ludoviciana* spp. *Estesii*, a Federal Category 2 Candidate[3] for protection under the Endangered Species Act.
Cultural	The upper Deschutes Corridor contains more than 100 known prehistoric sites which are eligible for inclusion in the National Register of Historic Places, making the prehistoric resources an Outstandingly Remarkable Value. Until further research on historic and traditional uses of the corridor is complete, they will also be treated as Outstandingly Remarkable Values.
Fisheries	The brown trout fishery in segments 2[4] and 3 is an Outstandingly Remarkable Value. The determination of value of the native redband rainbow trout population in segment 4 has been deferred until a genetic study has been completed. Until that time, the population is to be treated as an Outstandingly Remarkable Value.
Geologic	The upper Deschutes River consists of two major features: the lava flows which have pushed the river west of earlier channels and created the stair step of falls and rapids, and the landforms created by the interaction of depositional and erosive actions. The river channel shape, size, and rate of change are not an outstandingly remarkable value within themselves, primarily because the dynamics are so affected by human controlled flows.
Hydrology	The hydrologic resource is a significant element of several Outstandingly Remarkable Values associated with the upper Deschutes River. Most Outstandingly Remarkable Values in and along the river are protected and enhanced by an abundant, stable flow of clear, clean water.
Recreational	Recreation is an Outstandingly Remarkable Value on the upper Deschutes River because of the range of activities, the variety of interpretive opportunities, and the attraction of the river for vacationers from outside of the region.

Outstandingly Remarkable Value (ORV)	Outstandingly Remarkable Value Description
Scenic	The mix of geologic, hydrologic, vegetative, and wildlife resources found along portions of Segments 2 and 4 of the upper Deschutes makes scenery an Outstandingly Remarkable Value. Although the level and proximity of private development intrudes on the scenic quality of Segment 3, the scenic value is still a significant element of the recreational value.
Wildlife	Wildlife populations in Segments 2 and 4 were determined to be Outstandingly Remarkable Values because of the populations of nesting bald eagles and ospreys in Segment 2 and the diversity of the bird population in Segment 4. Despite extensive private development in Segment 3, the wildlife habitat was considered significant because it provides important nesting habitat for birds and travel corridors for migrating game animals such as deer and elk.

Notes:
[1] Segment 3 includes the south boundary of LaPine State Recreation Area to north boundary of Sunriver.
[2] Segment 4 includes the north boundary of Sunriver to the COID Canal.
[3] The upper Deschutes Wild and Scenic River and State Scenic Water Management Plan was written in 1996. Since the time of the management plan, this species has been reclassified as Species of Concern – Taxa for which additional information is needed to support a proposal to list under the ESA (ORBIC 2016).
[4] Segment 2 includes Wickiup Dam to east end of Pringle Falls Campground and the east end of Pringle Falls campground to south boundary of LaPine State Recreation Area.
Source: USDA 1996

Table E-23. Outstandingly Remarkable Values for the Middle Deschutes River and the Lower Crooked River.

Outstandingly Remarkable Value	Outstandingly Remarkable Value Description
Botany/ Ecology	The middle Deschutes River segments are in an ecological condition unusual for similar areas within the region and contain a significant portion of Estes' wormwood.
Cultural	Cultural resources on the middle Deschutes River include prehistoric and historic sites found along the corridor and traditional uses associated with the area. Evidence that rare and/or special activities took place in the river canyon areas is represented by lithic scatters or flaking stations, shell middens, rock shelters, rock features and rock art. These sites have the potential to contribute to the understanding and interpretation of the prehistory of the Deschutes River and the region and are considered to eligible for inclusion in the National Register of Historic Places.

Outstandingly Remarkable Value	Outstandingly Remarkable Value Description
Fisheries	Surveys have identified fishing as the number one recreation activity in the upper sections. Stories and pictures of huge catches are found in historical records of the early 1900's.
Geologic	Fifty million years of geologic history are dramatically displayed on the canyon walls of the middle Deschutes River and lower Crooked Rivers. Volcanic eruptions which occurred over thousands of years created a large basin dramatized by colorful layers of basalt, ash and sedimentary formations. The most significant contributor to the outstandingly remarkable geologic resources is the unique intra-canyon basalt formations created by recurring volcanic and hydrologic activities.
Hydrology	Water from springs and stability of flows through the steep basalt canyons has created a stream habitat and riparian zone that is extremely stable and diverse, unique in a dry semi-arid climate environment. Features, such as Odin, Big and Steelhead Falls; springs and seeps; white water rapids; water sculpted rock; and the river canyons, are very prominent and represent excellent examples of hydrologic activity within central Oregon.
Recreational	These river corridors offer a diversity of year-round, semi-primitive recreation opportunities, such as fishing, hiking, backpacking, camping, wildlife and nature observation, expert kayaking and rafting, picnicking, swimming, hunting and photography. Interpretive opportunities are exceptional and attract visitors from outside the geographical area.
Scenic	The exceptional scenic quality along the middle Deschutes River is due to the rugged natural character of the canyons, outstanding scenic vistas, limited visual intrusions and scenic diversity resulting from a variety of geologic formations, vegetation communities and dynamic river characteristics. These canyons truly represent the spectacular natural beauty created by various forces of nature.
Wildlife	The river corridor supports critical mule deer winter range habitat and nesting/hunting habitat for bald eagles, golden eagles, ospreys and other raptors. Bald eagles are known to winter along the Deschutes River downriver from Lower Bridge and also within the lower Crooked River segment. Outstanding habitat areas include high vertical cliffs, wide talus slopes, numerous caves, pristine riparian zones, and extensive grass/sage covered slopes and plateaus.

Source: www.rivers.gov/rivers/deschutes.php accessed September 10, 2018 and BLM 1992.

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