Appendix B

Project Maps

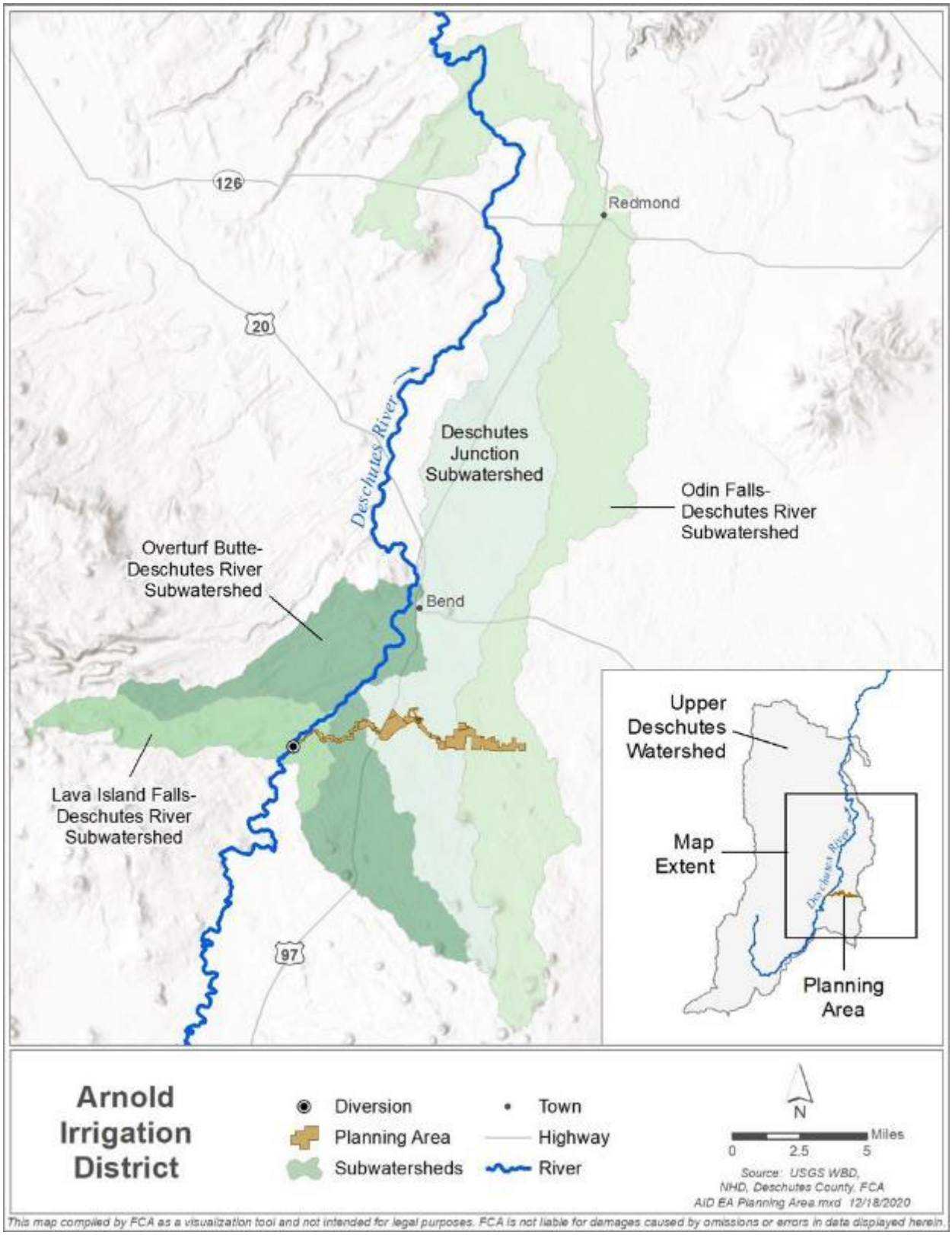


Figure B-1. The Arnold Irrigation District planning area.

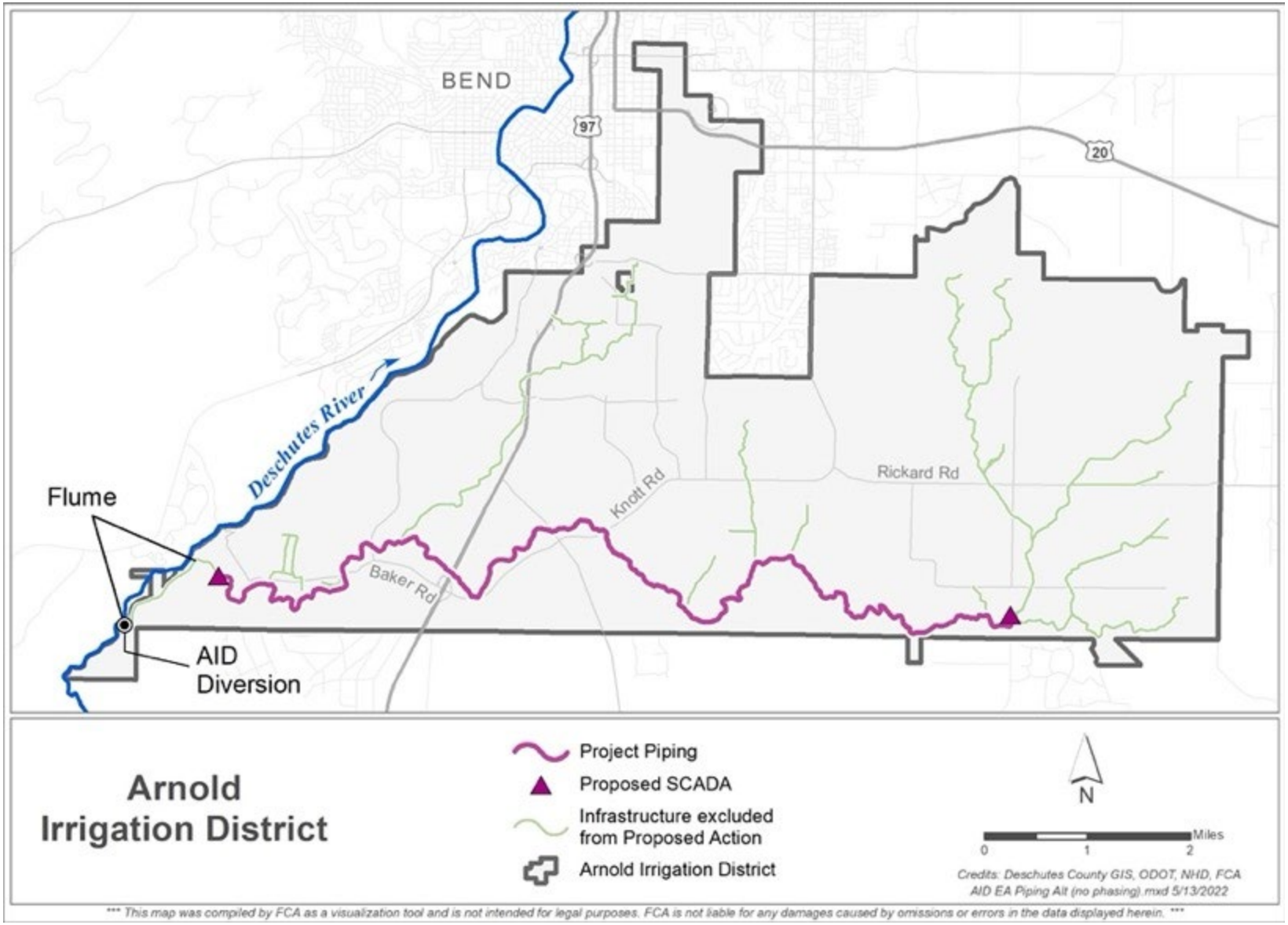


Figure B-2. Arnold Irrigation District Infrastructure Modernization Project area.

Appendix C

Supporting Maps

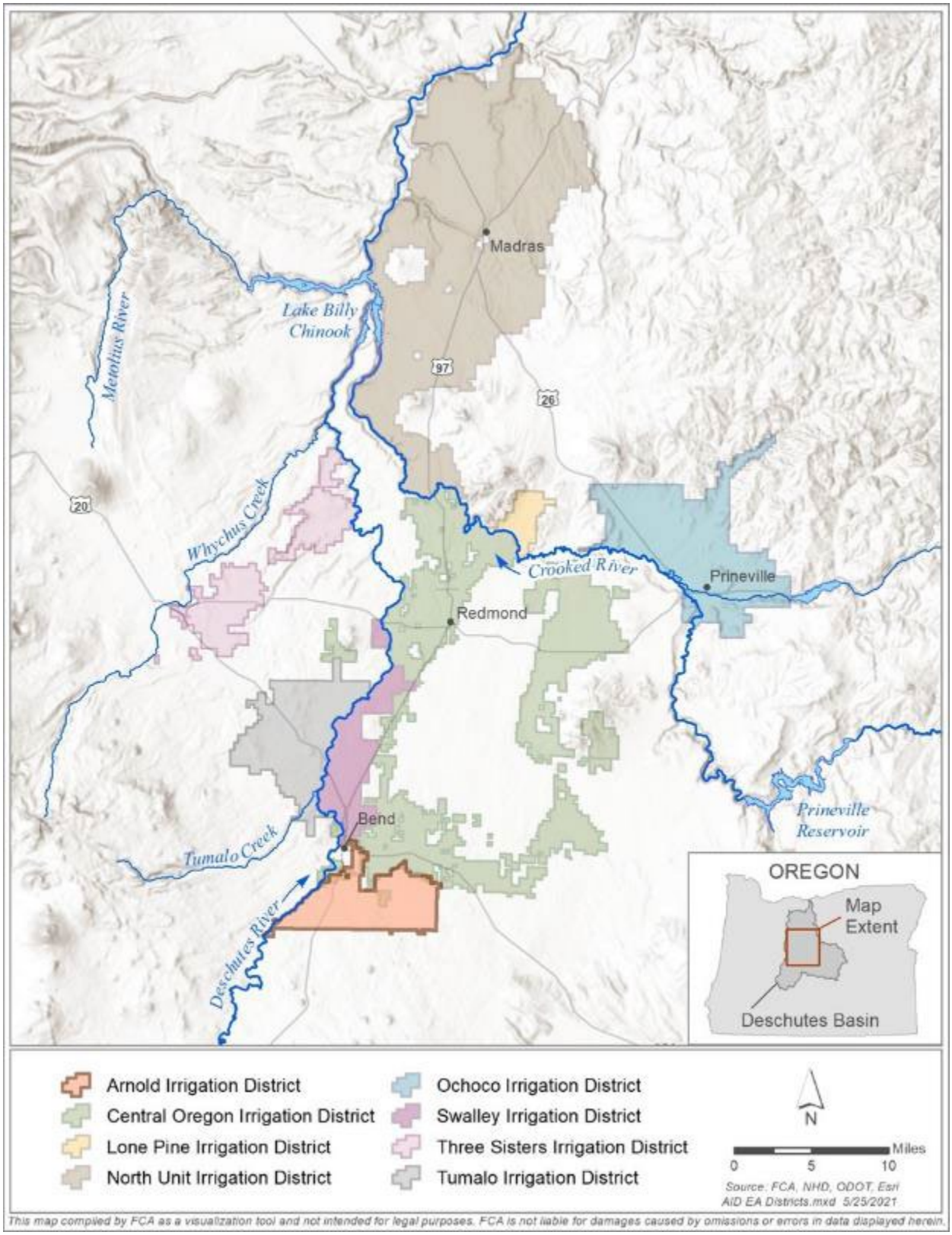
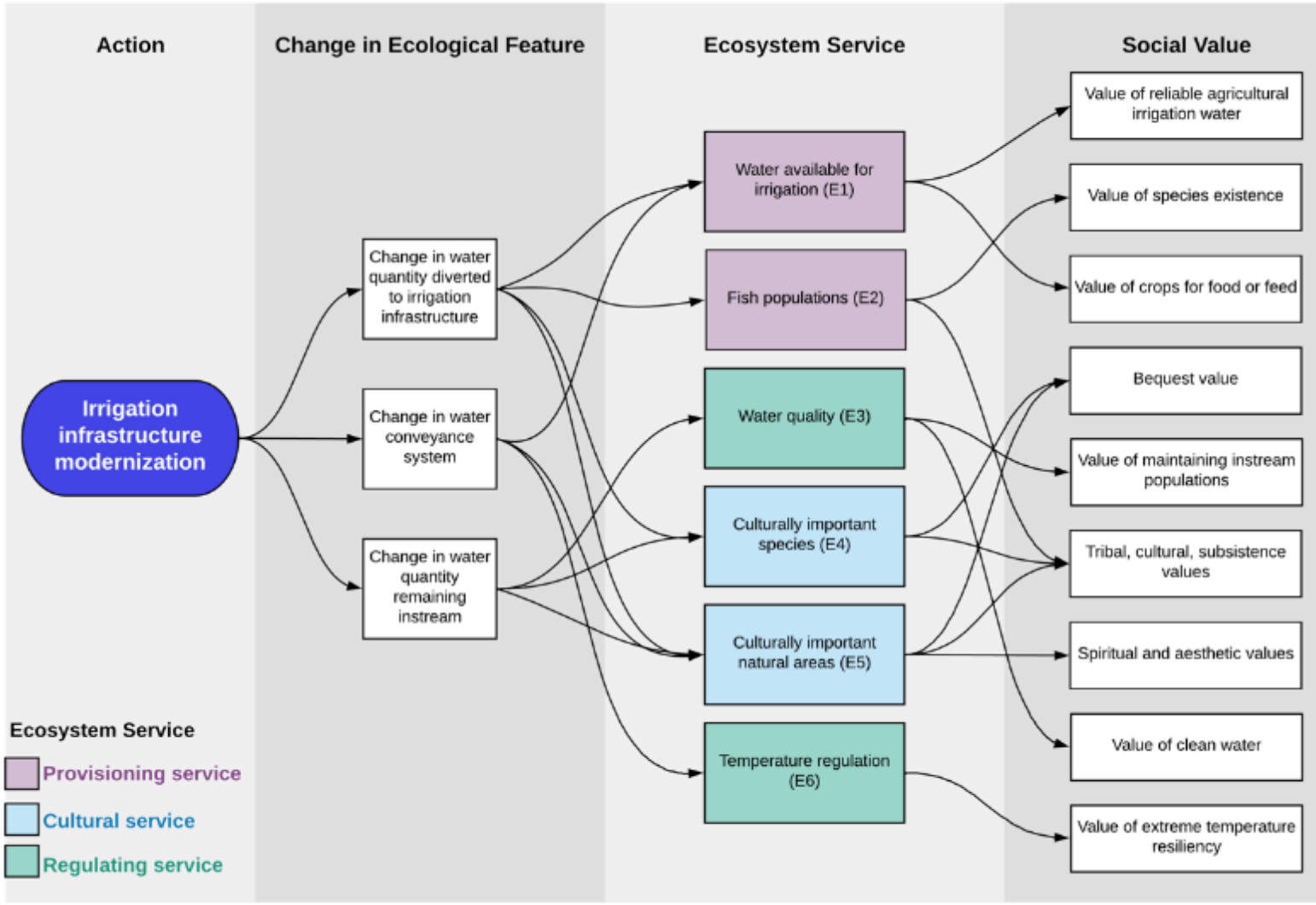


Figure C-1. Irrigation districts within the Deschutes Basin.



Note: 1) E1 through E6 refer to ecosystem services 1 through 6. These services are referenced and explained in more detail throughout Sections 4 and 6.
2) Ecosystem services concept diagram developed by Farmers Conservation Alliance

Figure C-2. Arnold Irrigation District Infrastructure Modernization Project ecosystem services concept diagram.

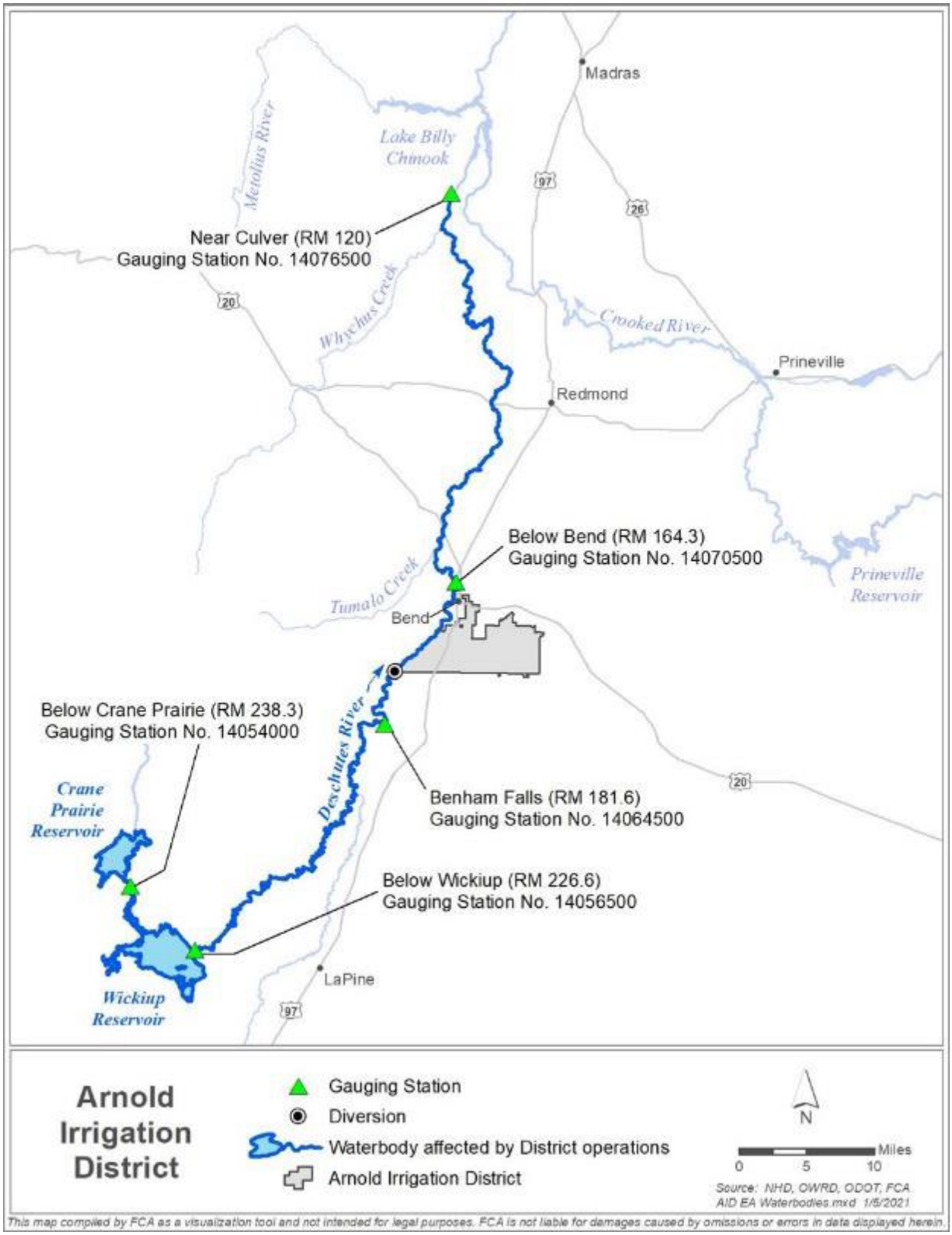


Figure C-3. Waterbodies and gauging stations associated with District operations.

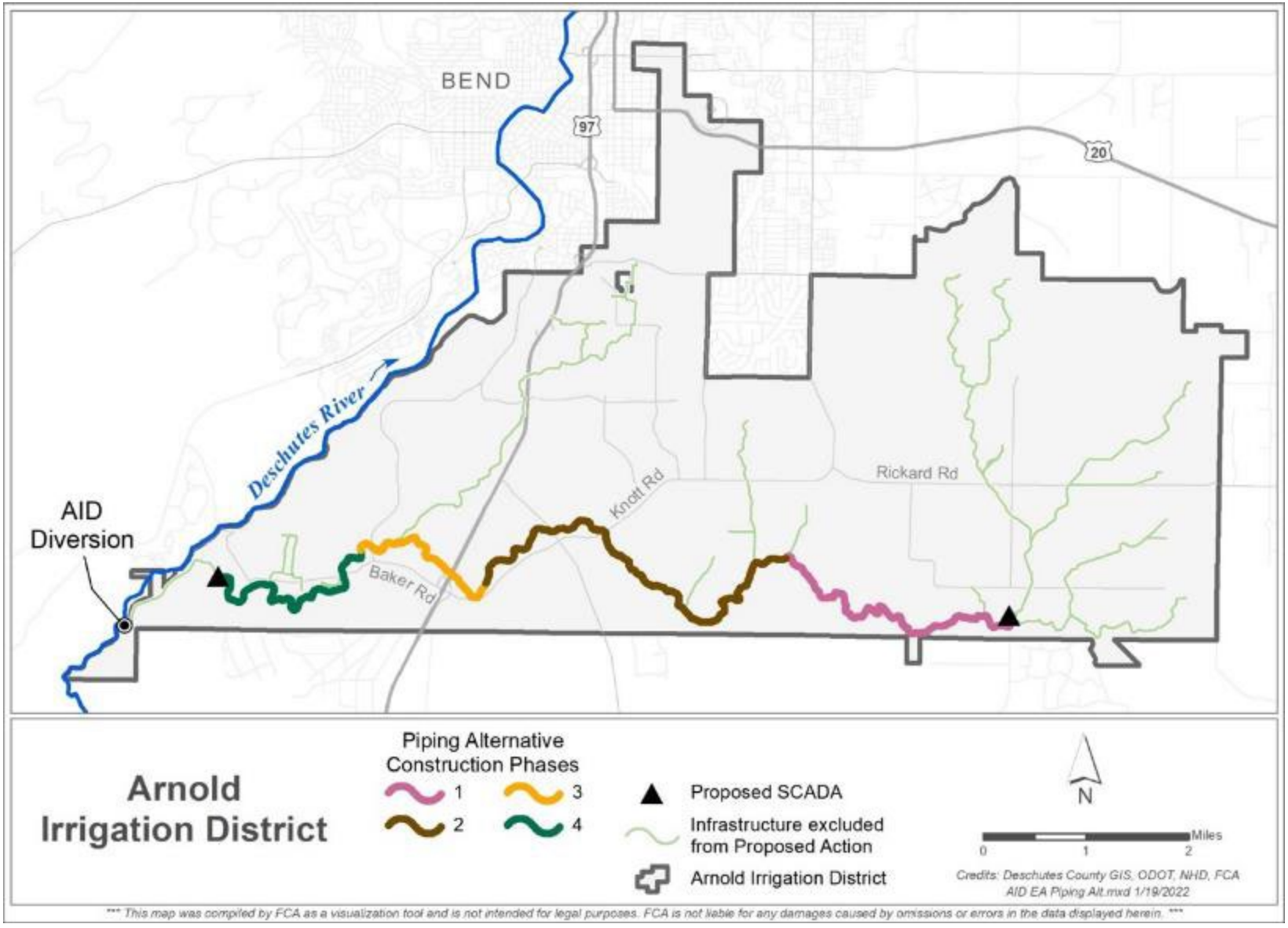


Figure C-4. Preferred Alternative construction phase map.

Figure C-5. Arnold Irrigation District Carey Act right-of-way map.

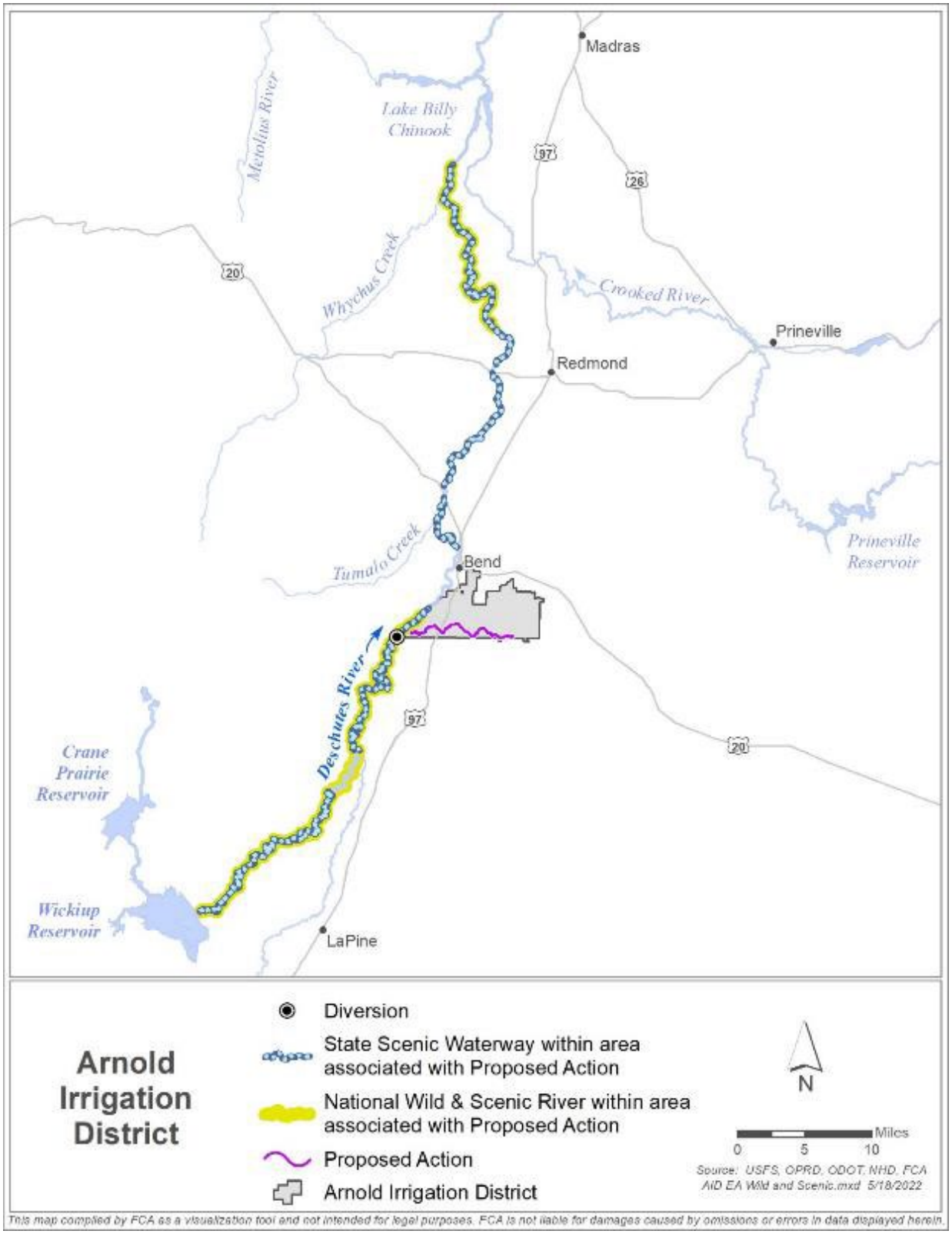


Figure C-6. State Scenic Waterway and National Wild and Scenic River within area associated with Proposed Action.

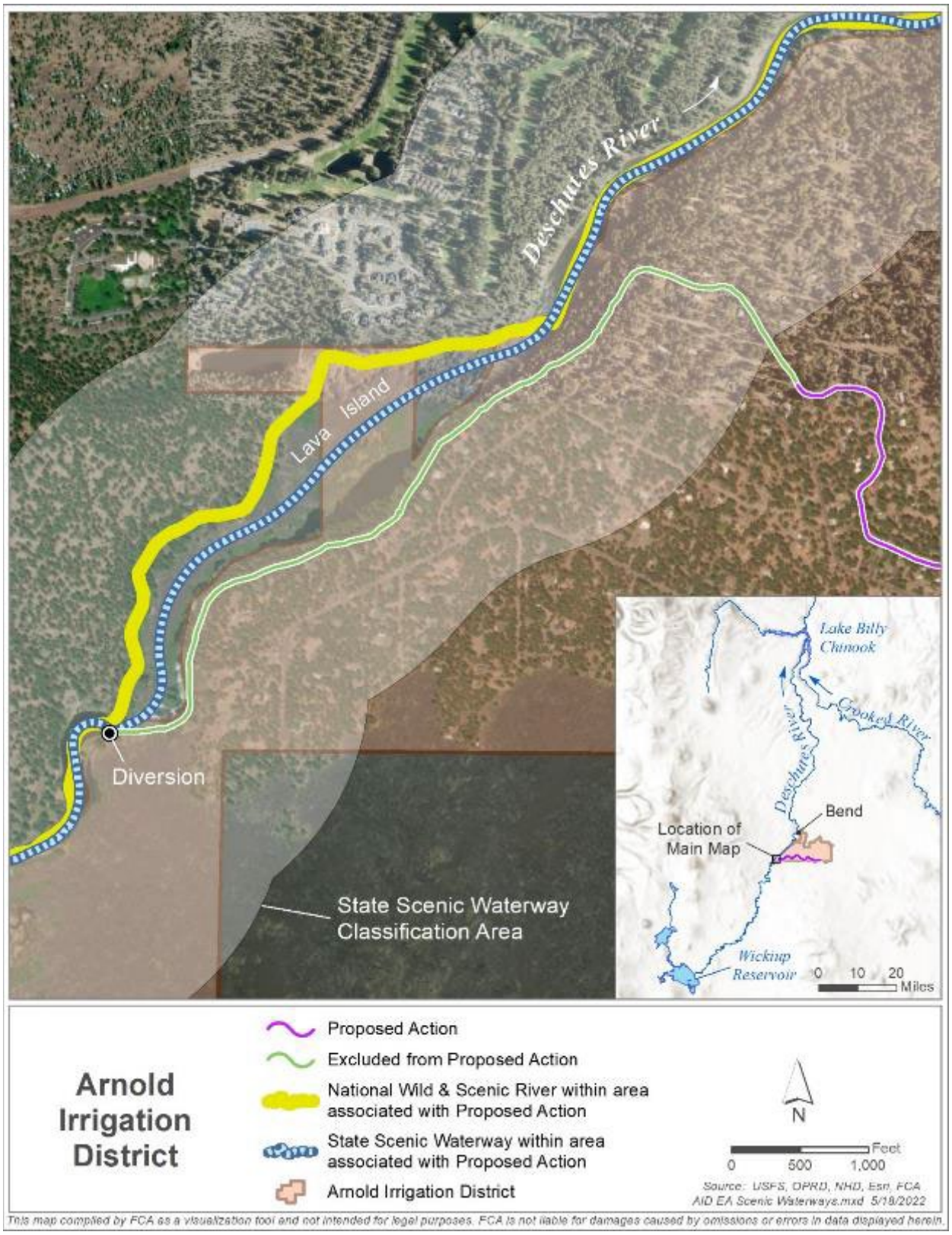


Figure C-7. State Scenic Waterway and National Wild and Scenic River within area associated with Proposed Action and near AID diversion.

Appendix D

Investigation and Analysis Report

D.1. National Economic Efficiency Analysis

Highland Economics LLC

National Economic Efficiency Analysis

Barbara Wyse and Winston Oakley
2/22/2022

Executive Summary

This National Economic Efficiency (NEE) analysis evaluates the costs and benefits of the Piping Alternative over the No Action Alternative for the Arnold Irrigation District (AID or District) Infrastructure Modernization Project. All economic benefits and costs are provided in 2021 dollars and have been expressed in average annual values using the fiscal year 2022 federal water resources planning rate of 2.25 percent.

The project would pipe 11.9 miles of AID's Main Canal to improve water conservation in AID-owned infrastructure, improve water supply management and delivery reliability to AID patrons, and improve public safety. In total, the project is anticipated to cost $34,899,000, which includes construction ($30.8 million), engineering ($296,000), technical assistance ($2.4 million), project administration ($476,000), and permitting ($932,000). Installation costs equate to an average annual cost of $838,000. Watershed Protection and Flood Prevention Act (PL 83-566) funds would cover $26,198,000 (or 75 percent of the total project cost), which includes $23,310,000 for construction costs, $2,412,000 for technical assistance, and $476,000 for project administration. The sponsors and other non-federal funds would contribute $8,701,000, or 25 percent of the total project cost.

Project construction would be completed over approximately 6 years. Other direct costs of the project (including groundwater pumping costs, carbon emissions, and additional AID replacement costs) carry an annual average cost of $14,000, resulting in the Piping Alternative's total average annual cost of $852,000. Additional potential costs not quantified in the analysis include those associated with changes in aesthetic values due to piping of the canal and the removal of some trees around the canal.

The Piping Alternative is anticipated to provide agricultural, ecological, operational, and safety benefits. By passing conserved water to North Unit Irrigation District to alleviate agricultural water shortages in that district, the proposed project is anticipated to generate $1.407 million in average annual agricultural damage-reduction benefits. Increasing instream flows would generate approximately $41,000 in annual average benefits, and support to the Oregon Spotted Frog would bring an estimated additional $37,000 in annual average benefits. The Piping Alternative would also provide savings to AID by reducing operations and maintenance costs ($211,000 in annual average benefits) and avoiding the costs of canal repairs ($3,000 in annual average benefits). In total, the Piping Alternative is projected to generate $1.7 million in annual average benefits. Additional benefits of the Piping Alternative that are not quantified in this analysis include other agricultural damage-reduction benefits in the District and improvements to public safety.

In sum, the Piping Alternative has an estimated $852,000 in annual average costs and would provide an estimated $1.7 million in annual average benefits; this would result in annualized net benefits of approximately $847,000.

D.1.1. Introduction

This NEE Analysis that evaluates the costs and benefits of the Piping Alternative over the No Action Alternative for the AID Infrastructure Modernization Project. The analysis uses Natural Resources Conservation Service (NRCS) guidelines for evaluating NEE benefits as outlined in the NRCS Natural Resources Economics Handbook and the U.S. Department of Agriculture's (USDA) Guidance for Conducting Analyses Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water Resource Investments (DM 9500-013).

All economic benefits and costs are provided in 2021 dollars and, in accordance with the NRCS Natural Resources Economics Handbook, are presented in average annual values using the fiscal year 2022 federal water resources planning rate of 2.25 percent.

D.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. All values in this analysis are presented in 2021 dollars and rounded to the nearest $1,000.

D.1.1.1.1. FUNDING

PL 83-566 funds would cover $26,198,000 (or 75 percent of the total project cost), which includes $23,310,000 construction costs, $2,412,000 technical assistance, and $476,000 project administration. The sponsors and other non-federal funds would contribute $8,701,000, or 25 percent of the total project cost.

D.1.1.1.2. EVALUATION UNIT

The proposed project is a single project group, which is the evaluation unit. The one project group consists of piping 11.9 miles of the AID-owned Main Canal, which serves the entire district and, therefore, represents a reasonable evaluation unit. For the purpose of an incremental analysis, the project group is divided into four phases of construction. 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.

D.1.1.1.3. PROJECT IMPLEMENTATION TIMELINE

If PL 83-566 funds are made available, AID staff indicate that construction would likely be completed over approximately 6 years (see Table 8-1 in the Plan-EA). The project would be completed in four phases based on the amount of construction that could be completed during the non-irrigation season. For each phase, the analysis assumes that full benefits would be realized the year after construction is completed (e.g., for Phase 1, which would complete construction in Year 1, full benefits would be realized in Year 2).

D.1.1.1.4. ANALYSIS PERIOD

The analysis period is defined as 106 years since the project would take 6 years to construct and 100 years is the expected project life of buried high-density polyethylene (HDPE) pipe. Because construction would start in Year 0, the analysis period extends from Year 0 to Year 105 (for a total of 106 full years). Construction and installation of Phase 1 is assumed to start in Year 0 and finish in Year 1, with a 100-year project life from Year 2 through Year 101, and Phase 2 would have a 100-year project life from Year 4 through Year 103, etc. Figure D-1 graphically summarizes the construction and benefit periods by phase, and how they relate to the 106-year period of analysis from Year 0 to Year 2015.

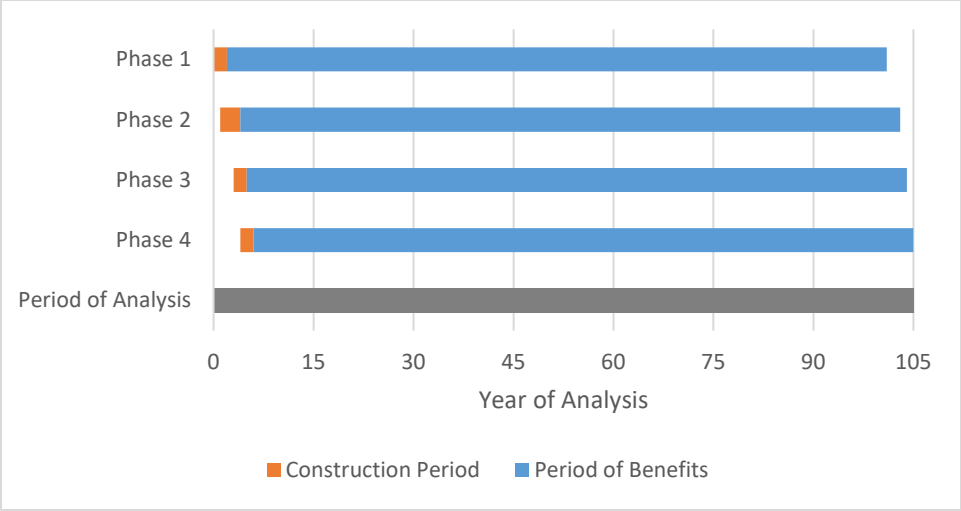


Figure D-1. Period of analysis, construction, and benefits by phase.

D.1.1.1.5. PROJECT PURPOSE

The purpose of the proposed project is to improve water conservation in District-owned infrastructure, improve water supply management and delivery reliability to District patrons, and improve public safety on up to 11.9 miles of the District-owned Main Canal.

D.1.2. Costs of the Piping Alternative

This section evaluates the costs of the Piping Alternative over the No Action Alternative. Under the No Action Alternative, the District would continue to operate and maintain the existing canal and lateral system in its current condition.

D.1.2.1. Proposed Project Costs

Table 8-2 (NWPM 506.11, Economic Table 1) and Table 8-3 (NWPM 506.12, Economic Table 2) in Section 8.9 of the Plan-EA summarize installation costs, distribution of costs, and total annual average costs for the Piping Alternative. Average annual costs include those associated with installation and other direct costs. Table 8-4 in the Plan-EA summarizes the annual average costs of the Piping Alternative over the No Action Alternative. These NEE annual average costs are estimated at $852,000 and include $838,000 in installation costs and $14,000 in other annual direct costs.

There are five primary types of other direct costs:

1. Increased pumping costs from potential increased depth to groundwater due to reduced recharge from canals
2. Increased social cost of carbon from increased carbon emissions
3. Increased replacement costs
4. Potential reduction in trees
5. Potential reduction in aesthetic values to area residents due to the removal of canals

Of these, only the aesthetic and tree costs are not quantified in this analysis due to a lack of available quantitative information. As AID expects cost savings, not cost increases, for infrastructure operations and maintenance (O&M) of the Piping Alternative, O&M costs are included as benefits in this analysis (Wills, 2020). Table D-2 and Table D-3 present the quantified other direct costs associated with piping (groundwater pumping and carbon costs, respectively). The subsections provide details on the derivation of the costs.

D.1.2.2. Project Installation Costs

The cost of piping and associated turnouts is projected to be approximately $31,545,700, which includes construction costs, planning/engineering/design, and construction management (Farmers Conservation Alliance, 2021). This also includes contingency costs (i.e., Class 3 costs), which are estimated at roughly 30 percent of construction costs. See Table D-22 for detailed cost derivation by pipe size, cost category, etc. Adding project administration, technical assistance, and permitting costs, the total cost for the Piping Alternative is estimated at $34,899,000. The average annual installation cost of the Piping Alternative is $838,000. Note that there are no expected installation costs associated with lands/easements/rights-of-way/etc.; fish and wildlife mitigation; or cultural mitigation. While operation, maintenance, and repair costs are expected to decrease relative to the No Action (and are considered a benefit of the project), there are replacement and rehabilitation costs of the Piping Alternative that exceed costs in the No Action Alternative. These replacement or rehabilitation costs are included as a type of other direct cost as discussed in Section D.1.2.3.3 below.

D.1.2.3. Other Direct Costs

D.1.2.3.1. 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 small groundwater declines and thereby increase pumping costs for all groundwater users in the basin. As such, it is possible that the Piping Alternative may result in a slight increase in pumping costs for groundwater users across the basin. The magnitude of this effect at the basin level is evaluated based on data from a 2013 study by the U.S. Geological Survey (USGS) that estimated the effects on groundwater recharge from changes in climate (reduced precipitation), groundwater pumping, and canal lining and piping. The study focused on the Deschutes River Basin and used data from the period 1997 through 2008 (Gannett & Lite, 2013). An important caveat to using the data and findings from this study is that the effects of piping AID canals may be different than previous canal lining and piping projects that have occurred throughout the basin.

The study indicated that during the 12-year period, 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 (approximately 0.5 to 1.4 feet) in groundwater level was due to canal lining and piping during the 12-year period (1997 through 2008). This reduction was modeled as the result of reducing the recharge from irrigation canal seepage by 58,000 acre-feet (AF) annually. This NEE Analysis uses these data to first estimate the approximate effect of reduced irrigation canal seepage on groundwater levels from the Piping Alternative, and 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. The analysis concludes that the effect on groundwater overall in the Deschutes Basin over the long term would be minor. However, localized effects could be greater with effects likely concentrated in shallow groundwater in areas immediately adjacent to the piped canal. As noted in the USGS study, the effects of canal lining and piping were modeled to be "most prominent at shallow depths closest to canals and attenuate with depth." Data are only available at the basin-wide level and are not specific to the District, with the 2013 USGS study noting that "there is a lack of monitoring in the southern part of the area with which to track water-level changes and verify simulation results;" the southern part of the study area is where the District is located. Due to the lack of data specific to the District, this analysis focused on the overall effect at the basin level using the available data.

The 2013 USGS study found that the cumulative effect of piping over the 12-year study period (1997 through 2008) resulted in an annual seepage reduction of 58,000 AF. If a uniform increase in canal lining/piping is assumed over this timeframe, in 1997 the decreased canal seepage was 4,833 AF annually, rising each year by another 4,833 AF annually until the reduced canal seepage in 2008 was 58,000 AF annually. Cumulatively

over the 12-year period, this represents a total of 377,000 AF of reduced recharge from canals.[1] 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 over the 12-year period. These data suggest that the average relationship between canal recharge and groundwater levels in this part of the basin is approximately 1 foot of groundwater elevation drop per 377,000 AF of reduced canal recharge, though as noted above, local effects may vary widely with likely greater effects on shallow groundwater levels in areas immediately adjacent to the canals. The Piping Alternative would reduce canal seepage and associated groundwater recharge by up to approximately 11,083 AF annually in this part of the Deschutes Basin once the proposed project is complete (see Appendix E.4.1 for detailed derivation of reduced canal seepage). On average, for this part of the central basin, this would translate into a decreased groundwater elevation of approximately 0.029 foot annually. (This is based on information presented above that a 1-foot groundwater elevation drop is expected to result from reduced recharge of 377,000 AF, so the corresponding drop from 11,083 AF is 0.029 foot since 11,083 AF divided by 377,000 AF is 0.029.) Due to the 6-year construction period (and subsequent phasing of groundwater impacts), over the course of approximately 106 years (the life of the project plus the construction period), this annual drop represents a cumulative decreased average groundwater elevation in the central basin of approximately 2.9 feet (see Table D-1). Such a drop in pumping elevation would have small effects on basin-wide pumping costs.

This analysis combines the decreased groundwater elevation for each year in the 106-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 AF per year of groundwater pumping for public supply and about 25,000 AF 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 AF from 2016 to 2035 and by a further 1,728 AF between 2036 and 2065 (Sussman, McMurtrey, & Grigsby, 2017).[2] The same study found that demand for public supply groundwater use would increase by approximately 10,590 AF from 2016 to 2035 and by a further 6,438 AF between 2036 and 2065.[3] These projections are adopted to model the amount of groundwater pumping in the Deschutes Basin in future years assuming that growth happens linearly during the time periods. It is further assumed that growth in pumping after 2065 would occur at the same rate as from 2036 to 2065. Given these assumptions, total groundwater pumping over 106 years may rise to 86,000 AF annually (with about 33,000 AF going to irrigation and roughly 55,000 AF dedicated to the public water supply). Due to limitations on groundwater pumping in the region, this estimate of total future pumping is anticipated to be on the high side, and associated estimated costs are likely higher than would be experienced in reality.

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1 In other words, adding 4,833 AF of seepage in 1997, to 9,666 AF of seepage in 1998, to 14,499 AF in 1999, and so forth to 58,000 AF of seepage in 2008 results in cumulative seepage over the 12-year period of 377,000 AF.

2 This estimate combines the use categories of irrigation, agriculture, and nurseries. The projected demand from 2036 to 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, we chose to update the analysis to incorporate the more recent estimates from GSI Water Solutions.

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

Table D-1. Approximate Depth to Groundwater in Central Deschutes Basin, Deschutes Watershed, Oregon.

Year	Volume Pumped (acre-feet per year)	Increased Potential Pumping Depth (in feet) Piping Alternative (NEE Alternative) vs. No Action
1	54,000	0
10	60,000	0.2
20	65,000	0.5
30	67,000	0.8
40	70,000	1.1
50	73,000	1.4
60	75,000	1.7
70	78,000	2.0
80	81,000	2.3
90	84,000	2.6
100	86,000	2.9

NEE = National Economic Efficiency Prepared February 2022

The increased depth to groundwater due to reduced recharge results in higher pumping costs in the Piping Alternative. 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 marginal cost for the City to pump groundwater is expected to be approximately $0.05409 per kilowatt-hour (kWh) under Schedule 28 (Pacific Power, 2022). Farmers who use electricity to irrigate fall under Central Electric Cooperative's Schedule C, which charges a rate of $0.0502 per kWh (Central Electric Cooperative, Inc., 2021); this analysis assumes this rate is the marginal cost to farmers for pumping groundwater. Applying the electricity prices, assuming a pump irrigation efficiency of 70 percent[4] and using the volume of pumping and pumping depths shown in Table D-1, the estimated total annual average cost across 106 years is $6,000 per year for the Piping Alternative (see Table D-2) after discounting and amortizing.

[4] This value was assumed in the Arnold Irrigation District On-Farm Water Conservation Report completed by Black Rock Consulting and Farmers Conservation Alliance in 2018.

Table D-2. Other Direct Costs of Reduced Recharge under Piping Alternative, Deschutes Watershed, Oregon, 2021$.[1]

Works of Improvement	Water Conservation (AF/Year)	Change in Groundwater Depth (ft/year)	Annual Average Cost from Reduced Groundwater Recharge
Piping Alternative	11,083	0.029	$6,000
Total	**11,083**	**0.029**	**$6,000**

Note: Totals may not sum due to rounding. Prepared February 2022
[1]/Price Base: 2021 dollars amortized over 100 years at a discount rate of 2.25 percent.

The costs estimated in Table D-2 likely overstate the costs of the Piping Alternative to groundwater pumping because AID would pass conserved water to NUID under the Piping Alternative. Some of the conserved water would be conveyed in unlined NUID canals between Bend and the Crooked River and would seep into the ground and recharge groundwater in the basin. An analysis of the NUID conveyance system suggested that around 36 percent of the water passed by AID that enters the NUID system would be lost to seepage and evaporation (Farmers Conservation Alliance, 2022). The increased seepage in NUID would likely partially offset the decreased seepage in AID and result in slightly less impact on groundwater pumping costs than estimated in Table D-2. Since only the potential costs of reduced AID seepage savings are accounted for in this analysis, the result is likely an overestimate of the basin-wide increase in groundwater pumping costs. Locally, seepage would increase in NUID (potentially decreasing local pumping costs) and decrease in AID (potentially increasing local pumping costs). However, the conclusion remains the same that even when likely overstated, the potential costs of reduced groundwater recharge are small compared to the benefits of the Piping Alternative.

Some residents with properties adjacent to the AID Main Canal have expressed concern that their groundwater wells will run dry if the canal is piped, and they claim that their wells rely on water seeped from the canal. While these localized groundwater effects are possible, prior experience from neighboring irrigation districts suggests this outcome is unlikely. Swalley Irrigation District (SID) and Tumalo Irrigation District (TID) have both conducted canal piping projects in recent years; the piping projects had the potential to impact nearby groundwater wells. However, SID has seen no reports of wells going dry after piping (Camarata, 2022). TID had a report of three wells going dry 1.5 years after piping, but given the small capacity of the adjacent sublateral (800 to 1,000 gallons per minute) and the depth of the wells (about 400 feet), it is unlikely that the wells were reliant on canal seepage (Schull, 2022). Other wells in TID that are still adjacent to open canals have gone dry; this suggests that there are other causes for wells to dry up. Other causes include sand collapses (which are common in the area) and the drawdown of aquifers that is unrelated to piping projects (Schull, 2022). These examples illustrate how the localized effects of groundwater reductions that could result from the Piping Alternative have a high level of uncertainty, and because of that uncertainty, localized effects are not quantified in this analysis.

D.1.2.3.2. CARBON COSTS

Changes in groundwater pumping and associated energy use due to potential groundwater decline would result in changes in carbon dioxide emissions from power generation. Every MWh of reduced energy use is an estimated reduction of 0.7525 metric tons (Mt) of carbon emissions, and the same amount of emissions

are assumed to be added for each MWh of increased energy use.[5] Consequently, the Piping Alternative could increase carbon emissions by increasing basin-wide pumping as a result of lower groundwater levels. Because groundwater levels may fall over time (see Section D.1.2.3.1), the emissions could increase from 0.6 Mt in Year 2 (when Project Group 1 would first impact groundwater levels) to 172 Mt in Year 101 (when the impact of all four project groups would reach its maximum during the study period). The emission increases of the modeled potential increases in pumping are expected to average roughly 86 Mt per year over the 106-year study period.

To value the potential decrease in carbon emissions, this analysis uses 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. 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 in 2013 developed a set of SCC estimates that could be used across federal agencies (Interagency Working Group on Social Cost of Greenhouse Gases, 2013). In February 2021, the IWG updated its estimates of the SCC. They estimated that in the year 2020, at a 3-percent discount rate, the SCC value was $52.46 per Mt (Interagency Working Group on Social Cost of Greenhouse Gases, 2021).[6] This value is applied to the net change in carbon emissions each year throughout the project life to estimate the change in carbon emissions from the Piping Alternative.

At an SCC value of $52.46 per Mt, 86 Mt of increased carbon emissions would have a value of roughly $5,000. When discounted and amortized, carbon emission increases that result from the Piping Alternative would have a cost of approximately $2,000. This is shown in Table D-3.

[5] 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 ton of carbon emitted from one 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.

[6] This value has been adjusted for inflation to 2021 dollars using the Consumer Price Index.

Table D-3. Annual Increased Average Carbon Costs of Piping Alternative, Deschutes Watershed, Oregon, 2021$. [1]

Works of Improvement	Average Annual Increased Emissions (from Reduced Recharge; Mt Carbon) [2]	Undiscounted Average Annual Net Change in the Value of Carbon Emissions	Average Annual NEE Costs (Social Cost of Carbon) [3]
Piping Alternative	86	$5,000	$2,000
Total	**86**	**$5,000**	**$2,000**

Note: Totals may not sum due to rounding. Prepared February 2022

1/ Price Base: 2021 dollars amortized over 100 years at a discount rate of 2.25 percent.

2/ Additional energy use elsewhere rises through time as the effects of reduced recharge accumulate and cause groundwater depths to drop over time. The average annual energy use increase elsewhere in the basin represents the average change in energy use across the 106 project years.

3/ The average annual NEE benefits may differ from the change in tons of carbon emitted multiplied by the $52.46 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).

D.1.2.3.3. ADDITIONAL REPLACEMENT COSTS

The Piping Alternative would result in additional replacement costs above the No Action Alternative since some installed components have useful lives that would expire before the 100-year project life. SCADA units have a useful life of roughly 20 years, and a pipe inlet that would be installed as part of Phase 4 would have a useful life of approximately 50 years. As a result, the SCADA unit in Phase 1 would require replacement in Years 21, 41, 61, 81, and 101; the SCADA unit in Phase 4 would require replacement in Years 25, 45, 65, 85, and 105; and the pipe inlet in Phase 4 would require replacement in Years 55 and 105. This analysis assumes the replacement costs are equal to the initial installation costs ($66,800 for the SCADA units in each phase and $75,600 for the pipe inlet). When discounted and amortized, replacing these components has a cost of approximately $6,000.

D.1.2.3.4. CHANGE IN AESTHETICS AND ASSOCIATED PROPERTY VALUES

Approximately 5.3 miles of the proposed project (44 percent of the total project length) passes through suburban neighborhoods just south of the Bend city limits. These two suburban neighborhoods are Deschutes River Woods and Woodside. The remainder of the proposed project passes through more rural areas. There are approximately 400 tax lots adjacent to the whole length of the proposed project. For some of these tax lots, the open Arnold Main Canal acts as a visual boundary with adjacent properties and provides aesthetic value to the property while water is in the canal during the irrigation season. Some residences have built structural and landscape features designed to view the canal, while others may have vegetation blocking the view. In 2019 during the project scoping meeting, around 125 residents in the project area voiced concern over losing the canal as a result of piping (Wills, 2020).

For these residents, the Arnold Main Canal is an aesthetic amenity with a positive economic value. According to real estate agents in the region, many people interested in purchasing property are willing to pay more for properties that have a view of a canal. Literature specifically looking at the effects of irrigation canals on property value was not found during a literature search. A meta-analysis of 25 studies that researched the impact of rivers, streams, and canals on property values showed that these water features increase property values in most cases (Nicholls & Crompton, 2017). None of the studies in the meta-analysis that looked at canals included irrigation canals. Three studies that were part of the meta-analysis focused on canals in the United States. However, these three studies were of boatable canals in urban settings in Texas and Florida.

These canals are very different from seasonal irrigation canals such as the Arnold Main Canal. The three studies found that nearby canals increase residential property values by 10 to 30 percent (Nicholls & Crompton, 2017).

To address the question of how the proposed project could impact property values of properties adjacent to the proposed project, in March 2022 NRCS conducted an analysis of properties close to the Arnold Main Canal and properties in nearby irrigation districts where an adjacent canal had been piped (USDA Natural Resources Conservation Service, 2022). The study found that the properties adjacent to an open canal had a sales value of 5 to 20 percent higher than properties not on an open canal (depending on the year and location of sale). The NRCS analysis also found that in other nearby irrigation districts where similar canal-to-pipe conversions have occurred, this additional property value remained after canal piping. This retention in value may be because the land over the canal was converted into greenspace that carries a similar value as the canal (see Appendix E.12 for additional information).

While a potential direct cost of the Piping Alternative is that some local residents may experience adverse effects on property values, there is no literature or available market data to confirm or quantify this effect. Additionally, there are three potential beneficial effects on property values that may partially or wholly offset the potential adverse effects identified above. First, the re-vegetated greenspace provided after project completion by the land covering the pipe may provide value (see above). Second, 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 and potentially limits the effect on property values. However, very few local residents have voiced such safety concerns to AID (Wills, 2020). Third, increased agricultural production value due to a more reliable water supply and delivery to AID patrons and NUID patrons may tend to increase property values (all else equal), which could offset the effect on property values. The potential change in property value due to increased water supply and delivery reliability is not quantified but is discussed in Section D.1.3.2.1. While the aesthetic value and the agricultural production value are not necessarily similar in magnitude, the population affected (patrons of AID and NUID) is largely the same (there may be some residents in the area who benefit from canal views who are not patrons of AID).

From a broader perspective, some residents may potentially experience adverse effects on quality of life due to the change in aesthetics from piping the canals. The potential aesthetic cost to residential landowners is not quantified due to a lack of available data of the number of properties with views of canals and the value of those views to each local resident. As such, while this effect is recognized as a likely cost, this analysis does not quantify the potential change in aesthetic values with the proposed project.

D.1.2.3.5. TREE LOSS

Under the Piping Alternative, project construction would likely require the removal of some trees in the AID right-of-way. The cost of removing these trees was included in the contingency costs of the Piping Alternative. Other trees located near the canal may rely on water seeping from the canal. Under the Piping Alternative this seepage would be eliminated, which could result in the death of canal-reliant trees.

Standing trees (as opposed to harvested timber) can provide a variety of economic benefits depending on their size and location. These benefits can include air quality, shade (or temperature regulation), wildlife habitat, climate regulation, and aesthetic value. Several studies have shown that trees can have a positive impact on property values (Lee, Taylor, & Hong, 2008; Sander, Polasky, & Haight, 2010; Donovan & Butry, 2010; Pandit, Polyakor, & Sadler, 2012). However, these studies only examined the impacts of urban trees, so their findings may not be applicable to trees in the rural/suburban environment of the project area. Still, if the trees adjacent to the AID canal do carry economic value, and the Piping Alternative resulted in the loss of some of the trees, it would negatively impact nearby residents who benefit from the trees.

This analysis does not quantify the potential cost of tree loss under the Piping Alternative for several reasons: (a) there is no available data on the number of existing trees that could be impacted by construction of the Piping Alternative, (b) there is no available data to indicate the reliance of trees on seepage from the AID Main Canal, and (c) there is a high degree of uncertainty regarding the local benefits of trees to residents near the canal.

D.1.3. Benefits of the Piping Alternative

Table 8-6 in the Plan-EA compares the project benefits (over the No Action Alternative) to the annual average project costs presented in Table 8-4 in the Plan-EA. The remainder of this section provides details on these project benefits. Table 8-5 in the Plan-EA presents on-site damage-reduction benefits that would accrue to agriculture and the local rural community, which include avoided damages from canal failures. It also presents off-site quantified benefits, which include the value of instream flow. Other benefits not included in the analysis, which may result indirectly from the Piping Alternative, include increased agricultural yields in District and the potential for increased on-farm investments in irrigation efficiency (as patrons have access to pressurized water and potentially more funds due to increased yields and reduced pumping costs).

D.1.3.1. Benefits Considered and Included in Analysis

D.1.3.1.1. AGRICULTURAL DAMAGE REDUCTION BENEFITS

Under the Piping Alternative, initially saved water would be used to augment instream flows. After year 2028 when instream flows under the Deschutes Basin Habitat Conservation Plan (HCP) are fully phased in, conserved water would be used to reduce agricultural water shortages that would otherwise be experienced. Most of the conserved water is expected to reduce agricultural water shortages in NUID. Specifically, of the estimated 11,083 AF saved annually under the Piping Alternative, NUID would benefit from roughly 98 percent (10,862 AF).[7] Because the NUID diversion point lies farther downriver than the AID diversion point, a small portion of the conserved water would seep into groundwater and result in NUID receiving slightly less water (10,446 AF) at its diversion point than the total amount of water conserved in AID (Farmers Conservation Alliance, 2022). An analysis of the NUID conveyance system indicated that it loses about 38 percent of its water from seepage, evaporation, and tailwater spills (Farmers Conservation Alliance, 2022). As a result, approximately 62 percent of the water that reaches the NUID diversion point would make it to NUID farms, or 6,426 AF per year. This amount of water is used to estimate the benefits to NUID agriculture of water conserved by piping in AID.

Figure D-2 shows that the average fallowed acreage in NUID increased from the 2009–2015 period to the 2016–2018 period.

[7] AID would pass live-flow water to NUID while retaining some stored water for its own use. An analysis of AID water use from 1981 to 2018 shows that in an average year, 2 percent of AID's water use is supplied by stored water (Farmers Conservation Alliance, 2022). Accordingly, this analysis assumes that AID would retain 2 percent of the water conserved under the Piping Alternative (222 AF) for its own use.

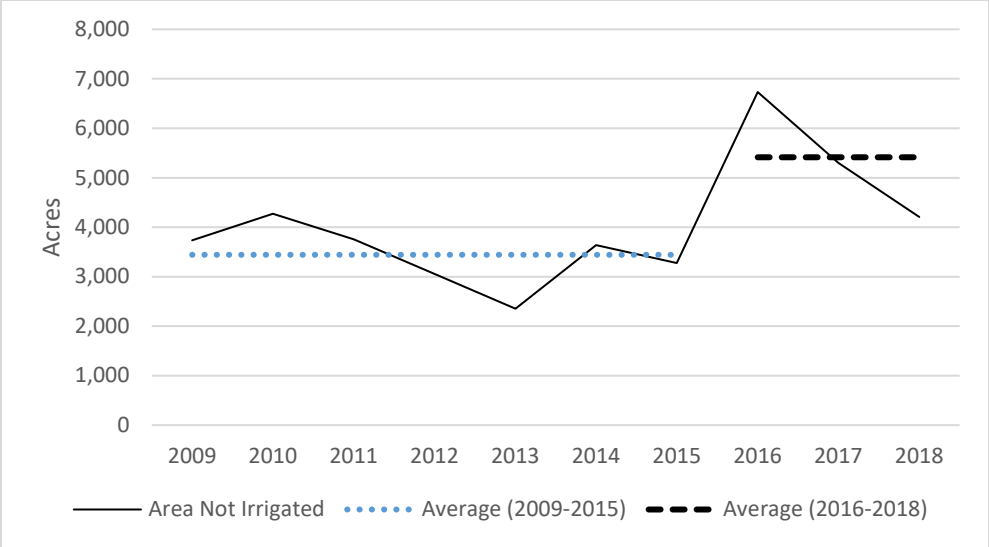


Figure D-2. NUID agricultural area not irrigated.[8]

Based on these data and the analysis of changes in NUID water supply contained in the environmental impact statement for the HCP (Oregon Fish and Wildlife, 2020), this analysis assumes that the 7,246 AF of additional water would reduce the agricultural damages arising from decreased water availability. Specifically, the additional water would reduce deficit irrigation on hay acres that causes a loss of one hay cutting totaling 25 percent of the annual yield under full irrigation. Because this analysis focuses on the impacts to hay only and does not include potential impacts to specialty crops grown in NUID, the benefits presented in this section likely underestimate the benefits of additional water to NUID. Roughly one-quarter of NUID's irrigated acres are dedicated to high-value specialty crops, which, in the absence of water conservation projects such as the Proposed Action, may be impacted by water shortages as the HCP changes in water management are phased into effect in future years.[9] In other words, if future NUID water shortages reduce acreage or yields of specialty crops, the value of additional water to NUID would be higher than is presented here.

With these assumptions, to estimate the value of reduced damages from deficit irrigation, a published Washington State University crop budget was adapted to model the net revenues of agricultural production in NUID for alfalfa hay. From this source budget, crop budgets were developed to model the net returns to hay under full irrigation and under deficit irrigation. The crop budgets are provided in Section B.1.1, with detailed explanation of the methods used to update revenues and costs to 2021-dollar values. The crop budget analysis is summarized in Table D-4.

[8] Source: (Bohle, North Unit Irrigation District 10 Year Average Crop Report 2009-2018, 2019)
[9] Source for NUID crop mix: (Bohle, North Unit Irrigation District 10 Year Average Crop Report 2009-2018, 2019)

Table D-4. Summary of Per-Acre Hay Net Returns Under Full and Deficit Irrigation in NUID, Deschutes Watershed, Oregon, 2021$.

Economic Variable (per acre)	Irrigation Level	
	25% Deficit (No Action)	Full (Piping Alternative)
Production Year 1 Net Returns	$190	$365
Production Years 2–6 Net Returns	$12	$155
Weighted Average Net Returns [1]	$42	$190
Increased Value per Acre of Full Irrigation [2]	$149	
Increased Value per AF of Full Irrigation [3]	$246	

Note: Full crop budgets are provided in Section B.1.1. Prepared February 2022

[1/] Averaged over a 6-year stand life with 5 years comprised of Years 2–6 net returns.

[2/] Equal to the difference of weighted average net returns between deficit and full irrigation.

[3/] Calculated assuming a 0.6 AF/acre difference between full and deficit irrigation.

Results from the analysis in Section B.1.1 are that alfalfa hay under full irrigation generates average annual net returns of approximately $190 per acre, while deficit irrigation generates approximately $42 per acre. Therefore, the marginal net benefit of providing full irrigation to deficit-irrigated alfalfa is approximately $149 per acre. The weighted average full-water allocation in NUID is 2.4 AF per acre.[10] With deficit irrigation at 75 percent of full irrigation, each acre would receive an additional 0.6 AF under full irrigation.[11] Dividing the marginal net returns of full irrigation ($149 per acre) by the amount of additional water (0.6 AF per acre) provides the marginal net returns to water: $246 per AF. This amount is used to estimate the damage-reduction benefit of each AF of water going to NUID under the Piping Alternative.[12]

Under the Piping Alternative, water is conserved once project phases finish beginning in Year 2. However, benefits to NUID agriculture are expected to begin in the year 2028 (Year 6 of this analysis) when the HCP instream requirements are scheduled to increase. (Prior to that time, conserved water is expected to be used to augment instream flows in excess of the requirements under the HCP.) In the absence of the project, the increased instream flow requirements in Year 2028 and onwards would reduce water supply further for NUID under the No Action Alternative. Under the Piping Alternative, AID-conserved water is anticipated to alleviate these shortages in NUID, as described above. Therefore, starting in Year 6 (or Year 2028) under the Piping Alternative, this analysis models an increase of approximately 6,426 AF per year to NUID farms. This volume of water, valued at $246 per AF, results in an undiscounted annual agricultural damage reduction

[10] Water allocations in NUID differ depending on the source; Deschutes River water rights get 2.5 AF per acre while Crooked River water rights get 1.5 AF per acre. Because there are 53,721 acres supplied by the Deschutes River and 5,164 acres supplied by the Crooked River, the weighted average allocation District-wide is 2.4 AF per acre (Britton, 2019).

[11] 2.4 x (1 - 0.75) = 0.6 AF per acre

[12] If 6,426 AF of additional water were distributed at 0.6 AF per acre (as is assumed in this analysis), about 12,000 acres could receive additional water. Over the last 10 years, NUID has averaged about 37,000 acres in hay and grain, which the net returns analysis is meant to represent (Bohle, 2019). Because the total area receiving additional water is less than half the total area of relevant cropland, it is reasonable to apply the benefit per AF to all 6,426 AF.

value of about $1,583,000. When discounted and annualized, the value of the Piping Alternative in avoiding agricultural damages in NUID totals $1,407,000 (as shown in Table D-5).

Table D-5. Avoided Damages to NUID Agriculture Resulting from Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2021$. [1]

Project Group	Total delivered water to NUID farms (AF per year)	Undiscounted Annual Benefit to NUID Agriculture	Annualized Average Net Benefits of Piping
Piping Alternative	6,426	$1,583,000	$1,407,000
Total	**6,426**	**$1,583,000**	**$1,407,000**

Note: Totals may not sum due to rounding. Prepared February 2022
[1/] Price Base: 2021 dollars amortized over 100 years at a discount rate of 2.25 percent

In addition to benefits to NUID irrigators, the proposed project would also enhance water supply reliability for AID patrons. As noted above, AID would retain 2 percent of conserved water, and this would be available to AID patrons under their existing water rights. Further, through piping of its system, AID may enhance the reliability of the water supply to its patrons due to reduced likelihood of canal breach or canal maintenance problems. As these water delivery and supply reliability benefits to AID patrons are likely small, agricultural damage-reduction benefits to AID are not quantified.

D.1.3.1.2. VALUE OF INSTREAM CONSERVED WATER

As described in the previous section, under the Piping Alternative, NUID would begin receiving water as the project phases are completed. As noted above, of the 11,083 AF per year conserved by AID once the project is completed, roughly 10,446 AF would reach the NUID diversion point. Prior to 2028, NUID would release an equivalent amount of water (up to 10,446 AF per year) from Wickiup Reservoir for instream flows during the non-irrigation (winter) season. Placing this water instream would provide instream flow benefits over the No Action Alternative in the years prior to 2028 when the HCP governing flows on the Deschutes River requires wintertime instream flows to increase. Under the No Action Alternative, NUID would not be required to put this additional water instream until 2028.

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 they 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). Market information is presented on the value of water rights to irrigators in NUID (since NUID would be putting the water instream) as this indicates the potential cost of purchasing water rights from these irrigators.

Based on the following discussion, it is assumed that the economic benefit of instream flow augmentation would be at least $75 per AF per year, such that this enhanced instream flow is estimated to have a value of approximately $783,000 per year once the project is complete under the Piping Alternative. Because of the construction-phase timing and because the instream benefits only accrue prior to Year 6 (Year 2028), on an average annualized basis the NEE benefit is roughly $41,000 as presented in Table D-6). 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.)

Values published in the economic literature are often quite high for enhancements to salmon, trout, and other fish and wildlife populations such as 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 for environmental water in the western United States. Table D-6 shows the estimated average annual benefits of enhanced instream flow that would occur prior to 2028 under the Piping Alternative.

Table D-6. Annual Estimated Instream Flow Value of Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2021$. [1]

Project Group	Undiscounted Annual Benefit of Conserved Water	Annualized Average Net Benefits of Piping
Piping Alternative	$783,000	$41,000
Total	**$783,000**	**$41,000**

Note: Totals may not sum due to rounding. Prepared February 2022
[1]/Price Base: 2021 dollars amortized over 100 years at a discount rate of 2.25 percent

This value of $75 per AF per year is based on the following information (see Table D-7):

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 $1,499 per AF per year with an average permanent sale transaction price of $204 per AF per year. Among the 51 permanent water right purchases with the sales price and volume recorded in the water transaction database published by the Bren School of Environmental Science and Management, the permanent sales price value in 25 transactions (49 percent) was above $75 per AF per year. As discussed at length below, these values paid are expected to provide a low-range estimate of instream flow value to society.

2. **Value of water to irrigators in the Deschutes Basin**—For hay and grain irrigators (relatively low-value crops, which are likely the first to sell water for environmental purposes), this is estimated at approximately $60 to $250 per AF per year. This value is important because 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 determines the agricultural sellers' willingness to accept a price for water) and because conserved water avoids potential future reductions in irrigation.

Table D-7. Value per AF per Year of Water (Market Prices and Value to Agriculture), Deschutes Watershed, Oregon, 2021$.

Type of Value	Low Value	High Value	Median Value	Average Value
Permanent water right transaction in western United States, 2000 to 2009 (converted to annual values)	~$0	$1,499	~$75	$204
Value of water to Deschutes Basin irrigators (Income Capitalization Approach)	$60	$250	N/A	$80

Note: N/A = Not applicable

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 the benefits exceed costs. Furthermore, funding organizations do not necessarily represent all individuals who value instream flow benefits. Only if all people who value instream flow were to pay their maximum willingness to pay for instream flow restoration, then the value paid would 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 its use of water (as evident through water right transactions from agriculture to environmental flows).

In the Deschutes Basin, approximately 90 projects have restored approximately 80,000 AF of water instream (Central Oregon Irrigation District, 2016). Based on data from the Deschutes River Conservancy (2012), costs of instream flow augmentation from piping projects have ranged from approximately $105,000 to approximately $344,000 per cfs conserved; this equates to roughly $300 to $1,000 per AF conserved.

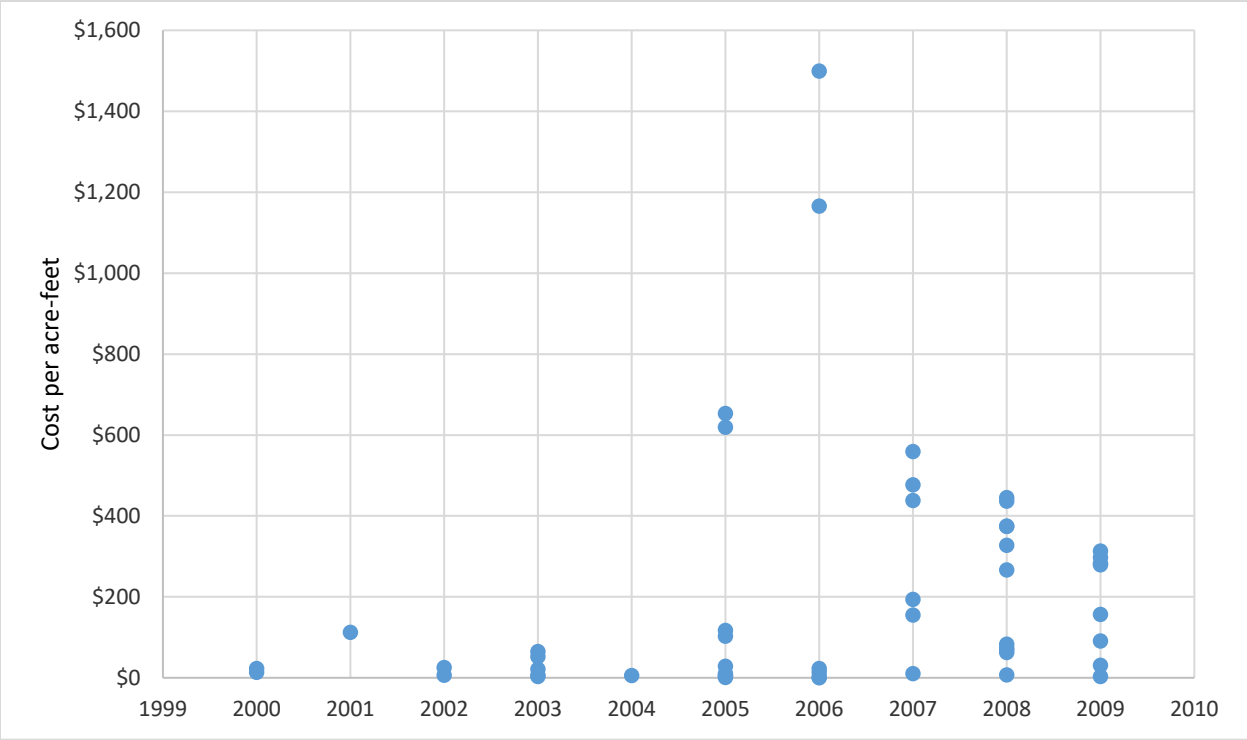
Water rights can be purchased or leased in Oregon. It is important to note that the value paid per AF depends on many variables including the value of water to the seller, funding available to the buyer, characteristics of the affected stream/river (including current flow levels, flow targets, and presence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

Water right leases and purchases for environmental purposes across the western United States were analyzed in a 2003 paper (Loomis, Quattlebaum, Brown, & Alexander, 2003). During the period between 1995 and 1999, 5 transactions of water right purchases averaged $388 per AF in Oregon, while 6 water right leases averaged $182 per AF 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 AF was $1,203, while across 35 lease transactions the annual price was $73 per AF.[13]

The Bren School of Environmental Science and Management 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

[13] All values were adjusted for inflation from 1999 dollars to 2021 dollars using the Consumer Price Index.

of the buyer and seller (e.g., agricultural or environmental) (Bren School of Environmental Science & Management, 2017). The two graphs shown below in Figure D-3 and Figure D-4 show more recent (from 2000 to 2009) sales and leases of water rights by environmental buyers on a price per AF per year basis. The figures show how water right transaction values vary widely, but sale prices (amortized to an annual price) typically are less than $200 per year while 1-year leases typically fall below $1,000 per AF per year (with several transactions showing prices rising over a $4,000 per AF per year). Among the 51 permanent water right purchases with the sales price and volume recorded in the database, the sales price value in 25 transactions (49 percent) was above $75 per AF per year. However, it is also important to note that the amount paid per AF tends to decline with an increase in water volume traded; weighting the purchase price by the water volume sold decreases the average permanent sale transaction price to $18 per AF per year.



Note that dollar per AF purchase prices were amortized using a 2.25 percent interest rate and a 100-year period to derive dollar per AF per year values.

Figure D-3. Western water right purchases for environmental purposes, 2000 to 2009, price paid per acre-foot per year.

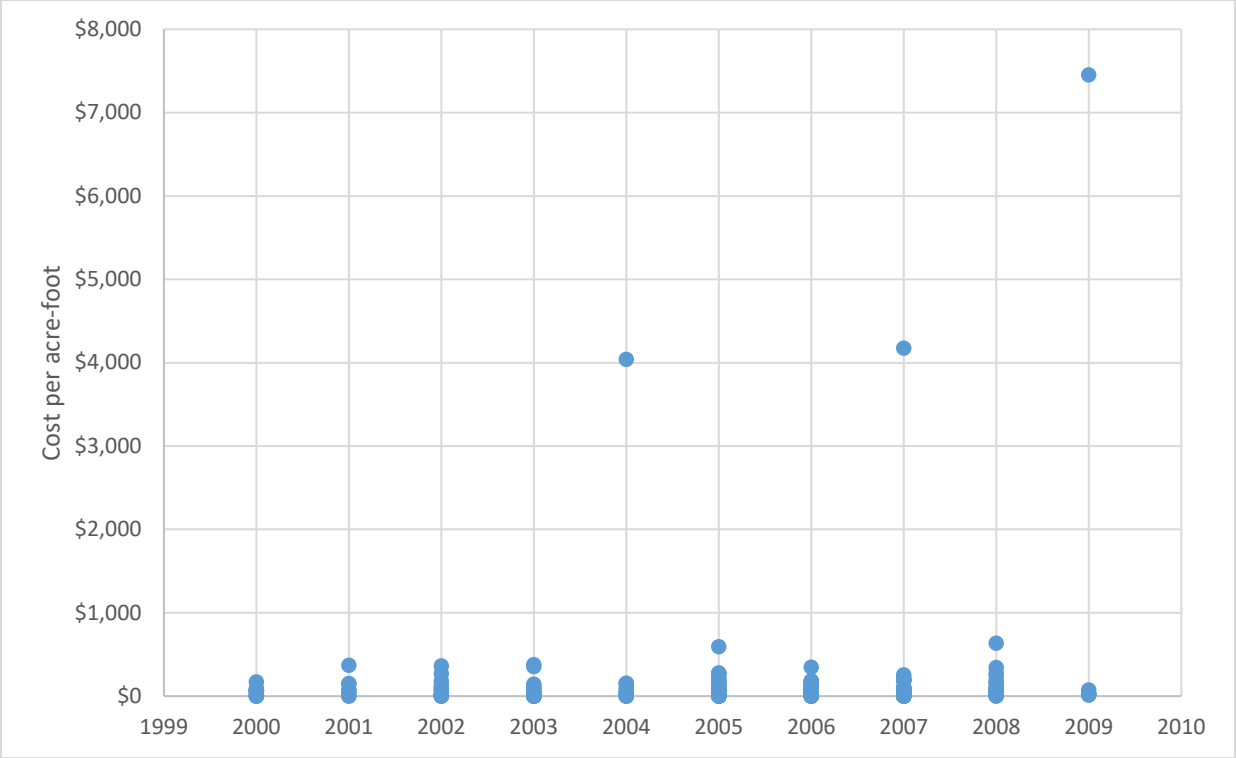


Figure D-4. 1-year water leases for environmental purposes, price paid per acre-foot in the western United States.

Current and Potential Future Water Right Purchase Values in the Surrounding Area

The value of water to irrigators (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). In the project region, water rights sold from one irrigator to another within the Tumalo Irrigation District (which is also located in the Deschutes Watershed) have typically had a purchase price between $5,310 to $7,970 per acre (Rieck, 2017).[14] These values are very similar to values provided by area real estate agents regarding the increased value of property in TID with irrigation water rights, with all else equal. Assuming approximately 4 AF per year delivered on average to acreage in TID, this equates to approximately $1,330 to $1,990 per AF ($5,310 to $7,970 per acre divided by 4 AF per acre delivery) or a value of approximately $40 to $70 per AF per year.

Because NUID's crop mix has a higher proportion of high-value crops than TID and higher yields, the value of NUID irrigation water is higher than for TID. Using the crop budgets created to model the agricultural benefits of the Piping Alternative (shown in detail in Section B.1.1), it is estimated that reduced irrigation of 0.6 AF per acre in a season causes hay growers in NUID to lose approximately $150 per acre in profits. This implies that NUID irrigators value water at the margin at approximately $250 per AF ($150 divided by 0.6). However, on average, NUID irrigators may be applying approximately 2.4 AF per acre to hay crops and getting profits of roughly $190, which implies approximately $80 per AF of value on average.

[14] These values have been adjusted for inflation to 2021 dollars using the Consumer Price Index.

D.1.3.1.3. VALUE OF SUPPORTING THE OREGON SPOTTED FROG

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 will benefit not only fish species but will also benefit and help recover the Deschutes River population of the threatened Oregon spotted frog (OSF) and enhance water quality. In this section, we describe the potential additional value of OSF conservation based on values from the literature regarding ecosystem and species conservation.

Our use of existing literature and previous studies regarding the value of ecosystem restoration and species conservation to estimate the value of OSF habitat enhancement in the Deschutes Basin was conducted in accordance with a methodology known as *benefits transfer*. Values estimated through benefits transfer are less certain and reliable than values estimated through a specific study of the value of OSF habitat in the Deschutes Basin as the resource being valued (OSF) and the population valuing the resource (the Deschutes County households) may differ in substantive ways that could significantly affect the value estimate. However, developing and implementing a new study of the value of OSF habitat in the Deschutes Basin through survey-based techniques such as contingent valuation or conjoint analysis would be resource-intensive and costly. Consequently, this analysis uses benefits transfer in a manner intended to be cautious and conservative with associated discussion on the lack of certainty in value estimates.

As an additional caveat, by estimating the habitat value of water for fish and also including a separate benefit related to OSF, the conservation value of the enhanced instream flow may be over-estimated. However, including both a general instream flow value and an OSF-specific value does not result in overestimation for three reasons:

1. Organizations acquiring environmental water for instream flow purposes are generally focused on enhancing instream flows in order to benefit fish.[15]
2. As discussed in the preceding section, the price paid for environmental water is highly influenced by the cost to agriculture of reduced irrigation water supplies and does not necessarily reflect the total ecosystem service value of the instream flow.
3. Studies of the willingness to pay for all habitat benefits of enhanced instream flow indicate that the total value derived by adding the per AF value from above with an OSF value (as derived below) is within the range of expected benefits to the public (on a per household per year willingness-to-pay basis) of restored aquatic ecosystems.

Long-term viability of the Deschutes population 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 (U.S. Fish and Wildlife Service, 2017). The U.S. Fish and Wildlife Service believes that for long-term species preservation, increased wintertime flows are necessary in the Deschutes River (the Piping Alternative would increase wintertime streamflow by up to 33.8 cfs). Although OSF and its habitat needs are still under scientific investigation, the U.S. Fish and Wildlife Service 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

[15] For example, the Freshwater Trust in Oregon, which has as its mission to preserve and restore freshwater ecosystems, emphasizes the benefits of instream flows for fish on its website. It notes that "We must implement practical, workable solutions that work for both fish and farmers"; presents an illustration showing that rivers sustain industry, drinking water, recreation, agriculture, and fisheries; and lists several fish-related benefits in its achievements but notes no other specific species.

streamflow and habitat on the Deschutes River, the target flow may change as biologists monitor how the ecosystem and OSF adjust to changes in flow management.

The economic value of conserving amphibian populations and OSF in particular may stem from the types of benefits to society provided by these species. As summarized in Table D-8, the 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 OSF may have an antimicrobial chemical in its skin secretions that provides resistance to a fatal amphibian disease (chytridiomycosis), which is causing declines in many amphibian populations (Conlon, et al., 2013).

Table D-8. Sources of Economic Value from Amphibian Conservation.

Source of Value	Description
Cultural Value	Frogs have cultural value that is evident in their symbolism and representation 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 values for the above uses, preservation of frog populations provides intrinsic value to people related to their enjoyment of knowing that the species exists and to their moral or ethical values associated with the conservation of the species for others including future generations.

Source: (Hocking & Babbitt, 2013) Prepared February 2022

Value per Household

In terms of specific dollar values for OSF, 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 that 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; 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; 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 has been estimated to average over $150 per household per year. Values for less iconic non-mammal species, however, are more pertinent to OSF. Preservation of non-mammal species that are less iconic are often valued by households in the United States in the range of $15 to $35 or more per household per year (Loomis & White, 1996; Martin-Lopez, Montes, & Benayas, 2008).[16] For example, the Palouse giant earthworm is valued at approximately $20 per year per household in eastern Washington state based on a conjoint analysis study, while the Riverside fairy shrimp is valued at approximately $35 per household per year by households in Orange County, California, based on a contingent valuation study (Stanley, 2005; Decker & Watson, 2016). These two species may be similar to 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
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

[16] 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 focused on studies conducted in the United States and Canada.

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 related to the natural environment including outdoor recreation, open spaces, 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, the following factors would tend to increase its value to households in the Deschutes Basin: (a) many people know about the species, and its conservation has come to represent, to many people, the restoration of the Deschutes River ecosystem, (b) the OSF species population is threatened, and researchers have identified that the Deschutes population of OSF is genetically distinct from other OSF populations (Moran & O'Reilly, 2018)[17] such that the population size of the genetically distinct species benefiting from increased wintertime Deschutes River flows is quite small, and (c) there are many visitors to the Deschutes Basin, and visitors tend to have relatively higher values (compared to local residents) for preservation of ecosystems and species in the areas they visit.

As instream flow augmentation in the Deschutes aids not just 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. As cited above, Orange County residents were estimated to value fairy shrimp recovery at $35 per household per year and preservation of all local endangered species at $78 per household per year (Stanley, 2005).[18] Perhaps more pertinently, a conjoint analysis 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 $11 per household per year, while conservation of three little-known riverine species (channel darter, eastern sand darter, and the spotted sucker) would increase value to $77 per household per year (Rudd, Andres, & Kilfoil, 2016). The same study found that conservation action that resulted in a large improvement to the channel darter population was valued at $25 per household per year, while a large improvement to the three species populations resulted in value of $93 per household per year. In other words, in both studies, preserving a single species was valued at approximately $11 to $35, while preserving habitat for a broader range of species was valued at $77 to $93 per household. As shown in Table D-9, 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 Proposed Action.

[17] In terms of its uniqueness, OSF is found in Oregon, Washington, and California, but the OSF population in the Deschutes Basin has 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 (Moran & O'Reilly, 2018). 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.

[18] The original study cited values of $25.83 and $55.22 in 2001 dollars, which were converted into annual 2021 dollars in this study.

Table D-9. Economic Values (2021 values) for Little-Known Ontario, Canada, Aquatic Species at Risk. [1]

Type of Benefit	Some Improvement	Large Improvement
One Riverine Species (Channel Darter)	$11	$25
Three Riverine Species (Channel Darter, Eastern Sand Darter, Spotted Sucker)	$77	$93
Water Quality Index	$101	$126

Source: (Rudd, Andres, & Kilfoil, 2016) Prepared February 2022

[1/] The original study cited values in 2011 Canadian dollars, which we converted to 2011 USD using a conversion rate of 1.0141 (the average from 2011) and updated to 2021 USD using the Consumer Price Index (Investing.com, 2021).

The instream flow value of $75 per AF per year described in the previous section translates into approximately $10 per Deschutes County household per year of conservation value.[19] 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 $45 per Deschutes County household. Although, as discussed above, there is significant uncertainty regarding this value, the finding appears reasonable based on the above-cited literature addressing the value of a single-species conservation compared to multiple-species conservation and improvements to an aquatic ecosystem.

Number of Resident and Tourist Households Holding Value for OSF and Deschutes Basin Habitat Conservation

In addition to local households, there may be many households outside of Deschutes County that value preservation of 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. , 2000). As noted above, visitors to an area, particularly tourists participating in outdoor recreation, may have even higher species preservation values than residents. As such, the estimated OSF species conservation value is applied 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), an estimated 102,000 households visit Deschutes County each year with the main trip purpose being outdoor recreation. The focus is on these visitor households because many of the surveys of

[19] Based on U.S. Census data, the population of Deschutes County in 2020 was 198,253 people; using the Census 2020 average household size of 2.47, this translates to approximately 80,300 households. The Proposed Action would increase instream flows by 10,446 AF annually. As such, using $75 AF per year value, the average estimated value on a per-household basis translates to $10 per year ($75 x 10,446 / 80,300 = $10/household).

visitor willingness to pay for conservation have been at outdoor recreation sites.[20] In sum, it is estimated that approximately 178,600 households (76,600 resident households and 102,000 visitor households) may value OSF habitat conservation in the Deschutes Basin. This represents approximately 7 percent of Oregon households.

Estimated OSF Conservation Value of NUID Flow Augmentation

While many factors create uncertainty in estimating the value of OSF habitat conservation,[21] the economic literature supports the notion that habitat conservation through flow augmentation in the Deschutes River 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, 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, this value conservatively apply 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. Under the Piping Alternative, NUID (in exchange for AID passing water to NUID conserved from the project) would match all water passed to it with wintertime releases from Wickiup Reservoir for the initial years of the analysis period (until 2028). These releases would total approximately 33.8 cfs once the project is complete (Farmers Conservation Alliance, 2022) or approximately 11.3 percent of the additional flow anticipated to be required for OSF conservation; therefore, 11.3 percent of the estimated value of $6.25 million for OSF conservation is apportioned to the AID Proposed project—$703,000 per year. Similar to instream flow benefits, additional flows that benefit OSF would be required starting in Year 6 of the No Action Alternative due to the increased HCP requirements. For that reason, this analysis only includes OSF benefits under the Piping Alternative prior to Year 6 when they would be additional over the No Action Alternative. When discounted and annualized, these benefits total $37,000 as shown in Table D-10.

[20] The tourism study by Longwoods Travel estimates 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. The proportion of visitor spending in each county was used 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 indicates 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. It is assumed 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, it is estimated that approximately 102,000 households take at least 1 overnight tourist trip to Deschutes County annually with the primary purpose of their trip being outdoor recreation.

[21] These factors include, first and foremost, the uncertainty in applying values from other contexts and species to 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.

Table D-10. Value of Supporting OSF Habitat under the Piping Alternative, Deschutes Watershed, Oregon, 2021$. [1]

Project Group	Water Conservation (cfs)	Undiscounted Annual Benefits	Annualized Average Net Benefits
Piping Alternative	33.8	$703,000	$37,000
Total	**33.8**	**$703,000**	**$37,000**

Note: Totals may not sum due to rounding Prepared February 2022
[1/] Price Base: 2021 dollars amortized over 100 years at a discount rate of 2.25 percent

D.1.3.1.4. DISTRICT OPERATIONS AND MAINTENANCE COST SAVINGS BENEFITS

AID anticipates that operations and maintenance (O&M) of canals would decrease as a result of the Piping Alternative. In total, it anticipates this amount to fall by about $222,000 per year, which is composed of the following costs:[22]

- $8,100 to clean the Arnold Main Canal with a rented excavator
- $26,700 for canal system maintenance
- $13,400 for canal road maintenance
- $163,600 for labor (including benefits)
- $10,300 in general construction costs (Wills, 2020)

Should the Piping Alternative be implemented, the AID does not plan to reduce staff or staff time in response to the avoided O&M labor costs. Instead, AID plans to assign staff to other activities that would benefit the District and its patrons. These activities would generate additional benefits that are at least equal to the cost of the staff time; this implies that the value of avoiding canal O&M would bring benefits at least equal to its current cost. In other words, if AID no longer has to pay $163,600 in labor costs to maintain canals, it would generate at least $163,600 in benefits by reallocating that labor to other valuable tasks. Accordingly, this analysis uses $222,000 to represent the annual O&M cost savings benefit to AID.

In addition to the avoided annual O&M costs, the Piping Alternative would also allow AID to avoid the one-time cost of removing 5,500 feet of canal lining. Under the No Action Alternative, this would likely occur sometime between Years 1 and 3 at a total cost of roughly $128,000 (Wills, 2020).[23] While the lining would be removed under the Piping Alternative, its removal would be included under the costs of canal demolition. Accordingly, under the Piping Alternative, this analysis assumes $128,000 in avoided costs have an equal chance of occurring any time between Years 1 and 3. As shown in Table D-11 below, after discounting and amortizing, the Piping Alternative would result in an estimated $211,000 in annual O&M cost-saving benefits relative to the No Action Alternative.

[22] All costs were adjusted from 2020 dollars to 2021 dollars using the Consumer Price Index.
[23] This cost was adjusted from 2020 dollars to 2021 dollars using the Consumer Price Index.

Table D-11. Annual Reduced Canal O&M Costs to AID of Piping Alternative, Deschutes Watershed, Oregon, 2021$. [1]

Works of Improvement	Length of Open Canal (miles)	Undiscounted Annual Canal O&M Costs	Undiscounted Avoided Cost of Removing Canal Lining (1x cost)	Discounted Annualized Benefit (OMR Cost Reduction)
Piping Alternative	11.9	$223,000	$128,000	$211,000
Total	**11.9**	**$223,000**	**$128,000**	**$211,000**

Note: Totals may not sum due to rounding. Prepared February 2022
1/Price Base: 2021 dollars amortized over 100 years at a discount rate of 2.25 percent.

D.1.3.1.5. AVOIDED INFRASTRUCTURE FAILURE DAMAGES

The Arnold Main Canal has sinkhole incidents or canal failures every year that develop as a result of the canal failing. Sinkholes form when irrigation water in the canal erodes the soil in the canal and eventually causes the surface to collapse. These sinkholes range in size from about 3 inches to 8 feet by 6 feet (Wills, 2020). Between 1986 and 2018, property owners have claimed about $157,000 in damages associated with failures of the Arnold Main Canal.[24] There is the potential for much greater losses as a major canal failure of the Arnold Main Canal could damage nearby properties that are valued in the millions of dollars (Wills, 2020).

Because these damages are caused solely by canal failures, the Piping Alternative would eliminate any future damages associated with the canal failures in the project area. To estimate the value of the damages avoided by the Piping Alternative, the average annual damage claim from 1986 to 2018 arising in the project area (based on data provided by AID) was estimated and it is assumed that this same annual average amount of damage would continue throughout the project life. As Table D-12 shows, the Piping Alternative would reduce damages from canal failures by an estimated $3,000 annually.

[24] These claims were made against AID and the Special Districts Association of Oregon (Wills, 2020). Each claim was adjusted for inflation to 2021 dollars using the Consumer Price Index.

Table D-12. Annual Avoided Canal Failure Damage Costs of Piping Alternative, Deschutes Watershed, Oregon, 2021$. [1]

Works of Improvement	Undiscounted Average Annual Canal Failure Claims	Discounted Annualized Avoided Canal Failure Damages (Cost Savings)
Piping Alternative	$3,000	$3,000
Total	**$3,000**	**$3,000**

Note: Totals may not sum due to rounding. Prepared February 2022
[1]/Price Base: 2021 dollars amortized over 100 years at a discount rate of 2.25 percent.

D.1.3.2. Benefits Considered but Not Included in Analysis

D.1.3.2.1. Additional Agricultural Damage Reduction Benefits

While all conserved water under the Piping Alternative would go to NUID after Year 8, the Piping Alternative could reduce damage to AID patrons' agricultural production through enhanced operational flexibility and efficiency and improved water quality, as well as improved water supply reliability related to AID retaining 2 percent of conserved water and reduced likelihood of canal failures. The District's antiquated canal and laterals make it difficult to deliver the correct amount of water to patrons at the correct time, particularly early and late in the irrigation season. During these periods, the District's water rights require it to divert water at a reduced rate. At these reduced flow rates, the canal and laterals are more sensitive to small changes in streamflow at the diversion. The reduced flow rates in the open canal and laterals make it much more challenging for the District to deliver the correct amount of water that patrons need when they need it. For example, a point of delivery near the end of a lateral may receive no water in the morning and excess water in the evening.

In addition to efficiency benefits, piping would also improve water quality, which could increase agricultural yields. In sections of the District that have been piped in the last 3 years, patrons on the piped laterals report that the delivered water is cleaner than the water delivered previously via earthen canal. This has resulted in increased crop yields and fewer issues with silt in ponds and pumps plugging up (Wills, 2020). The Piping Alternative would likely bring similar benefits to patrons in other parts of the District. Although identified as potential benefits, current delivery and delivery capabilities after piping are not included in the analysis due to the limited amount of available data.

D.1.3.2.2. Public Safety Avoided Costs

Piping irrigation water removes the hazard of drownings in canals and eliminates the potential for earthen canals to fail and cause potential damages to downstream property and lives. While AID canal failure is very possible, the extent of damage varies dramatically depending on the timing and location of failure. A history of recent drownings in Central Oregon irrigation canals provides evidence that fast-moving water in irrigation canals, often with steep and slippery banks, can be a threat to public safety. In 2004, a toddler drowned in a Central Oregon Irrigation District canal, and in 1996 and 1997, respectively, a 12-year-old boy and a 28-year-old man drowned in North Unit Irrigation District canals (Flowers, 2004). Other drownings may have occurred in the past as a comprehensive list of drownings in Central Oregon irrigation canals was not available from the Bureau of Reclamation or other sources. However, the data indicate at least 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 11.9 miles of AID's open Main Canal. This section qualitatively discusses the potential magnitude of the public safety benefit of piping this part of the Main Canal and includes information on the recent history of drownings and the mileage of exposed canal.

Level of Public Safety Hazard

This analysis estimates the public safety hazard of open canals in the District based on past drownings in open canals in Central Oregon. Data from the Oregon Water Resources Department (OWRD) show that there are 1,072 miles of irrigation canals in Central Oregon districts (see Table D-13). Starting in the late 1980s and early 1990s, sections of these canals began to be piped. 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; therefore, approximately 973 miles were open 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 it 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 the No Action Alternative, AID would continue to have approximately 11.9 miles of open 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 open canals in AID carry a risk of 0.0017 deaths per year.

Table D-13. Irrigation Canal Mileage by District.

District	Canal and Lateral Mileage
Arnold Irrigation District	47.3
Central Oregon Irrigation District	430.0
Lone Pine Irrigation District	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	**1,072.2**

Note: Totals may not sum due to rounding. Prepared February 2022
Source: Oregon Water Resources Department, database maintained and provided by Jonathon LaMarche on March 9, 2017.

D.1.4. Incremental Analysis

The Piping Alternative is evaluated using an incremental analysis, which identifies how total costs and benefits change as project phases are added (see Table D-14). In the incremental analysis, the single project group is divided into four phases of construction. These phases were selected for several logistical reasons. First, AID has a limited amount of time in the non-irrigation season to complete the project. Second, AID will need time to raise the necessary capital to finance its portion of the project costs. Lastly, the project phases make the most sense from an operational perspective (i.e., mobilizing construction equipment in an efficient manner and completing the project in a sequential order). The engineering pipeline design (pipe diameters, pressure ratings, etc.) is independent of the number of phases and the construction order. In engineering the design of the system, AID and Black Rock Consulting mapped and collected digital elevation data to create a hydraulic model that determined pipe sizes for each pipeline (canal or lateral to be piped) in the system.

Table D-14. Incremental Analysis of Annual NEE Costs and Benefits Under the Piping Alternative for AID, Deschutes Watershed, Oregon, 2021$. [1]

Phases	Total Costs	Incremental Costs	Total Benefits	Incremental Benefits	Net Benefits
1	$273,000	N/A	$589,000	N/A	$316,000
1, 2	$583,000	$310,000	$1,241,000	$652,000	$658,000
1, 2, 3	$687,000	$104,000	$1,424,000	$183,000	$737,000
1, 2, 3, 4	$852,000	$165,000	$1,701,000	$277,000	$849,000

[1/]Price Base: 2021 dollars amortized over 100 years at a discount rate of 2.25 percent. Prepared June 2022
N/A = Not applicable

D.1.5. References

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D.1.6. NEE Appendix

D.1.6.1. Crop Enterprise Budgets

This appendix presents the crop enterprise budgets used to estimate the benefits under the Piping Alternative of avoiding agricultural damage to NUID (described in Section D.1.3.1.1). The analyses use a total of four crop budgets, which are listed in Table D-15:

Table D-15. Summary of Crop Budgets.

Scenario	Production Year	Budget Table
Deficit Irrigation	Year 1	Table D-16
	Years 2–6	Table D-17
Full Irrigation	Year 1	Table D-18
	Years 2–6	Table D-19

The costs and benefits of agricultural production are estimated using an enterprise budget that represents typical costs and returns of producing crops in the Deschutes Watershed of Central Oregon. Enterprise budgets aim to reflect common practices and relevant costs for production in the region, but they do not necessarily represent conditions of any particular farm. As a starting point for the crop budgets in this analysis, a crop budget for alfalfa hay developed by Washington State University was selected and then values in the budget were adjusted to account for changes in prices through time and local conditions in NUID. A more recently published alfalfa hay budget for Central Oregon was not available from Oregon State or Washington State University. The following section outlines the data and assumptions used in adjusting the Washington State alfalfa hay budget.

D.1.6.1.1. ALFALFA ENTERPRISE BUDGETS

The alfalfa hay enterprise budgets were based on a 2012 budget developed by Washington State University for establishing and producing alfalfa hay in the Washington Columbia Basin (Norberg & Neibergs, 2012). These budgets were selected as the basis for NUID crop production costs because they are the most recent crop budgets developed for producing alfalfa hay in an area that is relatively close to Central Oregon.

Costs presented in the original budgets were updated to account for changing values over time and to reflect conditions specific to NUID. Returns to alfalfa were based on average hay yields in Jefferson County and 7-year normalized average hay prices in Oregon.[25]

D.1.6.1.2. MODELED FARM

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. 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.

[25] A normalized average is calculated by removing the highest and lowest values in a set of data and taking the mean of the remaining values.

D.1.6.1.3. INPUT COSTS

For fertilizers in the non-establishment budgets, the amount used is adjusted proportionally according to differences in yield from the original budget. For example, the original budget calls for 92 pounds (lbs) of dry phosphate to produce 8 tons of hay per acre; in the Full Irrigation Production Budget (Table D-19), a yield of only 5.4 tons per acre (68 percent of the original yield) is modeled, so the amount of dry phosphate is reduced to 62 lbs (68 percent of 92 lbs). One exception to this method is the amount of dry sulfur applied, which is held constant at 30 lbs per acre during production years per guidance from an Oregon State University Extension Agent in Central Oregon (Bohle, 2020).

All costs are adjusted from the original values in the WSU budget. Area-specific values for fuel prices, irrigation charges, and land costs are used. For costs that did not have area-specific values, the value in the original budget is adjusted 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, 2021). For example, there are price indices for fertilizer, herbicides, supplies, tractors, and custom work, as well as one for the farm sector in general. The PPI cost adjustments range from a 21-percent decrease in the price of potash and phosphorus to a 25-percent increase in machinery costs.

For land costs in the establishment budget, NASS data on rental rates for irrigated cropland in Jefferson County are used: $121 per acre (NASS, 2021).[26] Because alfalfa is seeded in the fall after another crop has been harvested, 25 percent of the land costs are ascribed to establishing alfalfa.

D.1.6.1.4. LABOR COSTS

Because most of the labor is provided by custom work, the only direct labor costs are for irrigation labor. For the cost of this labor, the median hourly wage rate for the farmworkers occupation in Oregon in 2020 is used and adjusted to 2021 dollars using the Consumer Price Index.[27] This wage rate is further adjusted up by 20 percent to account for non-wage employment costs such as health care and insurance.[28] This results in total labor costs of $18.01 per hour for irrigation labor.

The cost of custom work is adjusted using the Custom Work PPI. For the production budgets, some labor costs are adjusted (including custom bailing, hauling, staking, and tarping) proportionally to the change in yield (e.g., if yield falls by 10 percent, the amount of labor also falls by 10 percent). To the extent that labor costs fall less than this, the results will under-estimate benefits (and vice versa). Management labor costs are estimated at 5 percent of total costs (following the original budget). Other custom labor, including swathing and raking, are adjusted based on the number of hay cuttings. The original budget modeled four cuttings; the Full Irrigation Budgets (Table D-18 and Table D-19) model three cuttings, while the Deficit Irrigation Budgets (Table D-16 and Table D-17) model two cuttings.

D.1.6.1.5. REVENUES

The estimate for the gross revenues of alfalfa hay uses the normalized average price per ton for alfalfa hay in Oregon from 2014 to 2020: $195.20 (NASS, 2021). The estimate for yields uses the average yield in Jefferson County from 2013 to 2017: 5.4 tons per acre (NASS, 2021).

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[26] The normalized average price from 2011–2020 is used. The normalized average is calculated by removing the high and low values from the dataset and taking the mean of the remaining values.

[27] This is the average wage for the Farmworkers and Laborers, Crop, Nursery, and Greenhouse (occupation code 45-2092) in the Central Oregon non-metropolitan area according to the Bureau of Labor Statistics' Occupational Employment and Wage Estimates data in May 2020 (Bureau of Labor Statistics, 2019).

[28] This is roughly the average proportion of non-wage labor costs for all private part-time workers in the United States in December 2018 (Bureau of Labor Statistics, 2018).

D.1.6.1.6. ALFALFA ENTERPRISE BUDGET TABLES

The tables below present alfalfa hay enterprise budgets used to estimate the costs and returns under different irrigation levels.

Table D-16. Alfalfa Net Returns in NUID Under Deficit Irrigation, Production Year 1.

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Alfalfa Hay	4.06	ton	$195.20	$792.39
VARIABLE COSTS				
Dry Nitrogen	0.0	lb	$0.40	$0.00
Dry Phosphate	0.0	lb	$0.74	$0.00
Dry Potash	0.0	lb	$0.53	$0.00
Dry Sulfur	0.0	lb	$0.22	$0.00
Custom - Swath	2.0	ac	$22.27	$44.54
Custom - Rake	2.0	ac	$11.14	$22.27
Custom - Bail	4.1	ton	$18.93	$76.85
Custom - Haul & Stack	4.1	ton	$10.02	$40.68
Custom - Tarping	4.1	ton	$5.57	$22.60
Irrigation - power	1.0	ac	$46.38	$46.38
Irrigation - water access	1.0	ac	$3.10	$3.10
Irrigation - repairs	1.0	ac	$17.95	$17.95
Irrigation - labor	0.5	ac	$18.01	$9.01
Gopher control	1.0	ac	$6.22	$6.22
Fuel	2.3	gal	$3.85	$8.78
Lubricants	1.0	ac	$1.00	$1.00
Machinery repairs	1.0	ac	$2.15	$2.15
Haystack Insurance	4.1	ton	$2.02	$8.21
Overhead	1.0	ac	$29.62	$29.62
Operating interest	1.0	ac	$7.64	$7.64
Total variable costs				$347.01
FIXED COSTS				
Machinery depreciation	1.0	ac	$6.77	$6.77
Machinery interest	1.0	ac	$3.15	$3.15
Machinery insurance, taxes, housing, license	1.0	ac	$2.82	$2.82
Management (5% of total cost)	1.0	ac	$24.05	$24.05
Establishment cost	1.0	ac	$97.41	$97.41
Land cost	1.0	ac	$121.20	$121.20
Total fixed costs				$255.40
Total costs				$602.42
NET RETURNS PER ACRE				**$189.97**

Table D-17. Alfalfa Net Returns in NUID Under Deficit Irrigation, Production Years 2-6.

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Alfalfa Hay	4.06	ton	$195.20	$792.39
VARIABLE COSTS				
Dry Nitrogen	0.0	lb	$0.40	$0.00
Dry Phosphate	46.7	lb	$0.74	$34.47
Dry Potash	71.0	lb	$0.53	$37.30
Dry Sulfur	30.0	lb	$0.22	$6.65
Zinc	2.5	lb	$2.25	$5.71
Boron	1.0	lb	$5.07	$5.14
Custom Application	1.0	ac	$10.02	$10.02
Soil Test	1.0	ac	$0.33	$0.33
Herbicide	2.0	lb	$16.62	$33.23
Custom Application	1.0	ac	$10.02	$10.02
Custom - Swath	2.0	ac	$22.27	$44.54
Custom - Rake	2.0	ac	$11.14	$22.27
Custom - Bail	4.1	ton	$18.93	$76.85
Custom - Haul & Stack	4.1	ton	$10.02	$40.68
Custom - Tarping	4.1	ton	$5.57	$22.60
Irrigation - power	1.0	ac	$52.18	$52.18
Irrigation - water access	1.0	ac	$3.10	$3.10
Irrigation - repairs	1.0	ac	$17.95	$17.95
Irrigation - labor	0.4	ac	$18.01	$6.75
Haystack insurance	4.1	ton	$2.02	$8.21
Gopher control	1.0	ac	$6.22	$6.22
Fuel	2.3	gal	$3.85	$8.78
Lubricants	1.0	ac	$1.00	$1.00
Machinery repairs	1.0	ac	$2.15	$2.15
Overhead	1.0	ac	$44.59	$44.59
Operating interest	1.0	ac	$11.27	$11.27
Total variable costs				$512.05
FIXED COSTS				
Machinery depreciation	1	ac	$6.77	$6.77
Machinery interest	1	ac	$3.15	$3.15
Machinery insurance, taxes, housing, license	1	ac	$2.82	$2.82
Management (5% of total cost)	1	ac	$37.17	$37.17
Establishment cost	1	ac	$97.41	$97.41
Land cost	1	ac	$121.20	$121.20
Total fixed costs				$268.53
Total costs				$780.57
NET RETURNS PER ACRE				**$11.82**

Table D-18. Alfalfa Net Returns in NUID Under Full Irrigation, Production Year 1.

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Alfalfa Hay	5.4	ton	$195.20	$1,056.52
VARIABLE COSTS				
Dry Nitrogen	0.0	lb	$0.40	$0.00
Dry Phosphate	0.0	lb	$0.74	$0.00
Dry Potash	0.0	lb	$0.53	$0.00
Dry Sulfur	0.0	lb	$0.22	$0.00
Custom - Swath	3.0	ac	$22.27	$66.82
Custom - Rake	3.0	ac	$11.14	$33.41
Custom - Bail	5.4	ton	$18.93	$102.46
Custom - Haul & Stack	5.4	ton	$10.02	$54.25
Custom - Tarping	5.4	ton	$5.57	$30.14
Irrigation - power	1.0	ac	$46.38	$46.38
Irrigation - water access	1.0	ac	$3.10	$3.10
Irrigation - repairs	1.0	ac	$17.95	$17.95
Irrigation - labor	0.5	ac	$18.01	$9.01
Gopher control	1.0	ac	$6.22	$6.22
Fuel	2.3	gal	$3.85	$8.78
Lubricants	1.0	ac	$1.00	$1.00
Machinery repairs	1.0	ac	$2.15	$2.15
Haystack Insurance	5.4	ton	$2.02	$10.95
Overhead	1.0	ac	$29.62	$29.62
Operating interest	1.0	ac	$9.50	$9.50
Total variable costs				$431.73
FIXED COSTS				
Machinery depreciation	1.0	ac	$6.77	$6.77
Machinery interest	1.0	ac	$3.15	$3.15
Machinery insurance, taxes, housing, license	1.0	ac	$2.82	$2.82
Management (5% of total cost)	1.0	ac	$28.28	$28.28
Establishment cost	1.0	ac	$97.41	$97.41
Land cost	1.0	ac	$121.20	$121.20
Total fixed costs				$259.64
Total costs				$691.37
NET RETURNS PER ACRE				**$365.15**

Table D-19. Alfalfa Net Returns in NUID Under Full Irrigation, Production Years 2-6.

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Alfalfa Hay	5.4	ton	$195.20	$1,056.52
VARIABLE COSTS				
Dry Nitrogen	0.0	lb	$0.40	$0.00
Dry Phosphate	62.2	lb	$0.74	$45.96
Dry Potash	94.7	lb	$0.53	$49.73
Dry Sulfur	30.0	lb	$0.22	$6.65
Zinc	3.4	lb	$2.25	$7.61
Boron	1.4	lb	$5.07	$6.86
Custom Application	1.0	ac	$10.02	$10.02
Soil Test	1.0	ac	$0.33	$0.33
Herbicide	2.0	lb	$16.62	$33.23
Custom Application	1.0	ac	$10.02	$10.02
Custom - Swath	3.0	ac	$22.27	$66.82
Custom - Rake	3.0	ac	$11.14	$33.41
Custom - Bail	5.4	ton	$18.93	$102.46
Custom - Haul & Stack	5.4	ton	$10.02	$54.25
Custom - Tarping	5.4	ton	$5.57	$30.14
Irrigation - power	1.0	ac	$52.18	$52.18
Irrigation - water access	1.0	ac	$3.10	$3.10
Irrigation - repairs	1.0	ac	$17.95	$17.95
Irrigation - labor	0.5	ac	$18.01	$9.01
Haystack insurance	5.4	ton	$2.02	$10.95
Gopher control	1.0	ac	$6.22	$6.22
Fuel	2.3	gal	$3.85	$8.78
Lubricants	1.0	ac	$1.00	$1.00
Machinery repairs	1.0	ac	$2.15	$2.15
Overhead	1.0	ac	$44.59	$44.59
Operating interest	1.0	ac	$13.80	$13.80
Total variable costs				$627.23
FIXED COSTS				
Machinery depreciation	1.0	ac	$6.77	$6.77
Machinery interest	1.0	ac	$3.15	$3.15
Machinery insurance, taxes, housing, license	1.0	ac	$2.82	$2.82
Management (5% of total cost)	1.0	ac	$42.93	$42.93
Establishment cost	1.0	ac	$97.41	$97.41
Land cost	1.0	ac	$121.20	$121.20
Total fixed costs				$274.28
Total costs				$901.51
NET RETURNS PER ACRE				**$155.01**

D.2. Alternatives Considered During Formulation

This section presents the alternatives considered in the formulation phase. References cited can be found in Section 9 of the Plan-EA.

During the formulation phase, alternatives were evaluated based on meeting both National Environmental Policy Act (NEPA) and environmental review requirements specific to NRCS federal investments in water resources projects (PR&G). According to NEPA, "agencies shall rigorously explore and objectively evaluate all reasonable alternatives" (40 Code of Federal Regulations 1502.14). "Reasonable alternatives means a reasonable range of alternatives that are technically and economically feasible, meet the purpose and need for the proposed action, and, where applicable, meet the goals of the applicant" (40 Code of Federal Regulations 1508.01). According to the PR&G DM 9500-013 (USDA-NRCS, 2017a), alternatives should reflect a range of scales and management measures and be evaluated against the Federal Objective and Guiding Principles; against the extent to which they address the problems and opportunities identified in the purpose and need; and against the criteria of completeness, effectiveness, efficiency, and acceptability.

1. Completeness is the extent to which an alternative provides and accounts for all features, investments, and/or other actions necessary to realize the planned effects including any necessary actions by others. It does not necessarily mean that alternative actions need to be large in scope or scale.
2. Effectiveness is the extent to which an alternative alleviates the specified problems and achieves the specified opportunities.
3. Efficiency is the extent to which an alternative alleviates the specified problems and realizes the specified opportunities at the least cost.
4. Acceptability is the viability and appropriateness of an alternative from the perspective of the Nation's general public and consistency with existing federal laws, authorities, and public policies. It does not include local or regional preferences for particular solutions or political expediency.

Alternatives that were eliminated during formulation are shown in Table D-20 and are further discussed below. Alternatives selected for further evaluation are discussed in the Plan-EA.

Table D-20. Alternatives Considered During the Formulation Phase.

Alternative	Which criteria in the PR&G does the alternative achieve?				Selected for Further Evaluation
	Completeness	Effectiveness	Efficiency	Acceptability	
Conversion to Dryland Farming			X		
Fallowing Farm Fields			X		
Market-Based Approaches to Include Voluntary Duty Reduction			X		
Exclusive or Partial Use of Groundwater					
On-Farm Efficiency Upgrades and Piping Private Laterals		X		X	
Piping with Sections of Lined Canal	X			X	
Managed Aquifer Recharge			unknown		
Aquifer Storage and Recovery			unknown		
Canal Lining	X	X		X	X
No Action (Future without Federal Investment)			X		X
Piping Alternative	X	X	X	X	X

D.2.1. Conversion to Dryland Farming

Dryland farming is a non-structural alternative. 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, and generally shallow and well- to excessively

drained soils with low storage potential makes dryland farming infeasible within the District (Daly et al., 1994; Gannett et al., 2001). In the District, agricultural production would substantially decrease if dryland farming were implemented. With decreased production and income, farmers could potentially sell their land due to the development pressure Deschutes County is experiencing. Dryland farming would be inconsistent with ensuring agricultural production is maintained in an area undergoing rapid urbanization.

Conversion to dryland farming would not meet any of the purposes of the proposed project. If water saved from conversion to dryland farming was put instream, it could meet the need of improving instream flow for fish and aquatic habitat, but this is not certain to occur because conversion to dryland farming would be voluntary, and any water saved would not necessarily be put in stream by the patrons. Conversion to dryland farming would not meet any of the other identified project needs.

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

D.2.2. Fallowing Farm Fields

Fallowing farm fields is a non-structural alternative that 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 remain instream for fish, wildlife, and habitat.

Fallowing farm fields would not meet any of the project purposes. If water saved from fallowing was put instream, it could meet the need of improving instream flow for fish and aquatic habitat, but this is not certain to occur because fallowing would be voluntary, and any water saved would not necessarily be put instream by patrons. Fallowing farm fields would not meet any of the other identified needs of the project.

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

D.2.3. Market-Based Approaches to include Voluntary Duty Reduction

For the purpose of this analysis, Market-Based Approaches refers to patrons' voluntarily accepting less than their full water delivery rate from the District or to patrons temporarily or permanently moving water or water rights from their lands to the river. Voluntary duty reduction refers to patrons voluntarily accepting less than their full water delivery rate from the District. A reduction in duty could mean AID diverts less water, which would leave more water instream. This water would not be permanently protected instream through a new instream water right.

Market-based approaches such as voluntary duty reduction would not meet any of the project purposes. If water saved from duty reduction was put instream, it could meet the need of improving instream flow for fish and aquatic habitat, but this is not certain to occur because duty reduction would be voluntary, and any water saved would not necessarily be put instream by the patrons.

For example, a reduction in duty by a patron could mean AID diverts less water, which would leave more water instream. Because AID is obligated to provide a certain amount of water to patrons to meet associated water rights, this alternative would be voluntary and at the discretion of individual landowners. For this

reason, there would be no certainty that water would be saved and that streamflow would be restored. Furthermore, AID lacks the legal authority to carry out, operate, and maintain voluntary duty reduction by its patrons, which is a required for the PL 83-566 program (USDA-NRCS 2015a). Further, because the system has open canals, subject to certain operating inefficiencies, AID would still have to divert enough water, accounting for seepage, to ensure those deliveries. Therefore, carrying out this alternative would be technically infeasible.

Market-based incentives including voluntary duty reduction were eliminated from further evaluation because they would not meet the project purpose; their effectiveness would be uncertain since reducing one's duty would be voluntary; AID lacks the ability to carry out patron duty reductions; they would not achieve the Federal Objective and Guiding Principles; and given current water delivery technology, it is technically infeasible by AID to accommodate.

D.2.4. Exclusive or Partial Use of Groundwater

The exclusive or partial conversion from surface water–sourced to groundwater-sourced irrigation were also initially considered as possible alternatives. To use groundwater in the Deschutes Basin, the District would have to apply for groundwater rights under the OWRD 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 16.65 cfs[29] are available for the whole Deschutes Basin, and it is unlikely that AID could obtain rights to all the remaining water (S. Henderson, personal communication, March 11, 2021). Given that only 16.65 cfs is available under this program, the District's exclusive use of groundwater to entirely replace its use of surface water is not feasible.

The partial use of groundwater for irrigation would have logistical and legal constraints. AID and patrons could use their surface water rights for groundwater mitigation credits[30] required by the DBGM program; however, AID would need the authority from each patron to convert surface water 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 AID's water rights. AID currently has 1905 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.

A feasibility study would be required to evaluate items including, but not limited to, the geology, hydrogeology, and location and suitability of groundwater aquifers. AID would also have to install, operate, and maintain groundwater wells and groundwater pumps. Depending on the required locations, wells and pumps might need to be sited on private lands owned by AID patrons. However, AID lacks the legal authority to carry out, operate, and maintain wells and pumps on private lands, which is a requirement of the PL-566 program (USDA-NRCS, 2015a). AID would, therefore, need to acquire new easements for any wells and/or pumps on private lands. This approach is logistically complex and would increase project costs.

Exclusive and partial use of groundwater would not meet any of the purposes of the proposed project. If water saved from conversion to groundwater was put instream, it could meet the need of improving instream flow for fish and aquatic habitat, but this is not certain to occur because switching to groundwater would be

[29] Currently, OWRD has 40.9 cfs left under the 200 cfs cap; however, it has pending applications with the amount of 25.24 cfs. Although there is no guarantee that these applications will be approved or processed, it is suggested that the cap would be at 16.65 cfs remaining (S. Henderson, personal communication, March 11, 2021).
[30] AID would not create groundwater mitigation credits under either the No Action Alternative or the Piping Alternative analyzed in the Plan-EA.

voluntary, and any water saved would not necessarily be put instream by patrons. Partially or exclusively switching to groundwater would not meet any of the other identified needs of the project. The exclusive and partial use of groundwater alternative was eliminated from further evaluation because it would not meet the project's purpose and need; its effectiveness would be uncertain as conversion to groundwater would be voluntary; there are inefficiencies associated with logistics in acquiring new easements and legal constraints obtaining groundwater rights; there would be low acceptability since converting to groundwater rights would result in junior water rights; and because it would not achieve the Federal Objective and Guiding Principles.

D.2.5. On-Farm Efficiency Upgrades and Piping Private Laterals

On-farm efficiency upgrades refer to AID patrons upgrading their on-farm infrastructure to use irrigation technologies that provide a more precise application of water. Piping private laterals refers to piping ditches or laterals that are owned by private patrons and that bring water from the District's infrastructure to the patron's fields. On-farm infrastructure and private laterals are distinct from District canals and laterals because they are owned and operated by patrons. Once delivered by the District, the water may have to be conveyed substantially further to fields, so the patron may have a long extent of private laterals and ditches they own and operate. All irrigated lands within the District use sprinklers to apply water (hand lines, side roll wheel lines, solid sets, and a few semi-big guns). Approximately 30 percent are either solid set sprinklers using portable hand lines or buried laterals. Approximately 10 percent of the solid set systems use automated timers (AID, 2013). Each irrigation system has a different application efficiency (i.e., its ability to deliver the irrigation water to the crop root system across the full field being irrigated).

On-farm efficiency upgrades and piping private laterals would not meet any of the purposes of the proposed project. If water saved from upgrades and piping was put instream, it could meet the need of improving instream flow for fish and aquatic habitat, but this is not certain to occur because upgrading on-farm systems would be voluntary, and any water saved would not necessarily be put instream by the patrons. On-farm efficiency upgrades and piping private laterals would not meet any of the other identified needs of the project: the Main Canal would remain open; water losses would still occur through seepage in the Main Canal; water delivery reliability would not be improved due to operational efficiencies; and public safety would remain an issue.

On-farm efficiency upgrades and piping private laterals are not within the scope of actions that AID can entertain as the project sponsor under PL 83-566 because AID lacks the authority to carry out, operate, and maintain on-farm infrastructure owned and operated by AID patrons.

In addition, if PL 83-566 funds were used to develop and implement on-farm efficiency upgrades and piping private laterals, the use of these funds would require AID to complete a State Historic Preservation Office/National Historic Preservation Office analysis on a tax lot-by-tax lot basis,[31] as well as receive permission to then operate and maintain the system including acquiring easements to do so. This approach is logistically complex and would increase project costs.

The on-farm efficiency upgrades and piping private laterals alternative was eliminated from further evaluation because AID lacks the authority to carry out, operate, and maintain on-farm infrastructure; it would not meet the project's purpose and need; its effectiveness would be uncertain as any water saved would not necessarily be put in stream by patrons; and because it would not achieve the Federal Objective and Guiding Principles.

[31] This could require AID to mitigate cultural resources on private property and potentially result in the District having to develop long-term maintenance or preservation agreements on lands not subject to AID control.

D.2.6. Piping with Sections of Lined Canal

This alternative would be the same as the Piping Alternative except sections of the Main Canal through the Deschutes River Woods and Woodside neighborhoods would remain open and would be lined.

As discussed in the Canal Lining Alternative (see Section 5.2.1 of the Plan-EA), lining would cover the bottom and sides of the canal with a geomembrane liner and shotcrete to prevent water from seeping into the underlying soils and rock. Earthwork conducted with heavy equipment would be required to modify and reshape the existing canal bed to accommodate the lining material. After reshaping the canal, a geomembrane liner would be installed in the open canal sections to cover the bottom and sides of the canal. The liner would extend up beyond the edges of the canal to anchor trenches. These trenches would help to anchor the liner in place.

Trees and other vegetation within approximately 7 feet of the edge of the canal on both sides would be removed to install the membrane. An anchor trench approximately 1 foot wide by 1 foot deep would be dug along the canal approximately 7 feet beyond the edge of the canal. The liner would extend from the canal edge into the trench where the liner would be covered and weighted by fill material to anchor the liner in place. Finally, a layer of shotcrete would be applied on top of the geomembrane liner in the canal. The shotcrete would be 6 inches thick to protect the liner from freeze-thaw movement and damage from animals and debris.

The Piping with Sections of Lined Canal Alternative would meet the project purpose of conserving water, though less water would be conserved as compared with the Piping Alternative. Piped sections of the canal would reduce water loss from seepage by up to 100 percent and lined sections would reduce water loss up to 95 percent (Swihart & Haynes, 2002).[32] Lined canals, however, are vulnerable to tears or cracks in the lining even with a shotcrete cover. Seepage from torn or cracked lined canals is similar to that from unlined canals.

The Piping with Sections of Lined Canal Alternative would not meet the project purpose to improve public safety. Water velocity in the lined sections would increase because the shotcrete cover would be a smoother surface than the existing underlying rock and dirt (Scoby, 1939). The liner's smoother surface would make the sides of the canal slippery, and the increased water velocity and decreased friction could make it more difficult for anyone who might accidently fall in the water to be able to climb out. Debris screens at the start of each piped section would also pose a safety risk for anyone who might accidently fall in.

The lined sections would require additional maintenance. For example, cracks in the shotcrete are likely to develop in the first few years following installation due to freeze-thaw cycles and would require a regular maintenance program to seal the cracks. In addition, sand blasting and removal of vegetation would be required. This maintenance would require equipment purchases, appropriate training, and recurring materials costs. Based on the findings from Baumgarten (2019) and the District's experience, the design life for the canal lining is estimated to be approximately 30 years; this would require full replacement of the

[32] Swihart and Haynes (2002) estimated a 5 percent water loss in AID's lined canals in 1998, 6 years after the lining was installed. However, based on existing widespread cracking in the shotcrete cover and holes in the geotextile liner, current rates of seepage are likely greater. To be conservative, a 5 percent water loss is assumed.

geomembrane liner and shotcrete every 30 years. The estimated capital costs, replacement costs, and annual operation and maintenance (O&M) costs are $52,474,000 (2022 dollars) over 100 years.[33]

As compared with the Piping Alternative, the Piping with Sections of Lined Canal Alternative would have greater costs and would result in less water conservation and a smaller improvement in water supply management and delivery reliability. The public safety risk would remain along the lined sections of the canal. Piping with Sections of Lined Canal was eliminated from further evaluation because it would not be cost efficient and it would not be effective at meeting the purpose and need of the proposed project.

D.2.7. Managed Aquifer Recharge

Under a managed aquifer recharge (MAR) alternative, MAR would be used in conjunction with the exclusive or partial use of groundwater (see Section D.2.4). During the non-irrigation season, additional water would be passed through or released from Wickiup Reservoir. AID would divert this water from the Deschutes River and use it to recharge the aquifer. AID would recharge the aquifer by conveying the water through its open canals and laterals and allowing it to seep into the aquifer. During the irrigation season, the District would pump an equivalent amount of groundwater from the aquifer, deliver that water to its patrons in lieu of surface water, and reduce its surface water diversions accordingly. The District's canals and laterals would remain open to allow for aquifer recharge during the non-irrigation season and to convey water during the irrigation season.

As described above, MAR would be used in conjunction with the exclusive or partial use of groundwater. The exclusive or partial use of groundwater alternative was considered and eliminated from further study (see Section D.2.4). MAR would not resolve the constraints associated with the exclusive or partial use of groundwater.

MAR would not meet the purposes of the project to conserve water in District-owned infrastructure or to improve public safety on the Main Canal, as water would flow through AID canals during the non-irrigation and irrigation seasons. Increases in water passed through or released from Wickiup Reservoir would meet the project's need of improving instream flow for fish and aquatic habitat but would likely be unacceptable to the public as it would reduce the volume of stored water in the reservoir. MAR would not meet any of the other identified project needs.

A MAR alternative is eliminated from further evaluation because it would not meet the project's purpose and need; and it would likely not be acceptable because it would reduce the volume of stored water in the reservoir.

D.2.8. Aquifer Storage and Recovery

Under an aquifer storage and recovery (ASR) alternative, AID would store water in the aquifer during the non-irrigation season for recovery during the irrigation season. During the non-irrigation season, AID would divert water from the Deschutes River, convey it through its existing canal and lateral system, and inject the water into the aquifer via wells. During the irrigation season, AID would recover the water from the aquifer by pumping out of the wells for delivery to its patrons in lieu of surface water.

[33] For this alternative, Phase 1 was assumed to be 25,026 feet of piping, Phase 2 was 9,083 feet of lining through Woodside, Phase 3 was 9,789 feet of piping, and Phase 4 was 18,975 feet of lining through Deschutes River Woods. Lining costs were estimated in the same manner as described in the Canal Lining Alternative. Piping costs were estimated in the same manner as described in the Piping Alternative.

Under this alternative, AID would divert, store, and recover water under its existing water rights. Any limitations (e.g., character of use, season of use) associated with the original water right would remain (Jen Woody, personal communication, June 30, 2022). The season of use for AID's existing water rights is April 1 to November 1, and, therefore, the District would not be able to divert water for aquifer storage and recovery during the non-irrigation season under these water rights. See Table 4-5 in the Plan-EA for additional information about AID's water rights.

If AID were able to obtain new water rights to make this alternative feasible, additional feasibility studies would be required related to the geology, hydrology, location, and suitability of the associated wells. This alternative would only be feasible if the associated aquifer would retain water stored during the pumping period to be recovered during the recovery period (Jen Woody, personal communication, June 30, 2022). Depending on the identified locations, wells and pumps might need to be sited on private lands owned by AID patrons. However, the District lacks the legal authority to carry out, operate, and maintain wells and pumps on private lands, which is a requirement of the PL 83-566 program (USDA-NRCS, 2015a). AID would, therefore, need to acquire new easements for any wells or pumps on private lands. This approach is logistically complex and would increase project costs.

New ASR projects initially apply for and operate under a limited license from OWRD. Applicants increase the amount of water stored and recovered during the limited license period to ensure that their ASR project operates as intended. AID would have no guarantee that their ASR project would yield the desired results and, therefore, no guarantee that the project would subsequently secure a permit.

An ASR alternative would result in no water conservation and no improvement in public safety risk since the Main Canal would remain open to convey water. As compared to the Piping Alternative, there would be a smaller improvement in water supply management and delivery reliability. An ASR alternative was eliminated from further evaluation because it would not be effective at meeting the purpose and need of the proposed project.

D.3. Capital Costs

References cited can be found in Section 9 of the Plan-EA.

D.3.1. Canal Lining Alternative Costs

The capital cost of the Canal Lining Alternative (Table D-21) for 11.9 miles of the Main Canal was estimated by using the following design and cost assumptions.

- The geomembrane liner would cover the sides and bottom of the canal at a cost of $0.79 per square foot using BTL Liners' 40 mil AquaArmor Double Scrim RPE Liner. This information was provided by Kevin Crew, Principal Engineer, of Black Rock Consulting on November 29, 2021, and is based on a recent North Unit Irrigation District project.
    - The geomembrane liner would extend 7 feet from the edge of the canal on either side and would be covered and weighted by fill material to anchor the liner.
- A layer of shotcrete (fine-aggregate concrete sprayed in place) would cover the geomembrane. A shotcrete thickness of 6 inches is recommended (K. Crew, personal communication, November 29, 2021). This assumption also conforms to NRCS engineering standards (USDA-NRCS, 2017b).
    - A shotcrete cost of $9.26 per square foot was used assuming a 6-inch depth; this is based on a quote of $500 per cubic yard (K. Crew, personal communication, November 29, 2021).
- Installation costs of $100 per linear foot were estimated. This includes excavation of the canal bottom, earth removal, canal reshaping to meet NRCS engineering standards (USDA-NRCS, 2017b), and installation of the geomembrane liner and shotcrete.
- The cross-sectional dimensions for lining the canal were estimated for each corresponding pipe diameter size using transects on a digital elevation model from an irrigation district in Central Oregon.
- Turnout costs were estimated using the same assumptions as for the Piping Alternative: $10,000 per turnout.
- Since there would be no concern with overflow at the start of the canal lining, this alternative does not include an inlet structure or SCADA systems.
- The estimate includes 2.25 percent for engineering and survey and 10 percent for construction management/general contractor services; this is similar to the Piping Alternative and is estimated as a percentage of construction subtotal.
- The estimate includes 30 percent for contingency—the same as for the Piping Alternative—and is estimated as a percentage of subtotal costs plus engineering and survey and construction management/general contractor services.

Table D-21. Canal Lining Alternative Costs.

Feature	Quantity	Unit	Cross section width (feet)	Channel depth (feet)	Geomembrane	Shotcrete	Canal Reshaping & Installation	Subtotal [1]
Lining	18,624	Foot	25.9	4.4	$586,768	$4,463,004	$1,862,430	$6,912,200
Lining	44,245	Foot	34.4	3.9	$1,691,335	$14,087,941	$4,424,521	$20,203,800
Turnout	88	Each	N/A	N/A	N/A	N/A	N/A	$880,000
							Subtotal	**$27,996,000**
							Engineering / Survey (2.25%)	$629,900
							Construction Management / General Contractor (10%)	$2,799,600
							Subtotal with Engineering, Survey, Construction Management, General Contractor	**$31,425,500**
							Contingency (30%)	$9,427,700
							Total	**$40,853,000**

[1]Subtotals are rounded to the nearest $100.

D.3.2. Photos of Existing Canal Lining in the District

The following photos are of existing canal lining sections in the District that were part of the Deschutes Canal-Lining Demonstration Project in partnership with the Bureau of Reclamation (Baumgarten, 2019). The photos were taken by AID in October 2021, approximately 30 years after installation.

Photograph D-1. Canal lining test section A-1 showing cracks and holes in the shotcrete.

Photograph D-2. Canal lining test section A-2 showing cracks in the shotcrete and broken pieces of shotcrete.

Photograph D-3. Canal lining test section A-2 showing broken shotcrete and exposed liner, which is vulnerable to damage.

Photograph D-4. Canal lining test section A-3 showing tears in the exposed liner and upwelling of the liner.

Photograph D-5. Canal lining test section A-3 showing vegetation and debris covering the liner and how the liner has been forced upward, which impedes water flow in the canal.

Photograph D-6. Canal lining test section A-7 showing cracking in the grout-filled mattress and vegetation growth.

Photograph D-7. Canal lining test section A-7 showing sediment covering the grout-filled mattress, which is difficult and time consuming to remove.

D.3.3. Piping Alternative/Preferred Alternative Costs

This section presents capital costs for the Piping Alternative, which is identified as the Preferred Alternative (Table D-22). In addition to the pipe cost, the cost estimate also includes other necessary appurtenances, a concrete inlet structure, and two SCADA systems.

A wide variety of materials are available for piping; the availability of piping materials, prices, and new products change over time. Materials that could be used for the Piping Alternative include, but are not limited to, polyvinyl chloride, steel, HDPE, fiberglass, and ductile iron. For costing this alternative, the price of HDPE was used.

At the time of project implementation, a different piping material could be selected if the material (a) would meet the NEE requirements; (b) meet construction requirements; and (c) result in no change or a minor

change to project effects described in Section 6 of the Plan-EA, as determined through the tiered decision framework approach outlined in Section 1.4 of the Plan-EA. The NRCS state conservationist would possess the final discretion to select the appropriate piping material.

Table D-22. Preferred Alternative Costs.

Feature	Diameter (inches)	Quantity	Units	Unit Cost	Subtotal [1]
Pipe	48	18,624	foot	$152	$6,687,100
Pipe	54	29,994	foot	$124 to $185 [2]	$9,322,500
Pipe	60	14,252	foot	$137	$4,479,900
Turnout	N/A	88	each	$10,000	$880,000
Energy Dissipator	48	1	each	$75,000	$75,000
Energy Dissipator	16	1	each	$15,000	$15,000
Energy Dissipator	10	2	each	$10,000	$20,000
Energy Dissipator	8	1	each	$5,000	$5,000
				Subtotal	**$21,484,500**
				Engineering/Survey (3%)	$644,800
				Construction Management/General Contractor (10%)	$2,148,500
				Contingency (30% for pipe and 10% for energy dissipators and turnouts) [3]	$7,058,700
				Pipe Inlet Structure	$75,600
				Two SCADA systems	$133,600
				Total	**$31,545,700**

[1] Subtotals are rounded to nearest $100 and include a variable construction cost multiplier for installation based on the pipe size. Multipliers range from 1 to 2.35 and are from installation costs of other piping projects in the Deschutes Basin.
[2] The unit cost is a range because it includes pipe with different pressure ratings (10 to 30 pounds per square inch).
[3] Since the Preferred Alternatives costs were estimated using a 10 percent design, the following have not been evaluated or may need further evaluation as the full design is developed: detailed design elements; geotechnical evaluations (if necessary); detailed topographic surveys that locate specific ground features; railroad and road crossings; major utility crossings or conflicts; major tree or other vegetation impacts; significant runoff channels; significant intake or outlet structure designs; cost escalation of construction, materials, structural engineering, and design; and other potentially significant items. For this reason, including a cost contingency is imperative in estimating costs.

D.4. Net Present Value of the Preferred Alternative and the Canal Lining Alternative

This section presents the estimated net present value of the Preferred Alternative and the Canal Lining Alternative (see Table D-23).

Discount Rate: 2.25%

Period of Analysis: 100 years

Table D-23. Net Present Value of the Preferred Alternative and the Canal Lining Alternative.

	Preferred Alternative	Canal Lining Alternative [1]
Design Life (years)	100	30
Capital Costs	$31,545,700	$40,853,000
Net Present Value of Replacement Costs	$169,000	$34,753,000
Annual O&M Costs	$34,000	$51,000
Net Present Value of O&M Costs	$1,347,000	$2,022,000
Total Net Present Value of Alternative	**$33,061,700**	**$77,629,000**

[1] 100 percent of the lining (geomembrane and shotcrete) would be replaced at both 30 years and 60 years.

Appendix E

Other Supporting Information

References cited in Appendix E can be found in Section 9 of the Plan-EA.

E.1. Intensity Threshold Table

This section presents the intensity threshold table (see Table E-1) used to quantify effects to resources of concern because of the proposed action.

Table E-1. Intensity Threshold Table for the Arnold Irrigation District Infrastructure Modernization Project.

Negligible	Changes in the resource or resource-related values would be below or at the level of detection. If detected, the effects on the resource or environment would be considered slight with no perceptible impacts.
Minor	Changes in resource or resource-related values would be measurable but small. The effects on the resource or the environment would be localized.
Moderate	Changes in the resource or resource-related values would be measurable and apparent. The effects on the resource or the environment would be relatively local.
Major	Changes in resource or resource-related values would be measurable and substantial. The effects on the resource or the environment would be regional.
Impact Duration Definitions	
Temporary	Transitory effects, which only occur over a period of days or months.
Short-Term effect	Resource or resource-related values recover in fewer than 5 years.
Long-Term effect	Resource or resource-related values take greater than 5 years to recover.

E.2. Supporting Information for Soil Resources

Table E-2. Project Area Length Crossing Farmland.

NRCS Farmland Class	Project Area (percent)	Project Area (miles)
Prime farmland if irrigated	2%	0.2
Farmland of statewide importance	97%	11.6
Not prime farmland	1%	0.1
Total	**100%**	**11.9**

Source: NRCS SSURGO FY2018 data

E.3. Supporting Information for Vegetation Resources

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 are recommended (Deschutes County, 2017). Table E-3 lists the noxious weeds and corresponding classifications known to occur in the project area.

Table E-3. Noxious Weeds Occurring in the Project Area.

Vegetation Species	Scientific Name	Deschutes County Noxious Weed Rating
Buffalobur	*Solanum rostratum*	A
Bull thistle	*Cirsium vulgare*	C
Canada thistle	*Cirsium arvense*	B
Cheatgrass	*Bromus tectorum*	C
Common mullein	*Verbascum thapsus*	C
Dalmation toadflax	*Linaria dalmatica*	B
Diffuse knapweed	*Centaurea diffusa*	B
Eurasian milfoil	*Myriophyllum spicatum*	A
Hoary alyssum	*Berteroa incana*	A

Vegetation Species	Scientific Name	Deschutes County Noxious Weed Rating
Hydrilla	*Hydrilla verticillate*	A
Kochia	*Kochia scoparia*	B
Leafy Spurge	*Euphorbia esula*	A
Mediterranean sage	*Salvia aethiopis*	A
Medusahead rye	*Taeniatherum caput-medusae*	A
Myrtle spurge	*Euphorbia myrsinites*	B
Orange hawkweed	*Hieracium aurantiacum*	A
Perennial pepperweed	*Lepidium latifolium*	A
Poison hemlock	*Conium maculatum*	B
Puncturevine	*Tribulus terrestris*	B
Purple loosestrife	*Lythrum salicaria*	A
Ribbon grass	*Phalaris arundinacea var. picta*	B
Russian knapweed	*Acroptilon repens*	A
Russian thistle	*Salsola* spp.	B
Saltcedar tamarix	*Tamarix ramosissima*	A
Scotch thistle	*Onopordum acanthium*	A
Spotted knapweed	*Centaurea stoebe*	B
Tansy ragwort	*Senecio jacobaea*	A
Ventenata	*Ventenata dubia*	A
Whitetop; Hoary cress	*Lepidium draba*	A
Wild Carrot	*Daucus carota*	A
Yellowflag iris	*Iris pseudacorus*	B
Yellow floating heart	*Nymphoides* spp.	A
Yellow toadflax	*Linaria vulgaris*	B

Source: Deschutes Soil and Water Conservation District, 2015

E.4. Supporting Information for Water Resources

E.4.1. Water Loss Information

This section presents the methodology and data used to evaluate the potential effects of the Preferred Alternative on water resources. Data used are from the Arnold Irrigation District (AID) System Improvement Plan (Crew, 2017) and a follow-up water loss study by Oregon Water Resources Department (OWRD) in 2019.

In 2016, Black Rock Consulting worked with AID to coordinate a seepage loss study performed by Farmers Conservation Alliance staff under direction from Black Rock Consulting/Kevin L. Crew, P.E., and David C. Prull, P.E. During the summer of 2016, a Seepage Loss Assessment Program (LAP), was implemented in seven of the eight Central Oregon irrigation districts including AID. The LAP was supported by Oregon State University and OWRD and was completed to inform the districts of current system losses. The LAP included the use of newly purchased and calibrated Sontek Flowtracker II technology, the Sontek Flowtracker II manual, and office and field training all in accordance with the U.S. Geological Survey and Bureau of Reclamation practices.

The primary purpose of the LAP was to perform a one-time measurement program in each district. The program provided the approximate seepage loss in canal segments of each individual district system. The measurements were performed at different times of the irrigation season within each district. Therefore, the percentage of peak flow at the time of measurement varied by district as the LAP team entered, measured, and exited each district. The results were interpolated or extrapolated based upon the maximum expected loss within each District. The final loss information was used to identify losses by project phase or lateral. This loss information was then validated in the AID system through a follow-up loss assessment performed by OWRD in 2019.

For AID, the LAP was implemented throughout the District's primary Main Canal and system laterals. Direct measurements identified a total seepage loss of approximately 46 cfs in the District's system. Seepage loss in the Main Canal was measured at 32.5 cfs (see Table E-4).[34]

Table E-4. Arnold Irrigation District Seepage Loss in the Project Area.

	Main Canal – Tail End (cfs)	Main Canal – Mid Section (cfs)	Main Canal – Upper (cfs)	Total (cfs)
Seepage Loss [1]	11.2	9.2	12.1	32.5

[1] While water loss must be initially calculated in cfs, the total volume of water lost through the season in the Main Canal was calculated to be 11,083 acre-feet.

[34] This water loss value reflects water lost in the 11.9-mile-long earthen section of the Main Canal.

E.4.2. Instream Flow Targets

This section presents supporting calculations used when evaluating the effects of the proposed action with respect to water resources (see Table E-5).

Table E-5. Pending and Certificated Instream Water Rights for the Deschutes River.

Source	From	To	Certificate	Priority Date	Instream Rates (cfs)											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Deschutes River	Crane Prairie Reservoir	Wickiup Reservoir	73233	10/11/1990	130	130	130	130	130	130	130	130	130	130	130	130
Deschutes River	Wickiup Reservoir	Little Deschutes River	59776	11/3/1983	300	300	300	300	300	300	300	300	300	300	300	300
Deschutes River	Little Deschutes River	Spring River	59777	11/3/1983	400	400	400	400	400	400	400	400	400	400	400	400
Deschutes River	Spring River	North Canal Dam	59778	11/3/1983	660	660	660	660	660	660	660	660	660	660	660	660
Deschutes River	North Canal Dam	Lake Billy Chinook	70695	Pending	250	250	250	250	250	250	250	250	250	250	250	250

Source: Oregon Water Resources Department Water Rights Information Query

E.4.3. Deschutes River, Below Wickiup Reservoir

This section presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in the Deschutes River at Wickiup Reservoir (see Table E-6 and Table E-7).

Table E-6. 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 Streamflow (cfs) – 20% Exceedance
Oct	107	8	115	409	524
Nov	107	10	117	13	129
Dec	103	2	105	82	187
Jan	104	4	108	92	200
Feb	101	7	108	87	195
Mar	100	8	108	86	194
Apr	415	192	607	106	712
May	728	255	983	238	1,220
Jun	1,030	180	1,210	220	1,430
Jul	1,358	52	1,410	190	1,600
Aug	1,300	120	1,420	122	1,542
Sep	690	350	1,040	220	1,260

Note: Streamflow in the Deschutes River downstream from Wickiup Reservoir at OWRD Gauge No. 14056500 from the October 2016 through September 2020 water years.

Table E-7. Deschutes River Post-Project Streamflow below Wickiup Reservoir.

Month	Pre-Project Daily Average Streamflow (cfs) [1]	Streamflow Restored Through Project (cfs)	Post-Project Daily Average Streamflow (cfs) [1, 2, 3]	ODFW Instream Water Right [4] in the Deschutes River from Wickiup Reservoir to the mouth of the Little Deschutes River	Post-Project Percentage Increase in Average Streamflow [2, 3]
Oct	115.0	0.00	115.0	300	0%
Nov	116.5	33.8	150.3	300	22%
Dec	105.0	33.8	138.8	300	24%
Jan	108.0	33.8	141.8	300	24%
Feb	108.0	33.8	141.8	300	24%
Mar	108.0	33.8	141.8	300	24%
Apr	606.5	0.00	606.5	300	0%
May	982.5	0.00	982.5	300	0%
Jun	1,210.0	0.00	1,210.0	300	0%
Jul	1,410.0	0.00	1,410.0	300	0%
Aug	1,420.0	0.00	1,420.0	300	0%
Sep	1,040.0	0.00	1,040.0	300	0%

Notes:
[1] Uses streamflow data in Table E-6 above.
[2] Post-Project Average Daily Streamflow does not include water saved and allocated instream in this reach from other water conservation projects currently being implemented in the Upper Deschutes Basin.
[3] This additional flow would be beneficial to the Deschutes River until Year 8 of the HCP when the minimum winter flow target is increased to 300 cfs.
[4] Certificate No. 59776

E.4.4. 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 Deschutes River at Benham Falls (see Table E-8 and Table E-9).

Table E-8. Deschutes River Daily Average Streamflow at Benham Falls 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
Oct	525	114	639	399	1,038
Nov	503	65	568	68	635
Dec	519	43	562	131	693
Jan	524	48	572	163	734
Feb	524	65	589	140	729
Mar	525	146	671	151	822
Apr	1,070	160	1,230	250	1,480
May	1,370	260	1,630	112	1,742
Jun	1,530	170	1,700	150	1,850
Jul	1,710	95	1,805	255	2,060
Aug	1,670	110	1,780	200	1,980
Sep	1,190	265	1,455	215	1,670

Note: Streamflow in the Deschutes River at Benham Falls at OWRD Gauge No. 14064500 vary within and between years. Data represent the October 2016 through September 2020 water years.

Table E-9. Deschutes River Post-Project Streamflow at Benham Falls.

Month	Pre-Project Daily Average Streamflow (cfs) [1]	Streamflow Restored Through Project (cfs) [2]	Post-Project Daily Average Streamflow (cfs) [1, 3, 4]	ODFW Instream Water Right [5] in the Deschutes River from the mouth of the Little Deschutes River to the confluence of Spring River	ODFW Instream Water Right [6] in the Deschutes River from the mouth of Spring River to the North Canal Dam at Bend	Post-Project Percentage Increase in Average Streamflow [3, 4]
Oct	639.0	0.0	639.0	400	660	0%
Nov	567.5	29.5	597.0	400	660	5%
Dec	562.0	29.5	591.5	400	660	5%
Jan	571.5	29.5	601.0	400	660	5%
Feb	589.0	29.5	618.5	400	660	5%
Mar	671.0	29.5	700.5	400	660	4%
Apr	1,230.0	0.0	1,230.0	400	660	0%
May	1,630.0	0.0	1,630.0	400	660	0%
Jun	1,700.0	0.0	1,700.0	400	660	0%
Jul	1,805.0	0.0	1,805.0	400	660	0%
Aug	1,780.0	0.0	1,780.0	400	660	0%
Sep	1,455.0	0.0	1,455.0	400	660	0%

Notes:
[1] Uses streamflow data in Table E-8 above.
[2] This additional streamflow includes an estimated 12.5 percent channel loss from Wickiup Reservoir to Benham Falls.
[3] Post-Project Daily Average Streamflow does not include water saved and allocated instream in this reach from other water conservation projects currently being implemented in the Upper Deschutes Basin.
[4] This additional flow would be beneficial to the Deschutes River until Year 8 of the HCP when the minimum winter flow target is increased to 300 cfs.
[5] Certificate No. 59777
[6] Certificate No. 59778

E.4.5. 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 Deschutes River at Bend, below North Canal Dam (see Table E-10 and Table E-11).

Table E-10. 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
Oct	81	369	450	87	537
Nov	454	47	501	77	577
Dec	474	31	505	130	634
Jan	450	40	490	171	661
Feb	431	65	496	146	642
Mar	447	107	554	124	678
Apr	91	281	372	371	742
May	81	35	117	17	133
Jun	121	4	125	257	382
Jul	122	4	126	7	133
Aug	119	6	125	7	132
Sep	90	33	123	14	137

Note: Streamflow in the Deschutes River downstream from the City of Bend at OWRD Gauge No. 14070500 from the October 2016 through September 2020 water years.

Table E-11. Deschutes River Post-Project Streamflow at Bend—Below North Canal Dam.

Month	Pre-Project Daily Average Streamflow (cfs) [1]	Streamflow Restored Through Project (cfs) [2]	Post-Project Daily Average Streamflow (cfs) [1, 3, 4]	Oregon Department of Fish and Wildlife Instream Water Right [5]	Post-Project Percentage Increase in Average Streamflow [3, 4]
Oct	450.0	0.0	450.0	250	0%
Nov	500.5	27.5	528.0	250	5%
Dec	504.5	27.5	532.0	250	5%
Jan	490.0	27.5	517.5	250	5%
Feb	496.0	27.5	523.5	250	5%
Mar	553.5	27.5	581.0	250	5%
Apr	371.5	0.0	371.5	250	0%
May	116.5	0.0	116.5	250	0%
Jun	125.0	0.0	125.0	250	0%
Jul	126.0	0.0	126.0	250	0%
Aug	125.0	0.0	125.0	250	0%
Sep	86.0	0.0	86.0	250	0%

Notes:
[1] Uses streamflow data in Table E-10 above.
[2] This additional streamflow includes an estimated 7 percent channel loss from Benham Falls to the City of Bend.
[3] Post-Project Daily Average Streamflow does not include water saved and allocated instream in this reach from other water conservation projects currently being implemented in the Upper Deschutes Basin.
[4] This additional flow would be beneficial to the Deschutes River until Year 8 of the HCP when the minimum winter flow target is increased to 300 cfs.
[5] Pending Instream Application #70695.

E.4.6. Arnold Irrigation District Diversion Rates

This subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources (see Table E-12).

Table E-12. AID Main Canal Diversion – Historic Daily Average Diversion Rate between 2000 and 2021

Month	Low Diversion Rate (cfs) 80% Exceedance	Lower Bar	Average Diversion Rate (cfs) 50% Exceedance	Upper Bar	High Diversion Rate (cfs) 20% Exceedance	Max Diversion Rate (cfs)
Oct	58	8	66	8	74	85
Nov	0	0	0	0	0	53
Dec	0	0	0	0	0	50
Jan	0	0	0	0	0	51
Feb	0	0	0	0	0	51
Mar	0	0	0	1	1	63
Apr	49	15	64	13	77	85
May	76	7	84	6	90	102
Jun	80	7	87	6	93	108
Jul	81	7	88	5	93	110
Aug	86	7	93	5	98	106
Sep	85	9	94	4	98	108

Note: Diversion Rate data sourced from OWRD Gauge No. 14065500 from the October 2000 through September 2021 water years.

E.4.7. Reservoir Storage Allocation Agreement

This section presents the 2019 Amendment to the AID, COID, and LPID 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:"

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 RESERVOIR STORAGE ALLOCATION AGREEMENT is effective as of the date set forth above.

Arnold Irrigation District ("AID")

By: _____ Date: 12-10-19
Its Board President

By: _____ Date: 12/10/19
Its Board Secretary

Central Oregon Irrigation District ("COID")

By: _____ Date: 12-2-19
Its Board President

By: _____ Date: 12.2.19
Its Board Secretary

Lone Pine Irrigation District ("LPID")

By: _____ Date: 12-11-19
Its Board President

By: _____ Date: 12-11-19
Its Board Secretary

The following entity acknowledges and agrees to Paragraph 2 above:

North Unit Irrigation District ("NUID")

By: _____ Date: 12-2-19
Its Board President

By: _____ Date: 12/2/19
Its Board Secretary

E.4.8. Summary of the Operation Measures Set forth by the Deschutes Basin Habitat Conservation Plan (2020)

This section presents a summary of the operation measures set forth by the Deschutes Basin Habitat Conservation Plan (HCP; AID et al., 2020). Figure C-3 in Appendix C includes locations of all the gages described.

1. From April 1 through September 15, flow at OWRD Gage 14056500 will be at least 600 cfs. An adaptive management element will be used to test whether going directly to 600 cfs by April 1 provides enhanced survival of Oregon spotted frog. In coordination with the U.S. Fish and Wildlife Service (USFWS), flows may be set at 400 cfs by April 1 and increased to 600 cfs within the first 2 weeks of April. Annual snowpack, weather, and in-stream conditions will inform this decision.

2. From April 1 through April 30, flow at OWRD Gage 14056500 shall not exceed 800 cfs unless USFWS or a biologist approved by USFWS has verified that Oregon spotted frog eggs at Dead Slough in La Pine State Park have hatched or are physically situated in a portion of the slough where an increase in flow will not harm them.

3. If the flow at OWRD Gage 14056500 is increased above 600 cfs during the month of April, it will not subsequently be allowed to decrease more than 30 cfs, whether in a single flow adjustment or cumulatively over the course of multiple flow adjustments, until after April 30 or an earlier date approved after coordination with USFWS.

4. From May 1 through June 30, flow decrease at OWRD Gage 14056500 over any 5-day period shall be no more than 20 percent of total flow at the time the decrease is initiated.

5. Flow at OWRD Gage 14064500 shall be no less than 1,300 cfs from July 1 through at least September 15.

6. For the first 7 years of HCP implementation, flow at OWRD Gage 14056500 shall be at least 100 cfs from September 16 through March 31. Beginning in Year 1 of HCP implementation, minimum flow at OWRD Gage 14056500 from September 16 through March 31 shall be increased above 100 cfs in proportion to the amount of live Deschutes River flow made available to North Unit Irrigation District (NUID) during the prior irrigation season as a result of the piping of Central Oregon Irrigation District (COID)–owned canals. For each acre-foot (or portion thereof) of live flow made available to NUID as a result of the piping of COID-owned canals after the date of incidental take permit issuance, an equal volume of water shall be added to the minimum flow below Wickiup Dam from September 16 through March 31. This water shall be in addition to the amount of water needed to maintain a flow at OWRD Gage 14056500 of at least 100 cfs. The timing for release of the additional water shall be determined in coordination with USFWS for optimal benefit to Oregon spotted frog.

7. Beginning no later than Year 8 of HCP implementation, flow at OWRD Gage 14056500 shall be at least 300 cfs from September 16 through March 31 and not more than 1,400 cfs for more than 10 days per year between April 1 and September 15. If NUID anticipates the need to exceed 1,400 cfs at OWRD Gage 14056500 in Years 8 through 12, it will contact USFWS in advance to discuss options for minimizing the adverse effects on the Deschutes River and Oregon spotted frog such as conditioning the rate or timing of flow increases above 1,400 cfs.

8. Beginning no later than Year 13 of HCP implementation, minimum flow at OWRD Gage 14056500 shall be between 400 cfs and 500 cfs from September 16 through March 31 (with actual flow during this period determined according to the variable flow tool described in the HCP) and not more than 1,200 cfs for more than 10 days per year between April 1 and September 15.

9. For all years, the volume of water equivalent to the amount scheduled for winter releases in excess of 100 cfs may be stored in Wickiup Reservoir for release later in the same water year. Water stored in this manner and released during the irrigation season will be treated as NUID storage and available for diversion by NUID at North Canal Dam. Water stored in this manner and not released for Oregon spotted frog or fish by the end of the same water year can be used to meet the minimum flow requirements of this conservation measure at OWRD Gage 14056500 through March 31 of the subsequent water year. Any water stored in this manner and not released to meet HCP minimum flow requirements by March 31 will become NUID storage and available for irrigation use.

10. During the fall ramp-down, flow reductions at OWRD Gage 14056500 shall be halted for 5 days when the corresponding flow at OWRD Gage 14064500 reaches 1,200 and again for 5 days when the corresponding flow at OWRD Gage 14064500 reaches 1,100 cfs.

E.5. Supporting Information for Fish and Aquatic Resources

This appendix section presents supporting information associated with Primary Constituent Elements for critical habitat of federally listed species (see Table E-13, Table E-14, and Table E-15).

Table E-13. Primary Constituent Elements for Oregon Spotted Frog Critical Habitat.

Primary Constituent Element (PCE) 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 waterbody (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)
		An absence or low density of nonnative predators (B, R, N)

Primary Constituent Element (PCE) Number	Habitat Description	Characteristics
PCE 2	Aquatic movement corridors; Ephemeral or permanent bodies of fresh water	Less than or equal to 3.1 miles (5 kilometers) 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)

Source: Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Oregon spotted frog (50 Code of Federal Regulations 17)

Table E-14. Primary Constituent Elements for Bull Trout.

Primary Constituent Element (PCE) 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.
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 degrees Celsius (36 to 59 degrees Fahrenheit) with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range 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 vary from system to system.
PCE 7	A natural hydrograph including peak, high, low, and base flows within historical and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.
PCE 8	Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
PCE 9	Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass), interbreeding (e.g., brook trout), or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

Source: Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for Bull Trout in the Coterminous United States (50 Code of Federal Regulations 17)

Table E-15. Fish and Mollusk Species within the Area Affected by District Operations for the Arnold Irrigation District Infrastructure Modernization Project.

Species Common Name	Scientific Name	Crane Prairie Reservoir	Wickiup Reservoir	Upper Deschutes River	Middle Deschutes River
Bull trout	*Salvelinus confluentus*				X
Steelhead trout	*Oncorhynchus mykiss*				X
Spring Chinook salmon	*Oncorhynchus tshawytscha*				X
Redband trout	*Oncorhynchus mykiss gairdnerii*	X	X	X	X
Kokanee Salmon	*Oncorhynchus nerka*	X	X		
Mountain whitefish	*Prosopium williamsoni*	X	X	X	X
Largescale sucker	*Catostomus macrocheilus*	X	X	X	X
Bridgelip sucker	*Catostomus columbianus*	X	X	X	X
Chiselmouth	*Acrocheilus alutaceus*	X	X	X	X
Dace species	*Rhinichthys* (spp.)	X	X	X	X
Sculpin species	Family Cottidae	X	X	X	X
Brook trout	*Salvelinus fontinalis*	X	X	X	X
Brown trout	*Salmo trutta*	X	X	X	X
Western pearlshell mussel	*Margaritifera falcata*			X	X
Western ridged mussel	*Gonidea angulata*				X

Source: AID et al., 2020

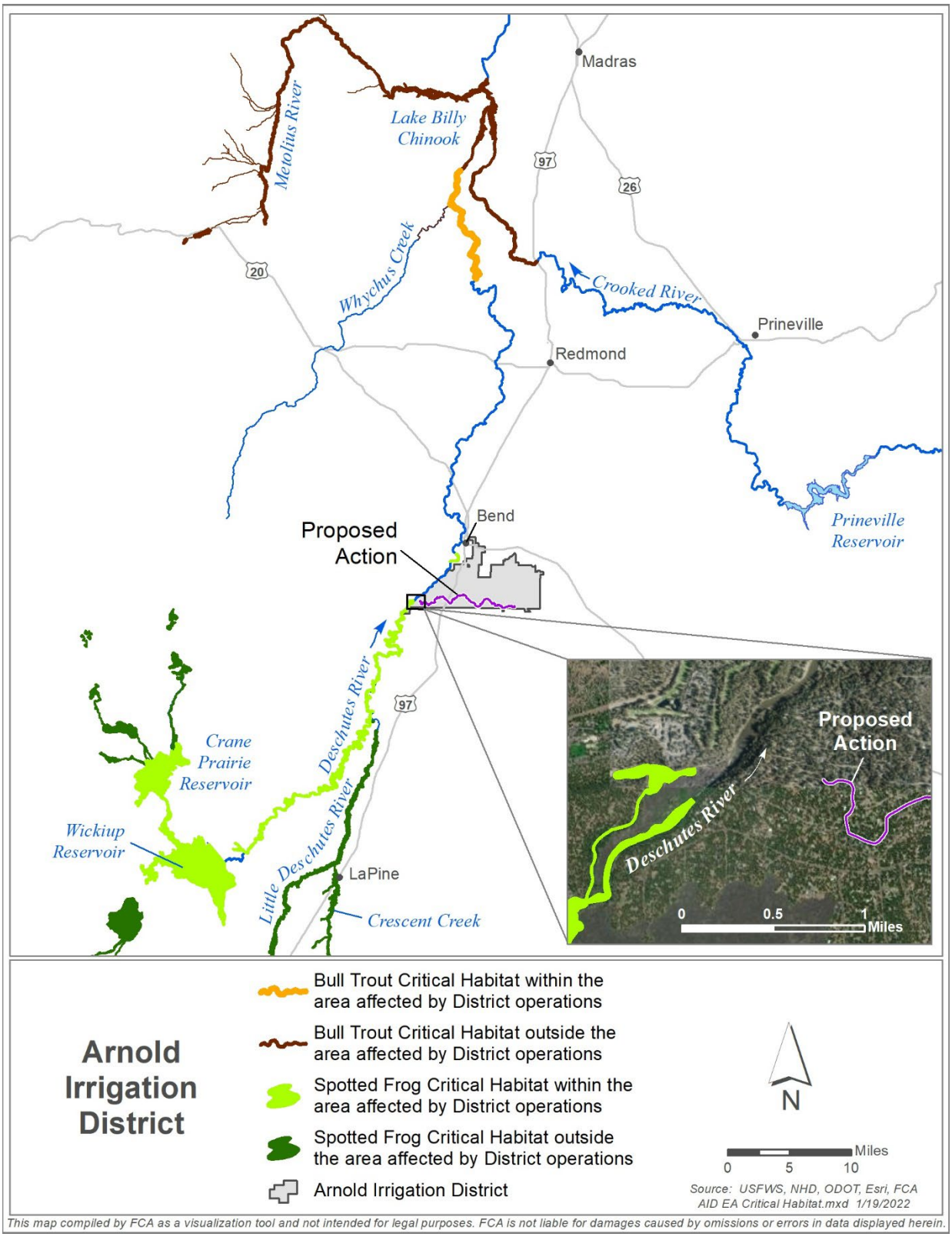
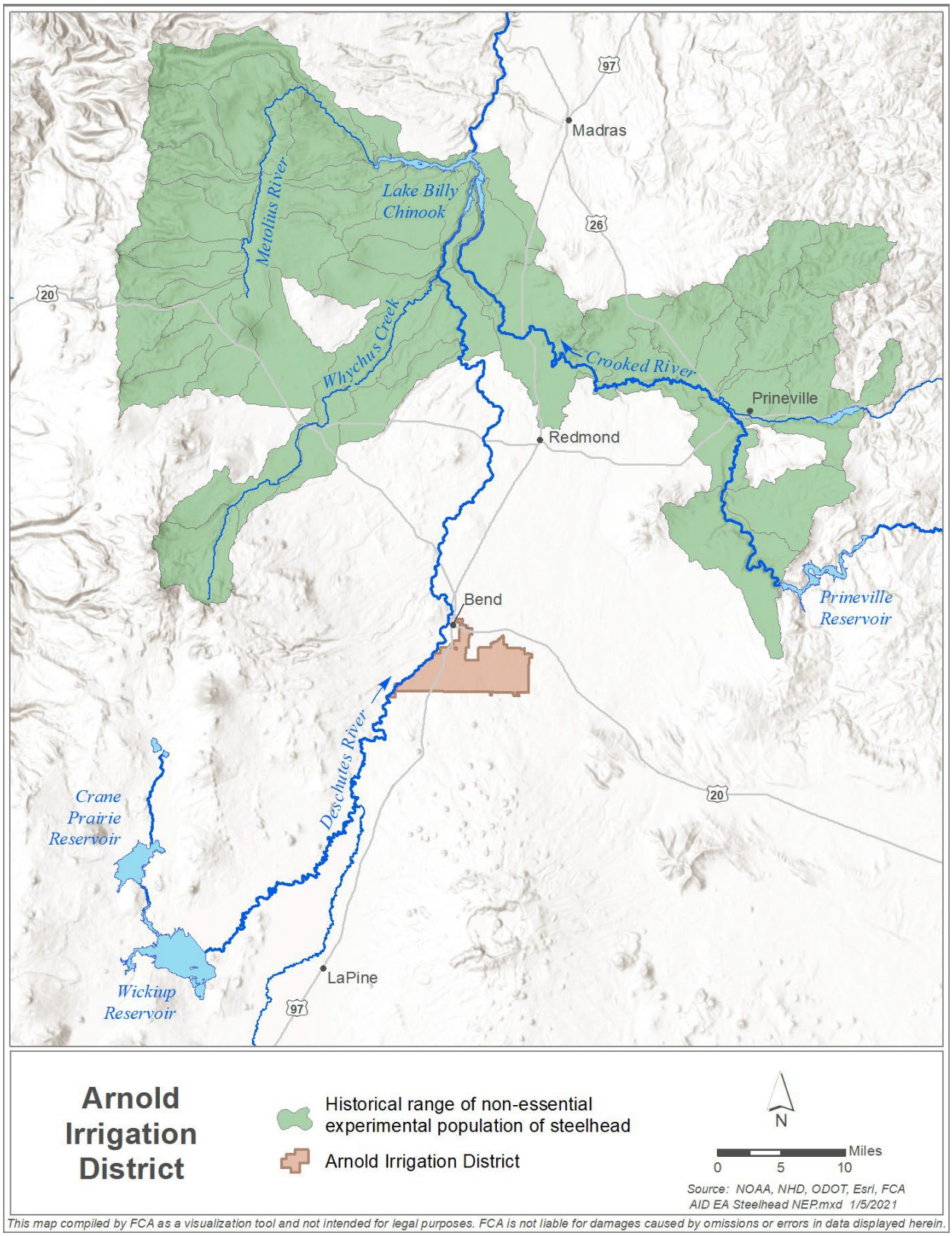


Figure E-1. Bull trout and Oregon spotted frog critical habitat within and outside the area affected by District operations.



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

E.6. Supporting Information for Wildlife Resources

This section presents supporting information for the wildlife resources section (see Table E-16).

Table E-16. Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species Potentially Occurring within the Project Area.[1]

Migratory Bird Treaty Act/Bald and Golden Eagle Protection Act Species	Scientific Name
Bald eagle	*Haliaeetus leucocephalus*
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*
Golden eagle	*Aquila chrysaetos*
Green-tailed towhee	*Pipilo chlorurus*
Lewis's woodpecker	*Melanerpes lewis*
Loggerhead shrike	*Lanius ludovicianus*
Long-billed curlew	*Numenius americanus*
Olive-sided flycatcher	*Contopus cooperi*
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 albolarvatus*
Williamson's sapsucker	*Sphyrapicus thyroideus*
Willow flycatcher	*Empidonax traillii*

Source: USFWS 2021

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

E.7. Wild and Scenic Outstandingly Remarkable Values

This section presents supporting information associated with Outstandingly Remarkable Values identified for the upper and middle Deschutes River (see Table E-17 and Table E-18).

Table E-17. Outstandingly Remarkable Values for the Upper Deschutes River.

Outstandingly Remarkable Value	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 Estes' Artemisia (*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 that 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 humancontrolled 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.

Outstandingly Remarkable Value	Outstandingly Remarkable Value Description
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.
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 to be significant because it provides important nesting habitat for birds and travel corridors for migrating game animals such as deer and elk.

Source: USDA, 1996
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 Central Oregon Irrigation District 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 Endangered Species Act (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.

Table E-18. Outstandingly Remarkable Values for the Middle Deschutes 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.
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 1900s.
Geologic	Fifty million years of geologic history are dramatically displayed on the canyon walls of the middle Deschutes River. 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 resource are 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; whitewater 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.

Outstandingly Remarkable Value	Outstandingly Remarkable Value Description
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. Outstanding habitat areas include high vertical cliffs, wide talus slopes, numerous caves, pristine riparian zones, and extensive grass/sage covered slopes and plateaus.

Source: National Wild and Scenic Rivers System, n.d.

E.8. Guiding Principles

Guiding Principles (USDA-NRCS, 2017a) The Guiding Principles identified in the PR&G are considered when developing and evaluating alternatives, as described below.	
Healthy and Resilient Ecosystems	A primary objective of the PR&G analysis is the identification of alternatives that protect and restore the functions of ecosystems. Alternatives should first avoid adverse impact. When environmental consequences occur, alternatives should minimize the impact and mitigate unavoidable damage. If damage occurs, mitigation to offset environmental damage must be included in the alternative's design and costs.
Sustainable Economic Development	Alternatives for resolving water resources problems should improve the economic well-being of the Nation for present and future generations. The PR&G analysis considers the effects of alternatives on both water availability and water quality to evaluate the sustainability of economic activity and ecosystem services. Water use or management factors that provide improved sustainability or reduced uncertainty should be identified in alternatives.
Floodplains	The PR&G seek to avoid unwise use of floodplains and flood-prone areas. Alternatives should avoid investments that adversely affect floodplain function such that the floodplain is no longer self-sustaining. If an alternative impacts floodplain function, then the alternative should describe efforts to minimize and mitigate the impact and the residual loss of floodplain function. The PR&G investment evaluation of alternatives must be consistent with Executive Order 11988 of May 24, 1977 (Floodplain Management), as modified by Executive Order 13690 of January 30, 2015 (Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input), and the Federal Flood Risk Management Standard, which require executive departments and agencies to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. The PR&G investment evaluation is informed by the processes to evaluate the impacts of federal actions affecting floodplains consistent with Executive Order 11988, as amended.
Public Safety	An objective of the PR&G is to reduce risks to people including life, injury, property, essential public services, and environmental threats concerning air and water quality. These risks to public health and safety must be evaluated and documented for all alternatives including those using nonstructural approaches. The residual risks to public health and safety associated with each of the water investment alternatives should be described, quantified if possible, and documented.

Environmental Justice	An objective of the PR&G investment evaluation process is the fair treatment of all people including meaningful involvement in the public comment process. Any disproportionate impact to minority, Tribal, and low-income populations should be avoided. In implementing the PR&G, agencies should seek solutions that would eliminate or avoid disproportionate adverse effects on these communities. For watershed investments, particular attention should be focused to downstream areas. The study area may need to be reexamined to include the concerns of affected communities downstream of the immediate investment area. The PR&G process should document efforts to include the above-mentioned populations in the planning process. The PR&G process must be in compliance with Executive Order 12898 of February 11, 1994 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations). Applications of the PR&G process in USDA agencies must be in compliance with USDA DR 5600-002 (Environmental Justice).
Watershed Approach	A watershed approach must be used when completing a PR&G analysis. This approach recognizes that there may be upstream and downstream impacts of a water resources activity that may be outside of the applicable political or administrative boundaries. A watershed approach is not necessarily limited to analyzing impacts within a specific hydrologic unit. Rather, it is broad, systems- based framework that explicitly recognizes the interconnectedness within and among physical, ecological, economic, and social/cultural systems. A watershed approach enables examination of multiple objectives, facilitates the framing of water resources problems, incorporates a broad range of stakeholders, and allows for identification of interdependence of problems and potential solutions. In many instances, a specific hydrologic unit may be the appropriate scale to examine alternatives to address water resources problems and opportunities. In this case, the watershed would become the study area. In other cases, environmental, economic, or social conditions may merit a study area that is a combination of various hydrologic units or other geographic groupings. Ideally, the area of analysis should represent a geographical area large enough to ensure plans address cause and effect relationships among affected resources, stakeholders, and investment options, both upstream and downstream of an investment site. The watershed approach also establishes the framework to examine cumulative effects and the interaction of a potential Federal investment with other water resources projects and programs. When considering the impact of Federal investments against some economic and ecological measures, the analysis may need to be expanded to include regional markets and habitat considerations beyond the initial study area (e.g., beyond the immediate hydrologic unit).

E.9. Supporting Information for Cultural Resources

USDA
United States Department of Agriculture

NRCS

State Office

1201 NE Lloyd Blvd.,
Suite 900
Portland, OR 97232
503.414.3212

20JULY2021

SHPO Compliance
State Historic Preservation Office
725 Summer Street, NE, Suite C
Salem, Oregon 97301-1226

Subject: Arnold Irrigation District System Improvement Piping

In compliance with the National Historic Preservation Act of 1966 (as amended), 36 CFR Part 800.11(d), Natural Resources Conservation Service is submitting the archaeological report, completed by Scott Stuemke to the Oregon State Historic Preservation Office for the following federally funded Watershed Protection and Flood Prevention Act (PL-566) project for the Arnold Irrigation District.

The Watershed Protection and Flood Prevention Act (PL-566) authorizes the USDA Natural Resources Conservation Service to help local organizations and units of government plan and implement watershed projects. PL-566 watershed projects are locally led to solve natural and human resource problems in watersheds up to 250,000 acres (less than 400 square miles).

PL-566 works through local government sponsors and helps participants solve natural resource and related economic problems on a watershed basis. Projects can include flood prevention and damage reduction, development of rural water supply sources, erosion and sediment control, fish and wildlife habitat enhancement, wetland creation and restoration, and increased recreational opportunities. NRCS has sub-contracted the Qualified Archaeologist named above,

NRCS has reviewed this report and concurs with the findings regarding eligibility for the Arnold Irrigation District Canal. We look forward to your review.

Sincerely,

Michael Petrozza, M.A., RPA
NRCS-OR State Cultural Resources Specialist

E.10. Supporting Information for Public Safety

The following is an excerpt from a U.S. Forest Service Oregon Wildfire Risk Explorer-Advanced Report that was generated using the AID watershed planning area.

Oregon Wildfire Risk Explorer- Advanced Report

AID

1,755 Acres: (3 Sq. Miles)

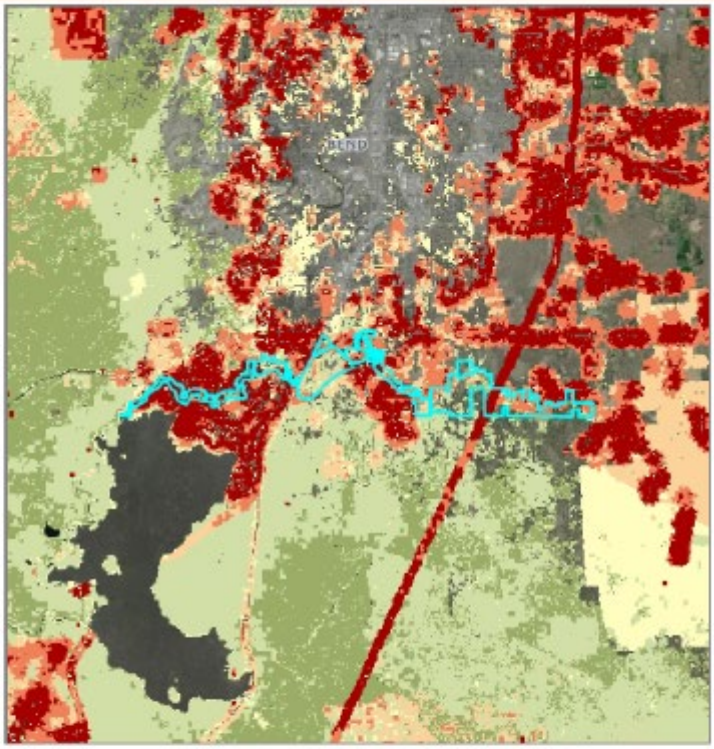
Generated: February 8, 2022

OVERALL WILDFIRE RISK

Overall wildfire risk combines both the likelihood of a wildfire and the expected impacts of a wildfire on highly valued resources and assets. (See other sections for more information on Burn probability and Overall potential impact.) Overall wildfire risk also reflects the susceptibility of resources and assets to wildfire of different intensities, and the likelihood of those intensities.

Mapped resources and assets include critical infrastructure, developed recreation, housing unit density, seed orchards, sawmills, historic structures, timber, municipal watersheds, vegetation condition, and terrestrial and aquatic wildlife habitat.

The data values in the overall wildfire risk map and chart reflect a range of impacts from a very high negative value, where wildfire is detrimental to one or more resources or assets, to positive, where wildfire has an overall benefit (e.g., forest health or wildlife habitat).



Overall wildfire risk: Legend	
Very High	Wildfire risk is very highly negative (top 5% of values).
High	Wildfire risk is highly negative (80th to 95th percentile).
Moderate	Wildfire risk is moderately negative (50th to 80th percentile).
Low	Wildfire risk is slightly negative(29th to 50th percentile).
Low Benefit	Wildfire is slightly beneficial (14.5 to 29th percentile).
Benefit	Wildfire is beneficial overall (0-14.5th percentile).
Non-burnable	There are no highly valued resources or assets mapped in the area, or it is considered non-burnable (urban, agriculture, etc).

9

Oregon Wildfire Risk Explorer- Advanced Report

AID

1,755 Acres: (3 Sq. Miles)

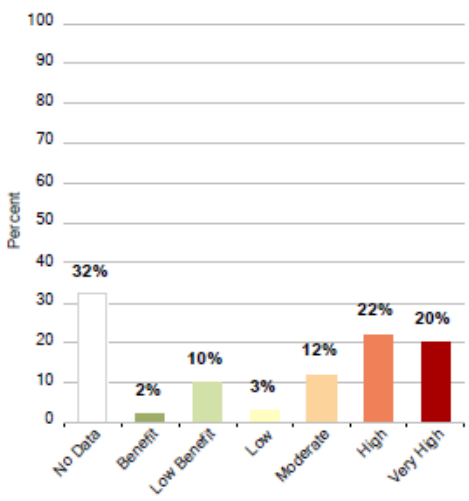
Generated: February 8, 2022

This page contains additional information about overall wildfire risk, including a table of classes by ownership to determine the distribution of categories across ownerships, and a chart of overall percentages of classes across the area. The inset box displays sub-watershed summaries for landscape-scale prioritization.

Overall wildfire risk in AID: estimated acres by ownership

Category	Total	Private	Local	State	BLM	USFS	USFWS	Other Fed	Tribal
Very High	343	343	0	0	0	0	0	0	0
High	378	377	0	0	0	1	0	0	0
Moderate	205	200	0	0	0	5	0	0	0
Low	47	45	0	0	0	2	0	0	0
Low Benefit	182	181	0	0	0	1	0	0	0
Benefit	29	29	0	0	0	0	0	0	0
No Data	563	560	0	0	0	3	0	0	0
Total Area	1,747	1,735	0	0	0	12	0	0	0

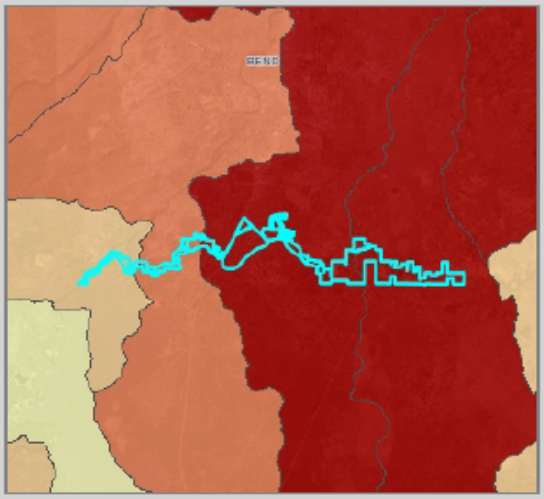
Overall wildfire risk in AID *



Source: 2018 Pacific Northwest Quantitative Wildfire Risk Assessment, US Forest Service

** Values may add up to over 100% due to rounding precision*

Overall wildfire risk in AID: sub-watershed summary map. Overall wildfire risk is summarized at the sub-watershed (6th field Hydrologic Unit Code, HUC12) level. Watershed summaries enable you to view the landscape context and identify and compare sub-watersheds for prioritization.



10

E.11. Consultation and Notice of Availability Letters

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Ms. Christine Curran
Deputy State Historic Preservation Officer
Parks and Recreation Department
State Historic Preservation Office
725 Summer Street, NE, Suite C
Salem, OR 97301-1226

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Ms. Curran,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

The purpose of this project is to improve water conservation and improve water supply management and water delivery reliability on District-owned canals and laterals. Arnold Irrigation District proposes to pipe 13.2 miles of the Arnold Irrigation District main canal, which is owned and operated by the District. Additionally, 88 turnouts would be upgraded to pressurized delivery systems, and the existing, elevated flume below the District's diversion would be replaced with HDPE and steel pipe. The proposed project would reduce seepage loss and provide better-managed water diversions for farm use, support agricultural land use, improved streamflow for fish, aquatic and riparian habitat, and improve public safety.

The draft watershed plan does not address the Agency's responsibilities for Section 106 of the National Historic Preservation Act (NHPA). As funding for project groups is allocated, consultation on the canals, turnouts, flume, and all associated structures will be addressed, in fulfillment of Section 106 of the NHPA.

We are requesting that you review this project in accordance with section 102(2)(C) of the National Environmental Protection Policy Act of 1969 (Public

Law 91-190). We request that comments be received by this office on or before July 8, 2021. If your comments are not received by the due date, we will assume you do not wish to comment.

The Draft Plan-EA is available for public review and comment. Copies may be obtained by contacting Gary Diridoni, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3092 or gary.diridoni@usda.gov. An electronic version has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:25:02 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Ecc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS
Michael Petrozza, Archaeologist, NRCS

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Mr. Barry Bushue,
State Director, Oregon-Washington
Bureau of Land Management
Oregon-Washington State Office
1220 SW 3rd Avenue
Portland, OR 97204

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Mr. Bushue,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

The purpose of this project is to improve water conservation and improve water supply management and water delivery reliability on District-owned canals and laterals. Arnold Irrigation District proposes to pipe 13.2 miles of the Arnold Irrigation District main canal, which is owned and operated by the District. Additionally, 88 turnouts would be upgraded to pressurized delivery systems, and the existing, elevated flume below the District's diversion would be replaced with HDPE and steel pipe. The proposed project would reduce seepage loss and provide better-managed water diversions for farm use, support agricultural land use, improved streamflow for fish, aquatic and riparian habitat, and improve public safety.

We are requesting that you review this project in accordance with section 102(2)(C) of the National Environmental Protection Policy Act of 1969 (Public Law 91-190). We request that comments be received by this office on or before July 8, 2021. If your comments are not received by the due date, we will assume you do not wish to comment.

The Draft Plan-EA is available for public review and comment. Copies may be obtained by contacting Gary Diridoni, Assistant State Conservationist (Watershed

2

Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3092 or gary.diridoni@usda.gov. An electronic version has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS Date: 2021.06.16 11:26:33 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS
Dennis Teitzel, District Manager, Prineville District Office

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Mr. Eric King, City Manager
City of Bend
710 NW Wall Street
Bend, OR 97703

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Mr. King,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

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97232, phone 503-414-3092 or gary.diridoni@usda.gov. An electronic version has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:28:06 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Mr. Steve Forrester, City Manager
City of Prineville
387 NE Third Street
Prineville, OR 97754

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Mr. Forrester,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

The purpose of this project is to improve water conservation and improve water supply management and water delivery reliability on District-owned canals and laterals. Arnold Irrigation District proposes to pipe 13.2 miles of the Arnold Irrigation District main canal, which is owned and operated by the District. Additionally, 88 turnouts would be upgraded to pressurized delivery systems, and the existing, elevated flume below the District's diversion would be replaced with HDPE and steel pipe. The proposed project would reduce seepage loss and provide better-managed water diversions for farm use, support agricultural land use, improved streamflow for fish, aquatic and riparian habitat, and improve public safety.

We are requesting that you review this project in accordance with section 102(2)(C) of the National Environmental Protection Policy Act of 1969 (Public Law 91-190). We request that comments be received by this office on or before July 8, 2021. If your comments are not received by the due date, we will assume you do not wish to comment.

The Draft Plan-EA is available for public review and comment. Copies may be obtained by contacting Gary Diridoni, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3092 or gary.diridoni@usda.gov. An electronic version

2

has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:29:23 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Mr. Keith Witcosky, City Manager
City of Redmond
411 SW 9th Street
Redmond, OR 97756

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Mr. Witcosky,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

The purpose of this project is to improve water conservation and improve water supply management and water delivery reliability on District-owned canals and laterals. Arnold Irrigation District proposes to pipe 13.2 miles of the Arnold Irrigation District main canal, which is owned and operated by the District. Additionally, 88 turnouts would be upgraded to pressurized delivery systems, and the existing, elevated flume below the District's diversion would be replaced with HDPE and steel pipe. The proposed project would reduce seepage loss and provide better-managed water diversions for farm use, support agricultural land use, improved streamflow for fish, aquatic and riparian habitat, and improve public safety.

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has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:30:45 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

The Honorable Jeff Merkley
United States Senator
131 NW Hawthorne Avenue, Suite 208
Bend, OR 97703

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Senator Merkley,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

The purpose of this project is to improve water conservation and improve water supply management and water delivery reliability on District-owned canals and laterals. Arnold Irrigation District proposes to pipe 13.2 miles of the Arnold Irrigation District main canal, which is owned and operated by the District. Additionally, 88 turnouts would be upgraded to pressurized delivery systems, and the existing, elevated flume below the District's diversion would be replaced with HDPE and steel pipe. The proposed project would reduce seepage loss and provide better-managed water diversions for farm use, support agricultural land use, improved streamflow for fish, aquatic and riparian habitat, and improve public safety.

We are requesting that you review this project in accordance with section 102(2)(C) of the National Environmental Protection Policy Act of 1969 (Public Law 91-190). We request that comments be received by this office on or before July 8, 2021. If your comments are not received by the due date, we will assume you do not wish to comment.

The Draft Plan-EA is available for public review and comment. Copies may be obtained by contacting Gary Diridoni, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3092 or gary.diridoni@usda.gov. An electronic version

2

has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:32:51 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

The Honorable Ron Wyden
United States Senator
911 NE 11th Avenue, Suite 630
Portland, OR 97232

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Senator Wyden,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

The purpose of this project is to improve water conservation and improve water supply management and water delivery reliability on District-owned canals and laterals. Arnold Irrigation District proposes to pipe 13.2 miles of the Arnold Irrigation District main canal, which is owned and operated by the District. Additionally, 88 turnouts would be upgraded to pressurized delivery systems, and the existing, elevated flume below the District's diversion would be replaced with HDPE and steel pipe. The proposed project would reduce seepage loss and provide better-managed water diversions for farm use, support agricultural land use, improved streamflow for fish, aquatic and riparian habitat, and improve public safety.

We are requesting that you review this project in accordance with section 102(2)(C) of the National Environmental Protection Policy Act of 1969 (Public Law 91-190). We request that comments be received by this office on or before July 8, 2021. If your comments are not received by the due date, we will assume you do not wish to comment.

The Draft Plan-EA is available for public review and comment. Copies may be obtained by contacting Gary Diridoni, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3092 or gary.diridoni@usda.gov. An electronic version

has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:34:00 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Mr. Jerry Brummer, County Commissioner
Crook County Courthouse
300 NE 3rd Street, Room 10
Prineville, OR 97754

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Mr. Brummer,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

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Sincerely,

JASON JEANS Digitally signed by JASON JEANS Date: 2021.06.16 11:35:05 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Mr. Robert Brunoe
General Manager Branch of Natural Resources
The Confederated Tribes of the Warm Springs Reservation
P.O. Box C
Warm Springs, OR 97761

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Mr. Brunoe,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

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has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org/. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:36:14 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Mr. Phil Henderson, County Commissioner Chair
Board of County Commissioners
1300 NW Wall Street, Suite 200
Bend, OR 97703

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Mr. Henderson,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

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We are requesting that you review this project in accordance with section 102(2)(C) of the National Environmental Protection Policy Act of 1969 (Public Law 91-190). We request that comments be received by this office on or before July 8, 2021. If your comments are not received by the due date, we will assume you do not wish to comment.

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97232, phone 503-414-3092 or gary.diridoni@usda.gov. An electronic version has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:37:19 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Mr. Paul Henson, PhD
State Supervisor, Oregon Fish and Wildlife Office
U.S. Fish and Wildlife Service
2600 SE 98th Avenue
Portland, OR 97266

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Mr. Henson,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

The purpose of this project is to improve water conservation and improve water supply management and water delivery reliability on District-owned canals and laterals. Arnold Irrigation District proposes to pipe 13.2 miles of the Arnold Irrigation District main canal, which is owned and operated by the District. Additionally, 88 turnouts would be upgraded to pressurized delivery systems, and the existing, elevated flume below the District's diversion would be replaced with HDPE and steel pipe. The proposed project would reduce seepage loss and provide better-managed water diversions for farm use, support agricultural land use, improved streamflow for fish, aquatic and riparian habitat, and improve public safety.

This project is not covered by the consultation provisions of the Fish and Wildlife Coordination Act of 1934, as amended (FWCA). However, consultation is required under Section 12 of P.L.83-566, which was added to P.L.83-566 by the 1958 amendments to the FWCA. Section 12 was added in recognition of the need for evaluation of fish and wildlife resources impacts and opportunities at P.L.83-566 projects in a manner similar to that required for other construction projects under the FWCA.

Section 12 provides that, in preparing project plans, the Department of Agriculture must consult with the Fish and Wildlife Service (FWS) with regard to

the conservation and development of fish and wildlife resources and provide the FWS with the opportunity to participate in project planning. The FWS is to be afforded the opportunity to make surveys and investigations and prepare reports with recommendations on the conservation and development of fish and wildlife. The Department of Agriculture must give full consideration to the recommendations contained in FWS reports and include features that are determined to be feasible and that are acceptable to the Department and the local project sponsor. FWS reports are to be included in project reports prepared by the Department of Agriculture. No funds are provided by the Department of Agriculture for FWS involvement in P.L.83-566 projects; funds for such work must come from those appropriated for FWS work in project planning.

This letter is being submitted to request consultation under the provisions of Section 12 of P.L.83-566 which provides for consultation similar to that required under the FWCA. This letter also is being submitted to request that you review this project in accordance with section 102(2)(C) of the National Environmental Protection Policy Act of 1969 (Public Law 91-190). We request that comments be received by this office on or before July 8, 2021. If your comments are not received by the due date, we will assume you do not wish to comment.

The Draft Plan-EA is available for public review and comment. Copies may be obtained by contacting Gary Diridoni, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3092 or gary.diridoni@usda.gov. An electronic version has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:38:23 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Ms. Leah Horner
Regional Solutions Director
State of Oregon
Office of the Governor Katherine Brown
900 Court Street NE, Suite 254
Salem, OR 97301-4047

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Ms. Horner,

In accordance with Section 2 of Executive Order 10913, and our responsibility as assigned by the Secretary of Agriculture, we are transmitting for your review and comment the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project located in Deschutes County, OR.

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

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We are requesting that you review this project in accordance with section 102(2)(C) of the National Environmental Protection Policy Act of 1969 (Public

Law 91-190). We request that comments be received by this office on or before July 8, 2021. If your comments are not received by the due date, we will assume you do not wish to comment.

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Sincerely,

JASON JEANS Digitally signed by JASON JEANS Date: 2021.06.16 11:39:32 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS
Lauri Aunan, Natural Resources Policy Advisor, Office of the Governor Katherine Brown
Jason Miner, Natural Resources Policy Advisor, Office of the Governor Katherine Brown
Chris Cummings, Interim Director, Business Oregon
Alexis Taylor, Director, Oregon Department of Agriculture (ODA)
Richard Whitman, Director, Oregon Department of Environmental Quality (ODEQ)
Curt Melcher, Director, Oregon Department of Fish and Wildlife (ODFW)
Vicki Walker, Director, Oregon Department of State Lands (ODSL)
Tom Byler, Director, Oregon Water Resources Department (OWRD)
Meta Loftsgaarden, Executive Director, Oregon Watershed Enhancement Board (OWEB)

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

The Honorable Cliff Bentz
United States House of Representatives
14 N. Central Avenue, Suite 112
Medford, OR 97501

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Representative Bentz,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

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Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:42:32 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Colonel Michael Helton
US Army Corps of Engineers Portland District
P.O. Box 2946
Portland, OR 97208-2946

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Colonel Helton,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

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Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:43:33 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS

USDA
United States Department of Agriculture

Natural Resources Conservation Service

1201 NE Lloyd Blvd.
Suite 900
Portland, OR 97232
503-414-3200

June 16, 2021

Mr. Talmadge Oxford
Area Manager Columbia-Cascades
U.S. Bureau of Reclamation
Columbia-Cascades Area Office
1917 Marsh Road
Yakima, WA 98901

Subject: Arnold Irrigation District Infrastructure Modernization Project Draft Watershed Plan–Environmental Assessment

Dear Mr. Oxford,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Arnold Irrigation District Infrastructure Modernization Project, located in Deschutes County, OR. Farmers Conservation Alliance prepared this Draft Plan-EA for the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in cooperation with the Deschutes Basin Board of Control (lead sponsor) and Arnold Irrigation District (co-sponsor). This plan was prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) and in accordance with section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190).

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Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3092 or gary.diridoni@usda.gov. An electronic version has been made available for viewing and downloading at Oregon Watershed Plans web page, found at https://oregonwatershedplans.org. NRCS will consider all comments received and will respond to those received by July 8, 2021. Comments received will be made available for public inspection.

Sincerely,

JASON JEANS Digitally signed by JASON JEANS
Date: 2021.06.16 11:44:37 -07'00'

JASON JEANS
Acting State Conservationist

Enclosure:
Notice of Availability of Draft Watershed Plan-Environmental Assessment and Public Meeting on June 23, 2021 for Arnold Irrigation District Infrastructure Modernization Project

Cc: Gary Diridoni, ASTC- Watershed Resources and Planning, NRCS
Gregg Garnett, Bend Field Office Manager, USBR

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Bend Field Office
63095 Deschutes Market Road
Bend, Oregon 97701

In Reply Refer To:
2022-0062518-S7

Jason Jeans, Acting State Conservationist
Natural Resources Conservation Service
1201 NE Lloyd Blvd., Suite 900
Portland, Oregon 97232

Subject: Arnold Irrigation District Infrastructure Modernization Project – Crook, Deschutes Counties, Oregon – Concurrence

Dear Mr. Jeans:

This letter responds to the Natural Resources Conservation Service's (NRCS) request for the U.S. Fish and Wildlife Service's (Service) concurrence on effects of the subject action to species and habitats listed under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.; [Act]). The NRCS's request dated July 27, 2022, and received by the Service on July 27, 2022, included a biological assessment entitled *Arnold Irrigation District Infrastructure Modernization Project - Biological Assessment* (Assessment) dated July 26, 2022. Information contained in the Assessment is incorporated here by reference.

Through the Assessment, the NRCS determined that the proposed action may affect, but is not likely to adversely affect Oregon spotted frog (*Rana pretiosa*) or designated Oregon spotted frog critical habitat. The Service concurs with the NRCS' determinations and presents our rationale below.

The NRCS also determined that the proposed project will have no effect on bull trout (*Salvelinus confluentus*), Middle Columbia River steelhead (*Oncorhynchus mykiss*), gray wolf (*Canis lupus*), or designated bull trout critical habitat. The regulations implementing section 7 of the Act do not require the Service to review or concur with no effect determinations. However, the Service does appreciate being informed of your determinations for these species.

Proposed Action

The Watershed Protection and Flood Prevention Act (PL-566) authorizes the NRCS to assist local organizations and units of government to plan and implement watershed projects. Arnold Irrigation District (AID) will be constructing and implementing the proposed action as described in the Assessment, but Federal funding will facilitate the project's successful completion. This funding is administered by NRCS; as such, NRCS is the lead Federal agency responsible for ensuring the project meets Federal requirements.

The proposed action seeks to improve water conservation and water supply management and delivery reliability within the Upper Deschutes River watershed of the Deschutes River Basin. The project includes installing 11.9 miles of buried pipe; installing small, automated supervisory control and data acquisition (SCADA) monitoring equipment in two locations; and updating 88 turnouts. The irrigation modernization activities will be implemented over a period of 6 years in four phases by AID. Each phase will take 2-3 years, with construction starting on the eastern end of the main canal l during the first phase and moving west during subsequent phases. Construction will occur within existing AID rights-of-way and/or easements.

All proposed infrastructure modifications will occur directly in AID's main canal and within the AID's existing rights-of-way and easements. Because construction will occur outside of the Deschutes River ordinary high water mark, none of the proposed construction will impact surrounding waterbodies. Piping AID's infrastructure will also reduce water loss to seepage. Water loss with the current infrastructure is approximately 32.5 cubic feet per second (cfs) of water (11,083 AF annually) to seepage through the porous underlying geology and evaporation.

The infrastructure modernization project implemented within the district is expected to result in indirect streamflow changes in other portions of the Deschutes River Basin. The piping effort is anticipated to save up to 11,083 acre-feet (AF) of water annually from seepage and evaporative loss. The hydrological model output in the Deschutes Basin Habitat Conservation Plan (HCP) predicts AID will continue to rely on storage water in Crane Prairie Reservoir. To remain consistent with the predictions, AID will reduce their maximum live flow water right to 10,862 AF per year, which is 98 percent of the total water savings (11,083 AF per year).

AID will incrementally reduce its maximum live flow diversion rate by the amount of live flow saved from piping following completion of each construction phase, up to 10,862 AF per year. AID will bypass this water savings as live flow in the Deschutes River for diversion downstream by North Unit Irrigation District (NUID) under NUID's existing water rights. In return, NUID will legally protect and release water from Wickiup Reservoir during the non-irrigation season in accordance with conservation measures of the Deschutes Basin HCP. AID will reduce its diversion rates following the completion of each phase of construction, incrementally bypassing these savings as live flow to NUID.

The action area encompasses AID infrastructure proposed to be modernized, areas where new infrastructure is proposed to be built, and associated AID-operated rights-of-way and/or easements where construction will take place and/or be staged. This area extends from the Deschutes River inflow at Crane Prairie Reservoir (river mile 238) to the mouth of Lake Billy Chinook (river mile 120) (Assessment, Figure 3, Table 3). The proposed action is fully described in the Assessment (pp. 5-11).

The following is a conceptual water summary associated with the Proposed Action:

- As a result of piping, AID will save water during the irrigation season.
- AID will pass the live flow portion of saved water to NUID during the irrigation season, reducing NUID's reliance on Wickiup Reservoir stored water.
- Approximately 3.8% of this water, or up to 416 acre-feet annually, passed from AID to NUID would be lost to seepage, and approximately 96.2% of the water, or up to 10,446 acre-feet annually, would reach NUID's diversion.

- In exchange, NUID will release the same volume of water from Wickiup Reservoir during the non-irrigation season.
- If the saved water were released at a flat rate for the duration of the non-irrigation season, NUID would release up to 33.8 cfs from Wickiup Reservoir.
- Until Year 8 of the HCP, water released during the non-irrigation season would be in addition to the 100 cfs minimum winter flow rate required by the HCP in the Deschutes River downstream of Wickiup Reservoir.
- After Year 8 of the HCP, water released during the non-irrigation season will help meet the 300 cfs minimum winter flow rate required by the HCP in the Deschutes River downstream of Wickiup Reservoir.

Species and Habitat Presence in the Action Area

The action area lies within critical habitat unit 8 (Upper Deschutes River), which encompasses 24,032 acres from headwater streams, lakes, and wetlands that drain to Crane Prairie and Wickiup Reservoirs and to the mainstem of the Deschutes River to Bend, Oregon. The Deschutes Basin remains a primary population center for the species. Within the Deschutes River Basin, Oregon spotted frogs are present in wetlands from headwaters lakes and streams to Bend. There are 34 known occupied sites within the action area. All areas occupied by frogs are within designated critical habitat. Within this area, Oregon spotted frog habitat has been significantly altered by water management activity in the basin and continues to be influenced by operations of Crane Prairie and Wickiup Reservoirs. Low streamflow during the non-irrigation season as well as rapid changes in streamflow and reservoir levels during the irrigation season have contributed to poor condition of Oregon spotted frog in the Deschutes River Basin.

Potential Impacts and Effects from the Proposed Action

Construction activities associated with the proposed action will not directly affect Oregon spotted frog or its critical habitat since neither are found within the network of AID irrigation infrastructure (Assessment, p. 18). The improved system will result in conserved water and transferred instream flows, indirectly impacting Oregon spotted frog and its habitat by decreasing Wickiup Reservoir storage levels (up to 10,446 AF annually) and increasing non-irrigation season streamflow in the Upper Deschutes River below the reservoir (up to 33.8 cfs). Over the long-term, the proposed action will result in incremental progress towards improved conditions for Oregon spotted frog and its critical habitat by providing more stable overwintering conditions in the Upper Deschutes River Basin (Assessment, p. 18).

If NUID releases up to 10,446 acre-feet of water from Wickiup Reservoir as a flat rate across the non-irrigation season (156 days), a rate of up to 33.8 cfs would be protected instream. Once an instream lease was approved by OWRD, the leased portion of NUID's water right would be unavailable for use by NUID or its patrons.

Concurrence

Based on the Service's review of the Assessment, we concur with the NRCS's determination that the action outlined in the Assessment and this letter, may affect, but is not likely to adversely

affect Oregon spotted frog or designated Oregon spotted frog critical habitat. This concurrence is based on improved conditions for Oregon spotted frog and its critical habitat by providing more stable overwintering conditions in the upper Deschutes River Basin, and location of activities that avoid or reduce impacts of the proposed action to listed species and their critical habitat to insignificant or discountable levels.

This concludes informal consultation. Further consultation pursuant to section 7(a)(2) of the Act is not required. Reinitiation of consultation on this action may be necessary if: (1) new information reveals effects of the action that may affect listed species or designated critical habitat in a manner or to an extent not considered in the assessment; (2) the action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the analysis; or (3) a new species is listed or critical habitat designated that may be affected by the proposed action.

Thank you for your continued interest in the conservation of threatened and endangered species. If you have any questions regarding this consultation, please contact Emily Weidner of this office at (541) 383-7146.

Sincerely,

BRIDGET MORAN

Digitally signed by BRIDGET MORAN
Date: 2022.07.29 15:57:54 -07'00'

Bridget Moran
Field Supervisor

cc:
National Marine Fisheries Service, Portland (Carlon)
National Resources Conservation Service, Portland (Diridoni)
U.S. Bureau of Reclamation, Bend (Garnett)
U.S. Fish and Wildlife Service, Bend (O'Reilly)
U.S. Fish and Wildlife Service, Bend (Soens)

E.12. Supporting Information for Property Value

United States Department of Agriculture

Natural Resources Conservation Service

MEMORANDUM FOR RECORD

DATE: MARCH 22, 2022

SUBJECT: Analysis of Market Values of Properties Adjoining Arnold Irrigation District Infrastructure Modernization Project

1. Arnold Irrigation District (AID or District) has requested technical and financial assistance from NRCS through its Watershed Program, authorized by Public Law 83-566, (the Watershed Protection and Flood Prevention Act of 1954, as amended), for the proposed Arnold Irrigation District Infrastructure Modernization Project. The purpose of the project is to pipe 11.9 miles of the District-owned Main Canal to improve water conservation, improve water supply management and deliver water reliably to District patrons, as well as improve public safety and enhance streamflow within the Deschutes River. NRCS is the lead federal agency for the project and is responsible for ensuring the project meets requirements of the Watershed Program, National Environmental Policy Act (NEPA), updated Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies (PR&Gs), and all other applicable federal laws. Farmers Conservation Alliance has been contracted to assist NRCS with preparing the combined Watershed Plan-Environmental Assessment (Plan-EA) and related materials for the project.

2. In compliance with program and NEPA requirements, the Draft Plan-EA was made available for public comment from June 8, 2021, to July 23, 2021. Numerous public comments were received during the review period, and of the 451 comments received, over 130 of the comments expressed concern regarding the potential of the project resulting in adverse impacts to residential property values. The following information in this Memorandum for Record details research conducted by NRCS Oregon and is used to support NRCS's economic analysis in consideration of potential adverse impacts to residential property values within the project area boundaries.

3. Limited literature exists concerning the effects of irrigation canals on property values in general, and NRCS was unable to find literature that specifically addressed effects associated with canal systems in the Western United States (where the canals are located in an urban semi-arid environment, do not have water running through the canal year-round, have a maintenance road adjacent to the canal on one side of the right-of-way, and are subject to operation and maintenance year-round), and their effect on property value in an urban semi-arid environment. The following 2 studies related to the effects of canals on property values were identified by NRCS and used to support the economic analysis:

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Natural Resources Conservation Service

a. A study titled "The Influence of Artificial Water Canals on Residential Sale Prices" published in the Appraisal Journal, Spring 2005, Volume 73 Issue 2, p167-174, finds the public in general will pay a price premium for canal-front properties on the magnitude of 11%. The journal article states, "All externalities, whether positive or negative, impact the utility that an individual derives from property ownership. Artificial water canals, function in a manner similar to parks, golf courses, and lakes in that they increase the utility derived by the individual property owner.

b. In a review paper, published in 2017 by John Wiley and Sons titled, "The Effect of Rivers, Streams, and Canals on Property Values", Sarah Nicholls writes, "Linear water features including rivers, streams, and canals are critical elements of the earth's ecosystem, supporting essential agricultural, industrial, and household uses, serving as transportation routes, and providing habitat for a variety of flora, fauna, and aquatic species. Though not always considered as critical as the services aforementioned, such features also fulfil important aesthetic, recreational, and sociocultural functions".

Although these articles were not specific to irrigation district canals in the West, to a certain extent the different values derived from this type of landscape feature are similar. Additionally, research in the fields of environmental psychology and landscape architecture demonstrate humans have an innate preference for natural water settings (See "The Influence of Artificial Water Canals on Residential Sale Prices" published in the Appraisal Journal, Spring 2005, Volume 73 Issue 2, p167)

4. Three approaches to market value were initially considered by NRCS in response to the public's request for additional analysis on effects to property values: 1) a sales comparison approach; 2) an income approach; and 3) a cost approach. However, due to the lack of data to derive any meaningful conclusions from conducting the income and cost approach, these two property valuation methodologies were dropped from further analysis and consideration.

5. The sales comparison approach compared sales of properties which directly adjoin the AID canal with sales of properties that do not adjoin the AID canal but are within the same neighborhood. This way proximity to community amenities, such as, shopping, recreation and other positive externalities were assumed to be identical for homes associated with the canal and those that are not.

   a. The ratio of the Land Market Value to the Total Market Value, as determined by the County's appraisers, was applied to each and all confirmed sales, regardless of location, to screen out the value of structures as part of the valuation. Because the Deschutes County Assessor's Office is responsible for the appraisal and assessment of all taxable property

within the county, it is assumed the reported Land Market Value and the Total Market Value are appropriate proxies to determine the ratio of land to total value. Applying this ratio eliminates the size, type, condition, and number of improvements contained within and around the property as a factor of consideration in the analysis, and therefore, only the land market value was used in the comparative market analysis.

b. Seven properties directly adjoining the AID canal and seven properties which do not directly adjoin the AID canal were evaluated in this analysis. Of the 7 directly adjoining properties, 3 properties sold in 2021, another 3 properties were sold in 2020, and 1 property was sold in 2018. These properties were compared with an identical number of confirmed sales that do not adjoin the AID canal during the identical time periods. No adjustments for time were deemed necessary and, therefore, were not implemented.

c. Based on the analysis of the properties, there is a positive contribution to property values for those sales that directly adjoin the AID canal system in comparison to those properties that do not. The sales data consistently demonstrated a positive property value effect between 5% and 20% depending on the year and location of the sale.

6. While the sales comparison approach demonstrated a positive property value effect for those properties directly adjoining the canal, the findings didn't necessarily demonstrate causation of increased property values due exclusively to the periodic presence of water within the canal. Under both the No Action Alternative (future without project) and in the Piping Alternative (with-project condition), the AID right-of-way would retain the same authorized purposes and legal description, thereby provide the potential benefits of green space, after the canal is converted to pipe under the Piping Alternative. Identical conditions exist for previously authorized irrigation canal piping projects within the Central Oregon Irrigation District and the Swalley Irrigation District, which are located immediately north of AID within the city of Bend, Oregon.

7. A two-pronged approach was used to analyze whether properties with the irrigation district right-of-way, where the canal had been converted to pipe, retained virtually the same positive property premium over time as the confirmed market sales approach for AID described above. The first approach analyzes land market values over time, while the second approach analyzes land market value under the current condition.

    a. The comparison of the before-condition with the after-condition method to establish and assess market values over time requires a couple of assumptions:

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i. A decline in the land market value over time for properties with an irrigation district right-of-way would indicate the market would not find any preference between the properties which adjoin an irrigation district right-of-way and those that do not.

ii. Should the difference in market value be sustained over time (that is, if the land market value was maintained at the same rate over time, regardless of whether the property has an irrigation district right-of-way or not), then the market would retain a preference for properties that have the irrigation district right-of-way in the backyard, as utility for having the perceived extra space, such as for recreational and/or wildlife benefit(s), is maintained.

b. Similar to the sales comparison approach used for AID properties described above, the land market value of properties with the adjoining irrigation district right-of-way were compared with neighboring properties that do not have the right-of-way in their backyard.

i. Zillow was used to estimate the current real market value for each property.

ii. Then the county's land market value to total market value ratio was used to determine the current land market value of each property.

iii. Properties with the irrigation district right-of-way either in or adjacent to the backyard were then compared with neighboring properties that do not have nor are adjacent to the right-of-way.

iv. In each comparison, regardless whether within the Swalley or Central Oregon Irrigation district, those properties associated with the right-of-way consistently were valued more than those properties without the right-of-way. The average percentage premium the market would provide a property associated with an irrigation district right-of-way was between 14% and 21% -- 14% for Swalley Irrigation District properties and 21% for Central Oregon Irrigation District. For a visual representation of this finding, please see Figures 1, 2 and 3 below. These figures demonstrate the price premium difference for properties along Stacy Lane, Bend Oregon. All three figures demonstrate Swalley Irrigation District right-of-way along the westerly boundary of the residential properties on the west side of the street. The residential properties on the east side of Stacy Lane have no association with the irrigation district right-of-way. The residential properties with a view of the

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irrigation district right-of-way continued to have positive property premiums in comparison to properties that do not. The conclusion derived from this analysis indicates the average percentage change in property values over time were virtually identical under both the before and after conditions.

c. Land market value for 5 properties within the Swalley Irrigation District, as determined by the Deschutes County Appraisers, which contained the right-of-way was compared against 5 properties without the right-of-way. The data revealed the average percentage change in property values over time were identical under both conditions. Using the same data acquisition methodology for the Central Oregon Irrigation District, identical findings held true for this District as well. In general, using the County's appraisers' data over a 4-year period indicated the market continued to prefer properties with the irrigation district right-of-way, regardless whether the canal was converted to pipe or not.

8. Conclusion: Based on the research conducted and best available information at this time, there is no market evidence to indicate property values would decline for canal-adjacent properties following the conversion of the Arnold Irrigation District canal to a piped system, as market data indicates residential "green belt" properties are purchased for the same price premium whether the periodic presence of water within the canal canal is present or not.

a. These findings are in line with established legal precedent (Swalley v. Alvis), whereby the court stated, "removal of any aesthetic benefits provided by the open canal merely eliminates an incidental benefit provided by Swalley's use of the easement; such action does not place an additional burden on the landowners' property."

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Figure 1. Map of Swalley Irrigation District Right-of-Way in Relation to Stacy Lane

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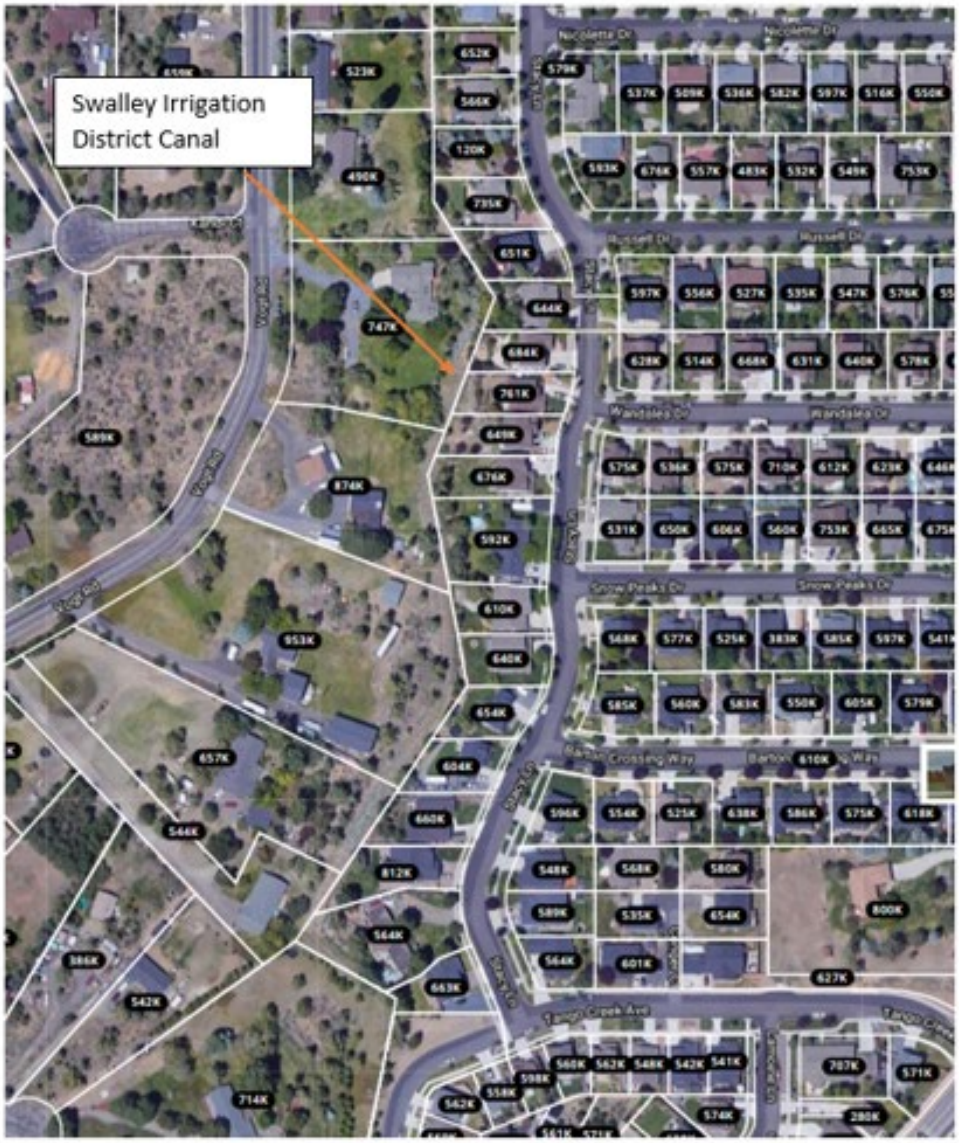

Figure 2. Aerial Photo of Stacy Lane. Properties Along the West Side of Stacy Lane Adjoin the Swalley Irrigation District Right-of-Way

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Figure 3. Properties on the West side of Stacy Lane, Which Adjoin an Irrigation District Right-of-Way, are Higher in Value Than Properties on the East Side of Stacy Lane.

E.13. Supporting Information for Visual Resources

Source: Libadisos, 2021

Photograph E-1. Image of Arnold Main Canal passing through private property.

Source: Rudloff, 2021

Photograph E-2. Image of Arnold Main Canal passing through private property.

Source: Clark, 2021

Photograph E-3. Image of Arnold Main Canal passing through private property.

Source: Prickett, 2021

Photograph E-4. Image of Arnold Main Canal passing through private property.

Source: AID 2021

Photograph E-5. Image of dewatered Arnold Main Canal.

Source: AID, 2021

Photograph E-6. Image of dewatered Arnold Main Canal.

Source: AID, 2021

Photograph E-7. Image of dewatered Arnold Main Canal.

Source: AID, 2021

Photograph E-8. Image of dewatered Arnold Main Canal.

E.14. Supporting Information for Planning Area

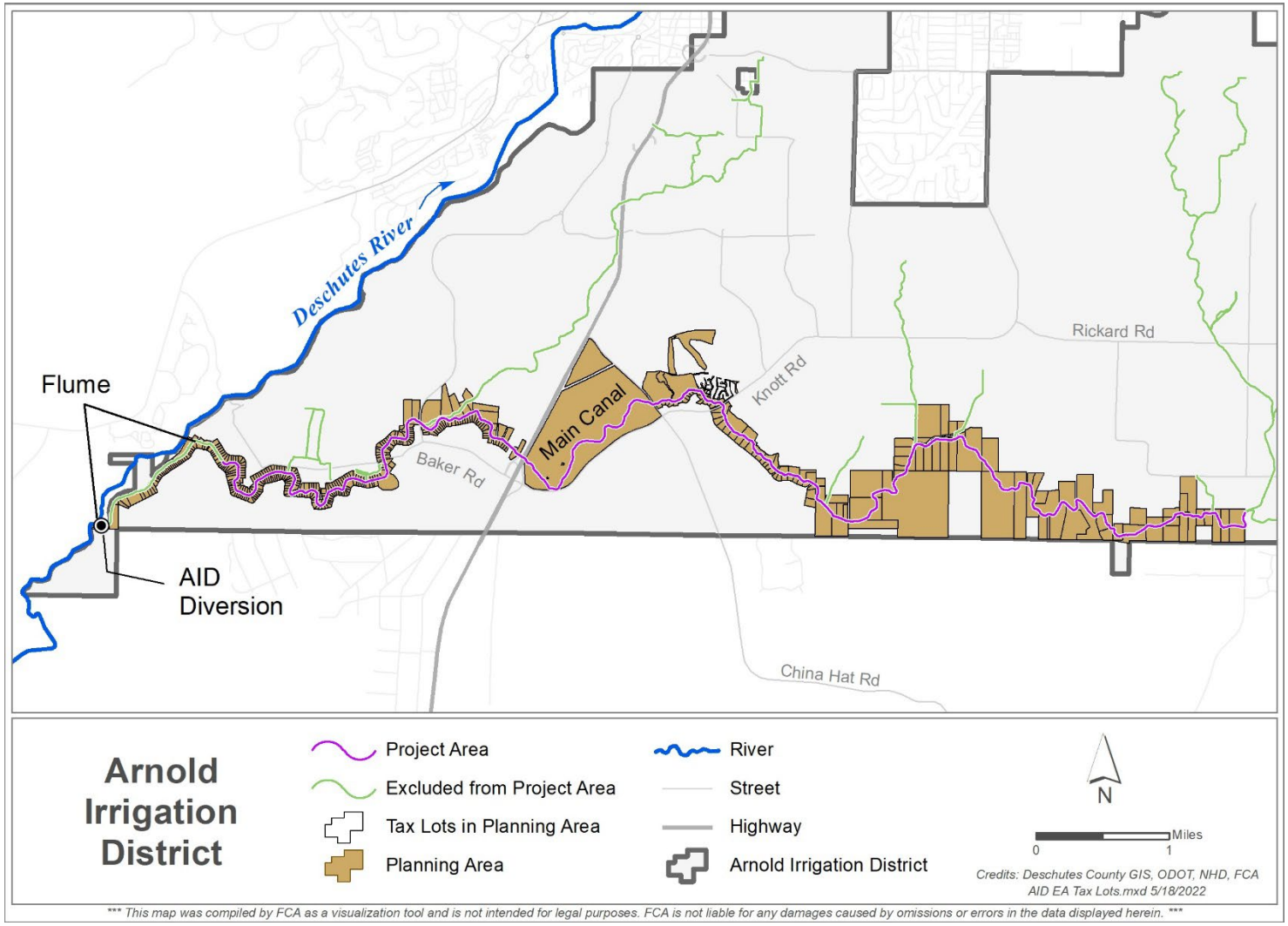

Figure E-3. Tax lots included in the planning area.