Appendix A

Comments and Responses

Table A-1. Topics and associated codes

Topic	Topic Code	Topic	Topic Code
Alternative Analysis	ALT	Project Cost	COST
Construction Practices	CONS	Property Value	PROP
Consultation	CONSU	Public Process	PROC
Cultural Resources	CUL	Public Safety	PUB
Energy Production	ENRG	Purpose and Need	PURP
Environmental Species Act	ESA	Recreation	REC
Fish and Aquatic	FISH	Soils	SOIL
Form Response	FORM	System Design	SYS
General	GEN	Vegetation	VEG
National Economic Development	NED	Water	WAT
Patron Delivery	PATD	Wildlife	WILD

Table A-2. Responses to Comments Received During the Public Comment Period for the Tumalo Irrigation District Watershed Plan-EA

Comment ID	Topic Code	Comment	Final Comment Response
1.01	WAT	I am a resident of Deschutes County and live close to the Deschutes River. I fully support the draft plan that reduces wasted water lost from the canals by seepage and evaporation. The use of pipe to improve the efficiency of this system does seem to be the best idea. It is important that this saved water be returned to the Deschutes River and Tumalo Creek. Both of these waterways are severely impacted by low water flows in the summer months.	Thank you for your comment.
1.02	PUB	This plan will also increase community safety. The canals are dangerous and I have rejected the purchase of certain properties within the TID due to safety concerns of the canals. Numerous fatalities have happened in the canals. Additionally, a pressurized delivery system can reduce power demands and increase user efficiency.	Thank you for your comment.

2.01	WAT	Here a few general comments: The document is extensive and thorough. If public funds are used, it should be with the requirement that water conserved be allocated permanently to the Deschutes River. 1-2 year leasing is not acceptable. Any such limitations because of state or irrigation district policies should be addressed.	Water conserved through the project will be permanently protected instream through Oregon's Allocation of Conserved Water Program. Please refer to Section 2.2.1 for more information on how the proposed project plans on using Oregon's Conserved Water Program.
2.02	WAT	The EIS should address impacts on private wells. I didn't catch that in the EIS.	Groundwater resources and the potential effects of the proposed project on those resources are discussed in Section 4.10.4 and 6.10, respectively. Potential effects on groundwater and private wells are also discussed in the National Economic Development Analysis, Appendix D.1, Section 2.2.
2.03	VEG	Invasive species such reed canary grass/ribbon grass should be included and discussed under invasive species.	To the District's knowledge, reed canary grass and ribbon grass do not have a strong presence along canals and laterals; however, the Plan-EA has been updated to reflect the minimal presence within the District. Please refer to Section 4.8.4, Table 4-13 for this clarification. As noted in Section 6.8.3.2, the conversion to a piped system would eliminate opportunities for aquatic noxious weeds to grow or be washed to other areas in the District. Measures that would be taken to prevent the spread of noxious weeds can be found in Section 6.8.3.2 and 6.8.4.
2.04	SOIL	The amount of farmland of statewide importance (hobby farms?) or prime farmland if irrigated seems high?	The terms "farmland of statewide importance" and "prime farmland" are soil group designations developed by the Natural Resources Conservation Service (NRCS). NRCS policy and procedures on prime and unique farmlands are published in the Code of Federal Regulations 7 CFR 657. Further information on each of these designations can be found in Section 4.3.2.1 of the Plan-EA. The numbers presented are based on data from the NRCS SSURGO database for Upper Deschutes River, Oregon (Full Citation: Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.nrcs.usda.gov/. Accessed June 24, 2018).
2.05	CUL	Are there historically significant sections of canals that would be piped?	The Tumalo Feed Canal (Project Group 1) and Columbia Southern Canal (Project Group 6) were evaluated for the National Register of Historic Places as contributing or potentially contributing features; however, neither feature is listed in the National Register of Historic Places. Both features would be piped as part of the proposed action. Please refer to Section 4.1 for a description of these features. Section 6.1 provides an overview of consultation with the State Historic Preservation Office, agreed upon mitigation measures, and mitigation measures under consideration.

2.06	ALT	On-farm efficiency in use of water should be undertaken concurrently with piping I am only representing myself in submitting these comments.	Project sponsors must have the legal authority and resources to carry out, operate, and maintain works of improvement (Public Law 83-566 Section 2 and Section 4(3)). Because PL 83-566 is a public law, rather than a policy, this consideration is a legal requirement and cannot be arbitrarily applied. Because TID lacks the statutory authority or responsibility to carry out, operate, and maintain on-farm infrastructure owned by TID patrons, on-farm efficiency upgrades are not within the scope of actions that TID can entertain as the Project Sponsor. Improving on-farm efficiency is, therefore, not consistent with PL 83-566 authorities under which this plan is being prepared as either a standalone alternative or as an additional measure added to an alternative under consideration. Additionally, per *Protect our Communities Foundation v. Jewell.* 825 F.3d 571 (9th Cir. 2016) "...the agency is not required to give exhaustive consideration to an alternative that it appropriately deems remote and speculative. *City of Angoon v. Hodel*, 803 F.2d 1016, 1021–22 (9th Cir. 1986) (alternatives 'must be ascertainable and reasonably within reach')". When deciding which alternatives to move forward in the Plan-EA, the agency took into consideration the feasibility issues of private installation and having enough participants to effectively conserve water, as well as the regulatory limitations to permanently protecting privately conserved water. For these reasons, on-farm efficiency upgrades were not brought forward for full consideration in this plan. Modernizing on-farm equipment to achieve optimal District efficiency is of important to TID; however, these on-farm projects will occur independently from the proposed project in the Plan-EA. On-farm efficiency is further discussed in section 5.2.5.
3.01	WAT	Thanks for the opportunity to comment. I support the project primarily to stay ahead of environmental and other issues that could threaten the future existence or functionality of the Tumalo Irrigation District. After reviewing the draft plan-EA online and attending the public meeting last night, my additional comments are as follows: 1. I support piping as the best alternative to save water, improve delivery, and enhance stream flows in creeks and the river.	Thank you for your comment.
3.02	VIS	2. I am pleased that "The proposed action would not remove or modify private water features or ponds". Property owners have considerable investment in the aesthetics, equipment and functionality of their ponds and private delivery systems.	Thank you for your comment.
3.03	VEG	3. I support concern, caution, and preventive action in the project regarding impacts on trees and wildlife. Project budgets should include preventive impact measures for trees and wildlife. I suggest project costs should include "thinning and cleaning" of trees over 6" DBH within canopy width and/or within easements. Thinning of canopy and cleaning trees of dead limbs would greatly improve tree survival after their water source is significantly reduced due to canal seepage no longer occurring.	TID will manage trees during and after construction consistent with previous piping projects. The District's best management practices and potential effects of the implementation of the proposed project to vegetation, including trees, are discussed in sections 6.8.3 and 6.8.4.

4.01	VEG	I am writing in response to the plan to pipe the irrigation canal that runs through our property at 19025 Couch Market Rd. We are account number 152 with the Tumalo Irrigation District and our family has owned this property since the 1960's. For over 50 years, the unlined and open canal has provided water to many volunteer ponderosa pines along our section of the canal which have grown to be mature and large beautiful trees. These pines provide significant shade and habitat for a wide array of species including great horned owls and red tailed hawks. If the canal is piped, these pines will very likely die resulting in an ecological loss as well as turning into a very significant hazard to our house. The 10 cfs of water that is projected to be returned to the river during irrigation season by piping this section of the canal is not worth the loss to the ecosystem of these mature pines. If the district moves forward with piping the canal, the district must be held responsible for removing any trees that die as a result of piping the canal and any damage that is caused to property or homes as a result of dying trees. I strongly encourage you not to pipe the small canal running through our property as the loss to habitat and cost to the district and property owners of dealing with large dead ponderosa pines outweighs the benefit of adding 10 cfs of water to the river.	Please see the response to comment 3.03.
5.01	VEG	I am writing to comment on your proposed plan to pipe the Tumlao irrigation ditches. My family has owned property in Tumalo for over 50 years and an irrigation ditch flows through the length of our property. While I understand the argument for piping the irrigation ditch to avoid water loss through evaporation and return about 10 cfs to the Deschutes, I strongly oppose this proposal. Since their construction the irrigation ditches have provided water to plants and wildlife throughout the Tumalo area. Our property and others nearby have mature ponderosa pine trees that receive the majority of their water from the ditch and will not survive if the ditch is piped. These trees provide shade and habitat to a wide variety of species including owls, hawks, and deer. We have owls that nest in the ponderosa pine trees along the ditch every year. Without the water to support these trees the trees will die and a significant amount of habitat will be lost. In addition to impacting wildlife, the death of these trees will be expensive to deal with and potentially dangerous for private landowners. If ditched the Irrigation District should be prepared to pay for all costs associated with the death of trees around the ditch. Given the downsides associated with piping the ditch I do not think that returning the more or less 10 cfs to the Deschutes will have enough of a positive impact justify this decision. With a mean annual flow of 915 cfs in the upper Deschutes and around 4,500 cfs in the lower Deschutes, an addition 10 cfs will make very little difference. Due to the impacts of piping the ditch to habitat and wildlife as well as the costs and potential danger associated with dying trees I strongly encourage you to leave the ditch un piped.	The proposed piping project is anticipated to return up to 48 cfs instream, not 10 cfs. Please refer to Section 2.2.1 for a discussion about how this water would be permanently allocated instream through Oregon's Allocation of Conserved Water Program. The District's best management practices and potential effects of the implementation of the proposed project to vegetation, including trees, are discussed in Sections 6.8.3 and 6.8.4. Please see response to comment 48.04 for additional discussion about the effects to wildlife.

6.01	WILD	I am writing in response to the proposed piping of the irrigation canals in the district around Couch Market Road. My brothers and I own a home there, which our family built over 40 years ago. I am strongly opposed to piping the irrigation canals. These canals have evolved somewhat from their original purpose and have become habitat. As such, they provide resources for aquatic animals and plants, as well as terrestrial animals such as deer, rabbits, owls, etc. These animals rely on these water sources. Piping the canals will certainly have a negative impact on the local flora and fauna of the region.	The District's best management practices and potential effects of the implementation of the proposed project to wildlife are discussed in Sections 6.12.3 and 6.12.4. Please refer to the response to comment 48.04 for additional discussion. The potential effects of the implementation of the proposed project to vegetation are discussed in Sections 6.8.3 and 6.11.3.
6.02	WAT	More significantly, the seepage from these canals helps recharge ground water in a semi-desert environment. Piping would inhibit seepage and have a potentially negative affect on the overall water table.	Please see the response to comment 2.02.
6.03	VEG	Pipe installation would also entail the removal of a large number of old growth Ponderosa pines, which, again are habitat for a variety of creatures.	Please see the response to comment 3.03.
6.04	PROP	Many of the people who live along these canals are not growing alfalfa, they've purchased their homes for the setting, which includes the canals. Therefore, this could also have a negative impact on local real estate values.	Property values have not been documented to decline in value following completed piping projects. Impacts to local real estate values were investigated in the National Economic Development Analysis in Section 2.3 of Appendix D.1.
6.05	ALT	Cement pipes require more maintenance than ditches, as well. Pipe maintenance along the irrigation district right of way will be disruptive, again, to all the creatures who enjoy that environment. Please, I respectfully ask that you reconsider this plan, after a more comprehensive study of the role these waterways play in the current environment.	The design for this project does not include cement pipes. Please refer to Section 8.3 for a description of piping materials specified for the preferred alternative.
7.01	GEN	In Regards to Tumalo Irrigations proposal for Modernization, Conservation and Piping of canals. First let us say that we are 100% percent in agreement that all of our canals should be piped to conserve water and electricity. As water users, with seven acres of water rights on our 10-acre farm, we see this as a benefit and cost savings to our sheep operation. Today the Northern Columbia Southern canal runs thru the middle of our farm, requiring bridges for the animals to cross for pasture during the irrigation season and when we require the use of farm equipment on the other side of the canal we must go out our driveway across the canal and back in another gate. With a piped canal, we would no longer have these restrictions.	Thank you for your comment.
7.02	ALT	Thanks for allowing us to respond to the draft proposal for modernizing the Tumalo Irrigation District (TID) System. Having read the draft plan and attending the May 8, 2018 TID information meeting, there is only one area of concern that I would like to address. My concern is the piping of the canal that runs into Tumalo Reservoir. The reservoir has never worked to hold water and without great expense to line the reservoir, I see the reservoir has no function in the Modernization Project. I would like to see	The District uses Tumalo Reservoir to manage water within its system. The implementation of the proposed action would not change Tumalo Reservoir operations, and the reservoir would not be lined under the preferred alternative. Please see the response to comment 22.04 for additional discussion about Tumalo Reservoir. Additionally, approximately 1,000 acres under and around Tumalo Reservoir contain a deed restriction specifying that the land cannot be sold.

		the piping into the reservoir removed from the plan and have TID consider selling any and all property to help cover the costs of the TID modernization project.	
8.01	WILD	I am writing to voice my strong opposition to the proposed piping of the existing, open-air canals in our area. Our family has owned and cherished our property for nearly 50 years. In that time we've observed how the canals support numerous habitats; many likely lost due to the proposed piping. Questions for the TID: Does the district acknowledge the habitat loss due to this action? How does the district reconcile the supposed benefit of increased streamflow (10 cfs) with the loss of multiple habitats?	Section 6.3.11 discusses the potential effects of the HDPE Piping Alternative on wetlands, including seasonal and artificial wetlands along canals and laterals. Section 6.8.3 discusses the potential effects of the HDPE piping alternative on vegetation. Section 6.10.2.2 discussed the potential effects of the HDPE Piping Alternative on streamflow.
8.02	VEG	Will the district be prepared to remove the dead pine trees that will result from this action? Will the district compensate owners for any damages incurred by the falling trees?	Please see the response to comment 3.03.
8.03	WAT	Does the district acknowledge that a piping would impact owners water rights by eliminating healthy seepage and lowering the water table?	Please see the response to comment 2.02.
8.04	PROP	Does the district acknowledge that property values will potentially fall by removing the canals, changing forever the landscape? Many questions surround this proposal. Too many. I respectfully ask the district to reconsider this proposal and save the canals.	Please see the response to comment 6.04.

9.01	GEN	We thank Ken Rieck and the Board of Tumalo Irrigation District for the recent public meeting presenting their plan to conserve water; more reliably provide for their patrons; provide environmental benefits; and improve public safety. Their decision to dedicate water rights to the river for all water conserved by TID, paid for by public funds, is very welcome. In view of the analysis of the Deschutes Basin Study Workgroup, recently compiled, water is not reliably available to in-stream and out-of-stream uses seasonally. Since more than 70% of water used in the basin is dedicated to agriculture their conservation efforts provide the greatest benefit for improving in-stream quality and quantity. The decision for the preferred project alternative to pipe the open canals and lateral with HDPE pressurized pipe appears to have the most promise to eliminate seepage, improve water delivery, conserve water and enhance stream flows on Tumalo and Crescent Creek. The cost of improvement falls disproportionately on irrigators but in light of the benefits to the community we support the use of Federal, State, and other funds to supplement the investments by the irrigators. We support balancing both in-stream and out-of-stream beneficial uses of water. We support using public funds to conserve water and transferring the conserved water right to the river. We recognize the time, effort and expertise that Tumalo Irrigation and its public and private partners have dedicated to recognizing existing problems and planning for future needs. We support and are grateful for the role of federal, state and local governments and private entities in financing and providing expertise and cooperation to ensure that water, necessary for life, is available to all. The League believes that water belongs to the people of Oregon but its allocation, use, and value, should be subject to debate and creative solutions. Public participation and cooperation are essential. We hope that this project will receive the funding and support that it needs. Thank you for this opportunity to comment.	Thank you for your comment.
10.01	WAT	I have the following comments on this plan. 1. Before any taxpayer dollars are used to construct a pipeline TID should be required to change their rules/ regulations/policies to allow users to return their water to the river at no charge.	Increased instream leasing and transfers would exacerbate the water conveyance challenges that the District already experiences with an open system (see Section 2.1.1 and Section 2.1.2) because it would affect flow rates across the District and water reliability to certain patrons. Additionally, patrons' costs for instream leasing are associated with state fees and mapping costs rather than with District fees or other policies.
10.02	WAT	2. Changes to the TID rules should also be changed to require users of water to be charged based primarily on the amount of water taken from the system.	The District's assessment structure complies with Oregon Revised Statutes 545, which pertains to irrigation districts. Changing how the District charges users for water would not meet the project purpose and need to improve water delivery reliability and public safety for District-owned canal and lateral infrastructure.
10.03	COST	3. The TID should be required to contribute a significant portion of the costs of these improvements.	Thank you for your comment.

		4. Any savings to TID generated by piping the system should be contributed towards the costs of the improvements.	
11.01	COST	I agree with the guest opinion in today's bulletin newspaper. Irrigators do not pay the public for the water they divert out of the rivers but they are the primary beneficiaries of this diversion. Why should they ask taxpayers to pay the cost of modernizing their system? Ask the Farmer's to pay their share!!	Thank you for your comment.
12.01	COST	1) TID and/or its patrons should bear some significant percentage of the cost of piping while returning all conserved water in-stream. Taxpayers should not bear all of the burden.	Thank you for your comment.
12.02	GEN	2) The EA states that TID has 70% irrigation efficiency. What does that mean? That only 70% of the patrons use sprinkler systems? That all patrons use sprinkler systems of some sort but they are inefficient?	The 70% irrigation (or application) efficiency is the ratio of the water applied to a field to the amount of water taken up by a crop. It represents the efficiency of the water application method. According to TID's 2016 Water Conservation Plan, most irrigators in the District use either pivot, wheel line, or drip line; very few acres are currently flood irrigated. A 70% efficiency is within the range expected for these application methods (U.S. Bureau of Reclamation. *AgriMet Irrigation Guide.* Available online at https://www.usbr.gov/pn/agrimet/irrigation.html. Accessed July 18, 2018.)
12.03	PUB	3) Improved on farm efficiency is dismissed as an alternative as it does not provide for public safety. There are no examples provided of any public safety events in TID. I certainly do not recall one. If public safety is not actually an issue in TID then why is it used as an excuse for ignoring on-farm efficiency?	Reducing risks to public safety is a guiding principal under USDA's Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water and Resource Investments (PR&G), which states that "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." (USDA 2017). Public safety is included in the purpose and need of the proposed action (see Section 2) and discussed in Section 4.5 and Section 6.5.3. Although drowning or loss of life is at the extreme spectrum of injury, lesser injuries could result due to recreating in or interacting with the canals. Piping would eliminate exposure to these safety risks. Reference: U.S. Department of Agriculture (USDA). (2017). Guidance for Conducting Analysis Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water and Resource Investments (DM 9500-013). Washington, DC: USDA.
12.04	PATD	4) It appears that TID does not actually plan to return all conserved water in-stream even if it is 100% paid for by the public. Appendix D has a table that shows increased water deliveries to patrons after piping is complete. Where is this extra water coming from?	Please see the response to comment 22.05.

13.01	GEN	After attending the public meeting for the Tumalo Watershed Plan on May 8th 2018, it has become perfectly clear to us the management and board of Tumalo Irrigation District's piping plan is underhanded and deceitful. Holding a public meeting while not allowing the public to speak is very one-sided. All entities involved in this project, (TID, COID, Swalley ID, NRCS, Farmers Conservation Alliance and others) who claim that "in the name of conservation", that it's good for everyone. It's not. Irrigation customers and tax payers lose to these entities' ill gotten gains. Furthermore, to prevent irreparable damage to our property as well as loss of property value and a declining water table for our ground water, We Dale Callen and Paul Callen, Trustees of the Callen Family Trust, DO NOT give Tumalo Irrigation District or its contractors permission to enter our property to excavate, trench or remove any trees or foliage for the purposes of piping, modifying or updating the irrigation canal. Anyone attempting to do so will be removed from the property and legal action will follow. However, we do give TID employees permission to enter the property to inspect, maintain or repair the existing canal and weir. If you would like to discuss this matter publicly we would be happy to do so.	NRCS guidance for holding a public meeting for public review of a NEPA document provides the latitude to select the format of a public meeting to elicit public comment (National Environmental Compliance Handbook, Section 610.68). Consistent with this guidance, the public meeting was held in an open table format. Under this format, NRCS and Farmers Conservation Alliance staff were available at several tables to answer questions and discuss the project with the public. NRCS provided both paper and digital forms to submit public comments, and NRCS staff were available to assistance the public in submitting comments if they desired assistance. This format was selected to better elicit public comments at and after the meeting. Please see TID's easement policy on their website. Please also see ORS 545.239, ORS 545.249, and ORS 545.287 which describes the rights of irrigation districts to enter upon lands with an easement for the purposes of maintenance and improvement of irrigation works. Reference: United States Department of Agriculture Natural Resources Conservation Service, "National Environmental Compliance Handbook" (2016). 190-610-H, 3rd Ed., May 2016. Available online at https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=39472.wba. Accessed July 17, 2018)
14.01	GEN	I found this to be a well written and easy to follow document.	Thank you for your comment.
14.02	WILD	You did not discuss effects on milkweed or Monarch Butterflies. The monarch butterfly is currently undergoing a status review by USFWS to determine if it is warranted for listing.	Monarchs occur seasonally in Deschutes County, leaving the county prior to the onset of cold weather. Based upon anticipated construction during the winter, implementation of the proposed project would not directly affect monarchs because they would not be in the project area at that time. District staff has not observed milkweed growing in the area affected by the implementation of the proposed project; therefore, the project would not have an indirect effect on monarch butterflies through the removal of milkweed plants. The presence of milkweed would, however, be evaluated prior to implementation of each piping project. If milkweed is found, TID has expressed their desire to incorporate milkweed seeds into the seed mix used for revegetation.
14.03	VEG	You did not discuss effects on milkweed or Monarch Butterflies…. Is there milkweed growing along any of these canals? Would you be able to include milkweed in your revegetation species mix?	Please see the response to comment 14.02.

14.04	NED	On page xxvii and following you discuss benefit to cost ratio. Some of these numbers seem very high. Your process for calculating benefit/cost ratio might need to be reviewed.	Please see Appendix D.1 for details about how the benefit cost ratios were calculated. Calculations were based on the NRCS Water Resources Handbook for Economics as well as guidance from Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. Reference: U.S. Department of Agriculture, Natural Resources Conservation Service. Water Resources Handbook for Economics, Part 611. Available online at https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=28583.wba. Accessed July, 19 2018.
14.05	GEN	On page 8, you discuss the Environmental Evaluation (EE) review tool. While I am not familiar with this tool, it does seem like a good idea for a staged project such as this. You will need to complete additional environmental analysis and documentation if there is new information or if the future phases of the project do not match up with the environmental consequences that are expressed in the EA.	As described in Section 1.5, environmental evaluation would occur prior to implementation of each project group when using a tiered analysis approach. If the project falls within existing project specifications in the Plan-EA, the project would proceed. If the project falls outside of the existing project specifications in the Plan-EA, if there is new information, or if the future phases of the project do not match up with the environmental consequences that are expressed in the Plan-EA, additional analyses would need to occur.
14.06	CUL	On page 16 you indicate that not all of the project has been surveyed for archaeological resources. The ongoing surveys could provide new information that would trigger additional environmental analyses.	Please see Sections 4.1.2 and 4.1.3 for surveys that have already occurred. Additional surveys would be completed prior to each construction project (see Section 1.5). The District's best management practices and compliance in regards to cultural resources and the implementation of the proposed project are discussed in sections 6.1.4.
14.07	FISH	On page ten you have: "The Deschutes River and its tributaries support sensitive species including the Oregon spotted frog, bull trout, steelhead trout, redband trout, Chinook salmon, as well as many other fish, bird, and wildlife species." I suggest that the term "sensitive" does not apply to all of this list as some of these have specific status under the Endangered Species Act.	Thank you for your comment. Section 2.1.3 has been updated to state that, "The Deschutes River and its tributaries support many fish, bird, and wildlife species. Among these include several sensitive species such as steelhead trout, redband trout, and Chinook salmon, as well as Oregon spotted frog and bull trout listed as 'threatened' under the Endangered Species Act."
14.08	CONS	On page 17, you indicate that there are no issues associated with noise. I think that the landowners would experience disruptive levels of noise while the equipment is working nearby. This should be discussed. Also the levels of noise would be likely to disrupt wildlife especially during nesting season for birds or mating season for elk. Will you have limited operating periods?	A limited operating period for construction was not identified as necessary to avoid effects from noise to breeding populations of wildlife, including migratory birds and elk, based on habitat utilized by wildlife and on construction dates. Please refer to Table 3-1 of the Plan-EA where clarifying language was added regarding noise and the proposed action. Please refer to Section 6.12.3 of the Plan-EA for a discussion of the potential effects of the implementation of the proposed project to wildlife. The District's best management practices in regards to construction practices during the implementation of the proposed project are discussed in Section 8.4.2.
14.09	VEG	On page 18, you discuss the BLM area of critical environmental concern for Peck's milkvetch. You indicate that there are no known occurrences. Have you completed surveys for this species?	Surveys have not been completed for Peck's milkvetch in the BLM Area of Environmental Concern (ACEC). Please see Section 6.8.2.3 and 6.8.4 for information about pre-construction surveys.
14.10	VEG	What do plan to do for invasive species and noxious weeds? You list them out on page 55 and following but do not identify actions	Section 6.8.2.2 and 6.8.3.2 describe the effects to invasive species and noxious weeds, as well as actions to control them.

14.11	WILD	On page 116, you indicate: “Due to the location of the Oregon spotted frog and bull trout populations at the very upstream and downstream ends of the area of potential effect, these listed species would not be affected by implementation of both action alternatives under consideration. Additionally, it has been determined that the project will not affect the PCEs identified in the critical habitat designations for Oregon spotted frog (81 Fed. Reg. 29335, 2016) and bull trout (70 Fed. Reg. 56211, 2005). Consequently, Section 7 consultation under the ESA as amended is not warranted for this project. Therefore, it has been determined by NRCS that no effects would occur to federally designated critical habitat for Oregon spotted frog and bull trout. There would be no change to the environmental baseline in relation to the PCEs and the Physical and Biological Features for Oregon spotted frog and bull trout.” Yet on page 10 you expressed: “The Deschutes River and its tributaries support sensitive species including the Oregon spotted frog, bull trout, steelhead trout, redband trout, Chinook salmon, as well as many other fish, bird, and wildlife species. Low streamflows in the Deschutes River and its tributaries limit habitat for many of these species. Reduced habitat associated with low streamflows increases competition between populations, which often favors non-native brown trout over native redband trout and can concentrate fish populations and increase susceptibility to predators and disease.” And on page 9 as part of your purpose and need statement, you have: “Federal action is needed to accelerate and provide certainty to address the following watershed problems and resource concerns: water loss in District conveyance systems, water delivery and operations inefficiencies, instream flow for fish and aquatic habitat, and risks to public safety from open irrigation canals.” These statements are not consistent with each other and if you are increasing stream flow, you need to consult with USFWS.	Please see Sections 6.2.3.1 and 6.2.3.3 for clarifying language regarding the effects of the proposed project on sensitive and listed species within the area affected by the project. Additionally, project-related effects to listed species have been reviewed and, upon this review, it has been determined that the project could affect, but is not likely to adversely affect, Oregon spotted frog because of entirely beneficial actions. The project has been determined to have no effect on bull trout based on the downstream effects of water, season of water instream, and location of bull trout in the Deschutes River. Consultation with USFWS has been initiated and a request for concurrence with these determinations has been submitted to the Service. Although Steelhead are listed as threatened under ESA 10(j) and are present within the area affected by the project, these populations have been classified as non-essential experimental populations (NEP). National Marine Fisheries Service (NMFS) has determined that, *when NEPs are located outside a National Wildlife Refuge or National Park, [NMFS] treat the population as proposed for listing and only two provisions of section 7 would apply: section 7(a)(1) and section 7(a)(4). In these instances, NEPs provide additional flexibility because Federal agencies are not required to consult with [NMFS] under section 7(a)(2) Section 7(a)(4) required Federal agencies to confer with the Service on actions that are likely to jeopardize the continued existence of a proposed species. The results of a conference are advisory in nature and do not restrict agencies from carrying out, funding, or authorizing activities* (USFWS 2015) Because our action is entirely beneficial we do not need to engage NMFS and obtain a conference report. Reference: United States Fish and Wildlife Service, "Endangered Species Act: Experimental Populations" (2015). Available online at https://www.fws.gov/verobeach/FloridaPantherRIT/20150819%2010j%20Experimental%20Population%20Fact%20Sheet.pdf. Accessed July 27, 2018) Please also see 76 FR 28715, 2011 and 81 FR 33416, 2016.
15.01	ALT	Three options were presented at the May 8th meeting regarding the TID Irrigation Modernization Project, including, No Action, Piping and Canal Lining. The Piping alternative is being reported as the preferred alternative. Preferred by who? Not these water users and we doubt if the majority of TID water users would prefer piping if given the opportunity to vote on the matter. Our preferred alternative going forward is NO ACTION. Piping is too costly relative to the speculative, exaggerated and erroneous reported benefits. Piping will financially harm many TID water users. Do not embark on additional piping of our canals. Thank you for accepting these comments from TID water users.	In the context of our watershed planning effort, the "Preferred Alternative" as defined in the National Watershed Plan Manual Title 390-500 is identified as "The option and course of action that the SLO (sponsoring local organization) and NRCS agree best addresses the stated purpose and need."
15.02	WILD	Piping fails to consider the devastating impact of many miles of lost spring and summer wildlife habitat.	Potential effects of the implementation of the proposed project to wildlife are discussed in sections 6.12.3 and 6.12.4

16.01	WAT	Both Tumalo Creek and the Deschutes River are priority streams within our basin. Accordingly, the proposed steps to improve TID's irrigation system through this Project and return all conserved water back to these streams represents a very positive step toward restoration of their fisheries. Current and prior studies indicate there is enough available water to meet most instream, agricultural and municipal supply demands in the Upper Deschutes Basin. In order to achieve this, conservation of agricultural water use through infrastructure modernization, management innovation, water market transactions and on-farm efficiencies is essential	Thank you for your comment.
16.02	WAT	Regarding conserved water, page 12 of the draft Watershed Plan states that 100% of conserved water will be returned instream. It is our understanding that the calculation of conserved water equals the conveyance loss due to seepage and evaporation, as measured directly per the Tumalo System Improvement Plan (SIP). As reported on page D-50, the actual measurements found 50.4 cfs loss in seepage and evaporation in the SIP study, while the Watershed Plan projects 48 cfs in conserved water. This discrepancy should be explained.	The change in total amount of conserved water from 50.4 cfs to 48 cfs is due to piping projects that TID constructed between the completion of the water loss assessments used in their System Improvement Plan (SIP; Appendix D.2) and the release of the Plan-EA. These completed projects and their associated losses are included in the SIP but not the Plan-EA.
16.03	PATD	A second point of concern is that stated benefits to patrons include increased amounts of irrigation water from the historical 3.5 ac-ft/acre to 5 ac- ft/acre (pages D-19-20). This is a large amount of water above that reported as conserved water. The offered explanation is that this reflects improved system efficiency. A transparent and detailed supporting analysis of how system efficiency allows this increase in irrigation use is needed, beyond the qualitative explanation offered.	Please see the response to comment 22.05.
16.04	WAT	It would seem appropriate to follow the recommendation of Black Rock Consulting and have their own loss assessment in the SIP confirmed by either USGS or OWRD prior to project completion (page 17 of the SIP). A commitment to this process in the watershed plan is called for.	TID will coordinate with partners to verify water losses and water savings associated with projects receiving funding through PL 83-566.
16.05	GEN	Our Chapter has been very involved with the Deschutes Basin Plan process and the work of the Deschutes River Conservancy. This collaboration has given us a better understanding of the challenges facing the irrigation districts and the complexities of water management in the basin. We are supportive of PL 566 and the funding this law provides for irrigation system improvements and on-farm efficiency. The public investment for both the TID Project and the other irrigation districts' watershed modernization plans is huge. While we cautiously support this level of public investment, we are committed to ensuring that public moneys spent to conserve water result in permanently protected instream flows in our public rivers, streams and creeks within the Deschutes Basin.	Thank you for your comment.

17.01	WAT	The City supports TlD's efforts to pipe its distribution system, conserve water and to increase flows in Tumalo Creek. Conservation of flows in Tumalo Creek is of particular interest to the City because more than half of the City's annual water supply is diverted from the Tumalo Creek watershed. Consequently, the health of the watershed and maintaining streamflows in Tumalo Creek are of vital importance to the City. (To this end, the City Council has passed resolutions supporting efforts to restore flows in the creek, and has appreciated the cooperative relationship between the City and TIO in working toward a common goal.) Nonetheless, this comment letter raises several significant concerns with the Draft EA. First, the City holds six water rights that authorize the above described municipal use of water from Tumalo Creek and Bridge Creek. Several of the City's water rights share the same priority date as TlD's water rights; however, the Draft EA fails to even mention the City's use of water from Tumalo Creek.	Thank you for identifying that project sponsors did not include information about the City of Bend's water rights in the draft Plan-EA. Although the City of Bend's water rights did not come up during public scoping, the City of Bend is a water user on the Tumalo Creek system. TID expects to work with the Oregon Water Resources Department and its partners to ensure that these allocations of conserved water avoid or mitigate for harm to other water users as described in Oregon Administrative Rules 690-018-0050.
17.02	CONSU	Second, the Draft EA identifies the City as a "local partner" (page 169); however, TID did not consult with the City regarding the development of the Draft EA. (Table 7-1 in the Draft EA does not include any reference to consultation with the City.) As the only other significant out-of-stream water right holder on Tumalo Creek, it will be important for TID to coordinate with the City as conserved water projects are developed and implemented.	The City of Bend was misidentified as a local partner who had been consulted in the Plan-EA process. The City of Bend was notified of both the public scoping meeting and the public comment period for the draft Plan-EA. The City of Bend has provided comments on the draft Plan-EA, and these comments have been included and addressed. Moving forward through implementation of project groups, TID will work with the City of Bend through the Allocation of Conserved Water Program.
17.03	WAT	Finally, the Draft EA includes an erroneous assumption regarding the distribution of TlD's conserved water between its water sources (Tumalo Creek and Crescent Lake), which raises serious concerns for the City. The Draft EA assumes a distribution of TlD's conserved water between its two sources based on the percentage of total annual volume used from each source. The Draft EA indicates that 38 percent of the conserved water would be allocated to Crescent Lake and 62 percent allocated to Tumalo Creek. Using these percentages, the Draft EA indicates that the water would be protected instream in Crescent Creek (below Crescent Lake) and Tumalo Creek at 18 cfs and 30 cfs, respectively. The Draft EA represents the rate of flow to be protected in Tumalo Creek as a constant rate from May 15 to September 15. Both the distribution between the two sources and the proposed constant rates for the instream water rights fail to recognize the seasonality of TlD's use of water from these sources. In general, TIO obtains the majority of its supply from Tumalo Creek (via the Tumalo Feed Canal) early in the irrigation season when streamflow is high. The district's rate of diversion from Tumalo Creek decreases beginning in June. By August of a typical year, TID diverts water from Tumalo Creek at approximately one-third of its earlier rate of diversion and replaces the Tumalo Creek water supply with water released from Crescent Lake (and appropriated via the Bend Feed Canal). (See Figure 1, which illustrates TID's typical use of supply from its two water sources, and Table 1, which provides TlD's monthly diversion volumes for each source from 2013). Thus, proposing instream water rights with constant rates throughout the irrigation season disregards this seasonal variation in TlD's water use. As a result, erroneously high rates of water will be protected in Tumalo Creek during periods of low flow in the late summer and early fall, as compared to the amount of	Sections 2.2.1 and 6.10 outline how the conserved water created through the proposed project could be allocated instream. Clarifying language has been added to Section 2.2.1. TID expects to work with the Oregon Water Resources Department and its partners to ensure that these allocations of conserved water are protected instream and to avoid or mitigate for harm to other water users as described in Oregon Administrative Rules 690-018-0050.

		Tumalo Creek water TID is actually conserving during this period of time. Since many of the City's surface water rights share priority dates with TlD's water right, and, consequently, with the instream water rights resulting from TID's conserved water project, the above-described seasonal imbalance would cause harm to the City's water rights. Avoiding harm to existing water rights is a fundamental principal of the Oregon Water Resources Department's (OWRD's) Allocation of Conserved Water Program. Pursuant to OAR 690-018-0050(4)(b), when reviewing an application for an allocation of conserved water, OWRD must determine whether the allocation of conserved water will harm existing water rights. If OWRD finds that existing water rights will be harmed, the agency must determine the quantity of conserved water needed to mitigate the harm, and any conditions or limitations to prevent or mitigate the harm. (OAR 690-018-0050(4)(d) and (j).) The Draft EA should be revised to address the allocation percentages between TID's sources and the reality that the instream water rights stemming from TlD's allocations of conserved water will need to be "shaped" in order to avoid harm to existing water rights on Tumalo Creek. In addition, the calculated flow restoration numbers following page 139 and in Appendix E should be revised accordingly; however, it is unclear how rates can be calculated without going through the detailed analysis of a conserved water application and considerations of harm to existing water rights. Inclusion of rates to be protected instream each month would presuppose the conclusions of the review that OWRD must conduct as part of the Allocation of Conserved Water Program. In addition to the detailed evaluation of potential harm to existing water rights, OWRD's review process also includes public notice and opportunities for public comments and protests. For these reasons, identification of monthly rates of flow to be protected instream is speculative. Despite the above-described concerns and over-sights in the Draft EA, the City supports TlD's efforts to restore streamflows in Tumalo Creek. The City looks forward to working cooperatively with TID to resolve these issues.	
18.01	WAT/ SYS	Thank you for the opportunity to comment on the draft Watershed Plan - EA. Although modernization/piping is a component of water conservation, I can only support it if: a) there are enforceable requirements that conserved water be returned to the river; b) specific in-stream flows will be sustained; c) conservation by senior rights holders is achieved before piping; and d) lateral canals are piped first, before the main canals. Piping canals may be part of the solution to a healthy Upper Deschutes, but only when conservation and enforceable measures to put water back in-stream are attached.	Please see the response to comments 16.04 and 17.03. Please see response to comment 26.29 for a discussion of the system design approach.

18.02	ALT	The argument for modernization is compelling... on its surface. I have deeper concerns about the piping of irrigation canals: 1) Senior rights holders may lose incentive to conserve water. Prior to piping canals, conservation measures must be implemented, such as: • a metered system that rewards irrigators for conservation through lower bills; • demand-based water delivery; • use of drip, sprinklers or pump-back systems.	Thank you for your comment.
18.03	ENRG	2) Development of in-pipe hydroelectric facilities creates a disincentive to conservation by senior rights holders, as more water produces more revenue.	The proposed project does not include in-pipe hydroelectric facilities.
18.04	WAT	3) Water isn't "lost" through leaking canals, rather, it recharges groundwater aquifers. Cold springs essential to threatened species (steelhead, bull trout) could be impacted if water doesn't seep into the ground from canals.	Please see Sections 4.10.4, 6.10.2.4, and 6.10.3.4 for discussions of groundwater resources and potential affects to them.
19.01	Land Use	The Draft EA is an unbalanced document. It is not credible in its assessment of the relevant facts. The Draft EA fails to pay adequate attention to the rights and interests of the landowners across whose land the easement runs. It is inexplicably dismissive of the most obvious, cheapest common sense solution to conservation of water – greater efficiency and responsibility from those who use it. It fails to consider the nature of Carey Act easements and the fact that rights of way are not equivalent to the rights of a landowner. 19th century statutes designed to assist hardscrabble settlers must not be abused as a legal cloak behind which construction crews may march uninvited on to private land within just a few feet of people's homes. For these reasons I would encourage the authors to revisit their proposals with regard to laterals running across land which they do not own. Should they fail to do so, with regret I will have no option but to consider all available legal means to protect my rights. It is disappointing that the authors of the Draft EA have been so brazen in sacrificing the values of the American West upon the altar of quick and easy private profit funded by government subsidy. I am disturbed by the double standards of Section 5.2.1. In considering pipeline realignment, the Draft EA notes that "new easements would disrupt prime farmland and residential living areas, and the easements would be a contentious and divisive issue within the surrounding community", and in rejecting this option cites "social effects to adjacent landowners." Yet in seeking to impose the pipeline along the existing canal route, no such negatives are discerned for the current landowners. I would also note that, as further detailed below, the current easement does not contemplate a pipeline in any case. Legality: In this country it ought to be very serious thing to interfere with a property	Please see TID's easement policy on their website. Please also see ORS 545.239, ORS 545.249, and ORS 545.287, which describe the rights of irrigation districts to enter upon lands with an easement for the purposes of maintenance and improvement of irrigation works. Swalley Irrigation District v. Alvis (2009) affirmed a district's right to pipe using its historical easement as authority. Regarding other means of water conservation, please see Sections 5.2.4, 5.2.5, and 5.2.6 of the Plan-EA for a discussion about why voluntary duty reduction, on-farm efficiency upgrades, and piping private laterals were considered but eliminated from further study. Please also refer to the response to comment 2.06; this response also applies to voluntary duty reductions and piping private laterals. Reference: Swalley Irrigation District v. Alvis. 326 Fed. App'x. 995 (9th Cir. 2009).

		owner's enjoyment of his or her own land; the bar for such interference must necessarily be set high. To borrow from the California Court of Appeal in Felsenthal v Warring: "We know of no principle of law or power in a court of equity to justify or authorize an invasion of the property rights of one private party to serve the convenience or necessities of another private party. Such a principle, if once adopted by judicial tribunals, upon grounds of necessity, would, in its practical operation, result in a system of judicial condemnation of the property of one citizen to answer an assumed necessity or convenience of another citizen, and the sacred right of private property, so jealously guarded by courts in all English-speaking countries, would become but a shadowy unsubstantiality." The easement holder does not enjoy the same latitude that the landowner does in improving the land, and the rights of the easement holder are to be construed restrictively. The Draft EA notes the geographical extent of its right of way under the Carey Act but fails to specify the substance of the easement. Evidently the Draft EA assumes that the easement permits TID to build and install a pipe. However, the relevant statutes provide for ditches and canals, and the right of way permits TID to maintain and repair those canals. The scope of an easement is fixed by the location, character and use in existence at the time the land became subject to the easement. Once fixed, the scope of the easement may not be changed without the consent of the servient owner - thus no right to install a pipe exists, and its installation would constitute an illegitimate creation of a new servitude upon the land. Case law clearly demonstrates that additional convenience or benefit to the dominant estate is immaterial where the alteration would result in the creation of a new servitude. In addition, the loss of existing riparian habitat would increase the burden upon the land, creating an additional bar to the proposed alteration of the easement. Nor is the construction of a pipe reasonably necessary to achieve the purpose of the easement – per the Draft EA, farms in the TID area could improve irrigation efficiency by almost half as much again, and any expansion of the needs served by TID subsequent to the vesting of the easement is irrelevant to the interpretation of the scope of that easement. Whilst the stated environmental aim of water conservation is laudable, it is not relevant to defining the scope of the easement and it may be achieved by other means. I am aware of the Swalley Irrigation District v Alvis case. I consider the court's decision in that case to have erred in both fact and law.	
19.02	ALT	The first, cheapest and simplest way to save water is to require individuals to be more responsible with its use. However, in 249 pages of the Draft EA the possibility of improving the irrigation efficiency of farms merits less than half a page (Section 5.2.4). This is strange given that TID estimates the current level of efficiency to be only 70%. It would seem incumbent upon	Please see the responses to comments 2.06 and 12.02.

		any enterprise, most particularly a commercial enterprise, to maximize its own efficiency in the utilization of a precious resource before asking the government to fund a major engineering project in order to increase the availability of that resource. On any given summer's day one can observe many farms irrigating in the blazing midday sun. Those seeking to conserve water must first look closer to home.	
19.03	PUB	But whereas the central issue of improving farm water use efficiency gets short shrift, the risk of drowning is mentioned over 30 times in the Draft EA and Appendices - presumably because it suits the authors' purpose to magnify imaginary dangers in order to solve them with a pipe. With regard to TID laterals, this risk is unsubstantiated by the sparse statistics adduced in Section 4.5 and Appendix D.	Please see the response to comment 12.03
19.04	PROP	The Draft EA is similarly disengaged from reality in its all too brief passing reference to landowners' interests in Section 4.9. The Draft EA's begrudging statement that "some viewers may consider [the canals and laterals] to be water features during the irrigation season" fails to recognize that homes have been intentionally built close to laterals and that the open nature of the laterals in the summer months adds value to these properties. Historically the aesthetic appeal of the canals has been the equitable quid pro quo for the tolerance of landowners in supporting the TID. The elimination of laterals and the resulting death of plants and trees that have grown up around them over the years will reduce the value and attraction of these properties, possibly to a material extent. I would invite the authors of the Draft EA to speak to local realtors should they doubt the validity of this point; they may wish to consult the current listing for 18281 Couch Market Rd for clear evidence of how the laterals are marketed as positive amenities. I would be happy to welcome the authors of the Draft EA to my home so they can observe this at first hand. I applaud the goal of water conservation for the good of wildlife. But we ought not to forget that farming itself pays little or no heed to wildlife; it cuts down trees and destroys other native vegetation in the name of profit, in some instances introducing chemicals and pesticides into the ecosystem. Of course, every man or woman has a right to make a living, it is simply a question of balance. Bend and Tumalo now enjoy a more diversified economy than in decades past, and the interests of one section of the community should not be unduly favoured at the expense of others. The skewing of the facts and absence of common sense in the Draft EA betray a disheartening lack of community and a troubling sense of entitlement.	Please see the response to comment 6.04.

20.01	GEN	The Coalition for the Deschutes (CFD) supports Tumalo Irrigation District's watershed Plan-Environmental Assessment and their Irrigation Modernization Project. Specifically, we support the Piping Alternative that will replace 1.9 miles of the Tumalo Feed Canal with 84-inch diameter HDPE pipe, replace 66.9 miles of open laterals with smaller diameter pressurized HDPE pipe, and provide other system improvements. As river advocates who also support sustainable irrigated agriculture in Central Oregon, we're excited and eager to see TID's irrigation modernization project move forward and be brought to fruition.	Thank you for your comment.
20.02	WAT	TID's Modernization Project is projected to reduce water seepage and evaporation losses by up to 48 cfs. TID's Board of Directors recently passed a resolution that, in total, commits to returning 100% of conserved water to instream use in the Deschutes River, Little Deschutes River, Tumalo Creek, and Crescent Creek. CFD applauds the resolution (attached). We believe that all of the conserved water should go instream with senior water rights so that it is permanently protected instream and is not subject to out-of-stream use. This water will benefit fish, wildlife, and other aquatic resources. Tumalo Creek is a significant tributary to the Middle Deschutes River and historically provided critically important cold, clear water to this 40-mile reach of the Deschutes River. Diverting less Tumalo Creek water for irrigation will help the Middle Deschutes River return to a healthier ecological condition. According to the Upper Deschutes Watershed Council, "New analyses show that restoring flow in Tumalo Creek can achieve a greater cooling effect than restoring the same amount of flow in the Deschutes. This information suggests a new approach to stream flow restoration that prioritizes increasing flows in Tumalo Creek." To read more, please see: http://www.upperdeschuteswatershedcouncil.org/monitoring/middle-deschutes-monitoring/	Clarifying language about the allocation of conserved water has been added to Section 2.2.1. Thank you for sharing this information from the Upper Deschutes Watershed Council; Section 6.10 references one of their reports on the relationship between streamflow and water temperatures in Tumalo Creek.
20.03	WAT	Third party oversight and confirmation is a valued part of managing public-owned resources such as the water. Thus, we affirm and agree with Blackrock Environmental's urging that either the USGS or OWRD monitor and evaluate the amount of water conserved and returned to instream use prior to TID's project being completed. The Coalition enthusiastically partners with irrigation districts, including TID, to implement district conservation projects, as well as other types of programs, to improve water supply availability in the basin and to restore much-needed flows to the Deschutes River and other related waters. We appreciate the commitment that the Tumalo Irrigation District has shown to helping restore the Deschutes River and the above-mentioned tributaries and return them to their historic healthy condition. We strongly believe that these actions will benefit all of Central Oregon.	Please see the response to comment 16.04.

21.00	WAT	I would like to express my support to the Tumalo Irrigation District's Watershed Plan-Environmental Assessment and their Irrigation Modernization Project. In particular, I support the Piping Alternative. I am concerned over the wasteful use of diverted water, and the negative effect our policies are having on the Deschutes River Basin. The current irrigation system of leaky, unlined canals built in the early 1900's, combined with an antiquated set of water use policies have put the health of the Basin and its economic viability at grave risk. Lowering flows in the Upper Deschutes in favor of filling the Wickiup Reservoir to meet next year's agricultural needs causes the death of thousands of stranded fish and untold numbers of aquatic invertebrates and amphibians, and the impacts of the draw down on the birds and other animals that depend on the river. Agriculture receives >80% of the water through diversion from the river to irrigate our local desert. Of that, approximately 50% of irrigation water is lost by the leaky canal system, combined with wasteful practices such as flood irrigation. Piping the water to the farmers, metering its use, coupled with keeping conserved water in the river are key elements that are in the best interests of the farmers, the tourism and recreation industry and all of the Bend business that benefit directly or indirectly from our precious river. By law, the water belongs to ALL the people of Oregon. We need to improve our irrigation infrastructure and modernize our policies to reflect 21st Century economics. Most importantly, the River needs our help and our voice. I appreciate that Tumalo Irrigation District's desire to restore the Deschutes River am pleased to see the TID cooperating with local business, conservation groups like the Coalition for the Deschutes and other stake-holders. I'm sure that, in the spirit of finding common ground, the health of the Deschutes and its tributaries like Tumalo Creek will be enhanced to the benefit of all.	Thank you for your comment.
22.01	WAT	TID commits to putting the whole of the project through the Conserved Water Act. We strongly support this approach, and commend TID for incorporating this into their watershed Plan.	Thank you for your comment.
22.02	WAT	TID commits to putting 100% of the water instream if public funds are used. We support this and commend TID for incorporating this into their Watershed Plan. That said, we would urge TID to put 100% of the water instream regardless of whether or not it is fully financed by public funds. (Footnote: As TID is aware, WaterWatch's reading of the Conserved water Act is that consumptive use of conserved water in the Deschutes Basin would be prohibited because of the impact to downstream instream water rights.)	Thank you for your comment.

22.03	PURP	WaterWatch would urge TID to expand the purpose of the project from "Agricultural Water Management (v)" to include the additional authorized PL-566 purpose of "Public Fish and Wildlife (iv)". While we appreciate that the stated purpose of "Agricultural Water Management" includes, broadly, water conservation, the term "water conservation" is not defined by the PL-566 as something that would necessarily benefit fish and wildlife. Given the significant amount of public funds being considered for investment in this project, having a clear tie to the public purpose of fish and wildlife is of critical importance both for optics and accountability purposes. REQUEST: Add "Public Fish and Wildlife" as a PL 566 authorized purpose in addition to "Agricultural Water Management".	The PL 83-566 authorized project purpose of "Public Fish and Wildlife" is defined in the National Watershed Planning Manual Title 390-500 as "Fish and wildlife development areas may be included in a watershed project plan when the SLO agrees to operate and maintain a reservoir or other area for public fish and wildlife access. Measures installed for public use of areas developed to improve the habitat or the environment for the breeding, growth, and development of fish and wildlife may be included in a watershed project plan" (USDA 2015a). The proposed project does not include the measures described; therefore, "Public Fish and Wildlife" would not be an appropriate authorized project purpose. Reference: U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). (2015a). *Title-390 National Watershed Program Manual* (4th ed.). January. Retrieved from: https://directives.sc.egov.usda.gov/ViewerFS.aspx?hid=36702. Accessed June 2016.
22.04		While WaterWatch supports the inclusion of District piping in the Watershed Plan, we urge TID to broaden this purpose to include the broad array of water conservation measures that could further lead to efficient irrigation and water restored instream, including but not limited to, on-farm efficiencies, piping of private laterals and duty reduction. As you likely are aware, numerous stakeholders (including TID) in the Deschutes Basin have been involved in the Bureau of Reclamation's Upper Deschutes Basin Study Workgroup (BSWG) over the past few years. This process will be coming to a close this summer. Included in the Study is an analysis of a number of water conservation tools including, but not limited to, on-farm efficiencies, piping/lining of private laterals, market approaches, and duty reduction, in addition to piping District canals (https://www.usbr.gov/pn/studies/deschutes/). While the BSWG will not result in a prescriptive plan, studies and modeling generated in this process do document the great potential of the whole of these collective tools to help address the ecological, agricultural and municipal needs in the basin. While the District's first priority may be District piping, it seems short sighted and contrary to meeting public purposes in Watershed Plan to limit the PL-566 watershed plan to the single purpose of District piping, especially given that this plan will govern the disbursement of PL 566 monies into the future. To that end, we would urge the District to broaden the plan to include all conservation measures studied in the BSWG. We would not object to a prioritization of District piping in the watershed Plan, but we do object to the exclusion of the broad array of available water conservation tools. We made this comment to a NRCS staff person at the May 8 public meeting on TID's draft EA and were told that PL 566 did not allow for the funding of on farm efficiencies and/or private laterals. We have studied the Act and have found no such restrictions in the law; to the contrary, both the Act as well as the watershed Plan PL-566 Handbook appear to contemplate that the sponsoring entity will help individual farmers on private lands, and that conservation measures can include both structural and non-structural measures. The Draft EA justifies its decision not to include a number of water conservation alternatives because of "logistics, social, or environmental"	Please see Section 5.2 for a discussion of alternatives that were considered and eliminated from further study. Clarifying text has been added to the Plan-EA regarding voluntary duty reductions, on-farm efficiency improvements, and piping of private laterals (see Sections 5.2.4, 5.2.5, and 5.2.6). Please see the response to comment 2.06 regarding why on-farm efficiency improvements cannot be incorporated into the plan; this response also applies to piping of private laterals and voluntary duty reductions. Please see the response to comment 25.04 regarding market-based programs. Please see the response to comment 22.03 regarding the addition of the PL 83-566 authorized project purpose of "Public Fish and Wildlife". The District's System Improvement Plan (SIP) indicated that, if the District were fully piped and Tumalo Reservoir were fully lined, the District would be able to conserve up to 53 cfs. The District developed this number based on the District's diversions and desired delivery rates in a 100% efficient system. The SIP did not further analyze losses in the reservoir itself, or further consider lining the reservoir as an action. The District had previously considered lining the reservoir but found that the costs such as permitting, lining installation, sediment removal associated with construction, and long-term sediment removal in the presence of the liner were likely prohibitive.

		reasons. Very little detail is provided here. For instance, for on farm efficiencies (section 5.2.4 of the EA) the EA notes that on-farm efficiencies were eliminated because they would not improve water delivery reliability and public safety. While on farm efficiencies might not improve public safety, public safety is not a requirement of the program. Similarly, ensuring delivery reliability is not a requirement of the program. TID's current stated purpose is "Agricultural Water Management", which allows for a broad array of projects. For instance, "irrigation projects" includes measures planned primarily to increase the efficiency of water use on cropland, grassland, and woodland and to obtain the maximum practical benefits for existing investments in irrigation." (National watershed Handbook at. 600.A-5, 2014). The handbook does not set limits as to what falls under this broad directive, nor does it limit project boundaries to irrigation works (i.e. projects can be within watershed or subwatershed areas composed partly or totally of lands irrigated or proposed to be irrigated.). It is also important to note that the very broad term "water conservation" falls under the "Agricultural Water Management" umbrella. On-farm efficiencies clearly meet the stated sub-purpose of "water conservation" under Agricultural Water Management, and therefor fit quite well under the District's proposed purpose. And finally, on farm efficiencies could also easily be justified under the Public Fish and Wildlife purpose if TID were to add that as a stated purpose REQUEST: Expand the proposed action to include additional water conservation projects, including on farm efficiencies, piping of laterals and other mechanisms outlined in BSWG (market approaches, duty reduction, etc). The lining of Tumalo Reservoir should also be included.[2] (Footnote 2: TID's SIP includes lining of Tumalo Reservoir as part of the District piping/lining recommendations, which would render conserved water closer to 53 cfs than the 48 cfs noted in the EA.)	
22.05	PATD	The EA states the project will put 100% of the saved water instream (EA pg 12). The EA also notes that piping open canals and laterals eliminates the need for carry water, and that this would improve operational efficiencies to ensure that patrons receive the water they need at the time that they need it. (EA pg.11-12). Appendix D then provides detail that shows that TID will, as a result of the project, actually increase average irrigation use from 3.5 af/acre to 5 af/acre feet. While we clearly support the dedication of the carry water instream, we have significant concerns regarding the proposed increase in duty delivered. Specifically, it conflicts with the commitment made in the EA that all saved water will be dedicated instream. Moreover, increasing average duty from an average 3.5 af/acre to 5 af/acre arguably conflicts with the principal of beneficial use without waste. The USGS Groundwater Study notes that Tumalo's mean crop water requirement is 2.31 af/acre. See USGS Ground-water Hydrology of the Upper Deschutes Basin, Oregon, Water Resources Investigations Report 00-4162, at 27. The EA states that TID's on farm efficiency is 70%, thus 3.5 af/acre would allow beneficial use without waste for District patrons[3]. (Footnote 3: We have heard it stated in many forums	Thank you for bringing this to our attention. The statement declaring an increase to patron supply from an average of 3.5 AF to 5 AF was an error and has been removed. The proposed project would allow TID to more precisely deliver the correct amount of water to patrons when they need that water through improved operations The District would not increase diversion nor would it increase water supply across the entire District. Section 2.2.1 discusses that the District would allocate 100% of the publicly funded conserved associated with the proposed project to instream use. Please see the response to comment 16.04 about verifying conserved water amounts.

		that having a fully piped and pressurized system will allow the District to meet patron needs. The EA does not provide adequate justification to increase duty from the current average of 3.5 af/acre to 5 af/acre.) At the same time, putting the difference instream would put significant additional water instream (1.5 af per acre over the course of the irrigation season results in approximately 34 cfs). In a nutshell, the proposed increase of the average irrigation deliveries from 3.5 af/acre to 5 af/acre undercuts the public benefit of water that could be returned to the stream via the investment of PL-566 public funds. REQUEST: Limit duty to a maximum of 3.5 af/acre (which is the current average use of TID patrons) and adjust the amount dedicated instream accordingly.	
22.06	WAT	The EA notes that "up to 48 cfs" will be returned instream as a result of piping the District's canals. The SIP notes between 50 and 53 cfs would be returned instream (53 if lining of Tumalo Reservoir is included). It is not clear to the public how this number was arrived at, nor the precision of the calculations. REQUEST: To ensure the maximum benefit to the public from the public funds that will be put into this project, we request that the EA include a commitment to measure and verify the amount saved by piping canals (pre and post project measurement/verification), and commit to putting the total of that water instream.	Please see the response to comments 26.02, 16.04, and 16.02.
22.07	WAT	The EA states that canal losses are 30%. The SIP notes it is 46%. See TID Sip at 16. Similarly, the USGS 2001 Groundwater Study shows TID's losses to be closer to 50%. See USGS Ground- Water Hydrology of the Upper Deschutes Basin, Oregon, Water Resources Investigations Report 00-4162, at 25. Given the large discrepancy in reported losses, reconciliation seems in order. Given the extensive work that went into development of the SIP, it seems that this is the number that should be used in the EA to calculate canal losses. REQUEST: Based saved water on information provided in the SIP.	Please see the responses to comments 26.02, 16.04, and 16.02.

22.08	WAT	Currently TID is releasing between 20 and 30 cfs outside of the irrigation season (depending on the month) for the Oregon Spotted Frog in accordance with the USFWS Biological Opinion for the Approval of Contract Changes for the 1938 Inter-District Agreement for operations of Crane Prairie and Wickiup Dams (hereinafter BiOp), 9/29/17 at 10. Before 2015 TID was releasing 5 cfs outside the irrigation season. The EA states that any future flow restoration activities, including instream transfers and allocation of conserved water, will be additive---not to the 20-30 cfs---but to the 5 cfs. EA at 63. What this means is that TID is proposing to use PL-566 monies to backfill for existing flow that is already being provided under the BiOp, not to create new instream flow. Thus, this project which purports to create 48 cfs, will actually only add 23 to 33 cfs to the system. WaterWatch opposes any use of future PL 566 monies to backfill for flows already being released in Crescent Creek under the Oregon Spotted Frog Biological Opinion. PL 566 monies should be used for future gains to the system, not to pay for water that is already instream. (Footnote: The EA notes that this water is not being protected instream. In the past, this water was protected under a limited license (time limited permit to protect water instream). This water could easily be protected; that TID is not doing so currently does not justify spending millions of dollars to pay for water that is already committed to the stream). Moreover, as noted, PL 566 funds should not be used to backfill for water that is already being provided instream. PL 566 monies should be limited to funding water conservation projects that provide additional water.	This comment accurately summarizes the history of the water provided through the Settlement Agreement. Per Oregon Revised Statutes 537.143, water provided under a limited license is for a short-term or fixed duration and junior in priority to all other water rights. Water allocated instream through this project would be permanently and legally protected through Oregon's Allocation of Conserved Water Program with the same priority dates as the District's existing water rights. Please see Sections 2.2.1, 4.10.2, and 6.10 for discussions of the Allocation of Conserved Water Program, surface water hydrology, and the potential effects of the project on water resources.
22.09	WAT	The EA does not address comments made with regards to groundwater mitigation. The EA (pg 18) notes that groundwater mitigation credits are not relevant to the proposed project because the proposed project would not "use" groundwater mitigation credits. To accurately address public concern on this matter the justification needs to be changed so it read that the proposed project would not "create" groundwater mitigation credits. REQUEST: change "use" to "create" and note that it is relevant.	Thank you for your comment. The word "use" has been changed to "create" in the Plan-EA.
22.10	ALT	The EA should include a detailed alternatives analysis of the broad array of conservation tools considered in the BSWG process, including but not limited to on-farm efficiencies, piping of private laterals, market approaches and duty reduction. The justification for not studying on-farm efficiencies was simply stated as "logistics, social, or environmental reasons." Little detail was given to back this, aside from stating that these measures would not protect public safety or lend to district delivery reliability. As noted previously, "Agricultural Water Management" is a broad authorized purpose that allows for a suite of projects, including, broadly, "water conservation." There is no requirement that each component of Agricultural Water Management purpose protect public safety or lend to district delivery reliability. On farm efficiency is broadly supported by stakeholders, and it, at the very least, should have s full alternatives analysis. NRCS should also look at additional water conservation measures such as private lateral piping. REQUEST: Include in the EA alternatives analyses of the broad array of conservation tools considered in the BSWG process, including but not limited to on-farm efficiencies, piping of private laterals, market approaches and duty reduction.	Many of the conservation tools considered during the Deschutes Basin Study process, including voluntary duty reductions, on-farm efficiency improvements, and private lateral piping, would require the voluntary participation of patrons. Clarifying language regarding voluntary duty reductions, on-farm efficiency improvements, and private lateral piping has been added to Sections 5.2.4, 5.2.5, and 5.2.6 of the Plan-EA, respectively. See comment response 2.06 regarding why on-farm efficiency improvements cannot be incorporated into the plan; this response also applies to piping private laterals and voluntary duty reductions. Voluntary duty reductions would require each patron to voluntarily accept less than their full water delivery rate from the District. Because the District has no statutory authority to compel participation in such a program, because there is insufficient information on which to plan or evaluate participation, and because there is a wide range of opinions on the merits of duty reduction and the impacts to agricultural operations, this action is not a good fit for NEPA analysis at this time. Please see the response to comment 25.04 regarding market-based approaches. See response 12.03 regarding the inclusion of public safety as part of the purpose and need of the project.

		While we very much appreciate TID's commitments to putting the project through the Conserved water Act and dedicating 100% of the water instream, TID's Watershed Plan could better provide public benefits by instituting the few changes contained in these comments, including but not limited to including a broader array of conservation projects, limiting duty to the current average use and changing the authorized purpose/projects.	The sponsors developed the project purpose and need statement to balance between breadth and specificity of the watershed problems and resource concerns while accommodating a range of reasonable alternatives as required by NEPA. Per 390-NWPH, Part 601, Subpart D, Section 601.34A, it is necessary to include at least one eligible program purpose within the project purpose and need, of which "Agricultural Water Management" is identified as one. Agricultural Water Management was selected as the only appropriate authorized purposes due to the types measures that would be included in the project. Please see the response to comment 22.03 regarding the addition of the PL 83-566 authorized project purpose of "Public Fish and Wildlife".
23.01	GEN	Trout Unlimited (TU) appreciates the opportunity to provide comments on the draft watershed Plan-Environmental Assessment (draft EA) for Tumalo Irrigation District's (TID) Irrigation Modernization Project (Project). The Watershed Plan, when complete, will enable the Natural Resource Conservation Service (NRCS) to access funding for irrigation improvements through the PL-566 program (Watershed and Flood Prevention Program). TU is a non-profit organization with a mission to conserve, protect and restore North America's coldwater fisheries and their watersheds. With more than 300,000 members and supporters nationwide, TU works to restore wild trout, salmon, and steelhead and their watersheds throughout the U.S. TU has over 3000 members in Oregon and over 550 in its local Deschutes Redbands Chapter. Restoring instream flows to the Deschutes River and its tributaries is a key objective of TU and its members. To that end, TU has been engaging in the Upper Deschutes Basin Study (Basin Study), a collaborative effort intended to help resolve long-standing water management issues. Irrigation improvements will be a key part of any long-term solution and TU commends TID for pursuing the planning, funding, and implementation of these improvements.	Thank you for your comment.
23.02	PURP	Purpose and Need: TU appreciates that the draft EA includes "water conservation" among its stated purposes. (Draft EA, p.9.) However, to improve clarity, TU recommends that the stated purpose identify that water conservation is for the purpose of permanently restoring flows to the upper Deschutes River for the benefit of instream resources. Additionally, to better align the draft EA's purpose and need statement with the PL-566 project purpose, we recommend that "Public Fish and Wildlife" be added as a PL-566 project purpose.	The sponsors developed the project purpose and need statement to balance between breadth and specificity of the watershed problems and resource concerns while accommodating a range of reasonable alternatives as required by NEPA. Please see the response to comment 22.03 regarding the authorized project purpose of PL 83-566 "Public Fish and Wildlife".

23.03	WAT	The draft EA notes that a key element of the Project is the dedication of conserved water to instream uses. Specifically, the draft EA notes that the "Project Benefits" include the conservation of up to 48 cubic feet per second (cfs) of water for instream uses. (Draft EA p. 1.) TU appreciates that the draft EA has assured that (1) water conserved as a result of proposed modernization actions will be returned to the river for instream uses and (2) the State of Oregon's Allocation of Conserved Water Program (CWP) will be utilized to ensure the water returned to the river is permanently and legally protected. Additionally, we appreciate that TID anticipates that 100 percent of the conserved water will be dedicated instream. However, TU recommends that the final EA include additional analysis and clarification regarding two points. First, TU recommends that TID commit to contributing 100% of conserved water instream regardless of funding source. While the draft EA indicates that 100% instream dedication of conserved water is the likely outcome, it notes that this could change if some level of private contribution is necessary for the Project to proceed. A dedication of 100% of the conserved water instream is appropriate given the level of biological need and the extensive amount of public funding support expected to be contributed to the Project. Additionally, it is the only action that will assure without a doubt that the requirements of the CWP have been met.	Oregon Revised Statues 537.455 - 537.500 authorize Oregon's Allocation of Conserved Water Program. Relevant to this comment, they state that, *After determining the quantity of conserved water, if any, required to mitigate the effects on other water rights, the commission shall allocate 25 percent of the remaining conserved water to the state and 75 percent to the applicant, unless the applicant proposes a higher allocation to the state or more than 25 percent of the funds used to finance the conservation measures comes from federal or state public sources. If more than 25 percent of the funds used to finance the conservation measures comes from federal or state public sources and is not subject to repayment, the commission shall allocate to the state a percentage equal to the percentage of public funds used to finance the conservation measures and allocate to the applicant a percentage equal to the percentage of other funds used to finance the conservation measures... In no event, however, shall the applicant receive less than 25 percent of the remaining conserved water unless the applicant proposes a higher allocation to the state.* (Oregon Revised Statutes 537.470 (3)) Section 2.2.1 discusses the District's commitments to restore the conserved water created through the project instream. These commitments to allocating at least 95% of the total conserved water instream, allocating 100% of the publicly funded conserved water instream, and not applying to create new water rights for out-of-stream use fully exceed the requirements of the Oregon's Allocation of Conserved Water Program.
23.04	WAT	Second, TU recommends that final EA provide additional detailed information and analysis supporting its conclusion that 48 cfs is the maximum amount of water that will be "conserved" and thus dedicated instream. This number differs from the number identified in TID's System Improvement Plan (SIP) and is based on a canal loss percentage that differs from that identified in the SIP and in other sources.1 The final EA should explain these discrepancies and should describe, in detail, the methodology that will be utilized to derive the final conservation numbers.	Please see the response to comments 16.02 and 16.04.
23.05	PATD	The draft EA is clear that the Project will result in operational efficiencies yet it anticipates that average irrigation use will increase from the historical 3.5 af/acre to 5 af/acre. (Draft EA, Appendix D, pages D-19-20). Effectively, this translates to less water conserved for instream uses. The draft EA does not provide sufficient information, analysis or justification for this increase. TU recommends that the existing duty of 3.5 af/acre remain the standard.	Please see the response to comment 22.05.
23.06	ALT	The final EA should include a more robust range of reasonable alternative measures to meet the purpose and need of the Project. Specifically, we recommend that the final EA consider an alternative that includes additional conservation actions identified by the Deschutes Basin Study Workgroup (BSWG) including measures to improve the efficiency of farm operations. The justification provided in the draft EA is insufficient to preclude these measures from additional analysis as a new alternative or part of an existing alternative. The conservation actions identified by the BSWG will help meet the Project purpose and need. Thorough consideration of their effects in the final EA will help ensure that they can be incorporated into the Project now or in the future if it makes sense.	Please see the response to comments 2.06, 22.10, 25.04, 26.24, and 26.26.

23.07	ALT	We also recommend a Combined Alternative that considers a suite of actions, including the piping actions identified in the Preferred Alternative and relevant BSWG actions, to best meet the short and long-term goals of the Project. Declining to include analysis of these measures will constitute a wasted opportunity to consider a more comprehensive approach to meeting in and out of stream needs in the Deschutes Basin. Conclusion: TU looks forward to continued collaboration with TID and others to develop and implement water management solutions in the Deschutes watershed. TU appreciates the opportunity to comment on this effort. Please contact me with any questions.	Please see the response to comments 2.06, 22.10, 26.24, and 26.26.
24.01	GEN	I support the piping of open irrigation ditches in the watershed plan and improvement of habitat and conditions for aquatic wildlife in and around Tumalo Creek. Please keep up the good work!	Thank you for your comment.
25.01	GEN	It is great to see the TID Draft Plan - EA documents shared with the public on-line. This is a comprehensive document that addresses the irrigation district infrastructure portion of the irrigation efficiency story. TID and other small IDs may soon be completely piped and that would be a great achievement.	Thank you for your comment.
25.02	ALT	Nevertheless, I would like to add that infrastructure improvement is not enough. I hope these comments are not disregarded by the guidelines, i.e. "Comments must be specific to TID's project." This is simply a plea to also address on-farm water efficiencies by the patrons -- who are the reason why the IDs exist; thus, they are directly related to TID's project. The plan (Section 5.2.4 on p.84) eliminates a serious consideration of on-farm efficiency by saying, "This alternative would meet the objective of conserving water; however, on-farm efficiency upgrades were eliminated because they would not improve water delivery reliability and public safety for District-owned canal and lateral infrastructure." This statement seems incorrect. The exact same water seepage problem that motivates the IDs is faced by the patrons. Patrons could also cost-share with state or federal programs on conveyance mechanisms to increase reliability of delivery. Farms throughout Tumalo, Bend and Redmond have become increasingly fragmented, in many cases beyond the point of commercial agricultural viability. Increased efficiency, tighter management of water within districts, and improved management of existing water supplies across districts remain the most cost-effective opportunities for meeting the water needs of rivers and growing cities in Central Oregon. It doesn't make sense to drastically improve irrigation infrastructure (at great cost) without a quid pro quo arrangement that the beneficiaries inside the ID head gates should also adopt high water management standards. The water is a shared public resource that requires stewardship of both the water and taxpayer money.	Please see the response to comments 2.06, 22.10, and 26.26.

25.03	REC	Over the last two decades, tourism and recreation have replaced timber and agricultural production as the primary economic drivers in major parts of the Deschutes Basin. Stream flow restoration will provide opportunities for strengthening local economies through increased tourism, recreation, and people moving to Central Oregon for its quality of life, which depends on the Deschutes River and tributaries. Therefore, our collective priorities should extend beyond agricultural water supplies to the restoration of the river, which is essential to all sides in the debate.	Thank you for your comment. 100% of the publicly funded conserved water from the project would be legally protected in stream.
25.04	ALT	RECOMMENDATIONS: Seek the significant funding necessary for conversion of open canals to piped systems but also; Fund market-based programs that will incentivize behavior change, rewarding land owners and water users for decisions that will reallocate water to more rational and beneficial public use and conservation of our rivers, creeks and streams.	Information defining this type of program would be necessary to determine if it was applicable under PL 83-566 authorities. Since NRCS does not have practice standards for market-based programs, and since PL 83-566 has never been used to fund market-based programs, there is insufficient information on which to plan or evaluate market-based programs. Consequently, the recommended action is not ripe for NEPA analysis at this time.
26.01	WAT	LandWatch is pleased that efforts are being taken to restore natural flows to Crescent Creek, the Little Deschutes River, the Deschutes River, and Tumalo Creek. However, we have several concerns with the EA's preferred alternative, including actual amount of water that will be conserved, cost efficiency, and the failure to consider other alternatives. The EA states that the preferred alternative (the HDPE Piping Alternative), through installation of pressurized HDPE pipe for all open canals and laterals, will result in prevention of loss of 48 cfs of water currently lost due to canal seepage and evaporation, and that this is the amount that the Tumalo Irrigation District ("District") will transfer to the State for instream use. Section 5.3.3 of the EA also states that 100 percent of all water conserved through this Project will be allocated to instream use. Section 6.10.3.1. The EA should include a full explanation and disclosure of how water savings of 48 cfs were calculated.	TID's System Improvement Plan (SIP; Appendix D.2) identifies how total water losses were determined. The response to comment 16.02 addresses differences in savings identified in the SIP and in the Plan-EA. In addition, please see the response to comment 26.02, which describes the differences between the two approaches to measuring water loss.
26.02	WAT	What methods were used to develop this number [the 48cfs]? Does this number represent only seepage and evaporation? Or does it also include operational savings/losses, including reduced need for carry water and spills of carry water due to piping?	As indicated in the District's System Improvement Plan (SIP; Appendix D.2), system loss numbers were evaluated through two approaches. First, they were evaluated by reviewing recent peak diversion rates and identified delivery rates. Differences between the diversion rate and the delivery rate provide one estimate of the maximum rate conserved from fully piping district infrastructure from the diversion to the point of delivery. This rate includes the elimination of any carry water and operational spills that would have contributed to peak diversion rates. Second, they were evaluated by performing water loss measurements throughout the District's system. The water loss measurements account only for seepage and evaporation. These two methods yielded savings estimates of 53 cfs and 50.4 cfs, respectively. The difference between these two estimates is within the expected range of error for flow measurements.
26.03	WAT	Both the District's System Improvement Plan (SIP) and the EA state that actual water savings that will result from the Project are well above the 48 cfs that the District commits to transferring instream.	Please see the response to comment 16.02.

26.04	PATD	Both the District's System Improvement Plan (SIP) and the EA state that actual water savings that will result from the Project are well above the 48 cfs that the District commits to transferring instream. The EA also admits that actual water savings resulting from the Project will be well above 48 cfs. In Appendix D at page 19, the EA states that "in addition to conservation of 48 cfs from reduced canal seepage, the HDPE Pressurized Piping Alternative will also increase water supply delivery to TID patrons." These additional water savings will occur through the preferred alternative's prevention of "excess water [that] operationally spills onto non-productive lands at the ends of the conveyance system." Appendix D, page 19. The District apparently does not plan to transfer these additional water savings instream, but plans to use these additional water savings to increase water deliveries to patrons from an average of 3.5 AF/acre per year to 5.0 AF/acre per year.2 Appendix D, page 19. Apparently, the EA justifies this large increase in water deliveries by stating that hay crops require 4.7 AF/acre per year. This number is wildly contrary to well-established crop water use and irrigation requirements for hay crops in the District, which are somewhere between 2.0 and 2.5 AF/acre per year.3 4 Especially in a fully piped, on-demand system, efficiencies should drastically increase, and duty requirements for hay crops should decrease below (not above) the current 3.5 AF/acre per year. Another way of stating it is that while average delivery is currently around 3.5 AF/acre, this Project is apparently intended to deliver full water rights of 5 AF/acre. This is not an appropriate use of public monies. Rather than expanding the current deliveries, the existing deliveries of 3.5 AF/acre should be maintained and the rest of the water returned to Tumalo Creek and Crescent Creek. The EA's planned increase in deliveries to patrons, along with the stated 48 cfs savings from prevented seepage and evaporation losses, converts to a total water savings of around 82 cfs. Accordingly, 82 cfs should be returned instream.	Please see the response to comment 22.05.
26.05	PATD	The District has publicly committed to returning 100% of water savings resulting from the Project to instream use. Hidden deep in the EA, however, are the above plans to use a significant amount of conserved water to increase water deliveries to patrons. The full amount of water not actually used by the District's patrons should be transferred to the State for instream use. At the May 8, 2018 public meeting, District personnel confirmed that the amount of water not used by patrons is higher than the 48 cfs proposed to be conserved by the preferred alternative. District Manager Ken Reick stated that the percentage of water the District loses to the ground underneath canals and laterals is likely higher than 48 cfs, and that the 48 cfs measure is a conservative estimate, but the real number is likely more. This is in addition to operational savings/losses associated with carry water.	Please see response to comments 22.05, 16.02, and 16.04.

26.06	PATD	Aside from the District's commitment to return 100% of water savings to instream use, the District likely does not have a legal right to use any water above the amount it has historically put to beneficial use.5 Any "paper" water rights above the 3.5 AF/acre that the District has not put to beneficial use are wasted, and usufructuary rights to that water are forfeit.	Please refer to Oregon Revised Statues 540.610 (3).
26.07	PATD	A proper use of public money through the PL-566 program will benefit the District while providing substantial benefits to the public by returning all conserved water instream. Accordingly, the Project should achieve the following benefits for both the District and the public: 1. Through the Project, the District gets a piped, pressurized system with 100% reliable deliveries of no more than 3.5 AF/acre, which should allow any patron to grow hay with wheel line sprinklers. Those patrons with properties big enough for a pivot can grow hay even more efficiently than that. 2. Tumalo Creek and Crescent Creek get all of the recouped losses resulting from the Project, including (1) operational spill, (2) carry water, (3) seepage and evaporation, and (4) water not used by patrons in an increasingly efficient on-demand system. All of that water is legally transferred to the State and protected instream. Current estimates are the losses (operational and seepage/evaporation) amount to around 82 cfs and these amounts should be verified before transfers happen.	Please see the responses to comments 22.05, 17.03, and 16.04.
26.08	WAT	In addition, the EA should commit to post-Project water savings verifications. This will be the only way to ensure that 100 percent of the water conserved through the Project will be transferred to the State for instream use, as promised by the District.	Please see the response to comment 16.04.
26.09	WAT	The EA identifies the creation of instream water rights "up to" 48 cfs through the State's Allocation of Conserved Water Program (ACWP). However, the EA falls short of identifying which senior water rights owned by TID or its patrons will be transferred to the state for instream use. Which District- or patron-owned water rights will be curtailed by 48 cfs?	Please see the response to comment 17.03.
26.10	WAT	How will the District ensure that the full amount of water that once seeped or evaporated below canals will be returned instream? Without this accounting, it is possible that not the full actual water diversion will be curtailed, and instead TID will transfer "paper" water rights rather than actual "wet" water rights. That would mean the Project will not satisfy the requirement of substantial benefits to the general public.	Please see the response to comments 16.04 and 17.03.

26.11	WAT	The EA does state that conserved water is to be allocated instream to Crescent Creek and Tumalo Creek and that it will carry the same priority dates as TID's water rights. "The instream water rights created as an effect of the Canal Lining Alternative would carry the same priority dates as TID's water rights. The District would permanently reduce its own water rights by corresponding rates and volumes, permanently reducing the rates of diversion at the TFC diversion and the BFC diversion." Section 6.10.3.1. However, the EA does not state what those priority dates are, and as such the EA includes no guarantee that the conserved water will carry senior water rights that will always take priority over other TID or patron water rights. We understand that the District's water right priority dates range from 1900 to 1913. The conserved water transferred from the State should carry proportional amounts of water from each of the District's water rights. For example, if 30% of the District's water rights have the seniority date of 1900, then 30% of all conserved water should be transferred from the 1900 water right. This way, a conserved water order from the State will reduce all of the District's water rights proportionally to the District's current mix of priority dates.	Please see the response to comment 17.03. Conserved water Application #37 (available online at https://bit.ly/2KfnRLb) identifies the priority dates associated with the first project group. The District expects that future conserved water applications associated with the project would identify proportions of priority dates for each source that reflect the District's proportions of priority dates. The District cannot predetermine the outcomes of the Oregon water Resources Department's administrative processes.
26.12	WAT	Because Tumalo Creek provides a more valuable source of cold water to the Deschutes River, all water savings should accrue first to Tumalo Creek, then move to Crescent Creek if all diversions from Tumalo Creek have been curtailed. Accordingly, diversion rates from the TFC (Tumalo Feed Canal) should be curtailed and transferred to the State for instream use before any diversion rates from the BFC (Bend Feed Canal) are curtailed.	Please see the response to comment 17.03.
26.13	WAT	In its description of the preferred alternative, Section 5.3.3, the EA states that "[a] piped and pressurized system greatly increases conveyance efficiency, allowing existing carry water to be available for patrons and further reducing the need to spill excess water as the system becomes on demand." How much of the carry water needed under current canal system will be conserved as a result of the preferred alternative?	The preferred alternative would fully pressurize the District's system and eliminate the need for carry water. Water returned instream through Oregon's Allocation of Conserved Water Program was based on water loss estimates described in TID's SIP (Appendix D.2).
26.14	WAT	Is that amount [the carry water] part of the 48 cfs of conserved water to be transferred to the State for instream use?	Yes. Please see the response to 26.02.
26.15	WAT	Which District water rights will be curtailed due to no longer needing carry water under the preferred alternative?	Please see the response to comment 17.03.
26.16	PATD	The EA is insufficient in fully explaining the actual water savings that will occur as a result of no longer needing carry water in a fully piped system. As explained above, it appears in the EA Appendix D that significant water savings above the stated 48 cfs will occur as a result of the Project, and the District plans to increase water deliveries to its patrons with these savings. Any portion of conserved water resulting in reduced need for carry water	Please see the response to comments 16.02, 22.05, and 16.04.

		should also be transferred to the State for instream use, above the 48 cfs water savings to result from reduced seepage and evaporation.	
26.17	PATD	The EA repeatedly emphasizes reliability of irrigation water for patrons in its discussion of the effects of both the Canal Lining alternative and the HDPE Piping alternative (the preferred alternative). Though "water reliability" would naturally occur due to a pressurized system, the use of the term in the EA suggests it means patrons getting more water. This notion of improved reliability is also used in the EA to argue that the agricultural land base will be strengthened, allowing for more productive harvests of existing crops and the opportunity for more diverse crop production because of increased "water supply security." Section 6.4.3.1 ("Implementation of the HDPE Piping Alternative would allow for more diversity in the types of crops grown in the District because of water supply security.") If all of the water conserved by these action alternatives is returned instream, how will patrons realize improved reliability of irrigation water? The insistent reference to water delivery reliability implies that not all conserved water will be transferred instream, but that more water will be available to patrons. Additional water availability beyond what exists today is otherwise known as "firming up" the District. This is not an appropriate use of public funding, and is contrary to the many promises made throughout the EA that all conserved water will be transferred to the State for instream use. The EA states that "the District would allocate 100% of the conserved water created for instream use" for both of these action alternatives. Section 6.10.2.1; Section 6.10.3.1.	Please see the response to comment 22.05 and 16.04.
26.18	PATD	The EA's discussion of the surface water impacts of the preferred alternative also includes a similar logical inconsistency: "[i]mplementation of the HDPE Piping Alternative would improve water supplies for both patrons and instream uses; therefore, minor, long-term effects would occur." Section 6.10.3.1. If all conserved water is to be transferred to the State for instream use, how can the Project improve water supplies for both instream uses and patrons? Without firm, legally enforceable commitments to transfer all recouped water to the State for instream use, the EA and its preferred alternative fail to provide what is promised in the Project.	Please see the responses to comments 22.05 and 16.04.
26.19	PATD	What evidence is there for greater demand of water supplies in the District? In a District with average parcel sizes between 10 and 13 acres, little potential for large commercial agricultural operations exists, and little opportunity for highly efficient pivot irrigation systems exists. The many existing small-scale agricultural operations do not need more than the 3.5AF/acre they currently receive, and a Project purpose of improving "reliability" (as meant in the EA) is arbitrary to the actual needs of the District. Again, the EA'a admission in Appendix D at page 19 that it plans to	Please see the response to comment 22.05.

		increase deliveries to patrons from 3.5AF/acre to 5AF/acre is contrary to the stated goal to allocate 100% of the recouped water to instream use.	
26.20	PATD	Similar to the water reliability issues discussed above, the EA also flouts that the Project will decrease the amount of water actually utilized by patrons: "As project groups of the District become piped, the conveyance system would convert into an on- demand system allowing water to remain instream (not be diverted at the TFC diversion) when not being utilized." Section 6.10.3.2. This idea needs to be further explained given the District's apparent plans to use more water.	Please see the response to comment 22.05.
26.21	ESA	The District has already committed to releasing 15 cfs - 30 cfs from Crescent Lake outside of the irrigation season as part of a package for the Upper Deschutes and the Oregon spotted frog. Is any portion of the "savings" discussed in the EA actually a prior and existing reduction in the District's storage in Crescent Lake?	Please see Section 4.10.2.2 for a discussion of the District's current commitments and of stream flows in Crescent Creek. Please see Section 6.10.3.2 for a discussion of the effects of the proposed project on stream flows in Crescent Creek.
26.22	ESA	The water conserved through this Project, using public money to benefit the general public, must be transferred to the State for instream use above and beyond any previous water left instream by the District. water savings resulting from the expenditure of PL-566 funding should be transferred instream for future increases to instream flows, and not to backfill existing instream flow commitments.	Please see Section 6.10 for a discussion of the effects of the proposed project on stream flows. Water returned instream through the Stipulated Settlement Agreement is not legally protected against diversion by other users, and the Stipulated Settlement Agreement is not permanent. The proposed action would permanently and legally allocate water instream.
26.23	ESA	More specificity is required in the EA as to the timing of instream water rights transfers to the State via the Allocation of Conserved Water Statute. As described above, post-Project conserved water verification studies should be completed following each stage of Project implementation, and using those data, a proportionate share of the District's existing water rights should be reduced and transferred to the State for instream use.	The allocation of conserved water instream would occur incrementally following completion of construction. Please see the response to comments 16.04 for further discussion of conserved water verification.
26.24	ALT	Increasing instream flow for fish and aquatic habitat is a stated need for the Project. Section 2. Protecting water instream is discussed in both Section 2.1.1 Water Loss in District Conveyance System and Section 2.1.3 Instream Flow for Fish and Aquatic Habitat. Thus, increasing instream flows is a dominant purpose of the EA, and all water conservation alternatives that can enhance these flows should be analyzed. This includes upgrading irrigation methods and equipment and market incentives that save water. Only two action alternatives – the Canal Lining alternative and the HDPE Piping Alternative – are considered alongside the required No Action alternative. This limited consideration of alternatives results in a myopic analysis that assumes that complete lining or piping of District canals and laterals is the only reasonable method for achieving the Project's purpose and need. Several other alternatives would achieve that Project's goal, and would do so more efficiently, conserving more water for less cost to the public. A basic requirement of NEPA is that a project such as this has a reasonable range of alternatives.	Other alternatives were considered for this project and were eliminated due to logistics, social or environmental reasons, or the inability to meet the project purpose and need. Please refer to Section 5.2 for the alternatives that were eliminated from the detailed study. Please see the response to comment 25.04 regarding market-based programs.

26.25	ALT	The EA's discussion of alternatives that were eliminated from further consideration includes on- farm efficiency. This alternative was eliminated because "[o]n-farm infrastructure is distinct from District canals and laterals because it is owned and operated by patrons" and because the alternative "would not improve water delivery reliability and public safety for District-owned canal and lateral infrastructure." Section 5.2.4. That "distinction" is not an excuse to disregard credible and cost-effective alternatives and ignores the obvious interconnection of the District and its patrons. Recent studies have found that big piping projects, such as the preferred alternative, are not practical or cost effective as compared to the piping of private laterals. In neighboring Central Oregon Irrigation District, the Farmers Conservation Alliance found that piping of main canals would cost $700 million and conserve 89,500 AF of water per year, but that improving private laterals would cost only $36.5 million and conserve 35,284 AF of water per year.6 In that case, piping of smaller private laterals achieves 39% of the water savings at only 5% of the cost of main canal piping projects.	Project sponsors must have the legal authority and resources to carry out, operate, and maintain works of improvement (Public Law 83-566 Section 2 and Section 4(3)). Because PL 83-566 is a public law rather than a policy, this consideration is a legal requirement and cannot be arbitrarily applied. Because TID lacks the statutory authority or responsibility to carry out, operate, and maintain infrastructure owned by TID patrons, private lateral upgrades are not within the scope of actions that TID can entertain as the Project Sponsor. Piping private laterals is, therefore, not consistent with PL 83-566 authorities under which this plan is being prepared as either a standalone alternative or as an additional measure added to an alternative under consideration. For these reasons, private lateral upgrades were not brought forward for full consideration in this plan. Modernizing private laterals to achieve optimal District efficiency is important to TID; however, these projects will occur independently from the proposed project in the Plan-EA. Private laterals are further discussed in section 5.2.6. Additionally, while Farmers Conservation Alliance completed a preliminary analysis of private lateral costs and water conservation in Central Oregon Irrigation District (as referenced in the comment) as part of an effort unrelated to PL 83-566, no such analysis has been completed for TID.
26.26	ALT	An alternative that is not exclusively piping of the District's canals and laterals, but includes both that piping and piping of private laterals, is needed. Other alternatives including piping with marketing and other options should also be included in the EA.	Private laterals are discussed in Section 5.2.6. The District is responsible for providing water through district infrastructure to the point of delivery, and the private landowners maintain responsibility for and authority over private laterals. Due to PL 83-566 program authorities, the District cannot fund or conduct improvements on private property, such as piping private laterals or conducting on-farm infrastructure improvements, with PL 83-566 funds. However, funding for private laterals and on-farm upgrades can be provided by NRCS through other mechanisms such as EQIP. Although currently unplanned, TID has indicated that it intends to work with patrons, NRCS, and the local working group(s) to highlight the need for on-farm water conservation in an effort to gain access to EQIP funding and to continue modernization efforts on-farm. Please see the response to comment 25.04 regarding market-based programs.
26.27	ALT	The EA's justification for ignoring alternatives involving patron operations is that only District operations can be considered. That is not correct. The preferred alternative ("HDPE Piping Alternative") is selected in part because of its ability to reduce Operations and Maintenance ("O&M") costs. The EA states that "a pressurized pipeline allows for the elimination of individual pumps serving farms across the District and the conservation of approximately 4 million kilowatt hours per year." Section 5.3.3. The HDPE Piping Alternative would further "reduce patron pumping costs by approximately $325,000 per year and reduce carbon emissions by approximately 2,200 metric tons per year." Section 5.3.3. Obviously, patron operations are relevant. If patron operations are not relevant, what is the public good of saving $325,000 in patron costs? How does this private enrichment benefit the public?	Section 6.2.3 discusses the potential effects of the proposed action on fish and aquatic resources. Section 6.7.3 discusses the potential effects of the proposed project on socioeconomics.

26.28	ALT	Under the preferred alternative, TID would upgrade 543 existing turnouts to pressurized delivery systems, including conversion of many existing shared turnouts to individual turnouts (requiring the purchase and installation of 119 new turnouts on patrons' property). Section 5.3.3.1. Here, again, is a direct private benefit to individual patrons. The EA writes off considering some on-farm upgrades (on-farm efficiencies) while proposing other on-farm upgrades (individual pressurized delivery systems).	Upgraded turnouts and the installation of new turnouts would be part of the District's infrastructure rather than private patrons' infrastructure. Please see Section 5.2.5 for a discussion of on-farm efficiencies.
26.29	ALT	The preferred alternative relies on converting the entire existing system of open canals and laterals to large pipes. These pipes have a lifespan of at least 100 years.7 This 'top-down' model begins with replacing the largest canals, and eventually replacing smaller conveyances if funding is available. The EA does not consider an alternative approach of first replacing smaller laterals and on-farm conveyances, which can be replaced for less money and result in greater water savings per dollar spent. Replacing these smaller conveyances in a 'bottom-up' model would ensure that the size of pipes is not larger than it needs to be. Additionally, water savings resulting from preventing operational losses (spillover of carry water) would be realized sooner. If pressurized water delivery systems are first provided at or near each patron's point of delivery, the District could then easily determine how much water its patrons actually put to beneficial use. Then, the District could determine the proper size of large pipes to replace further up the system. This approach would provide flexibility in future investments, and the ability of the District to fine-tune future investments based on actual water need of its patrons.	The "top-down" model was selected following recommendations from the project engineer based on the characteristics of TID's current system. The top-down approach is for a pressure-driven system that allows for the subsequent modernization of on-farm irrigation systems. This approach sizes sections of pipe lower in the system properly to ensure that the entire system stays pressurized. It ensures that the project provides the full benefits of converting from open channel canal flow to a piped and pressurized system. The "bottom-up" approach requires larger diameter pipe in the lower portions of the system to convey water; the pipe grade or slope is flatter and does not have the pressure to push the water through the pipe. The larger pipes can be thinner or have lower pressure ratings, but this bottom-up design acts as a series of partially full pipes and provides no benefit of pressurization. The upper portions of the system remain in open channel and cannot provide the "static head" or change in elevation to push the water through the pipes. The top-down approach can allow for smaller diameter pipes in the lower portions of the system to convey water because the entire system is in a pipe from the source. The change in elevation from the diversion all the way down to the end user gravity-pressurizes the system, allowing for full pipe flow and fully pressurizing the turnouts. The top-down design allows for smaller diameter pipes with higher pressure ratings along with a known quantity of static pressure while still keeping conduits at full flow. As the pipe is progressively installed from the upper end of the open system to the lower end of the system, the District can provide pressurized water at a known pressure to each turnout that the pipe passes. The bottom-up approach would continue to provide water to patrons following the construction of each section pipe, but full pressurization cannot be realized until the remainder of the pipes are installed at higher elevations in the system. In addition, the pipe diameter required under this approach may not provide consistent pressure. Furthermore, the bottom-up approach often requires additional inlet and outlet control at the head of each pipe where it connects to the open canal system. This can result in expensive valves/gates, significant labor costs, and complicated automation equipment for the system to operated correctly.

26.30	ALT	The multi-year Upper Deschutes Basin Study Work Group, sponsored by the U.S. Bureau of Reclamation, has produced important studies. Its Multi-Criteria Evaluation ("MCE") rates four scenarios of flow targets in the Upper Deschutes, two targeting 300 cfs in the Upper Deschutes Below Wickiup Reservoir, and two targeting 600 cfs. The MCE states: "Private lateral piping is the most cost-effective piping alternative, offering reliable, long- term water supply at lower cost than other hard infrastructure investments." MCE page 1, Exhibit A. An objective of this Project should be to conserve the most amount of water for the least amount of money. Any piping option should prioritize piping smaller private laterals first, and only then consider moving up the line to pipe large canals and laterals. The MCE also estimates that on-farm upgrades are often cheaper ($3,800 per acre foot of water savings) than piping of district-owned canals ($2,333 - $7,000 per acre foot of water savings). On-farm upgrades "offer greater flexibility and are rarely opposed by community members." Exhibit A. Of the four scenarios considered in the MCE, the scenario with by far the lowest cost per acre foot of water savings relies on water leasing, water transfers, and voluntary duty reductions. This scenario prevents 99.9% of potential agricultural shortages in an average precipitation year, and 92.3% of potential agricultural shortages in a dry year. No canal linings or piping projects whatsoever are needed to achieve these savings. None of the other four scenarios come close to achieving the cost efficiency of this scenario. As stakeholders from across the Upper Deschutes Basin have come together to determine the most prudent options for restoring streamflows, Tumalo Irrigation District should not ignore their collective expertise, and at a minimum should give full consideration to a Project alternative that utilizes additional tools beyond just canal lining or piping. The failure to include these analyses also violates the NEPA standard that the best available science be utilized. Many of the draft BSWG final report materials and technical reports that support the BSWG's findings are attached here as Exhibits A-E. Although the BSWG's final report is pending, all of the materials in Exhibits A-E have been through extensive stakeholder review, are in "final draft" form, and are only awaiting a final "technical sufficiency review" by the Bureau of Reclamation.	The studies and reports associated with the Deschutes Basin Study, including the MCE, are draft-level documents. They have not been fully reviewed, revised, or endorsed by the Basin Study Work Group and/or Reclamation. They are not ready for incorporation into the Plan-EA or for reference in these comments. However, the preliminary draft information discussed through the Basin Study process can help to inform public discussion (M. Relf, personal communication, July 12, 2018). Preliminary draft information from the Basin Study also suggests that private ownership creates coordination, authority, and other logistical challenges for actions that would take place on private land. It is these logistical challenges associated with private ownership, in addition to the authorities provided by PL 83-566 (see response 2.06 regarding on-farm improvements; this response also applies to each of voluntary duty reductions and piping private laterals), that contribute to voluntary duty reductions, private lateral piping and on-farm improvements not being ripe for further consideration within the Plan-EA. Please see Sections 5.2.4, 5.2.5, and 5.2.6 for a further discussion of voluntary duty reductions, private lateral piping, and on-farm improvements, respectively.
26.31	PUB	Public safety is listed as a primary need for the Project throughout the EA. In section 4.5, the EA notes that two deaths have occurred in open canals of other irrigation districts but does not report any public safety incidents in the canals of the Project sponsor, TID. Despite no record of public safety incidents, each of the three alternatives that is considered by the EA is evaluated for its potential to improve public safety. In the EA's discussion of the No Action Alternative, EA Section 5.3.1, the EA states that "[a] history of drowning in District canals can be found in section 4.5." There is no history of drowning in Tumalo Irrigation District canals, and thus any consideration of drowning as a public safety concern in the analysis of Project alternatives is speculative and arbitrary.	Please see the response to comment 12.03

26.32	ENRG	Although not discussed directly in the EA, we remain concerned that an unspoken motivation for identifying the HDPE Piping alternative as the preferred alternative is its potential to generate hydroelectricity and revenue for the District. PL-566 funding cannot be used for hydroelectric generation, but converting all of the District's open canals and laterals to pressurized pipes could facilitate future installation of in-pipe hydroelectricity generation infrastructure. This potential is discussed in conjunction with canal piping in the District's SIP, which estimated a potential hydroelectric power generation of 1,538,492 KHW.8 Any potential plans for the District to generate hydroelectricity in pipes funded through PL-566 should be disclosed as part of this EA.	Please see the response to comment 18.03.

6.33	WAT	The effect of the preferred alternative on groundwater levels in the Deschutes Basin is likely much greater than the EA describes. The EA relies on a prior study (Gannett and Lite 2013) that found that "canal piping and lining accounted for 10 percent" of the total decrease in the historic groundwater level. Section 6.10.3.4. We do not dispute the methods of that study. However, only a small percentage of Central Oregon's open canals and laterals have been lined or piped to date. While the effect of lining and piping on groundwater levels may only contribute 10 percent to date, that percentage will likely increase. The combined effect of TID's and the other districts' plans to line and pipe most of their open canals and laterals could substantially reduce the region's groundwater levels, far above the current 10 percent contribution from historic lining and piping projects. The EA states that over the course of 50 years, the preferred alternative will result in a total average groundwater elevation decrease of 2 feet. This is only the effect of TID's piping projects, but combined with other area irrigation districts' plans to line or pipe canals, the groundwater level will decrease well beyond 2 feet. The EA gives only cursory significance to the localized effects of reduced groundwater recharge caused by the preferred alternative. While the basin-wide average may be 2 feet, springs and wells nearer to canals and laterals will likely experience much greater decreases. These effects are not "negligible [sic]" as stated in the EA. Section 6.10.3.4. While many cumulative effects of other irrigation districts' canal lining and piping projects are described in Section 6.14.2 and Section 6.14.3, the EA does not contain any description of these cumulative effects on groundwater. Significantly omitted in the EA is that the 2013 USGS model update was done because groundwater levels dropped by 14 feet near Redmond. The EA is also not using the best available science where there has been an updated 2017 USGS study and model available since last fall. Impacts on springs which provide cold water refugia for threatened and endangered species are also not adequately addressed. Attached are the 2013 and 2017 USGS reports.	Clarifying language has been added to the Plan-EA describing the cumulative effects on groundwater with reasonably foreseeable projects. Please see Section 6.14.3.10 for this language. Seepage from TID's canals most likely percolates to shallow aquifers, where it is extracted for groundwater consumption or ultimately discharges into Deschutes River (Gannett et al. 2017). The piping of canals and laterals of reasonably foreseeable projects would occur in Swalley and Central Oregon Irrigation Districts. These projects would occur on the eastern side of the Deschutes River and would not be expected to affect groundwater levels on the western side of the Deschutes River (the District's project area). However, should funding be available for future projects in other irrigation districts, specifically the Swalley Irrigation District (SID) and Central Oregon Irrigation District (COID) Irrigation Modernization Projects, groundwater levels could decline 0.6 ft and 5 ft, respectively, over the course of 50 years. In total, these cumulative effects, with TID, could potentially affect groundwater levels in the greater Deschutes Basin up to 7.6 ft in 50 years. Certainly, variability around these averages would exist depending on the spatial location; however, these gains and losses are difficult to estimate (Gannett et al. 2017). The updated Deschutes Basin groundwater model, referenced in Gannett et al. 2017, suggests that groundwater in the Redmond area (and the Deschutes Basin at large) is influenced by canal piping and pumping but that the effects of piping and pumping are overshadowed by changes in climate. Per Gannett et al. (2017), "Groundwater levels show a modest and spatially variable decline in recent decades, about 25 ft since 1990 and 15 ft since 2000. This decline abates for several years in the late 1990s in response to wet climate conditions… water levels in well 14S/12E-09ACB exhibit a climate driven rise of about 6 ft in the late-1990s followed by an 8-ft decline from about 2000 to 2013". In the Plan-EA we acknowledge that canal piping will have an effect on groundwater level, however, the data suggest that the effects of climate and groundwater pumping will have a greater impact. Because the 2017 report does not appear to provide updated information regarding relative the impacts of piping, groundwater, and climate, we continue to assume that piping broadly contributes to approximately 10% of the potential decline in groundwater levels (Gannett et al. 2017, Gannett and Lite 2013). The USGS has not yet published and released an updated groundwater model. Please see the response to comment 27.20 about how new information such as an updated groundwater model will be incorporated and addressed as appropriate. Reference: Gannett, M.W., Lite, K.E., Jr., Risley, J.C., Pischel, E.M., and La Marche, J.L. (2017). Simulation of groundwater and surface-water flow in the upper Deschutes Basin, Oregon (Scientific Investigations Report 2017–5097). Reston, VA: U.S. Geological Survey. Reference: Gannett, M.W. & Lite, K.E. Jr. (2013). Analysis of 1997–2008 Groundwater Level Changes in the Upper Deschutes Basin, Central Oregon (Scientific Investigations Report 2013-5092). Reston, VA: U.S. Geological Survey.

26.34	FF	As we stated in our Preliminary Investigative Report comments (incorporated by reference herein), this Project is likely a major action significantly affecting the quality of the human environment, and thus requires a full EIS under 7 CFR § 650.7. This is especially true considering the similar projects underway in the Swalley and Central Oregon Irrigation Districts. These projects will significantly alter local and regional streamflows, riverine and riparian habitat, groundwater, water quality, and alter the management of hundreds of water diversion projects on several rivers and streams. The cumulative total of these piping projects as identified in the districts' SIPs is around three-fourths of a billion dollars ($750,000,000). A significant effect to the quality of the human environment is all but guaranteed, and a full Environmental Impact Statement should be prepared.	Consistent with the guidance provided in 7 CFR 650.7 and 40 CFR 1500-1508, an Environmental Assessment (EA) has been prepared to determine if there would be a significant impact on the human environment from the project. The assessment will determine if the project requires the preparation of an Environmental Impact Statement (EIS) or if a Finding of No Significant Impact (FONSI) is appropriate. This Plan-EA used a systematic interdisciplinary analysis and evaluation of data and information responding to the five provisions of Section 102(2)(C) of NEPA to include economic or social and natural or physical environmental effects. A threshold matrix of effects was developed to assist in determining if the proposed action results in significant direct, indirect, or cumulative effects on resources and consequently whether it would be a major action significantly affecting the quality of the human environment, requiring an EIS to be prepared. This analysis included the resources you identified in addition to multiple other resources (see Table 3.1 of the Plan-EA). Furthermore, it should be noted that economic or social effects are not intended by themselves to require the preparation of an EIS. The analysis of interrelated effects upon the human environment will determine if an EIS is necessary (see 40 CFR 1508.14). Additional language discussing the cumulative effects on individual resources has been added to Section 6.14 of the Plan-EA. The magnitudes of those effects were determined based on thresholds outlined in the Intensity Threshold Table found in Appendix E.1 of the Plan-EA.
26.35	PATD	As described above, we have many concerns with the Draft EA. One of those concerns, described in "I. Accounting of conserved water" above, is this Project's lynchpin. The District states that 100 percent of the water conserved through this Project will be transferred to the State for instream use, but the District's own reports (in the EA Appendix D and in the SIP) are contrary to this statement. To truly benefit the public, as the Project must do in order to receive public funding through the PL-566 program, we reiterate that the Project should achieve the following: 1. Through the Project, the District gets a piped, pressurized system with 100% reliable deliveries of no more than 3.5 AF/acre. 2. Tumalo Creek and Crescent Creek get all of the recouped losses resulting from the Project, including (1) operational spill, (2) carry water, (3) seepage and evaporation, and (4) water not used by patrons in an increasingly efficient on-demand system. All of that water is legally transferred to the State and protected instream. Current estimates are that losses (operational and seepage/evaporation) amount to around 82 cfs and these amounts should be verified before transfers happen. If this tradeoff is achieved in the final EA, our other concerns will become less urgent.	Please see the response to comments 22.05 and 16.04.
27.01	GEN	Overall, state agencies appreciate the opportunity to comment on the Draft EA. They found that the document is well written and that it covers a wide range of subject matter related to the Tumalo Irrigation District's (TID) impact on the central Oregon environment. The document also does a good job of chronicling the historical aspects of converting the open ditches to pipelines.	Thank you for your comment.

27.02	GEN	Flow management and water temperatures limit fish and frog populations in the Deschutes River from Wickiup and Crescent Reservoirs to Lake Billy Chinook. ODFW's goal is to increase flows for aquatic species in this reach by meeting and permanently protecting ODFW's instream water right certifications and applications. ODFW also has interim objectives to help meet these goals incrementally, for example, increasing flows by 50 cubic feet per second (cfs) from mid-April to mid-May downstream of Bend to maintain a 130 cfs year-round base flow. ODFW believes the Tumalo project could help meet these goals and objectives. Alternatives two and three of the Tumalo project would both conserve water, which if protected permanently instream would benefit fish and wildlife.	Thank you for your comment.
27.03	FISH	ODFW also believes the comments below should be considered to ensure the greatest benefit to fish and wildlife: - Alternative 3 (High-density polyethylene piping) conserves 48 cfs and Alternative 2 conserves 43 cfs of water. ODFW prefers Alternative 3 to Alternative 2 for benefits to fish and wildlife.	Thank you for your comment.
27.04	WAT	ODFW also believes the comments below should be considered to ensure the greatest benefit to fish and wildlife: Conserved water will be allocated between Crescent Creek and Tumalo Creek. Tumalo Creek provides cooler water to the Deschutes River than Crescent Creek. ODFW prefers that a majority of the conserved water be allocated to Tumalo Creek, especially in summer months.	Thank you for your comment. Please see the response to comment 17.03 for more information on the distribution of conserved water.
27.05	ALT	ODFW also believes the comments below should be considered to ensure the greatest benefit to fish and wildlife: - The Environmental Assessment considers no action, canal lining and piping. Integrated approaches often yield similar or greater results with less effort. ODFW recommends that additional water saving measures be considered or integrated into Alternatives 2 and 3.	Clarifying text has been added in the Plan-EA regarding alternative conservation tools including on-farm efficiencies, piping of private laterals, and duty reduction (see Sections 5.2.4, 5.2.5, 5.2.6).
27.06	WAT	ODFW also believes the comments below should be considered to ensure the greatest benefit to fish and wildlife: - Alternative 3 will result in the loss of 15,000 acre feet of groundwater recharge. However, the effect of this on the volume of cold-water returns to the Deschutes River through downstream springs is not communicated. The strongest fish populations between Wickiup and Lake Billy Chinook reside between Bend and Billy Chinook. If piping results in a significant loss of cold water to the Deschutes River, ODFW recommends the consideration of new alternatives.	Groundwater resources and the potential effects of the Piping Alternative on those resources are discussed in Section 4.10.4 and 6.10.3.4, respectively. Potential effects on groundwater and private wells are also discussed in the National Economic Development (NED) Analysis, Appendix D.1, Section 2.2. The Plan-EA does not specifically quantify the effects of the proposed project on cold-water returns to the Deschutes River through downstream springs. As discussed in Section 6.10.3, the proposed project would increase streamflow in Tumalo Creek, a tributary to the Deschutes River that enters the river between the City of Bend and Lake Billy Chinook during the irrigation season and, as a result, decreases water temperatures in the reach downstream from the Tumalo Creek confluence. Please also see response to comment 26.33 for a discussion about groundwater recharge based on Gannett and Lite 2017.
27.07	GEN	The document did an excellent job of setting the context of the District operations as it relates to usage of the water resources of the basin. The description of the streamflow, hydrology, ground water resources, impacts positive and negative, district operations and relation to other water resource development was very accurate and detailed. WRD could not find	Thank you for your comment.

		any inaccuracies in the information provided and does not believe anything was left out as far as what needed to be addressed. The TID has a long track record of conservation and efficiency measures dating back to the mid 1990's when the District built a new section of pipe at the Tumalo Feed Canal and abandoned the Columbia Southern Canal. This conservation measure alone, put a tremendous amount of water back in Tumalo Creek through Shevlin Park where in the past, flows could have been as low as 5 cfs. Tumalo continues to be a leader in the piping program alongside Three Sisters Irrigation District and is well poised to complete this proposal as outlined the plan.	
27.10	WAT	With the saved water, the TID is going to use the Allocation of Conserved water process with our agency and protect up to 48 cfs instream. Capitalizing on Tumalo Creek instream water is a priority from a stream temperature stand point. However, the EA outlines a prescriptive allocation of water between the TID's two sources, Crescent Lake and Tumalo Creek, which may not be the appropriate division through the allocation of Conserved water process. Discussions are needed among stakeholders and the water Resources Department as to how the project can leverage or emphasize Tumalo Creek saved water as a priority from a flow restoration standpoint without impacting other water users from Tumalo Creek.	Please see the response to comment 17.03.
27.11	CONS	The project map (Appendix B) shows several crossings of the irrigation canal on US 20 between Bend and Sisters. It is unclear if there will be any construction work that would affect traffic on US 20 at the crossing locations or what work or methods of construction would be used. This should be made clear in the description of the alternatives.	Many of the US 20 crossings are already updated in a way that there would be very little, if any, effects on traffic. The methods of construction would be described in detail in the further engineering and design work associated with each construction project. Please see Section 8.4.2 for further discussion of measures to minimize and avoid the effects of construction on traffic.
27.12	CONS	If the project construction for the canal includes any work within the ODOT Right of Way, it would require an ODOT permit. The need for an ODOT permit to work within the ODOT Right of Way should be included in Section 8.6.	Per ODOT's suggestion, text has been added to Section 8.6.2.
27.13	CONS	If canal construction activities will disrupt traffic flow on US20, all work that disrupts traffic on the highway will need to occur at night due to mobility requirements and the traffic volumes on US 20. This information should also be included in Section 6.64 and the mitigation section (Section 8.4.2).	TID would manage all road crossings consistent with its previous and ongoing construction management practices. Clarifying information has been included in Section 8.4.2.
27.15	WAT	DEQ believes that project largely supports the state's goals of improving stream flows to meet instream flow targets and improve water quality and offers the following questions and comments: 1. The seasonal instream flow and water quality benefits from conserved water going into Crescent Creek during the irrigation season (May-September) are not clear from the draft EA. The allocation of conserved water to Crescent Creek is described in the Surface water Hydrology sections for both Alternatives 2 and 3 (Section 6.10.2.2 and Section	Please see the response to comment 27.16.

		6.10.3.2, respectively). In both sections, the document states that the conserved water would be allocated outside of the irrigation season and that summer releases from Crescent Lake dam would decrease during the summer. The magnitude of the decrease in the summer flows is not quantified in the document. Furthermore, a summer-time decrease is not indicated in the related tables in Appendix E; Tables E-16 and E-17 both show that average daily stream flow in May-September is the same in the "modified" and "future" scenarios. Because flows in Crescent Creek influence flows in the Little Deschutes and Deschutes Rivers, it appears that this summer decrease should also be shown in the other related tables in Appendix E.	
27.16	WAT	Will there be a decrease in summer flows in Crescent Creek in May-September under Alternatives 2 and 3? -If so, what is the magnitude of the decrease? Please include this information in the Stream Flow tables in Appendix E, as appropriate. -If so, what will be the water quality impacts of the decreased summer flows? While we understand the desire to return to a more natural hydrograph, the water quality is not "natural" because of the presence of the Crescent Lake dam. As DEQ indicated in our comments on the Preliminary Investigative Report for this project (dated July 21, 2017), evaluating the water quality effects of storing water can be complicated. In addition, decreased flows during the summer months could exacerbate current temperature impairments observed in all reaches.	There would likely be a decrease in summer flows in Crescent Creek in April-October under Alternatives 2 and 3. Clarifying language has been added to Sections 6.10.2.2 and 6.10.3.2. This decrease depends on the amount of conserved water allocated to Crescent Lake through the Oregon water Resources Department's administrative process (see Section 2.2.1 with added clarifying language). The corresponding tables in Appendix E.6 have been updated to estimate the effects of the project on irrigation season streamflows. These estimates are based on simplifying assumptions that future conditions will reflect historical conditions, that the project would be the only change to these conditions, and that increases and decreases to streamflow associated with the project would be spread evenly across the non-irrigation and irrigation seasons, respectively.
27.17	WAT	2. The draft EA indicates that the conserved water will be split between Crescent Creek and Tumalo Creek, with 38 percent of the water being allocated to Crescent Creek (in the non- irrigation season) and 62 percent of the water allocated to Tumalo Creek (in the irrigation season). Given the seasonal differences in allocation and the thermal nature of the two creeks, what is the rationale for splitting the conserved water as is proposed in the draft EA? We support the Oregon water Resources Department suggestion that discussions are needed among stakeholders to better understand and evaluate this issue.	Please see the response to comment 17.03.
27.18	WAT	3. Under the Surface Water Quality section for Alternative 3 (Section 6.10.3.3), the document states that the irrigation canal and lateral system would continue to deliver contaminates, such as herbicides and pesticides, to patrons. However, Table 5-2 on page 103 indicates that this alternative has the potential to improve the quality of irrigation water delivered to patrons. Given that it seems likely that piping (as opposed to lining) would reduce the delivery of contaminates, we wondered if Section 6.10.3.3 includes a typo and should be re-worded?	Thank you for catching this error in the Plan-EA. The piping project would prevent contaminants from infiltrating the District's conveyance system and improve water quality as noted in the comment. Section 6.10.3.3 has been updated accordingly.
27.19	WAT	4. Section 4.10.3.2 describes the dissolved oxygen impairments in the Little Deschutes and Deschutes Rivers in the area of potential effect. This section notes that there are impairments during the trout spawning season from January 1 to May 15. The draft EA does not mention that there are also non-spawning season impairments for dissolved oxygen in both rivers in the project area. The criterion during this time of year is designed to	Thank you for bringing this to our attention. The appropriate changes have been made in Section 4.10.3.2.

		protect cold-water aquatic life. Please add this additional information to Section 4.10.3.	
27.20	WAT	5. As described in the draft EA, Alternatives 2 and 3 could both result in a decrease in groundwater recharge. Groundwater recharge, in the form of springs entering the Deschutes River downstream of Lower Bridge Road, provides an important source of cold water to the river. The figure below shows the thermal profile of the Deschutes River from a thermal infrared survey conducted on 7/26/2001 (Aerial Surveys in the Deschutes River Basin, Watershed Sciences, 2002, http://www.oregon.gov/deq/FilterDocs/deschutes.pdf). In this figure, Bend is indicated on the right-hand side of the figure and the confluence with Lake Billy Chinook is on the left-hand side. The little red squares indicate spring inputs and show the magnitude of the cooling effect that these springs have on the Deschutes River. Section 6.10.3.4 in the draft EA suggests that the reduction in recharge from lining or piping TID canals would not have a significant impact on groundwater recharge, referencing earlier reports by Gannett and Lite. DEQ understands that USGS has been working to revise some of the earlier groundwater models, and we would encourage the incorporation of new groundwater information as it becomes available. We support the Oregon Department of Fish and Wildlife recommendation that additional alternatives be consider if lining/piping results in a significant loss of cold water to the Deschutes River.	Please see the response to comment 26.33. Additionally, at the programmatic level, watershed planning documents are reviewed at regular intervals (approximately 5 years). This review ensures that conditions remain as described and that any changes in information or conditions that might result in a new or altered finding are identified early on and addressed. A new groundwater model and associated studies, if developed and published, would be identified and incorporated during this review.
28.01	GEN	The Service supports piping the canals and laterals, and is eager to see the resulting conserved water returned to the Deschutes River.	Thank you for your comment.
28.02	PURP	Section 2 of the EA, Purpose and Need for Action, highlights the primary considerations for the Project. "The purpose of this project is to improve water conservation, water delivery reliability, and public safety on up to 68.8 miles of District-owned canals and laterals." While the Service is supportive of these objectives, given the long-term potential use of this Project, we believe the Purpose and Need may limit the scope of the Project. The limited scope may preclude the use of other available conservation tools. Broadening the Purpose and Need statement to include benefits to agriculture as well as conservation benefits for fish and wildlife will provide greater opportunity to use all available tools for conservation.	Please see the response to comment 23.02.
28.03	ALT	The alternatives each evaluate specific approaches to modernization that will yield conservation. The Service supports use of all tools available for conservation, since the conservation need is so great. We recommended considering an approach which allows for the greatest flexibility over time to conserve water and return it to the Deschutes River. The Service supports the Preferred Alternative (Alternative 3); however, given the long-term nature of the Project and the high conservation need, we suggest using a more integrated approach. While the Service wants to see the piping commence, the funding opportunity that PL 83-566 provides may also be used to achieve conservation through the use of other tools. If needed, the	The proposed project would, when complete, eliminate existing water management challenges associated with open canals and laterals within the District (see Section 2.1.2). It would facilitate the use of additional tools for conservation. See response 2.06 for the legal requirements that must be considered when using PL 83-566. The District appreciates the offer of feedback regarding other conservation tools that would complement the proposed project.

		Service is happy to provide more substantive feedback about specific conservation tools that would complement the Project.	
28.04	WAT	Appendix D (pp. D19 - D20) suggests TID will be increasing their duty from 3.5 to 5 gal/min/acre. The Service was not aware that TID would be increasing their duty with the conserved water. Please clarify and/or confirm in the final EA where the conserved water will go.	Please see the response to comment 22.05.
28.05	WAT	It is unclear to the reader where and how the saved water will be measured, and how much of that will be returned instream. Please clarify the accounting in the final EA.	Please see the response to comments 16.04 and 17.03.
28.06	ESA	TID has been implementing conservation measures to increase flows as the result of an ESA litigation settlement agreement. It is unclear to the reader if the conserved water will be added to the conservation already provided from that settlement, or if it will backfill that conservation commitment. Again, the Service is very supportive of piping canals and laterals, and appreciates NRCS' endeavors to facilitate those efforts through PL 83-566.	Please see the response to comment 26.22.
29.01	PROC	I would like to be able to stand up at the meeting and address my concerns in person at meetings so that all the people present would hear.	Thank you for your comment.
29.02	WAT	I disagree that 30% of the water is lost. Seepage water goes down and provides water for wells and ground water and trees etc. I believe wells will go dry in time without the ditch.	Please refer to sections 6.8.3.1 and 6.10.3.4 for a discussion about the effects of eliminating seepage on vegetation and groundwater, respectively. Please see response to comments 2.02 and 26.33 for information on the potential effects of the implementation of the proposed project to groundwater and private wells.
29.03	PATD	I was told that I would have to pay to carry water in pipes from the turnout onto my property to a pond 885 feet away, which I would have to repump out of my pond to irrigate. I'm not getting any value out of this, in that I would still be using my own pump to irrigate. I want to know exactly how my irrigation system is going to work and who's going to pay for any additional piping to our pond?	The need to continue pumping or not would be specific to a particular property. Please see the responses to comment 26.25 and 26.26.
29.04	PATD	I believe we will not be getting any more water than we were before.	Please see the response to comment 22.05.
29.05	PATD	How much more am I going to pay for water than I am now? Right now I am paying $1,050 for water per year for 3 acres. Will it go up?	Thank you for your question. This question is outside of the scope of this Plan-EA. Please contact the District regarding this question.
29.06	VEG	I believe that many trees growing along the ditch benefit from the water and will die without the ditch water. I think wildlife will also be affected by removing the ditch water.	Please see the response to comment 3.03.

29.07	PROP	How is my property value going to be affected by the removal of the ditch water and by the death of numerous ponderosa pine trees depending on the ditch for water? I believe that my property value will decline due to the death of these trees combined with marijuana grows operating in my neighborhood. If we are so worried about seepage, why not pipe the whole Deschutes river? Because there's seepage there too isn't there? I imagine there are going to be a lot of lawsuits against this pipeline, especially when wells go dry and property value is lost.	Please see the response to comment 6.04.
30.00	WAT	I believe we need to update our laws and policies on irrigation in Central Oregon. They are over 100 years old and a lot has changed in Central Oregon since then. We need to stop penalizing those ranchers, farmers and residents who do not need the water diverted from the Deschutes River. Newer, more modern methods of water capture/conservation have taken away much of the needs for such obsolete irrigation methods as river diversion. We need new laws to help property owners conserve river diversion without penalties. We need to face the fact that much of Central Oregon is not suitable, (less than 2% of Deschutes County's GDP) for efficient farming. The Deschutes River is our icon, our lifestyle and the cause of our high quality of life in Central Oregon. We need to protect our treasure, not give it away.	Changing water laws is outside the scope of the project.
31.00	COST	The guest column writer in today's Bulletin seems to have made some unstated assumptions. To wit, the cost per acre foot assumes an amortization period of only one year when it should be over the whole lifetime of the pipe.	Please see the Section 1.1 of the National Economic Development (NED) Analysis (Appendix D.1) for analysis parameters.
32.00	GEN	I see no valid reason why taxpayers should pay for piping irrigation canals.	Thank you for your comment.
33.01	WAT	As a condition of providing any tax funds to pipe the TID canals the responsible entities should first require TID to incorporate the following changes to their practices, policies, regulations and by-laws: 1. Charges to TID users should be based on the amount of water they use.	Please see the response to comment 10.02.
33.02	WAT	2. Allow users to leave their water in the river at no charge.	Please see the response to comment 10.01.
33.03	ALT	3. Implement all recommendations of the study plan which are less expensive than piping to leave more water in the river.	Please see the response to comment 26.24.
33.04	WAT	4. Allow users to sell or otherwise transfer their rights out of the TID and back to the river.	Please see the response to comment 10.01.
34.01	WAT	I am concerned about the piping of the canal. This is an extremely costly and irreversible solution. I have read reports that there are other more cost effective solutions available. The first and least costly would be to allow	Please see the response to comment 10.01.

		people to give their water rights back to the river instead of the canal companies. Why is this option off the table?	
34.02	SYS	The pressurized water system will place a new burden on the laterals. How has this been addressed? From what I have read, this system may make the system more efficient but it still takes as much water from the river. If fewer people need their water and want to return it to the river would this not make the size of the pipe smaller? Has the efficiency of the laterals really been considered when sizing the pipe?	The system has been designed to consider the efficiency of laterals. It has been designed to have the capacity to serve all of the irrigated lands within the District, but could also function at less-than-full capacity.
34.03	WAT	I have read how much water will be saved by these efforts but I have not seen any mention of not taking water in the first place. I have read that the water will be returned to the river. How is this going to be managed?	Please see the response to comments 10.01 and 17.03.
35.01	ALT	As a fiscal conservative I find it abhorrent that we give our water away for free, see it wasted on marginal crops and then are expected to pay up to almost $900,000 per cfs to make these systems more efficient. One possible solution that was not considered was purchasing land that is irrigated, putting the water back instream and re-selling the property. What would that cost per cfs?	Please see Section 5.2.3 for a discussion of fallowing farm fields.
35.02	ALT	Also, charging enough for water to encourage efficient use of it was apparently not on the table.	Charging more for water to encourage efficient water use would fall under voluntary duty reductions and market-based approaches. Please see Section 5.2.4 for a discussion of voluntary duty reductions. Please see the response to comment 2.06 regarding why on-farm efficiency improvements cannot be incorporated into the plan; this response also applies to voluntary duty reductions. Please see the response to comment 25.04 regarding market-based approaches.
36.00	COST	TID should be required to pay for the non-grant funded balance of the proposed piping project and return most, if not all, of the conserved water to the Deschutes River. The proposed work will improve the delivery and efficiency of TID, however, these improvements should not be a public subsidy to a private irrigation district.	Thank you for your comment.
37.00	GEN	I think the plan makes a lot of sense. We are fortunate that money is available to pipe much of the water and reduce its loss.	Thank you for your comment.
38.01	GEN	Re: Tumalo Irrigation District's Watershed Plan-Environmental Assessment As a member of the Coalition for the Deschutes (CFD), I support Tumalo Irrigation District's Watershed Plan-Environmental Assessment and their Irrigation Modernization Project. Specifically I support the Piping Alternative that will replace 1.9 miles of the Tumalo Feed Canal with 84-inch diameter HDPE pipe, replace 66.9 miles of open laterals with smaller diameter pressurized HDPE pipe, and provide other system improvements. As river advocates who also support sustainable irrigated agriculture in	Thank you for your comment.

		Central Oregon, we're excited and eager to see TID's irrigation modernization project move forward and be brought to fruition.	
38.02	WAT	TID's Modernization Project is projected to reduce water seepage and evaporation losses by up to 48 cfs. TID's Board of Directors recently passed a resolution that, in total, commits to returning 100% of conserved water to instream use in the Deschutes River, Little Deschutes River, Tumalo Creek, and Crescent Creek. CFD applauds the resolution. We believe that all of the conserved water should go instream with senior water rights so that it is permanently protected instream and is not subject to out-of-stream use. This water will benefit fish, wildlife, and other aquatic resources.	Thank you for your comment.
38.03	WAT	Tumalo Creek is a significant tributary to the Middle Deschutes River and historically provided critically important cold, clear water to this 40-mile reach of the Deschutes River. Diverting less Tumalo Creek water for irrigation will help the Middle Deschutes River return to a healthier ecological condition. According to a report published by the Upper Deschutes Watershed Council, new analyses show that restoring flow in Tumalo Creek can achieve a greater cooling effect than restoring the same amount of flow in the Deschutes. This information suggests a new approach to stream flow restoration that prioritizes increasing flows in Tumalo Creek.	Please see Sections 6.10.2.3 and Sections 6.10.3.3 for discussions of streamflow and water temperatures.
38.04	WAT	Third party oversight and confirmation is a valued part of managing public-owned resources such as the water. Thus, we agree with Blackrock Environmental that either the US Geological Society or Oregon Water Resources Department should monitor and evaluate the amount of water conserved and returned to instream use prior to TID's project being completed. The Coalition supports the work of local irrigation districts, including TID, to implement district conservation projects, as well as other types of programs, to improve water supply availability in the basin and to restore much-needed flows to the Deschutes River and other related waters. We appreciate the commitment that Tumalo Irrigation District has shown to helping restore the Deschutes River and the above-mentioned tributaries and return them to their historic healthy condition. We strongly believe that these actions will benefit all of Central Oregon. Thank you for your work to restore and maintain our rivers.	Thank you for your comment.
39.00	GEN	Thank you for any efforts to support maintaining water levels in the upper Deschutes, while assuring farmers and ranchers will have their water needs met. Please consider canal options that will reduce seepage and evaporation so that the essential water needs for wildlife, river health, and agriculture can be met.	Thank you for your comment.

40.00	WAT	I support the proposed project under the condition that 100% of the saved water be conserved instream.	Thank you for your comment.
41.00	WAT	I support the Piping Alternative that will replace 1.9 miles of the Tumalo Feed Canal with 84-inch diameter HDPE pipe, replace 66.9 miles of open laterals with smaller diameter pressurized HDPE pipe, and provide other system improvements. This is projected to reduce water seepage and evaporation loss up to 48 cfs. Conserved water should go instream with senior water rights so that it is permanently protected and not subject to out-of-stream use. Either the US Geological Society or Oregon Water Resources Department should monitor and evaluate the amount of water conserved and returned to instream use prior to TID's project being completed.	Thank you for your comment.
42.00		Attached	Comment was not received.
43.00	FORM	Re: Tumalo Irrigation District's Watershed Plan-Environmental Assessment I am a member of The Coalition for the Deschutes (CFD) which supports Tumalo Irrigation District's Watershed Plan-Environmental Assessment and their Irrigation Modernization Project. Specifically we support the Piping Alternative that will replace 1.9 miles of the Tumalo Feed Canal with 84-inch diameter HDPE pipe, replace 66.9 miles of open laterals with smaller diameter pressurized HDPE pipe, and provide other system improvements. As river advocates who also support sustainable irrigated agriculture in Central Oregon, we're excited and eager to see TID's irrigation modernization project move forward and be brought to fruition. TID's Modernization Project is projected to reduce water seepage and evaporation losses by up to 48 cfs. TID's Board of Directors recently passed a resolution that, in total, commits to returning 100% of conserved water to instream use in the Deschutes River, Little Deschutes River, Tumalo Creek, and Crescent Creek. CFD applauds the resolution. We believe that all of the conserved water should go instream with senior water rights so that it is permanently protected instream and is not subject to out-of-stream use. This water will benefit fish, wildlife, and other aquatic resources. Tumalo Creek is a significant tributary to the Middle Deschutes River and historically provided critically important cold, clear water to this 40-mile reach of the Deschutes River. Diverting less Tumalo Creek water for irrigation will help the Middle Deschutes River return to a healthier ecological condition. According to a report published by the Upper Deschutes Watershed Council, "New analyses show that restoring flow in Tumalo Creek can achieve a greater cooling effect than restoring the same amount of flow in the Deschutes. This information suggests a new approach to stream flow restoration that prioritizes increasing flows in Tumalo Creek." Third party oversight and confirmation is a valued part of managing public-owned resources such as the water. Thus, we agree with Blackrock Environmental that either the US Geological Society or Oregon Water	Please see the response to comment 16.04 for a discussion of the verification of the amount of water conserved.

		Resources Department should monitor and evaluate the amount of water conserved and returned to instream use prior to TID's project being completed. The Coalition supports the work of local irrigation districts, including TID, to implement district conservation projects, as well as other types of programs, to improve water supply availability in the basin and to restore much-needed flows to the Deschutes River and other related waters. We appreciate the commitment that Tumalo Irrigation District has shown to helping restore the Deschutes River and the above-mentioned tributaries and return them to their historic healthy condition. We strongly believe that these actions will benefit all of Central Oregon.	
44.00	FORM	Re: Tumalo Irrigation District's Watershed Plan-Environmental Assessment I am a member of The Coalition for the Deschutes (CFD), which supports Tumalo Irrigation District's Watershed Plan-Environmental Assessment and their Irrigation Modernization Project. Specifically we support the Piping Alternative that will replace 1.9 miles of the Tumalo Feed Canal with 84-inch diameter HDPE pipe, replace 66.9 miles of open laterals with smaller diameter pressurized HDPE pipe, and provide other system improvements. As river advocates who also support sustainable irrigated agriculture in Central Oregon, we're excited and eager to see TID's irrigation modernization project move forward and be brought to fruition. TID's Modernization Project is projected to reduce water seepage and evaporation losses by up to 48 cfs. TID's Board of Directors recently passed a resolution that, in total, commits to returning 100% of conserved water to instream use in the Deschutes River, Little Deschutes River, Tumalo Creek, and Crescent Creek. CFD applauds the resolution. We believe that all of the conserved water should go instream with senior water rights so that it is permanently protected instream and is not subject to out-of-stream use. This water will benefit fish, wildlife, and other aquatic resources. Tumalo Creek is a significant tributary to the Middle Deschutes River and historically provided critically important cold, clear water to this 40-mile reach of the Deschutes River. Diverting less Tumalo Creek water for irrigation will help the Middle Deschutes River return to a healthier ecological condition. According to a report published by the Upper Deschutes Watershed Council, "New analyses show that restoring flow in Tumalo Creek can achieve a greater cooling effect than restoring the same amount of flow in the Deschutes. This information suggests a new approach to stream flow restoration that prioritizes increasing flows in Tumalo Creek." Third party oversight and confirmation is a valued part of managing public-owned resources such as the water. Thus, we agree with Blackrock Environmental that either the US Geological Society or Oregon Water Resources Department should monitor and evaluate the amount of water conserved and returned to instream use prior to TID's project being completed. The Coalition supports the work of local irrigation districts, including TID,	Please see the response to comment 16.04 for a discussion of the verification of the amount of water conserved.

		to implement district conservation projects, as well as other types of programs, to improve water supply availability in the basin and to restore much-needed flows to the Deschutes River and other related waters. We appreciate the commitment that Tumalo Irrigation District has shown to helping restore the Deschutes River and the above-mentioned tributaries and return them to their historic healthy condition. We strongly believe that these actions will benefit all of Central Oregon.	
45.01	ALT	We are not in favor of piping of the Tumalo water district canals for the following reasons: 1. There are several less costly alternatives (rather than piping) to increase stream flow in Tumalo creek.	Please see the response to comment 26.24.
45.02	PROP	2. Die off of ponderosa pines and riparian specific vegetation will occur and will significantly affect wildlife as well as property values for many parcels. Is there a plan to reimburse property owners for loss of property value?	The District would not reimburse property owners for potential declines in property values. Please see the response to comment 6.04 related to property values.
45.03	WAT	3. Reduction of water table over time	Groundwater resources and the potential effects of the proposed project on those resources are discussed in Section 4.10.4 and 6.10.3.4, respectively. Potential effects on groundwater and private wells are also discussed in the National Economic Development (NED) Analysis, Appendix D.1, Section 2.2.
45.04	COST	4. How will cost overages for this project be allocated? On a per patron or per acre foot basis?	Paying for cost overages would be determined by the District. In past projects, cost overages have not been paid directly by patrons.
45.05	WAT	5. Patrons should be allowed to voluntarily retire their irrigation permits without penalty	Please see the response to comment 10.01.
46.01	GEN	Tumalo Irrigation District's (TID) piping and modernization plan is an important part of restoring healthy flows in the Deschutes River while insuring adequate water supplies for Agriculture and Cities in the face of Urbanization, Population Growth, and Climate Change. Although water Marketing Strategies and On-farm efficiencies can also generate conserved water, it will be nearly impossible to conserve enough water to restore the river without piping and modernizing irrigation systems. Tumalo Irrigation District's Watershed Plan to pipe both their main feed canal and open laterals are an important step in meeting all of those needs. TID's Modernization Project is projected to reduce water seepage and evaporation losses by up to 48 cfs, and the TID Board has passed a resolution that puts 100% of the conserved water back instream. Tumalo Creek is a significant tributary to the Middle Deschutes River and historically provided critically important cold, clear water to this 40-mile reach of the Deschutes River. Diverting less Tumalo Creek water for irrigation will help the Middle Deschutes River return to a healthier ecological condition. According to a report published by the Upper Deschutes watershed Council, "New analyses show that restoring flow in Tumalo Creek can achieve a greater cooling effect than restoring the same amount of flow in the Deschutes. This information suggests a new approach to stream flow restoration that prioritizes increasing flows in Tumalo Creek." Of course, the TID Board's resolution putting 100% of	Thank you for your support. Please see Section 2.2.1 for a discussion about protecting the conserved water instream.

		the conserved water back instream will need to be formalized to assure the public that 100% of the conserved water will be permanently transferred instream.	
46.02	WAT	Regarding that conserved water, there are a couple of questions to be addressed: 1. The TID System Improvement Plan shows a water savings of 48 cfs, while the Blackrock Consulting report shows a savings of 50.4 cfs. Per Blackrock Consulting's report, the amount of conserved water should be verified by the USGS or OWRD to ensure that 100% of the conserved water is returned instream.	Please see the response to comments 16.02, 16.04, and 17.03.
46.03	PATD	2. TID's Watershed Plan also shows making additional water available to TID patrons. This significant increase in irrigation use from 3.5 acre feet per acre to 5.0 acre feet per acre should be fully explored to ensure that all water conserved with the use of public funds is returned instream. The above clarifications notwithstanding, piping projects like TID's are critical to restoring the Deschutes River and its tributaries and should be supported with both public and private funding for the benefit of all.	Please see the response to comment 22.05 and 16.04.
47.01	WAT	We now live in a different age than when the laws were written to help the farmers with water. Now we must use the water more wisely! The water belongs to ALL of us so the farmers need to catch up with improvements in administering water. I am a fisherman and would like more water in the river and would like more natural flows. Maybe we could limit the amount of water piped to farmers and increase the pricing of the water. The farmers who innovate would be better able to live within the newer policy. Piping the canals would save more water for the farmers. Also, the farmers who have been using most of the water over the years should fit the bill. Why should I (who uses very little water because I drip irrigate) have to lose water to the farmers who use overhead sprinklers (very wasteful). As water is more precious, we need the newer policy. The users should foot the bill.	Changing water laws is outside the scope of the project.
48.01	VEG	We attended your meetings on the modernization project for Tumalo Irrigation District, and have many concerns about it. Our 15 acres is the first property- off of the main feeder canal with three different sizes of canal ditches running through it to Tumalo Res. Rd.. Re have many huge ponderosa pine trees on each side of these ditches, which we fear will die, when the water is piped, and not going into the aquafer.	Please see the response to comment 3.03.
48.02	WAT	That water [referring water lost from seepage] is not wasted as they all say – as it goes back into the aquifer and soil –just like the Deschutes River does!	Thank you for your comment.

48.03	WAT	We are also concerned about what will happen to our home well when the irrigation water is all piped.	Please see the response to comment 2.02.
48.04	WILD	We are backed into the Winter Deer Range, with BLM and National Forest around us and enjoy all the wildlife around us like: deer, elk, bald eagles, duck, geese, all variety of birds, raccoons, skunk, badgers, squirrels, frogs, etc., etc. –what will happen to them, without access to water.	As this project would not affect private property outside of the canal corridor, ponds and irrigation infrastructure would be maintained by landowners on their private properties. Therefore, although access to water would be reduced, it would not be eliminated across the landscape. Piping may cause localized effects to individuals within populations, which include displacement and modification of habitat use based upon both loss of localized surface water and habitat modification along the canal corridors. The canal water and corridor, however, has not been identified as a critical habitat feature necessary to support populations of wildlife within the basin. Although individuals within populations that have become habituated to rely on the habitat provided by the canals could experience increased stress and potential mortality, the populations of various wildlife species, which are considered "urban adaptors" and could occur within the area, are anticipated to experience negligible effects due to the piping of the canals. Potential effects of the implementation of the proposed piping alternative to wildlife are discussed in Section 6.12.3, and the compliance and best management practices for wildlife are described in Section 6.12.4.
48.05	PUB	One concern, about the open irrigation canals and ditches was safety, and after living near the main Tumalo feeder canal and settling pond for over 40 years –we have never had a drowning or injury.	Please see the response to comment 12.03
48.06	PROP	We bought this property over 40 years ago because of its beautiful setting—the huge ponderosa pine trees and flowing three irrigation ditches, all the wildlife and scenic close view of the mountains. If our ditches are all piped –we feel it will devalue our property if we want to sell it at some time. Between the piping and all the marijuana grow operations (went to countless meetings on marijuana grow operations, too) our property will not have the value it once had and we pay very high taxes to live in this beautiful, desirable area. We sit through all of these meetings and all of your people make all of these major decisions, but you don't have to live with it, on a daily basis. We will retain a lawyer if needed.	Please see the response to comment 6.04.
48.07	PATD	We can't even imagine, what it will cost to pipe all of these lateral lines into each irrigators varied irrigation set-ups. Who's paying for that?	Please see the response to comments 2.06 and 26.26.
49.01	WAT	My comment is that I have lived in the Tumalo Irrigation District since 1975 and farmed 34 acres for 30 years, of this time and think piping the supply part of the district was a good idea with reservations. I do not think pressurization of the individual deliver points should be done. A great part of the inefficacy at the delivery point is due to the poor management in place at this point in time.	Thank you for your comment.
49.02	VEG	If the lateral system is allowed to dry up due to piping the ecosystem which, has been established over the past 100 years plus would suffer unmeasurable results to the country side.	Thank you for your comment.
49.03	PROP	It also would diminish property values. Right now when you mention that your live in the Tumalo area they remark what a beautiful area it is and how lucky we are to live in this area. In conclusion, I believe the TID should	Please see the response to comment 6.04.

		leave the system in place but only to run the present system more efficiently even if it means a complete change in management, so be it. By forcing the piping of the laterals it could open the powers that be to a number of class action lawsuits pertaining to existing to future property values which when the piping is not needed. It should be well established what the exact cost will be to the residences in the very end product design and what the costs will be to them in the future none of this government guessing and have it in contract form. Also in contract form what they can expect and penalties to the government or governing agency that are to assume full responsibility for money losses to people in the area, whether it be in farm crop failure or real estate losses due to the changing of landscape in a negative way.	
50.00	GEN	We have been patrons of the Tumalo Irrigation District for more than 30 years. We very much supported the canal piping project that was proposed in the early 1990s and were disappointed when that effort was not sustained. In earlier years our families were patrons of Central Oregon Irrigation District. Individually and jointly we have spent many strenuous hours cleaning ponds and sumps and ditches, cleaning and repairing delivery gates, weirs and trash racks. We have spent a great deal of money operating and maintaining irrigation pumps. We have worried about keeping cisterns full of (reasonably) clean water. We very much support the TID Modernization Project –Piping Plan—and appreciate the District's conscientious and forward looking efforts in designing and implementing this project. A system whose components are more than 100-years old will simply become more and more expensive and impractical to maintain and should be completely modernized. We cannot afford to miss another opportunity to do so. We have an obligation to conserve diverted water and to stabilize natural, seasonal stream flow. We are fortunate that the Draft Watershed Plan and the Basin Study point us toward ways to maintain healthy aquatic habitats and avoid endless litigation. An efficient, pressurized system will be vitally important to protect District patrons from at least some of the inevitable effects of drought and climate change. We can build a system with more predictability year after year. We recognize that there is a great deal of money involved in this project and accept that if most of the expenses come from "public" funds then it is appropriate that conserved water remain in the public domain – the existing streams and rivers. At the same time, an investment of this scale in irrigation infrastructure will contribute greatly to the economic viability of agriculture in our area. We appreciate the opportunity to comment on this important project.	Thank you for your comment.
51.00	WAT	I have heard at several TID board meetings that a large amount of water is being saved and that the whole system (almost) will be under pressure. Why then has TID proposed twice that they will need as much as two ten acre lakes or more as a recharge pumped facility.	A recharge pump facility would not be part of the project.

52.00	GEN	I moved into TID in 1983 and live on a 10-acre property with 4 acres of water - clearly a "mini ranch." We raised beef on rented pasture and clearly enjoyed the "creek" flowing through the property. I also served as a district rep for TID and ultimately served as Chairman of the Board of Directors. I heartily support this project! We all must work to save our Earth's most precious resource.	Thank you for your comment.
53.00	VIS	We live above the Bend fish screen at 1968 NW 1st in Bend. We are concerned about the visual impact of the cover and the materials that will be used. We are wondering what the design and material options are and how the visual character will be impacted from our deck and from those on the path. We would appreciate the opportunity to be included on the design concept process. We are concerned about the visual impact from our deck and that the design could negatively impact our property value. Thank you, please contact us when you are designing this.	The Bend Feed Canal fish screen would not be part of the project.
54.00	VEG	About 15 years ago the canal was diverted on our property. It used to have a secondary canal and when that dried up (approx. 200 yards) we must have lost 50-60 ponderosa pines. The lateral that runs through our property must be about 1/4 mile. It is lined with at least 100 old growth large ponderosas. These are at a huge risk of dying. We are very concerned and can only hope this wouldn't happen. Please consider this for us and others.	Please see the response to comment 3.03.
55.00	ENRG	The City of Portland is installing electric generators in the Bull run reservoir to the Portland/Gresham area. The water as it flows by gravity turn "pen stocks" in the pipes which allows PGE to … electricity put directly into the electric grid. It seems to be a real win win plan.	Please see the response to comment 18.03.
56.00	PROC	Since this is a public meeting, it should be recorded and available for download and viewing on line	The slide deck from the meeting is available online at https://oregonwatershedplans.org/tumalo.
57.01	VEG	We are extremely concerned about the covering of the ditch through our property. We have hundreds of trees along the ditch that will die and we own a multi-million-dollar property that will be adversely affected by these trees dying, falling, and becoming severe fire danger. This will also affect our CUP on the front lot and could make it impossible to build one lot. Will the trees be cleanly and safely removed before they become damage. I cannot incur any of these expenses.	Please see the response to comment 3.03.
57.02	WAT	And our natural water table could be negatively affected, which will damage our home, loss to aquifer.	Please see the response to comment 2.02.
57.03	PATD	We spent a lot of money to build out our pastures and if it is covered our cattle won't have access to water. Will these costs be reimbursed and covered? Will I get access for my cattle?	No changes would be made to private systems as part of the project. The District is responsible for providing water to the point of delivery. The District will not reimburse any costs to private infrastructure.

Appendix B

Project Maps

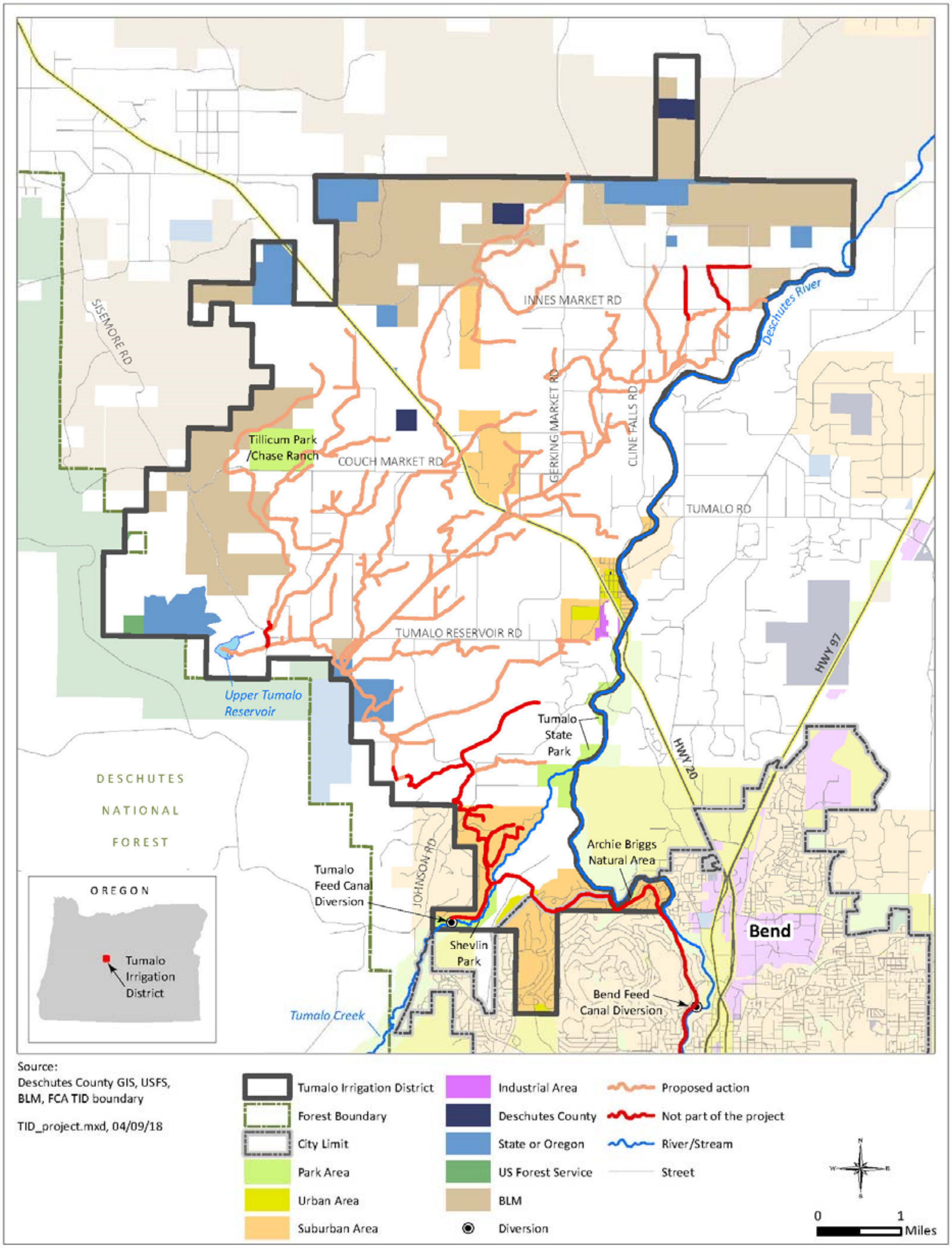

Figure B-1. Location of Tumalo Irrigation District – Irrigation Modernization Project.

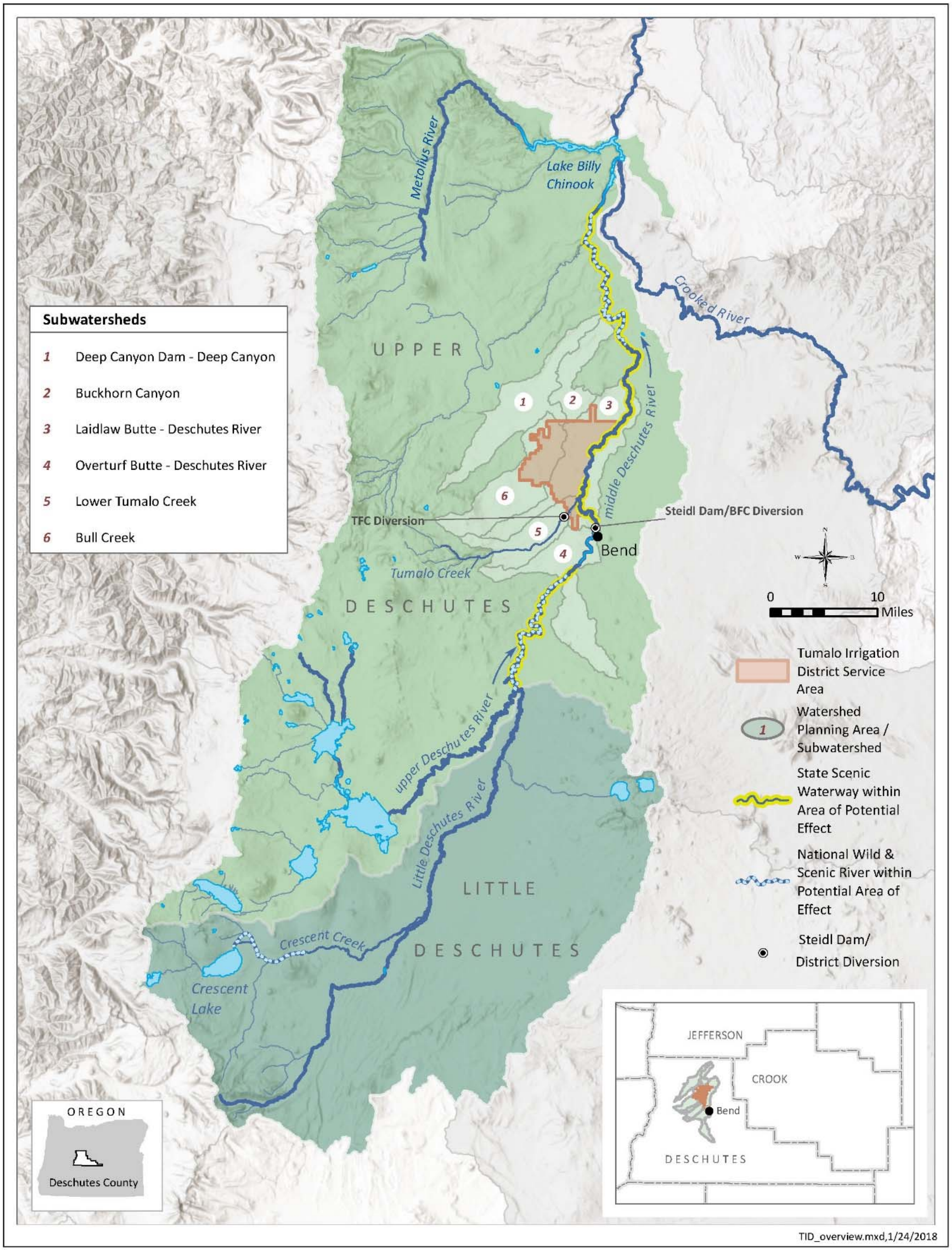

Figure B-2. The Six Subwatersheds Comprising the Tumalo Irrigation District Watershed Planning Area.

Appendix C

Supporting Maps

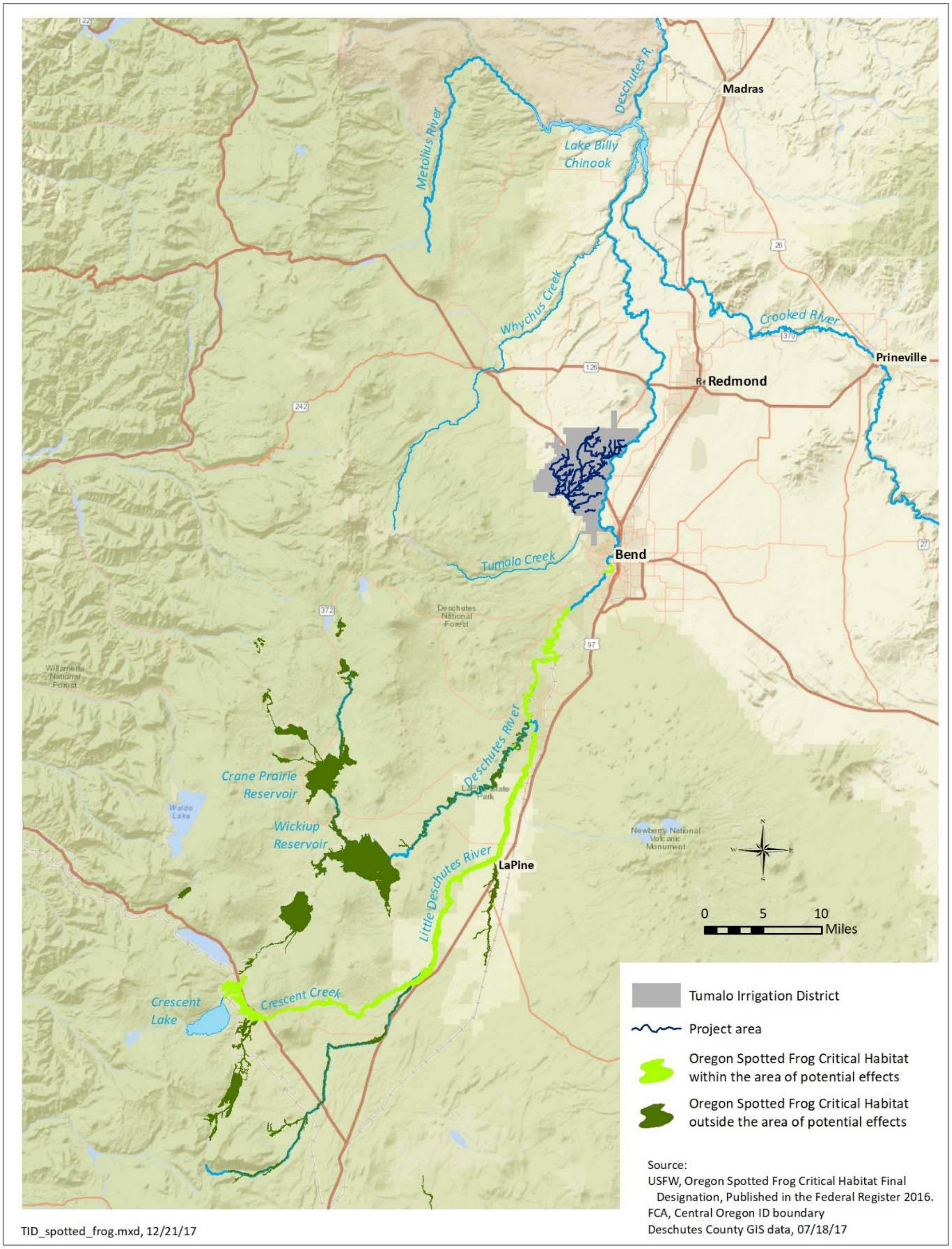

Figure C-1. Oregon Spotted Frog Critical Habitat near the Tumalo Irrigation District.

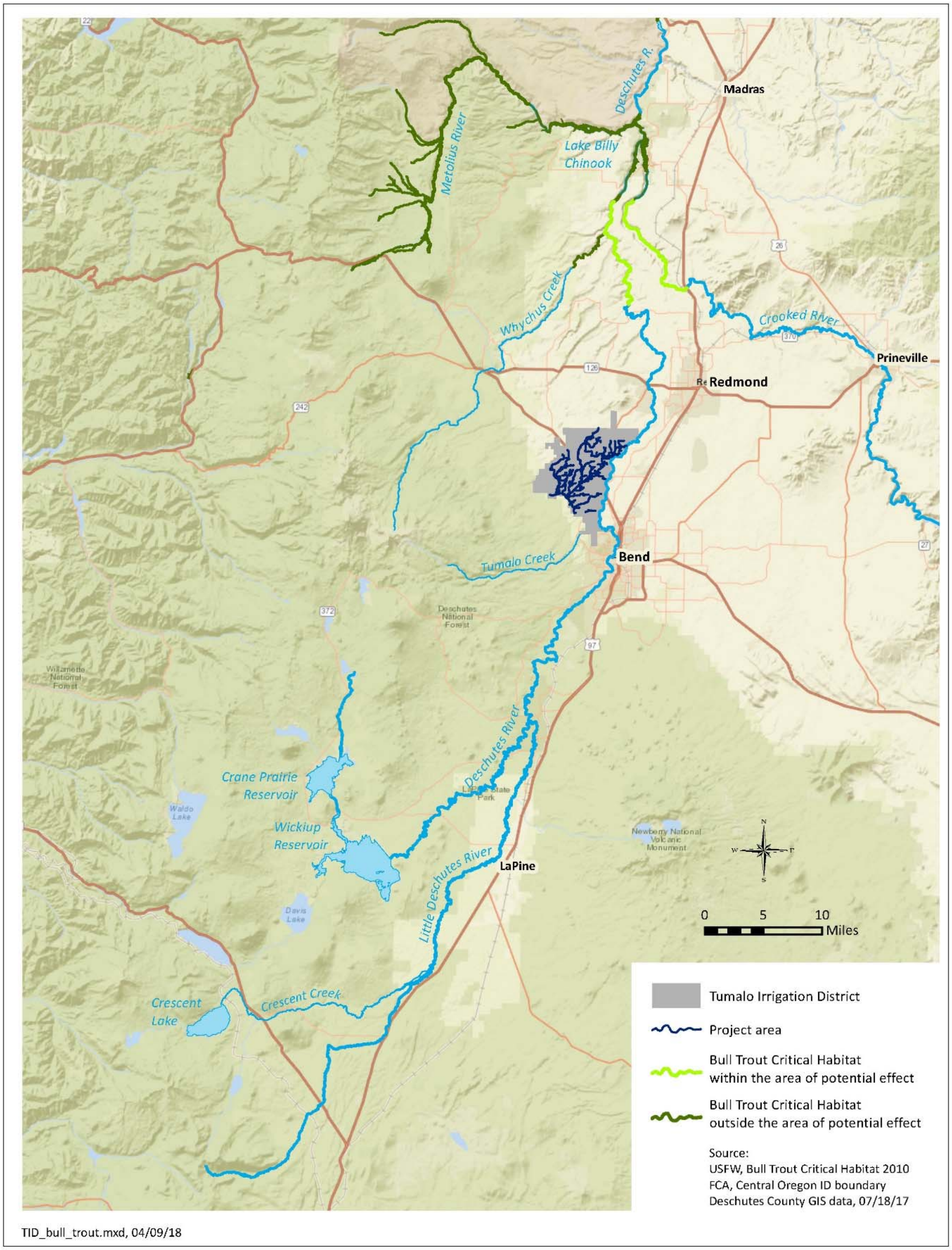

Figure C-2. Bull Trout Critical Habitat near the Tumalo Irrigation District.

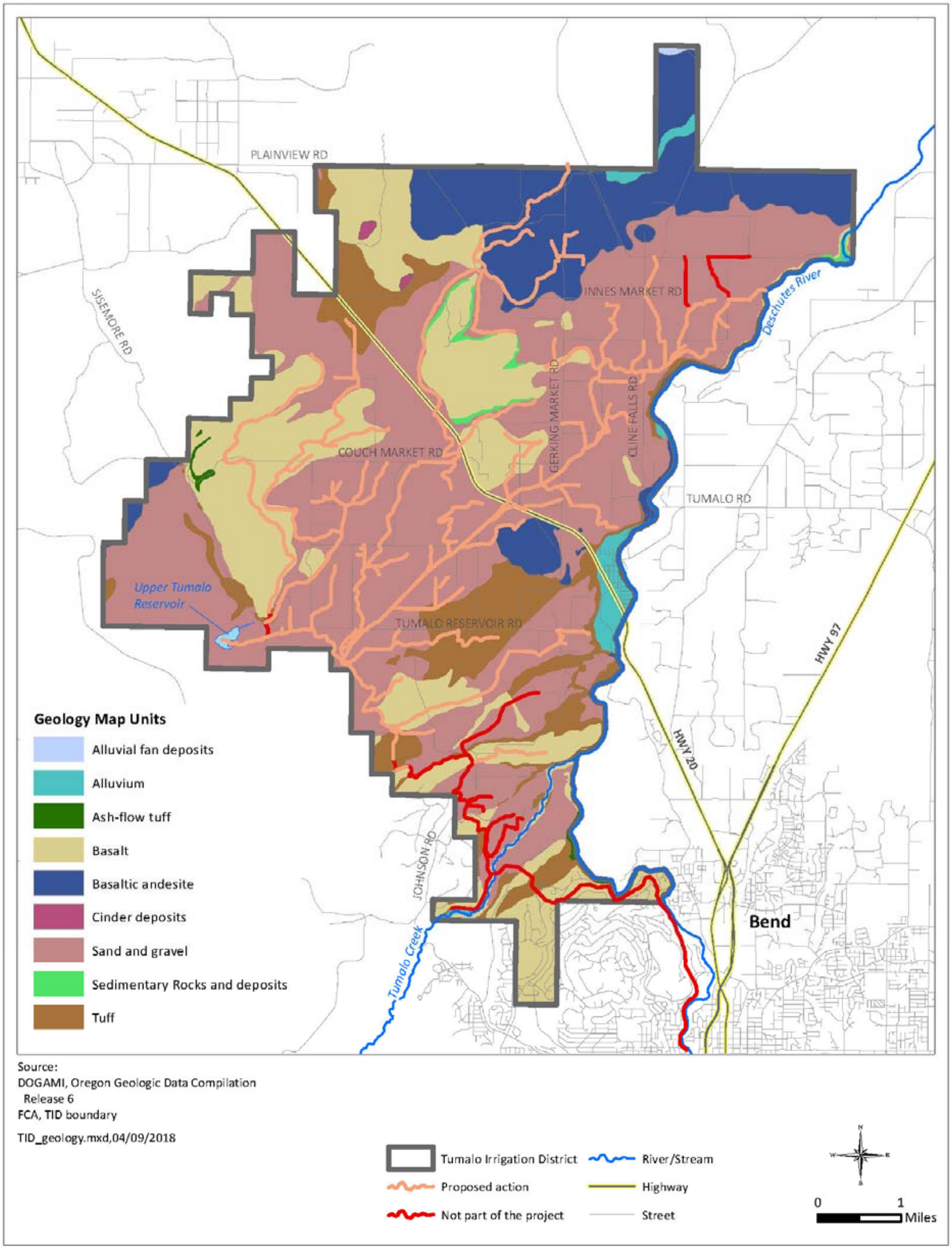

Figure C-3. Geologic Formations in the Tumalo Irrigation District.

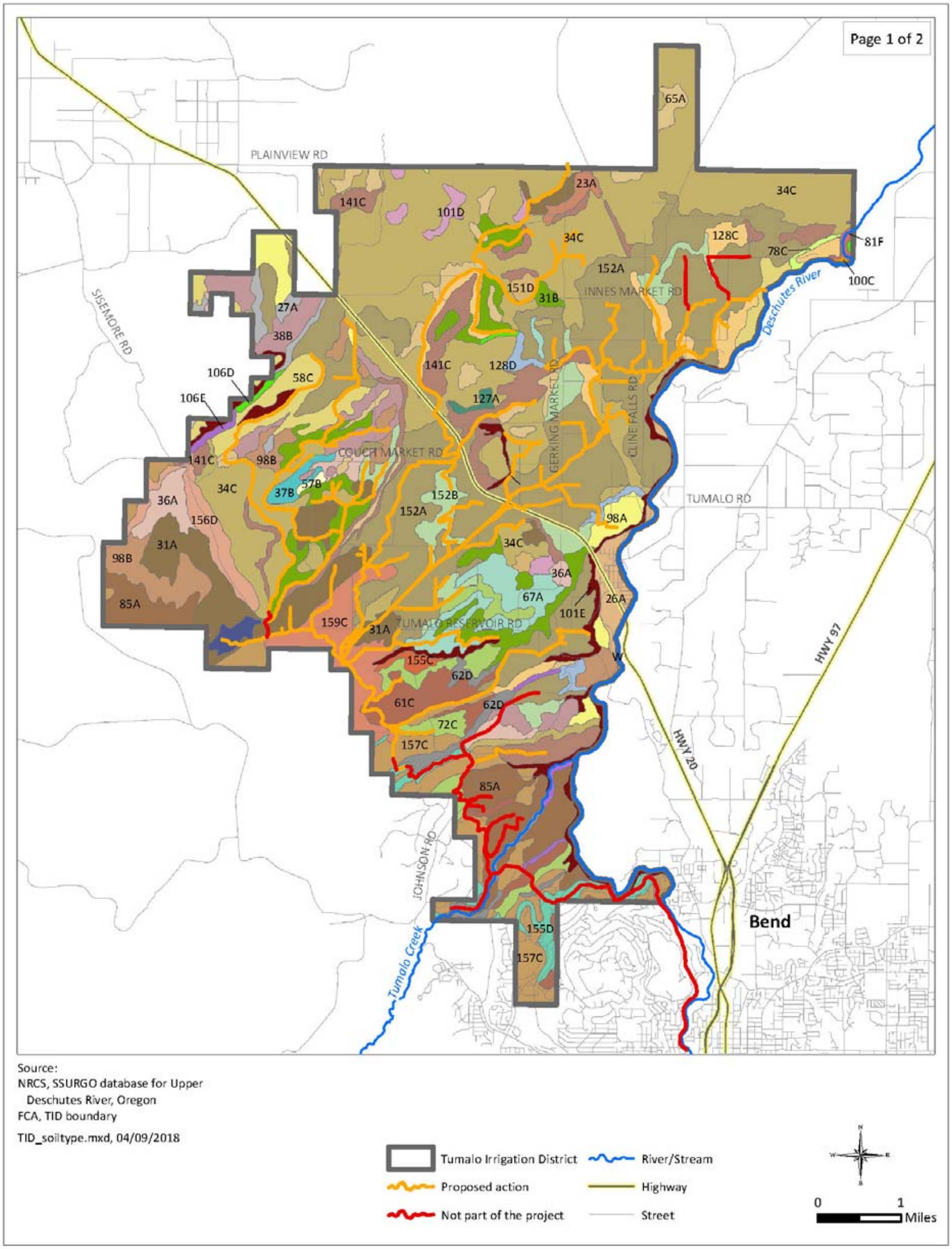

Figure C-4. General Soil Types in Tumalo Irrigation District.

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NRCS Map Unit Descriptions

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

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

TID_soiltypelegend.mxd, 08/09/17

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

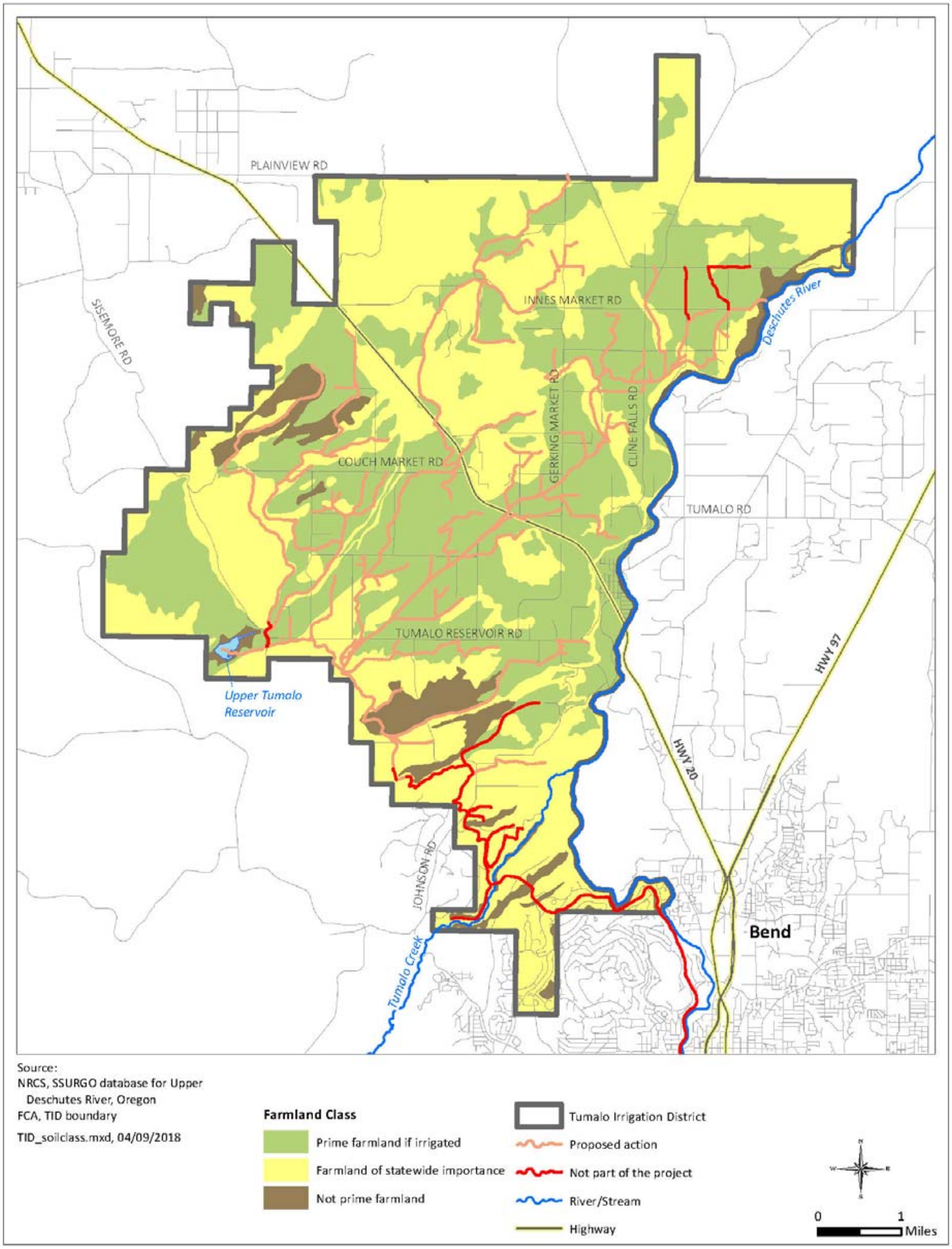

Figure C-6. NRCS Classification of Farmlands within the Tumalo Irrigation District.

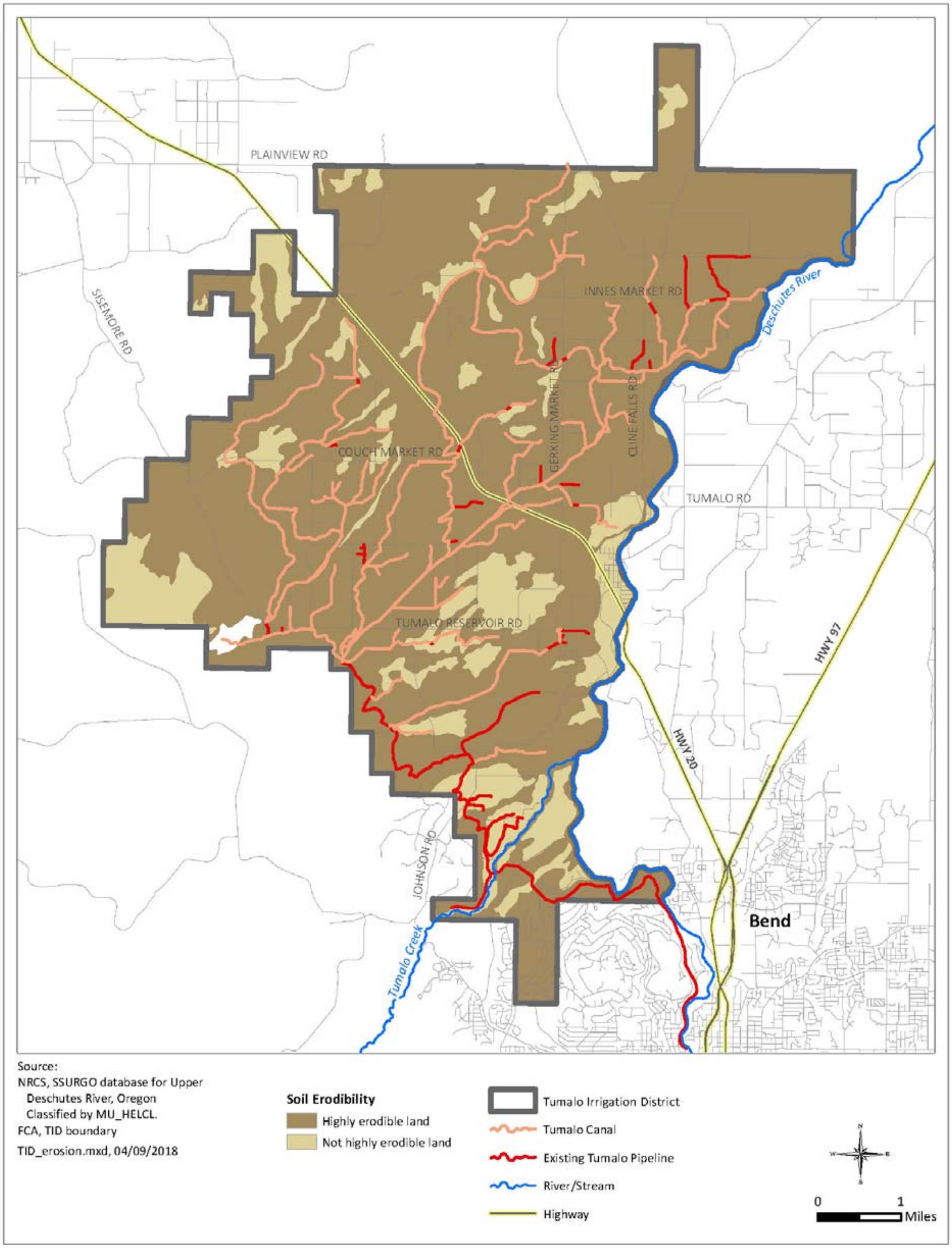

Figure C-7. Erosion Potential of Soils in the Tumalo Irrigation District.

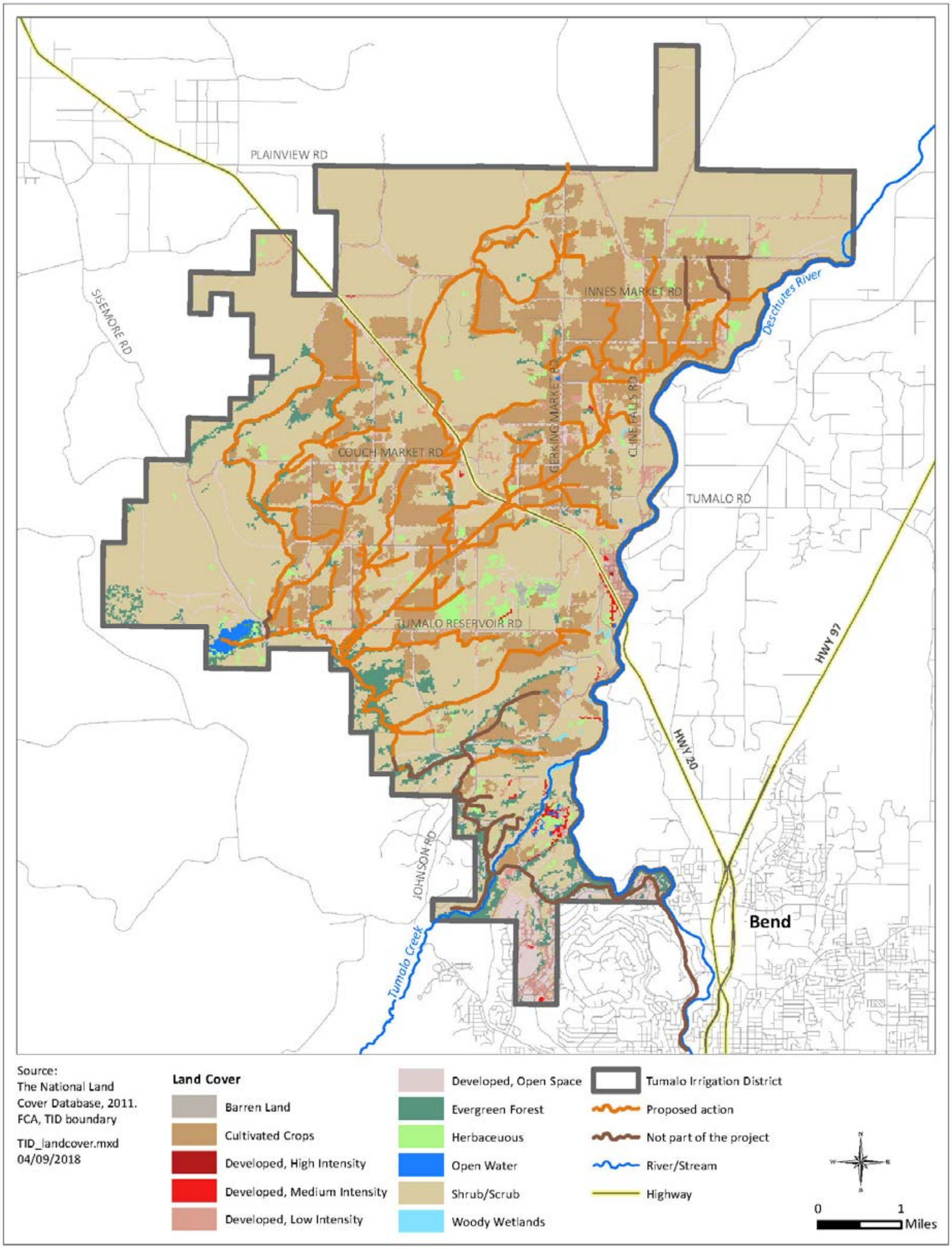

Figure C-8. Land Cover in the Tumalo Irrigation District.

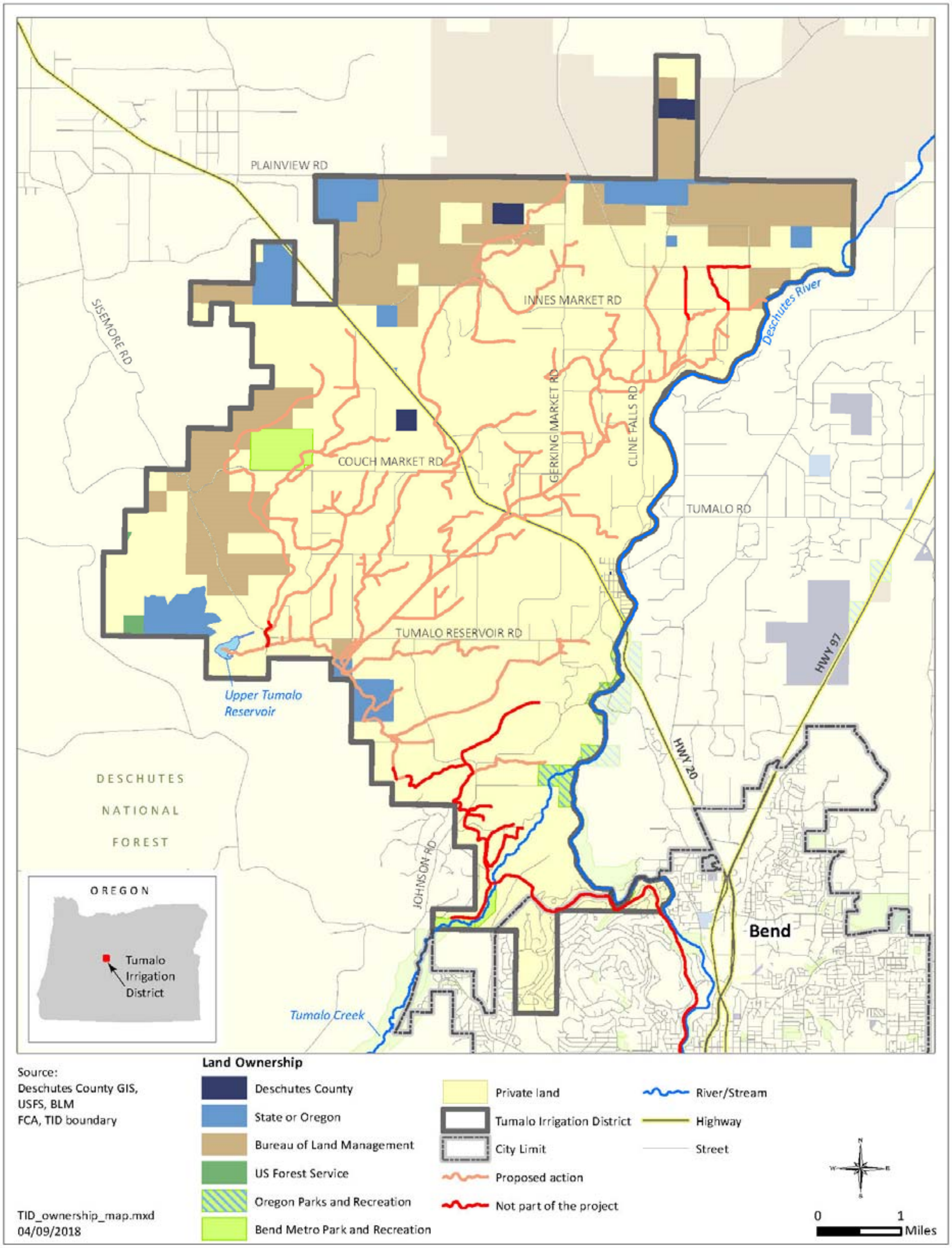

Figure C-9. Land Ownership within Tumalo Irrigation District.

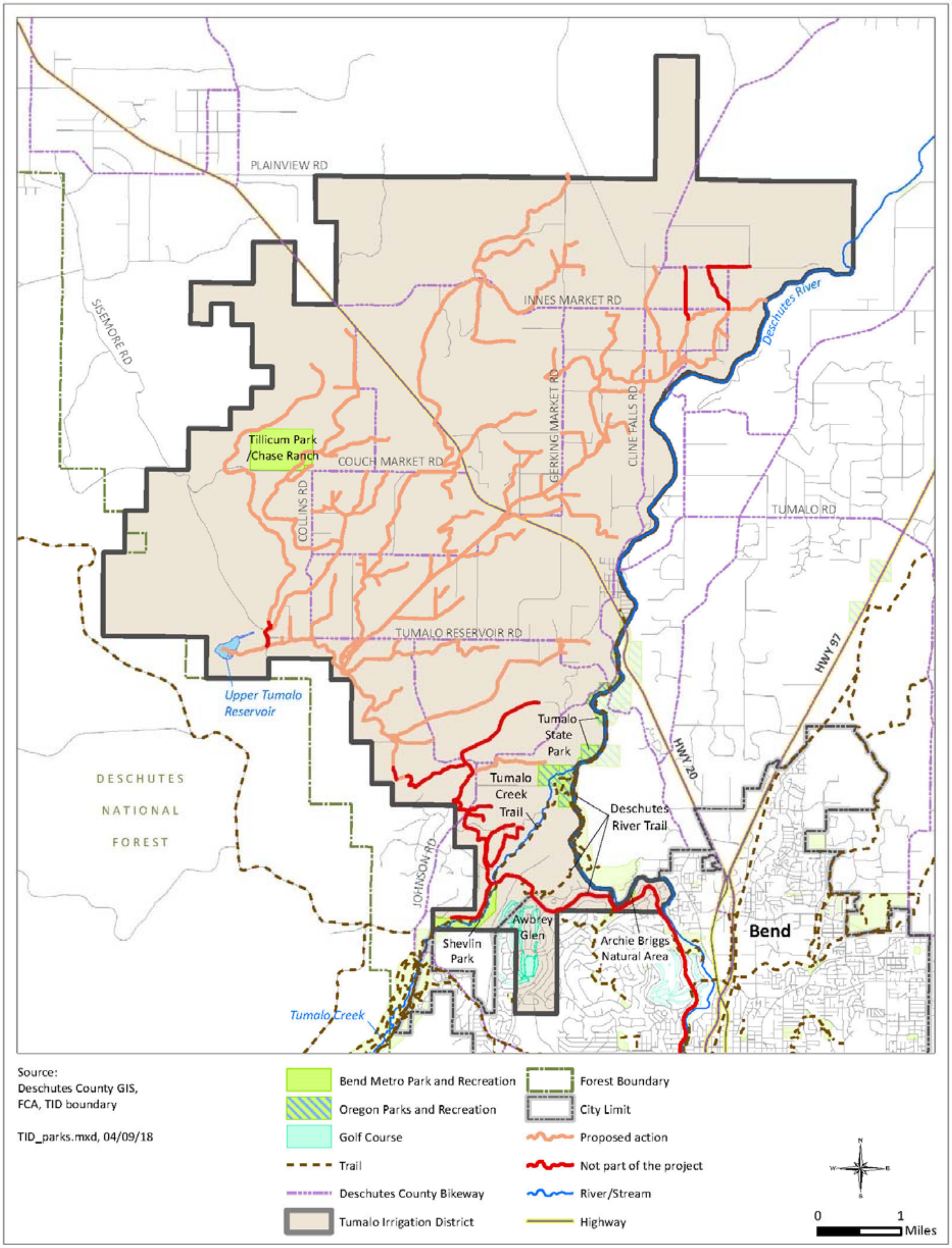

Figure C-10. Recreation Including Parks, Trails, and Bikeways in the Tumalo Irrigation District.

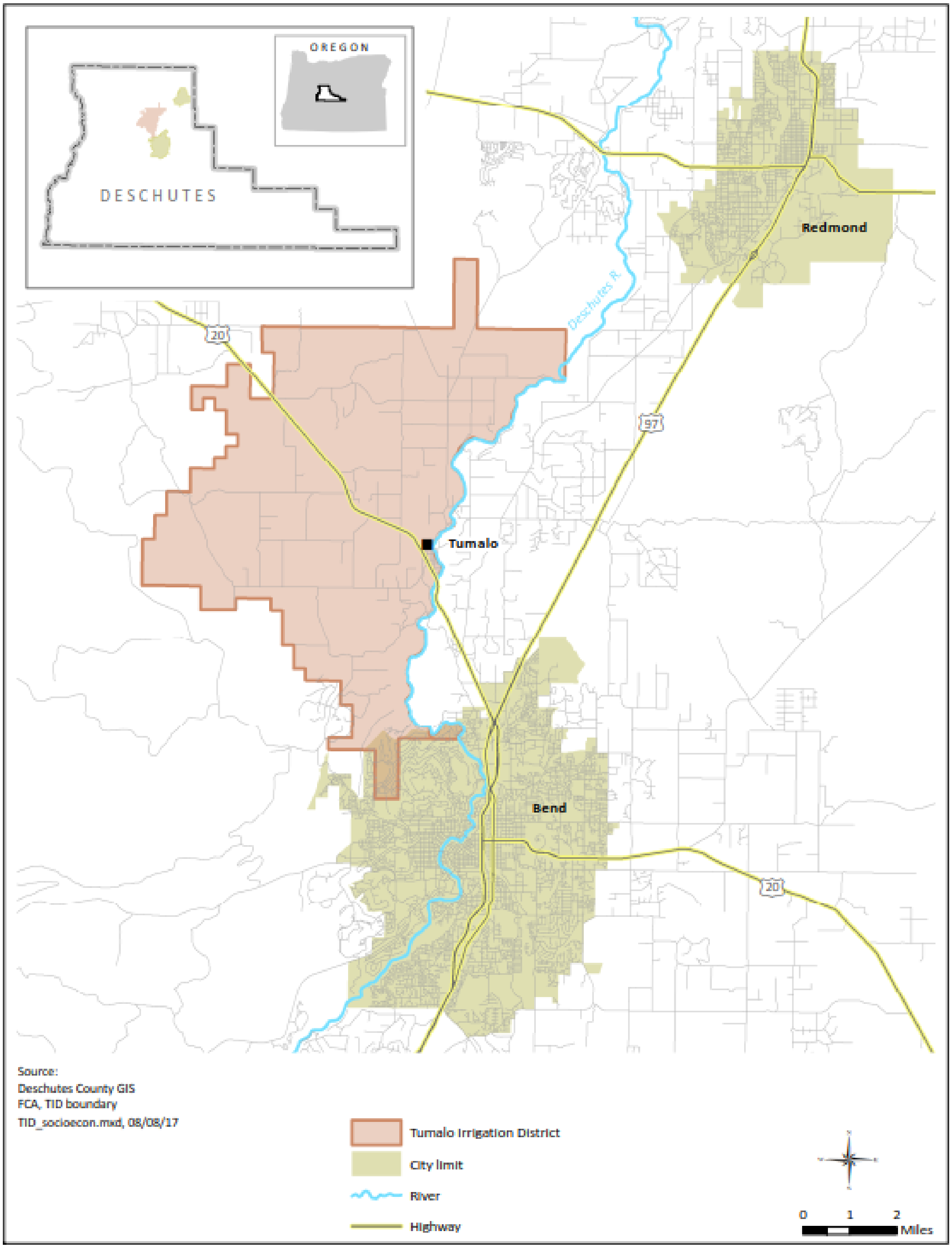

Figure C-11. Location of the Tumalo Irrigation District within the Socioeconomic Area of Potential Effect.

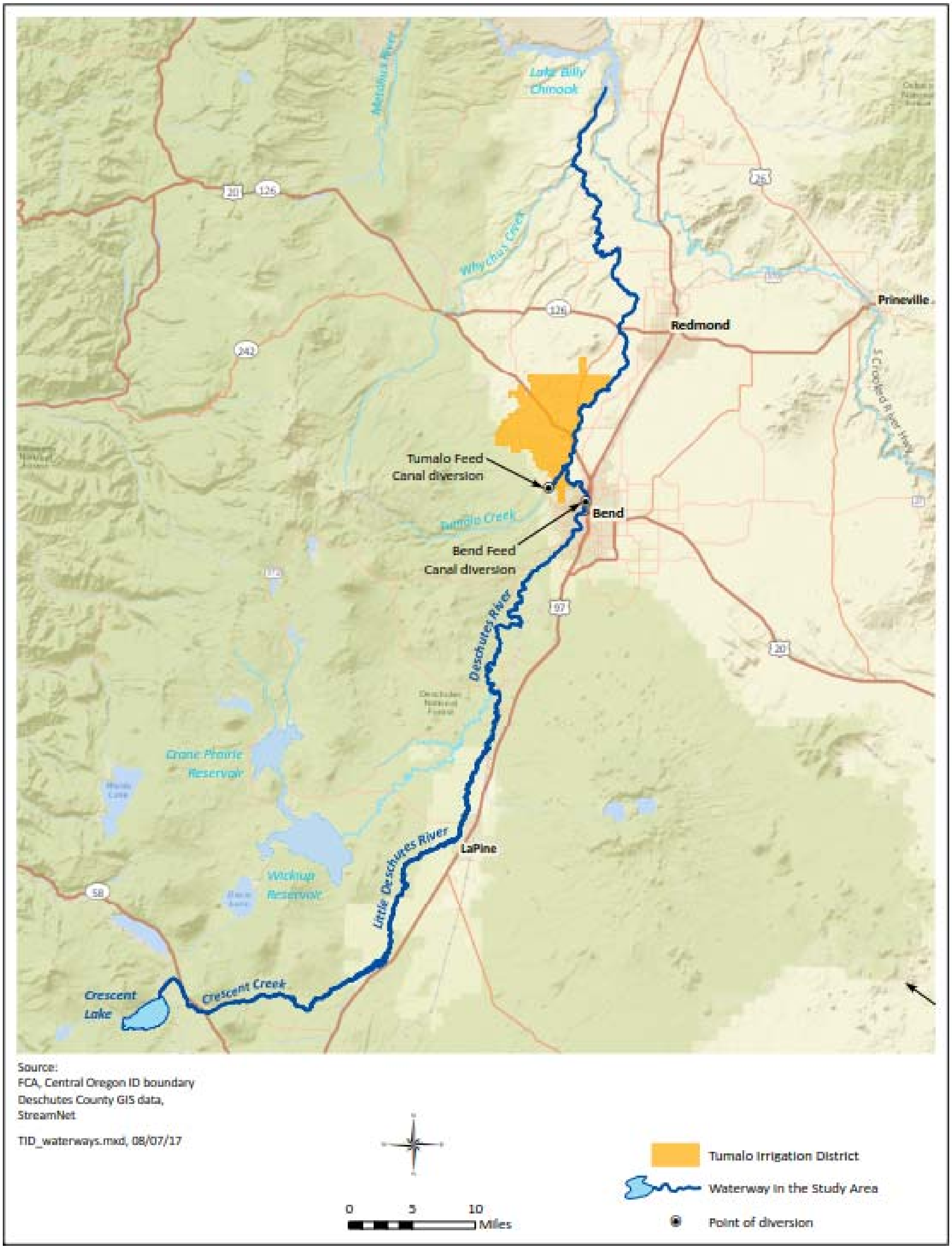

Figure C-12. Waterbodies Included in the Area of Potential Effect for Surface Water Resources.

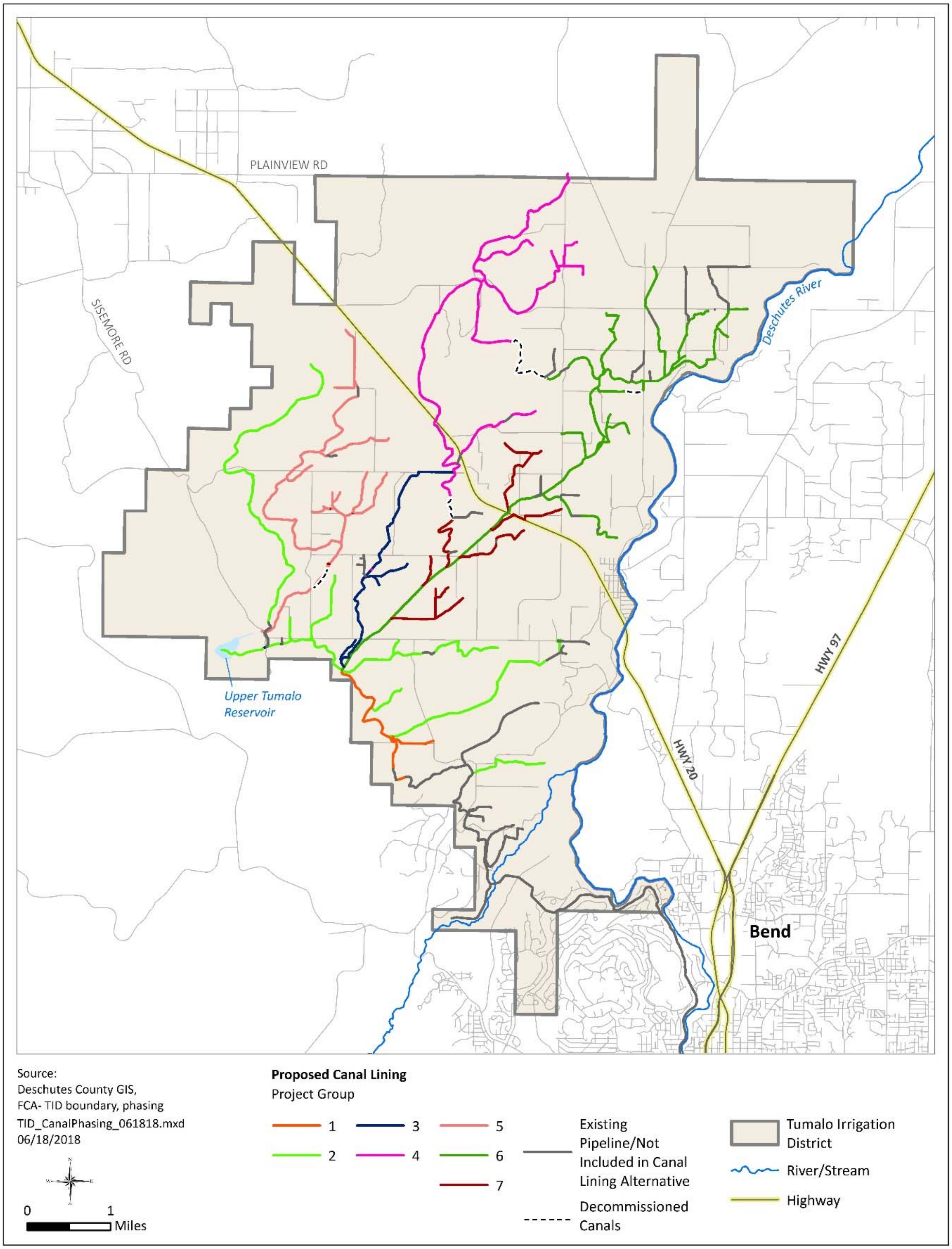

Figure C-13. Project Groups of the Canal Lining Alternative for Tumalo Irrigation District – Irrigation Modernization Project.

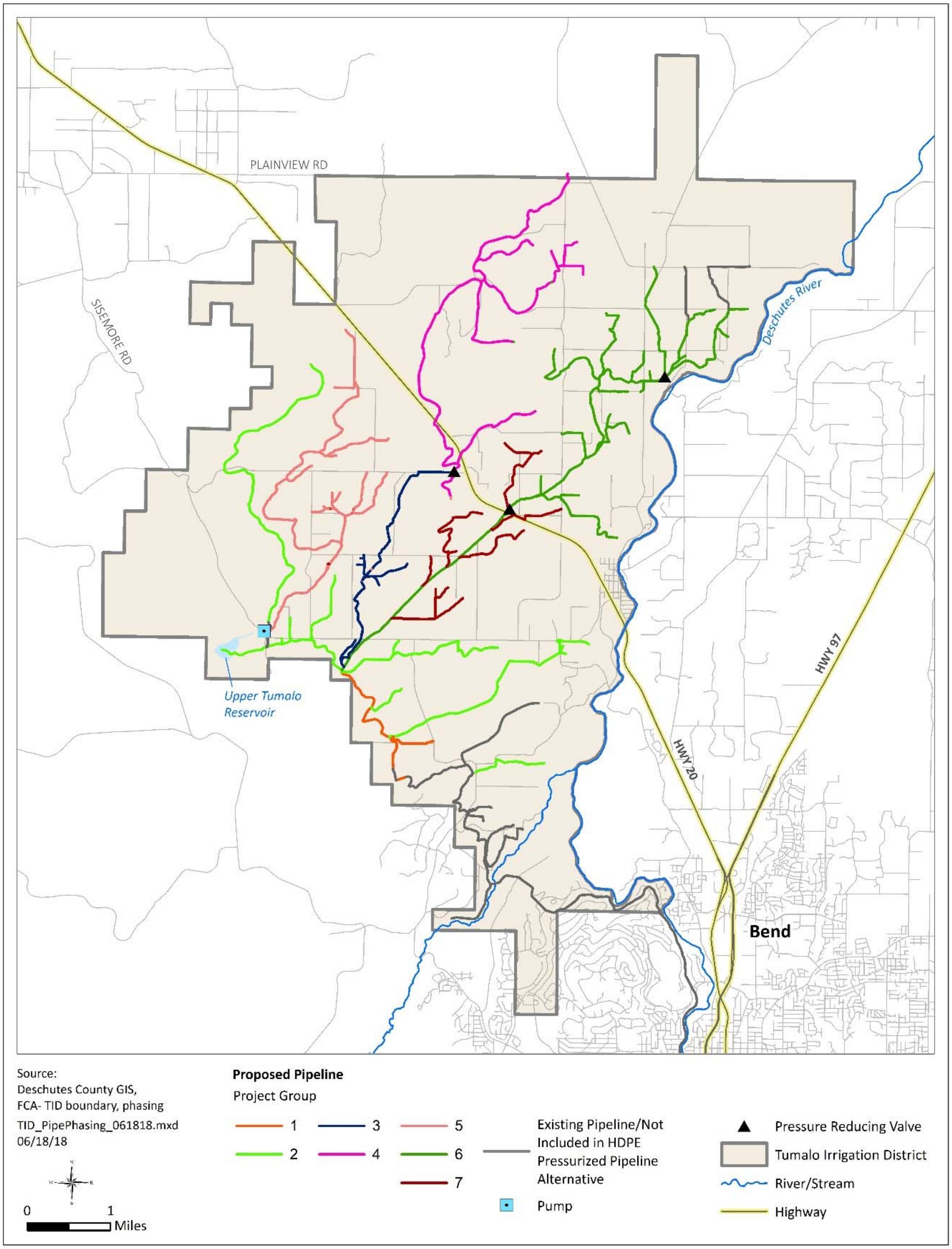

Figure C-14. Project Groups of the HDPE Piping Alternative for Tumalo Irrigation District – Irrigation Modernization Project.

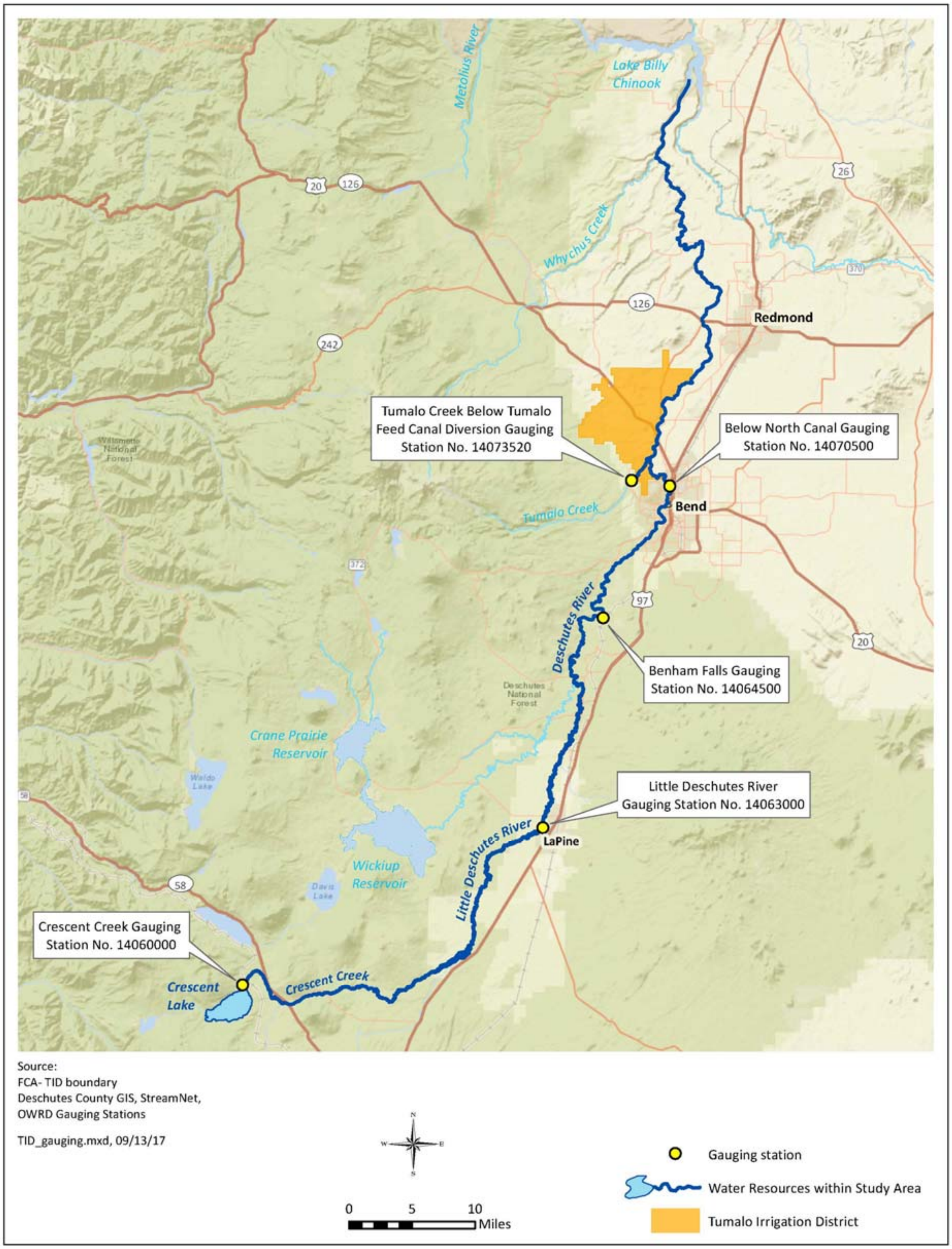

Figure C-15. Location of Gauging Stations No. 14060000, 14063000, and 14064500 within the Tumalo Irrigation District Area of Potential Effect.

Appendix D

Investigations and Analysis Reports

D.1 National Economic Development Analysis

Highland Economics LLC

National Economic Development Analysis

Barbara Wyse and Winston Oakley
07/11/2018

Table of Contents

List of Tables

List of Figures

1. Benefits and Costs

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

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

1.1 Analysis Parameters

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

1.1.1 Funding

According to TID District Manager (Rieck, Tumalo District Manager, 2017), nearly all funding is expected to be provided through grants. If necessary, approximately 31 percent of the project may be financed. If financing is required, TID expects to apply for funding through the Oregon Department of Environmental Quality Clean Water State Revolving Fund. TID expects that funding from this source would be at an interest rate of 2.5 percent with a 0.5 percent annual fee paid on the remaining loan balance. These financing costs are not included in the NED analysis. All funding sources other than PL 83-566 are from non-federal funds.

1.1.2 Evaluation Unit

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

1.1.3 Project Implementation Timeline

At present, the implementation timing of the proposed project is not known, or whether the implementation would occur in project groups, as this depends on the level and timing of project funding. However, based on conversations with the District manager, it is likely that the construction would be completed over approximately 11 years, with approximately one project group constructed each year. Some project groups, such as Project Group 1 and Project Group 6 would be completed over several years. For all project groups, the analysis assumes that full benefits would be realized the following year after construction is completed (e.g., for Project Group 1, which is completed in Construction Year 1, full benefits are realized in Year 2). The analysis also assumes that project groups are completed in numeric order (i.e., Project Group 1 is completed first, followed by Project Group 2, and so on). This approach is expected to slightly understate the net present value of the proposed project as benefits are slightly over-discounted compared to costs as it is expected that only 6 months (rather than 1 year) would lapse between incurring construction costs for each project group and realizing benefits from each project group (see Table A).

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

Construction Year	Works of Improvement	Public Law 83-566 Funds	Other, Non-Federal Funds	Total Construction Costs
0, 1	Project Group 1	$5,179,100	$1,756,800	$6,935,900
2	Project Group 2	$2,582,100	$799,800	$3,381,900
3	Project Group 2	$2,923,200	$904,100	$3,827,300
4	Project Group 3	$3,019,600	$943,600	$3,963,200
5	Project Group 4	$3,559,400	$1,108,700	$4,668,100
6	Project Group 5	$2,965,700	$927,200	$3,892,900
7	Project Group 6	$2,644,500	$815,700	$3,460,200
8	Project Group 6	$4,724,800	$1,451,800	$6,176,600
9	Project Group 6	$1,917,900	$3,089,600	$5,007,500
10	Project Group 7	$265,400	$1,747,000	$2,012,400
Total Project		$29,781,700	$13,544,300	$43,326,000

1/ Price Base: 2017 dollars — Prepared June 2018

1.1.4 Analysis Period

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

1.1.5 Project Purpose

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

2. Proposed Project Costs

Table B (NWPM 506.11, Economic Table 1), Table C (NWPM 506.12, Economic Table 2), and Table D (NWPM 506.18, Economic Table 4) below summarize installation costs, distribution of costs, and total annual average costs for the HDPE Pressurized Piping Alternative. (Note that Economic Table 3, Structural Data—Dams with planned storage capacity, is omitted as dams are not proposed). Tables E, F, and G present other direct costs associated with reduced groundwater recharge resulting from piping or lining of the canals. The subsections provide detail on the derivation of the values in the tables.

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

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

Works of Improvement	Unit	Number			Estimated Cost (dollars)[1]						
					Public Law 83-566 Funds			Other Funds			
		Federal land[3]	Non-Federal Land	Total	Federal Land NRCS[4]	Non-Federal Land NRCS	Total	Federal Land	Non-Federal Land	Total	Total
Project Group 1	Feet	0	12,716	12,716	$0	$5,179,000	$5,179,100	$0	$1,757,000	$1,756,800	$6,935,900
Project Group 2	Feet	11,660	69,936	81,596	$787,000	$4,719,000	$5,505,300	$243,000	$1,460,000	$1,703,900	$7,209,200
Project Group 3	Feet	2,193	23,326	25,519	$260,000	$2,760,000	$3,019,600	$81,000	$862,000	$943,600	$3,963,200
Project Group 4	Feet	9,634	51,917	61,551	$557,000	$3,002,000	$3,559,400	$174,000	$935,000	$1,108,700	$4,668,100
Project Group 5	Feet	1,620	54,330	55,950	$86,000	$2,880,000	$2,965,700	$27,000	$900,000	$927,200	$3,892,900
Project Group 6	Feet	436	89,727	90,163	$45,000	$9,242,000	$9,287,200	$26,000	$5,331,000	$5,357,100	$14,644,300
Project Group 7	Feet	0	35,650	35,650	$0	$265,000	$265,400	$0	$1,747,000	$1,747,000	$2,012,400
Total Project	Feet	25,544	337,601	363,145	$1,735,000	$28,047,000	$29,781,700	$551,000	$12,992,000	$13,544,300	$43,326,000

Note: Figures may not sum due to rounding. Prepared June 2018

1/ Price Base: 2017 dollars

2/Project cost as identified in the Tumalo Irrigation District System Improvement Plan prepared by Black Rock Consulting, 2016, updated to 2017 dollars and including an additional 3 percent project administration cost and 8 percent technical assistance cost.

3/Federal agency responsible for assisting in installation of works of improvement.

4/BLM land. The project would cross BLM land; however, BLM is not assisting in the installation of the works of improvement.

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

Works of Improvement	Installation Costs - PL 83-566 Funds				Installation Cost - Other Funds				Total Installation Costs
Piping	**Construction**	**Engineering**	**Project Admin [3]**	**Total PL 83-566**	**Construction**	**Engineering**	**Project Admin[3]**	**Total Other**	
Project Group 1	$4,748,100	$150,000	$281,000	$5,179,100	$1,582,700	$50,000	$124,100	$1,756,800	$6,935,900
Project Group 2	$4,605,600	$251,700	$648,000	$5,505,300	$1,535,200	$83,900	$84,800	$1,703,900	$7,209,200
Project Group 3	$2,540,900	$123,700	$355,000	$3,019,600	$846,900	$41,200	$55,500	$943,600	$3,963,200
Project Group 4	$2,972,600	$167,800	$419,000	$3,559,400	$990,900	$55,900	$61,900	$1,108,700	$4,668,100
Project Group 5	$2,459,800	$156,900	$349,000	$2,965,700	$820,000	$52,300	$54,900	$927,200	$3,892,900
Project Group 6	$7,573,000	$397,200	$1,317,000	$9,287,200	$5,072,900	$132,300	$151,900	$5,357,100	$14,644,300
Project Group 7	$0	$85,400	$180,000	$265,400	$1,680,600	$28,500	$37,900	$1,747,000	$2,012,400
Total Costs	$24,900,000	$1,332,700	$3,549,000	$29,781,700	$12,529,200	$444,100	$571,000	$13,544,300	$43,326,000

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

1/ Price base: 2017 dollars

2/Project cost as identified in the Tumalo Irrigation District System Improvement Plan prepared by Black Rock Consulting, 2016, updated to 2017 dollars and including an additional 3 percent project administration cost and 8 percent technical assistance cost. Of total estimated costs presented in the System Improvement Plan, Black Rock Consulting estimated 75 percent is for construction and 25 percent for engineering.

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

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

Works of Improvement[2]	Project Outlays (Amortization of Installation Cost)	Other Direct Costs[3] (Increased Pumping Costs Elsewhere in Basin from Reduced Groundwater Recharge)	Total
Project Group 1	$199,800	$5,200	$205,000
Project Group 2	$198,300	$2,400	$200,700
Project Group 3	$104,700	$1,300	$106,000
Project Group 4	$120,100	$1,400	$121,500
Project Group 5	$97,400	$1,000	$98,400
Project Group 6	$346,300	$4,100	$350,400
Project Group 7	$45,200	$1,200	$46,400
Total	**$1,111,800**	**$16,600**	**$1,128,400**

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

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

2/ This assumes approximately one project group would be completed in each year, such that Group 1 is completed in Year 1 and Group 7 is completed in Year 10.

3/ Other direct costs include the uncompensated economic losses due to changes in resource use or associated with installation, operation, or replacement of project structures. For Project Groups 2 through 7, other direct costs are presented for increased pumping costs elsewhere in the basin from reduced groundwater recharge (i.e., seepage from unlined canals). For Project Group 1, other direct costs include the cost of increased carbon emissions associated with increased groundwater pumping energy use (in all other project groups, total groundwater energy use declines, so carbon is a benefit). This does not include operations, maintenance, and repair costs because these decline under the HDPE Pressurized Piping Alternative, so these are presented as a benefit.

2.1 Project Installation Costs

According to the 2016 System Improvement Plan (SIP) conducted for Tumalo Irrigation District (Black Rock Consulting, 2016) and subsequent conversations with the District, the cost of piping and associated farm turnouts is $38,680,300 (2016 dollars). See Appendix D.3 for detailed cost derivation by pipe size, cost category, etc. All values in this analysis are presented in 2017 dollar values, and rounded to the nearest $100 value. To convert this cost to 2017 dollars, this analysis inflates the cost by 1.63 percent annually, which is the average annual increase in the RS Means construction cost index during the period July 2011 to July 2016 (RS Means, 2017). The resulting estimated capital cost in 2017 dollars is approximately $39,206,000. Of total estimated costs, Black Rock Consulting estimated the proportion that is for construction and the proportion that is for engineering (which varied by project group).

Adding an additional 3 percent for in-kind project administration from TID, 8 percent technical assistance from NRCS,[1] and permitting costs of $129,000, the total cost for the HDPE Pressurized Piping Alternative in 2017 dollars is estimated at $43,326,000. The average annual cost by project group is shown in Table D, with total average annual costs in 2017 dollars of $1,128,400 for the HDPE Pressurized Piping Alternative (assuming piping projects are completed in the order shown in Table D). The total cost for the Canal Lining Alternative is estimated at $84,334,900 with total average annual costs of $3,197,700.

1 With the exception of Project Group 1, which includes a flat $200,000 for technical assistance.

2.2 Other Direct Costs: Groundwater Recharge Costs

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

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

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

The HDPE Pressurized Piping Alternative would reduce canal seepage, and associated groundwater recharge, by up to approximately 15,115 AF annually in this part of the Deschutes Basin once all project groups are complete (see Appendix D for detailed derivation of reduced canal seepage).[2] On average, for this part of the central basin, this translates into a decreased groundwater elevation of approximately 0.04 foot annually (based on information presented above that a 1-foot groundwater elevation drop is expected to result from reduced recharge of 377,000 AF, so the corresponding drop from 15,115 AF is 0.04 foot since 15,115 AF divided by 377,000 AF is 0.04). An important caveat is that localized effects on groundwater of the HDPE Pressurized Piping Alternative would differ throughout the central basin. Over the course of approximately 100 years, this annual drop results in a cumulative decreased average groundwater elevation in the central basin of 4.0 feet (note that this drop in pumping elevation would have small effects on pumping costs, but would not be expected to result in the need for drilling deeper wells or replacing pumps at a faster rate).

This analysis combines this decreased groundwater elevation for each year in the 100-year analysis period with the estimated volume of groundwater pumping in the central Deschutes Basin to

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

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

In terms of power rates, according to the 2010 *Water System Master Plan Update Optimization Study*, most of the City of Bend's 25 groundwater wells fall under Pacific Power's Rate Schedule 28, while three wells fall under Rate Schedule 30 (Optimatics, 2010). The current marginal cost for the City to pump groundwater is expected to be approximately $0.05970 per kilowatt-hour (kWh) under Schedule 28 (Pacific Power, 2017). Farmers who use electricity to irrigate fall under Schedule 41, which applies the same price to all electricity used during the summer (April 1 to November 30). This rate is $0.09624/kWh, which this analysis assumes is the marginal cost to farmers for pumping groundwater.[3]

Under the No Action Alternative, groundwater levels would still decline. The USGS study notes that groundwater levels in the area between Clines Butte and Redmond (the closest area in the study to the proposed project) fell approximately 12 to 14 feet from 1994 to 2008 from a combination of climate, increases in groundwater pumping, and reduced groundwater recharge from canal lining (Gannett & Lite, 2013). This is an average drop of roughly 1 foot per year, which we assume will continue under the No Action Alternative. Data from the Oregon Department of Water Resources indicate that depths to groundwater vary widely within the area; depths in Bend are around 740 feet, while depths near Redmond are about 265 feet (Oregon Department of Water Resources, 2016). For the No Action Alternative, we assume a current average groundwater pumping depth in the Central Deschutes Basin of 500 feet; assuming a 1-foot drop in groundwater depth in each year over 100 years, groundwater depths would be approximately 600 feet. Over the course of 100 years, the HDPE Pressurized Piping Alternative and the Canal Lining Alternative both result in a pumping depth of approximately 604 feet, or an increased depth to groundwater of 4 feet compared to the No Action Alternative.

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 E, the total cost of groundwater pumping under the No Action Alternative is projected to grow from around $2.9 million in Year 1 to $17.6 million in Year 100.

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[3] The costs to power a pump represent the vast majority of variable costs of irrigation pumping. Maintenance costs on electric pumps are minimal. One study estimated that maintenance costs represented only 1 to 4 percent of the variable costs of pumping, with electricity costs comprising the other 96 to 99 percent (Robinson, 2002). The costs of diesel pumps show a similar pattern. Because maintenance costs are such a small part of the variable costs of irrigation pumping and would have a small effect on expected average annual values, only energy costs are included in this analysis.

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

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

Year	Volume Pumped (acre-feet per year)	Average Depth to Groundwater (feet)		
		No Action Alternative	HDPE Pressurized Piping Alternative (NED Alternative)	Canal Lining Alternative
1	51,000	500	501	501
10	64,000	510	510	510
20	82,000	520	521	521
30	105,000	530	531	531
40	134,000	540	542	542
50	172,000	550	552	552
60	220,000	560	562	562
70	282,000	570	573	573
80	360,000	580	583	583
90	461,000	590	594	594
100	591,000	600	604	604

Prepared June 2018

The increased depth to groundwater due to reduced recharge results in higher pumping costs in the HDPE Pressurized Piping Alternative and the Canal Lining Alternative. The increased cost to groundwater pumpers over the 100-year analysis period rises each year as the cumulative effect of reduced recharge may cause the groundwater elevation to continue to decline. For example, as a result of reduced recharge due to installation of Project Group 1, the groundwater elevation may decline 0.007 foot in Year 1, rising up to a 0.7-foot decline by Year 100 (0.007 multiplied by 100), with associated costs rising from approximately $42 to $21,800. In total, after discounting and amortizing these costs across all project groups, the estimated total annual average NED cost across 100 years is $14,000 per year for the HDPE Pressurized Piping Alternative (see Table F) and $13,200 per year under the Canal Lining Alternative (see Table G).

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

Works of Improvement	Water Conservation (cfs)	Water Conservation (AF/Year)	Change in Groundwater Depth (ft/year)	Annual Average NED Cost
Project Group 1	8.7	2,739	0.007	$2,700
Project Group 2	7.8	2,456	0.007	$2,400
Project Group 3	4.3	1,354	0.004	$1,300
Project Group 4	4.9	1,543	0.004	$1,400
Project Group 5	3.5	1,102	0.003	$1,000
Project Group 6	14.6	4,598	0.012	$4,100
Project Group 7	4.2	1,323	0.004	$1,200
Total	**48.0**	**15,115**	**0.040**	**$14,000**

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

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

Works of Improvement	Water Conservation (cfs)	Water Conservation (AF/Year)	Change in Groundwater Depth (ft/year)	Annual Average NED Cost
Project Group 1	7.8	2,466	0.007	$2,500
Project Group 2	7.0	2,210	0.006	$2,200
Project Group 3	3.9	1,219	0.003	$1,200
Project Group 4	4.4	1,389	0.004	$1,300
Project Group 5	3.2	992	0.003	$1,000
Project Group 6	13.1	4,138	0.011	$3,900
Project Group 7	3.8	1,190	0.003	$1,100
Total	**43.2**	**13,604**	**0.036**	**$13,200**

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

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

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

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

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

3. Proposed Project Benefits

Table H (NWPM 506.20, Economic Table 5a) summarizes annual average NED project benefits, while Table I (NWPM 506.21, Economic Table 6) compares them to the annual average project costs presented in Table D. On-site damage reduction benefits that would accrue to agriculture and the local rural community include reduced power costs. Off-site quantified benefits include the value of reduced carbon emissions and the value of enhanced fish and wildlife habitat. Other benefits not included in the analysis that may result indirectly from the HDPE Pressurized Piping Alternative include increased agricultural yield and the potential for increased on-farm investment in irrigation efficiency (as patrons have more funds due to increased yields and reduced pumping costs).

The analysis recognizes that instream flows may affect recreation, both in-river and adjacent land-based recreation. However, aside from positive impacts on fish and wildlife-related recreation (both fishing and wildlife viewing) from improved species populations, it is not clear how recreation may be affected. Numerous interviews with recreation planners and recreation industry professionals in the area indicate that effects on boating and in-water recreation of enhanced instream flows resulting from the HDPE Pressurized Piping Alternative may be both positive and adverse (depending on flow timing and magnitude), with no indication of whether there may be net benefits or net costs to recreation. As such, this analysis assumes no net impact on recreation. Table H presents total annual NED benefits, and Table I compares annual NED benefits and costs.

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

Item	Damage Reduction Benefit, Average Annual	
	Agricultural-related	Non-Agricultural-related
Project Group 1		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$5,000	
Other - Power Cost Savings	$700	
Subtotal	$5,700	
Off-Site Damage Reduction Benefits		
Water Conservation		$199,900
Subtotal		$199,900
Total Quantified Benefits	$5,700	$199,900
Project Group 2		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$30,600	
Other - Power Cost Savings	$49,500	
Subtotal	$80,100	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[b]		$19,200
Water Conservation		$170,000
Subtotal		$189,200
Total Quantified Benefits	$80,100	$189,200
Project Group 3		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$9,300	
Other - Power Cost Savings	$25,400	
Subtotal	$34,700	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[b]		$9,800
Water Conservation		$91,100

Item	Damage Reduction Benefit, Average Annual	
	Agricultural-related	**Non-Agricultural-related**
Subtotal		$100,900
Total Quantified Benefits	$34,700	$100,900
Project Group 4		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$21,800	
Other - Power Cost Savings	$58,400	
Subtotal	$80,200	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[b]		$23,900
Water Conservation		$101,000
Subtotal		$124,900
Total Quantified Benefits	$80,200	$124,900
Project Group 5		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$19,300	
Other - Power Cost Savings	$31,400	
Subtotal	$50,700	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[b]		$12,600
Water Conservation		$70,200
Subtotal		$82,800
Total Quantified Benefits	$50,700	$82,800
Project Group 6		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$29,600	
Other - Power Cost Savings	$133,100	
Subtotal	$162,700	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[b]		$53,600
Water Conservation		$279,500

Item	Damage Reduction Benefit, Average Annual	
	Agricultural-related	Non-Agricultural-related
Subtotal		$333,100
Total Quantified Benefits	$162,700	$333,100
Project Group 7		
On-Site Damage Reduction Benefits		
Other - Reduced O&M	$11,000	
Other - Power Cost Savings	$27,000	
Subtotal	$38,000	
Off-Site Damage Reduction Benefits		
Other - Social Value of Carbon (Avoided Carbon Emissions)[b]		$10,500
Water Conservation		$75,600
Subtotal		$86,100
Total Quantified Benefits	$38,000	$86,100

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

[a] Price Base: 2017 dollars amortized over 100 years at a discount rate of 2.75 percent

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

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

Works of Improvement	Agriculture-Related		Nonagricultural		Average Annual Benefits	Average Annual Cost[2]	Benefit–Cost Ratio
	Reduced O&M	Power Cost Savings	Carbon Value	Instream Flow Value			
Project Group 1	$5,000	$700	$0	$199,900	$205,600	$205,000	1.00
Project Group 2	$30,600	$49,500	$19,200	$170,000	$269,300	$200,700	1.34
Project Group 3	$9,300	$25,400	$9,800	$91,100	$135,600	$106,000	1.28
Project Group 4	$21,800	$58,400	$23,900	$101,000	$205,100	$121,500	1.69
Project Group 5	$19,300	$31,400	$12,600	$70,200	$133,500	$98,400	1.36
Project Group 6	$29,600	$133,100	$53,600	$279,500	$495,800	$350,400	1.41
Project Group 7	$11,000	$27,000	$10,500	$75,600	$124,100	$46,400	2.67
Total	$126,600	$325,500	$129,600	$987,300	$1,569,000	$1,128,400	1.39

Note: Totals may not sum due to rounding.

Prepared June 2018

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

2/ From Economic Table 4

3.1 Incremental Analysis

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

The engineering pipeline design (pipe diameters, pressure ratings, etc.) is independent of the number of project groups and the order that the project groups are installed. The District's SIP (Black Rock Consulting, 2016) describes how the District designed modern pipelines to replace its open canals and laterals. The District mapped and collected digital elevation data along its entire delivery system. The District determined that the system needed to be able to deliver 7.48 gallons per minute per acre served. The system also needed to be able to handle an upper limit of 9 gallons per minute per acre served.

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

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

If the engineer designs a pipeline for 5 cfs for Project Group 1, this would be a relatively small pipeline. This small pipeline would then be connected to the larger Project Group 2 pipeline. The small Project Group 1 pipeline would have to convey 20 cfs of flow through a pipeline designed for 5 cfs. This would result in a pipeline that does not meet NRCS design standards and would likely not function and meet the project goals.

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

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

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

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

Groups	Total Costs	Incremental Costs	Total Benefits	Incremental Benefits	Net Benefits
1	$205,000		$203,900		-$1,100
1,2	$405,700	$200,700	$474,900	$271,000	$69,200
1,2,3	$511,700	$106,000	$610,500	$135,600	$98,800
1,2,3,4	$633,200	$121,500	$815,600	$205,100	$182,400
1,2,3,4,5	$731,600	$98,400	$949,100	$133,500	$217,500
1,2,3,4,5,6	$1,082,000	$350,400	$1,444,900	$495,800	$362,900
1,2,3,4,5,6,7	$1,128,400	$46,400	$1,569,000	$124,100	$440,600

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

3.2 Benefits Considered and Included in Analysis

3.2.1 Operations and Maintenance Cost Savings Benefit

The current annual operation and maintenance (O&M) costs for TID are roughly $946,500, which includes maintenance of equipment, buildings, and irrigation systems; payroll expenses; and administrative expenses (Tumalo Irrigation District, 2017). It is expected that these costs will continue in the future under the No Action Alternative. Implementing the HDPE Pressurized Piping Alternative is expected to reduce costs by roughly $147,200 per year as a result of reduced maintenance and salary expenses. The Canal Lining Alternative is expected to increase maintenance and administrative costs by about $52,800 per year, which is presented in the table as negative benefits (Tumalo Irrigation District, 2017). For the HDPE Pressurized Piping Alternative and the Canal Lining Alternative, expected operation and maintenance costs were provided by the irrigation District manager and calculated based on miles of canal that would be piped.[5] Tables K and L allocate these savings or cost increases to TID for each project group.

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

Table K. Annual Reduced Operation and Maintenance Costs to TID Patrons of HDPE Pressurized Piping Alternative by Project Group, Deschutes Watershed, Oregon, 2017$[1]

Works of Improvement	Mileage	Undiscounted Annualized Cost of No Action Alternative	Undiscounted Annualized Cost under HDPE Pressurized Piping Alternative	Undiscounted Annual Benefit	Average Annual NED Benefits (Discounted and Amortized, 2017$[a])
Project Group 1	2.4	$33,100	$27,900	$5,200	$5,000
Project Group 2	15.5	$212,700	$179,600	$33,100	$30,600
Project Group 3	4.8	$66,500	$56,200	$10,300	$9,300
Project Group 4	11.7	$160,400	$135,400	$25,000	$21,800
Project Group 5	10.6	$145,800	$123,100	$22,700	$19,300
Project Group 6	17.1	$235,000	$198,400	$36,600	$29,600
Project Group 7	6.8	$92,900	$78,400	$14,500	$11,000
Total	68.8	$946,500	$799,300	$147,200	$126,600

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

Table L. Annual Increased Operation and Maintenance Costs to TID Patrons of Canal Lining Alternative by Project Group, Deschutes Watershed, Oregon, 2017$[1]

Works of Improvement	Mileage	Undiscounted Annualized Cost of No Action Alternative	Undiscounted Annualized Cost under Canal Lining Alternative	Undiscounted Annual Benefit	Average Annual NED Benefits (Discounted and Amortized, 2017$[a])
Project Group 1	2.4	$33,100	$35,400	-$2,300	-$2,200
Project Group 2	14.5	$212,700	$226,400	-$13,700	-$12,700
Project Group 3	4.9	$66,500	$71,100	-$4,600	-$4,100
Project Group 4	11.0	$160,400	$170,700	-$10,300	-$9,000
Project Group 5	10.2	$145,800	$155,400	-$9,600	-$8,100
Project Group 6	18.8	$235,000	$252,700	-$17,700	-$14,300
Project Group 7	3.3	$92,900	$96,000	-$3,100	-$2,400
Total	65.1	$946,500	$1,007,900	-$61,400	-$52,800

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

3.2.2 Energy Cost Savings and Carbon Benefits

The SIP for TID estimates that compared to the No Action Alternative, the system improvements associated with the HDPE Pressurized Piping Alternative would result in a net energy savings of 4,004,161 kWh per year since it is much more efficient for patrons to receive pressurized water than to pressurize it themselves (Black Rock Consulting, 2016). This energy savings cost is evaluated based on a cost of summer irrigation pumping of $0.09624 per kWh. Table M presents the energy use under the No Action Alternative and Canal Lining Alternative and displays the savings to TID patrons for each project group under the HDPE Pressurized Piping Alternative. Once all project groups are complete, the savings to TID patrons would be approximately $325,500 each year.

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

Works of Improvement	Total Annual Energy Use Under No Action/Canal Lining Alternative (kWh)	Annual Energy Use under HDPE Pressurized Piping Alternative	Reduced Annual Energy Use (kWh)[2]	Undiscounted Annual Energy Cost Savings (2017$)	Average Annual NED Benefits (Avoided Energy Costs, Discounted and Amortized, 2017$)
Project Group 1	81,439	73,917	7,522	$724	$700
Project Group 2	1,363,656	806,433	557,223	$53,627	$49,500
Project Group 3	439,895	145,144	294,751	$28,367	$25,400
Project Group 4	892,452	197,836	694,616	$66,850	$58,400
Project Group 5	697,222	313,747	383,475	$36,906	$31,400
Project Group 6	2,134,425	435,841	1,698,584	$163,472	$133,100
Project Group 7	463,659	95,669	367,990	$35,415	$27,000
Total	6,072,748	2,068,587	4,004,161	$385,000	$325,500

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

Reduced energy use also reduces carbon dioxide emissions from power generation. Every MWh of reduced on-farm energy use is estimated to translate into an estimated reduction of 0.75251 metric tons of carbon emissions.[6] Accordingly, compared to the No Action Alternative, the annual net energy savings of the HDPE Pressurized Piping Alternative would reduce CO_2 emissions by approximately 3,013 metric tons (approximately 4,004 MWh multiplied by 0.7521), adjusted to approximately 2,289 metrics tons each year (on average) to take into account the average annual increased energy usage associated with reduced recharge throughout the 100-year project life for each project group (see Table N). To value these reduced carbon emissions, this analysis uses an estimate of the social cost of carbon (which is the estimated total cost to society of emitting carbon related to the expected damages associated with future climate change). The Environmental Protection Agency and other federal agencies use a social cost of carbon estimate recommended by the federal Interagency Working Group on the Social Costs of Greenhouse Gases, of approximately $42 per metric ton (2017 dollars) (Interagency Working Group on Social Cost of Greenhouse Gases, 2013). At this value, the avoided carbon emissions from the HDPE Pressurized Piping Alternative provide an estimated average annual benefit of approximately $127,000, as shown in Table O.

6 This assumes that marginal changes in energy demand are met with fossil fuel-based production (renewable energy is typically used first and then fossil fuel powered generation is then used), such that 100 percent of energy use reduction and green energy production results in reduced fossil fuel-powered generation. Furthermore, this estimate assumes 0.75251 metric tons of carbon emitted from one MWh of fossil fuel powered electricity generation based on 1) the current proportion of fuel source–oil, natural gas, and coal–for fossil fuel-powered electrical power generation in the West, and 2) the associated metric tons of CO_2 produced per MWh powered by each fossil fuel source, as reported by the Energy Information Administration.

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

	No Action Alternative		HDPE Pressurized Piping Alternative (NED Alternative)			Canal Lining Alternative		
Works of Improvement	**Average Annual Carbon Emissions, Basinwide Pumping**	**Annual Carbon Emissions, TID Patron Pumping**	**Average Annual Carbon Emissions, Basinwide Pumping**	**Annual Carbon Emissions, TID Patron Pumping**	**Net Annual Carbon Savings (Compared to No Action)**	**Average Annual Carbon Emissions, Basinwide Pumping**	**Annual Carbon Emissions, TID Patron Pumping**	**Net Annual Carbon Savings (Compared to No Action)**
Project Group 1	N/A	61	N/A	171	-110	N/A	61	-104
Project Group 2	N/A	1,026	N/A	715	311	N/A	1,026	-97
Project Group 3	N/A	331	N/A	171	160	N/A	331	-55
Project Group 4	N/A	672	N/A	222	450	N/A	672	-65
Project Group 5	N/A	525	N/A	290	235	N/A	525	-48
Project Group 6	N/A	1,606	N/A	566	1,040	N/A	1,606	-214
Project Group 7	N/A	349	N/A	146	203	N/A	349	-67
Total	**98,988**[1]	**4,570**	**99,712**[1]	**2,280**	**2,289**	**99,640**[1]	**4,570**	**-651**

Note: Prepared June 2018

1/ Note these values show an average annual increase over 110 years. Carbon emissions rise over time because groundwater pumping volume increases throughout the basin through time, and the depth to groundwater also rises through time due to reduced recharge from canals.

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

Works of Improvement	Annual Avoided Emissions (Reduced TID Patron Energy Use, Metric Tons Carbon)	Average Annual Increased Emissions (from Reduced Recharge, Metric Tons Carbon)[2]	Net Average Avoided Emissions	Average Annual NED Benefits (Social Cost of Carbon, 2017$)[3]
Project Group 1	6	115	-110	-$2,500
Project Group 2	419	108	311	$19,200
Project Group 3	222	62	160	$9,800
Project Group 4	523	73	450	$23,900
Project Group 5	289	54	235	$12,600
Project Group 6	1278	238	1040	$53,600
Project Group 7	277	74	203	$10,500
Total	**3,013**	**724**	**2,289**	**$127,000**

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

The Canal Lining Alternative would not provide pressurization, so it would not reduce pumping or generate carbon benefits. However, it would carry higher carbon costs compared to the No Action Alternative because of the increased energy use associated with falling groundwater depths, which is expected to average roughly 651 metric tons annually. These emissions would incur a cost valued at approximately $13,600 per year, shown as a cost in Table P.

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

Works of Improvement	Annual Avoided Emissions (Reduced TID Patron Energy Use, Metric Tons Carbon)	Average Annual Increased Emissions (from Reduced Recharge, Metric Tons Carbon)[2]	Average Annual NED Costs (Social Cost of Carbon, 2017$)[3]
Project Group 1	0	104	$2,500
Project Group 2	0	97	$2,300
Project Group 3	0	55	$1,200
Project Group 4	0	65	$1,400
Project Group 5	0	48	$1,000
Project Group 6	0	214	-$4,200
Project Group 7	0	67	$1,200
Total	**0**	**651**	**$13,600**

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

3.2.3 Value of Conserved Water

The value of the conserved irrigation water can be looked at in two ways: the value of increased water instream, or the value of maintaining irrigated agricultural production value. This analysis focuses on the value of instream flow as the conserved water from the HDPE Pressurized Piping Alternative would be used to augment instream flows. However, this analysis also presents the value of water to agriculture as the HDPE Pressurized Piping Alternative also enhances water supply reliability to the District. (As described elsewhere, the TID agreement to augment flows in Crescent Creek could further reduce deliveries in the District in the future. This Project provides the water for this flow augmentation, limiting the effects on TID water deliveries of this flow augmentation agreement).

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

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

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

Project Group	Water Conservation Under HDPE Pressurized Piping Alternative (AF/year)	Instream Flow Value under No Action Alternative	Annualized Average Net Benefits of HDPE Pressurized Piping Alternative
Project Group 1	2,739	$0	$199,900
Project Group 2	2,456	$0	$170,000
Project Group 3	1,354	$0	$91,100
Project Group 4	1,543	$0	$101,000
Project Group 5	1,102	$0	$70,200
Project Group 6	4,598	$0	$279,500
Project Group 7	1,323	$0	$75,600
Total	**15,115**	**$0**	**$987,300**

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

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

1. Prices paid for water by environmental buyers throughout the western United States. In the period 2000 to 2009, purchase price of environmental water varied from just over $0 to nearly $1,665 per AF per year, with an average permanent sale transaction price of $165 per AF per year. Among the 51 permanent water right purchases with the sales price and volume recorded in the database, the permanent sales price value in 27 transactions (53 percent) was above $75 per AF per year. As discussed at length below, these values paid are expected to provide a low range estimate of instream flow value to society.
2. Value of water to irrigators in TID. Depending on method used, this is estimated at $40 to $120 per AF per year (for an average value of water to agriculture of approximately $80 per

AF). This value is important as the value of water to local agriculture is a key factor determining water sales and lease prices to environmental buyers in the project area (i.e., the marginal value of water to agriculture will determine agricultural sellers' willingness to accept a price for water), and because conserved water avoids potential future reductions in TID deliveries.

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

Type of Value	Low Value	High Value	Median Value	Average Value
Permanent water right transaction in western U.S., 2000 to 2009 (*Converted to Annual Values*)	~$0	$1,665	~$75	$165
Value of water to TID irrigators (*Income Capitalization Approach and Sales Price of Water in Ag to Ag Transfers, Converted to Annual Values*)	$40	$120	N/A	~$80

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

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

Project Group	Water Conservation Under Canal Lining Alternative (AF/year)	Instream Flow Value under No Action Alternative	Annualized Average Net Benefits of Canal Lining Alternative
Project Group 1	2,465	$0	$179,900
Project Group 2	2,210	$0	$152,900
Project Group 3	1,219	$0	$82,000
Project Group 4	1,389	$0	$90,900
Project Group 5	992	$0	$63,200
Project Group 6	4,138	$0	$251,500
Project Group 7	1,190	$0	$68,100
Total	13,603	**$0**	$888,500

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

Past Costs Paid as a Proxy for Value

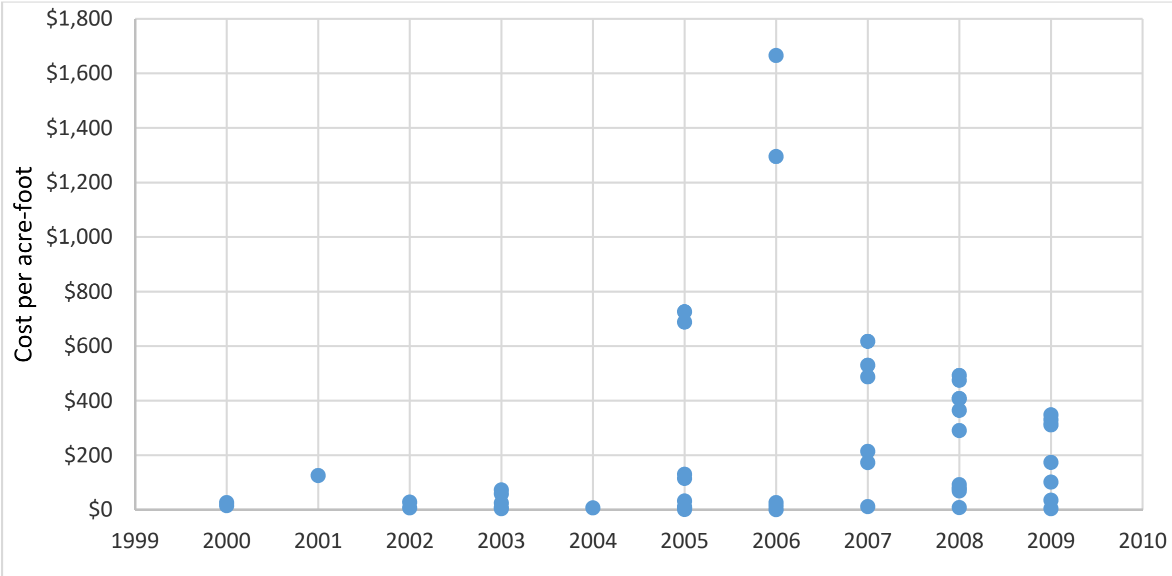
Past piping projects in the Deschutes Basin highlight the willingness of funding entities to pay for instream flow augmentation. These values are evidence of the *minimum* benefit of the instream flows purchased, as perceived and experienced by these entities. Project costs paid are indicative of the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

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

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

Water right leases and purchases for environmental purposes across the western United States were analyzed in a 2003 paper (Loomis, Quattlebaum, Brown, & Alexander, 2003). During the period between 1995 and 1999, six transactions of water right purchases averaged $360 per AF in Oregon, while five water right leases averaged $114 per AF per year. 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 $1,114, while across 35 lease transactions the annual price was $68 per AF.

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



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

Figure A: Western Water Right Purchases for Environmental Purposes, 2000 to 2009, Price Paid per Acre-Foot per Year

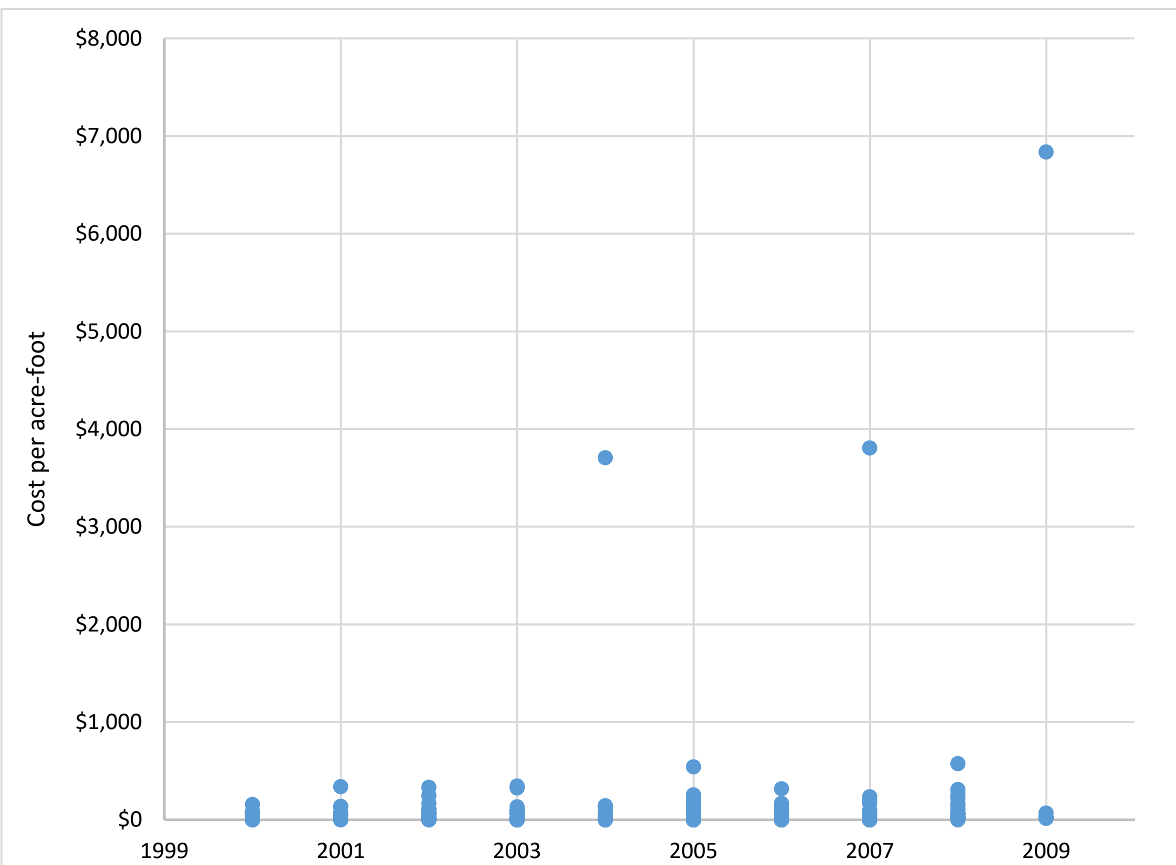


Figure B: One-Year Water Leases for Environmental Purposes, Price Paid Per Acre-Foot in Western United States

Current and Potential Future Water Right Purchase Values in TID

Specific to the project area, water rights sold from one irrigator to another within TID have typically had a purchase price between $5,000 to $7,500 per acre (Rieck, Tumalo Irrigation District Manager, 2017). These values are very similar to values provided by area real estate agents regarding the increased value of property with irrigation water rights, with all else equal. Assuming approximately four AF per year delivered on average to acreage in the district; this equates to approximately $1,250 to $1,875 per AF ($5,000 to $7,500 per acre divided by 4 AF per acre delivery), or a value of approximately $40 to $60 per AF per year.

Prices paid for the limited number of agricultural water right sales may not reflect the average value of water to irrigators in TID and the cost of acquiring water in the future. The value of water to irrigators in TID (i.e., the increased farm income from having access to water) is important as it is a key determinant of the price at which irrigators would be willing to sell water rights (and the price at which environmental water buyers could obtain water from agricultural water right holders, which are the primary water right holders that could sell water rights to augment instream flows). The price paid per AF in the limited number of current TID water transactions is lower than the value derived from the effect on farm income of more reliable access to irrigation water (income capitalization approach), which indicates that if additional water were available it would raise farm income by approximately $100 per AF per year.[7]

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

3.3 Benefits Considered but Not Included in Analysis

3.3.1 Agricultural Intensification Benefit

While all conserved water under the HDPE Pressurized Piping Alternative and the Canal Lining Alternative would go to enhance instream flow, the HDPE Pressurized Piping Alternative could increase water supply reliability to District patrons through enhanced operational flexibility and efficiency and reduced canal breaches. The District's antiquated canal and laterals make it difficult to deliver the correct amount of water to patrons at the correct time, particularly early and late in the irrigation season. During these periods, the District's water rights require it to divert water at a reduced rate. At these reduced flow rates, the canals and laterals are more sensitive to small changes in streamflows at the diversion or deliveries at each point of delivery. The reduced flow rates in the open canal and laterals make it much more challenging for the District to deliver the sufficient amount of water that patrons need when they need it. For example, a point of delivery near the end

[7] We based this estimate on an analysis of the net returns to water of grass hay. An agricultural expert in the area estimated that (assuming there is not already a full water supply) an additional AF of water would increase grass hay yields by approximately 0.5 tons per acre (Bohle, 2018). Assuming that each ton of grass hay generates $200 in revenue after harvest costs are subtracted, an AF of water is worth approximately $100 to growers (Painter, 2015; NASS, 2017). However, we do not assume these yield benefits will accrue to District patrons under the HDPE Pressurized Piping Alternative.

of a lateral may receive no water in the morning and excess water in the evening. The District also has to pass excess water, known as carry water, to ensure that adequate water reaches all points of delivery when required by patrons according to their water rights. When the patrons' demand subsides, this excess water operationally spills onto non-productive lands at the ends of the conveyance system. Although identified as potential benefits, current delivery and delivery capabilities after piping were not included in the analysis due to the limited amount of available data.

3.3.2 Public Safety Avoided Costs

Piping irrigation water removes the hazard of drownings in canals, and also eliminates the potential for unlined canals to fail, causing potential damages to downstream property and lives. While TID routinely experiences canal failure, the damage extent varies dramatically depending on the timing and location of failure. Given the limited amount of available data on the cost of these canal failures, the public safety (and property damage reduction) benefit of piping is not analyzed in this analysis. However, a history of recent drownings in Central Oregon irrigation canals provides evidence that 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 will increase.

The HDPE Pressurized Piping Alternative would pipe the remaining open canals in its system. Under the Canal Lining Alternative, the canals would remain open but they would be fenced, which is expected to provide public safety benefits. The public safety benefits from fencing would be less than those under the HDPE Pressurized Piping Alternative as fencing does not guarantee all drownings would be prevented.

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

Level of Public Safety Hazard

This analysis estimates the public safety hazard of unlined canals in TID based on past drownings in unlined canals in Central Oregon. Based on data from Oregon Water Resources Department (OWRD) on canals in Central Oregon, there are 1,072 miles of irrigation canals in Central Oregon districts (see Table T). Starting in the late 1980s and early 1990s, sections of these canals began to be piped, with the result that today, the OWRD database records that approximately 209 miles have been piped. Assuming piping occurred uniformly across the 21-year period of 1996 to 2016, approximately 9.9 miles were piped each year, leaving approximately 973 miles unpiped on an average annual basis during this period. Given that an average of 0.143 drowning deaths occurred annually during this period (3 deaths over 21 years as described above), the annual drowning risk per mile of exposed canal was 0.000147 (0.143 divided by 973). This may be an overestimate of risk if there were an abnormally high number of drownings in the last 20 years or so, but may also be an underestimate of risk as the population of Bend continues to grow and the areas around irrigation canals continues to urbanize (thereby increasing the risks of drownings).

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

Table T. Irrigation Canal Mileage by District

District	**Canal and Lateral Mileage**
Arnold Irrigation District	47.3
Central Oregon Irrigation District	430.0
Lone Pine	2.4
North Unit Irrigation District	300.1
Ochoco Irrigation District	100.3
Swalley Irrigation District	27.6
Tumalo Irrigation District	95.8
Three Sisters Irrigation District	68.7
Total	**1,072.0**

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

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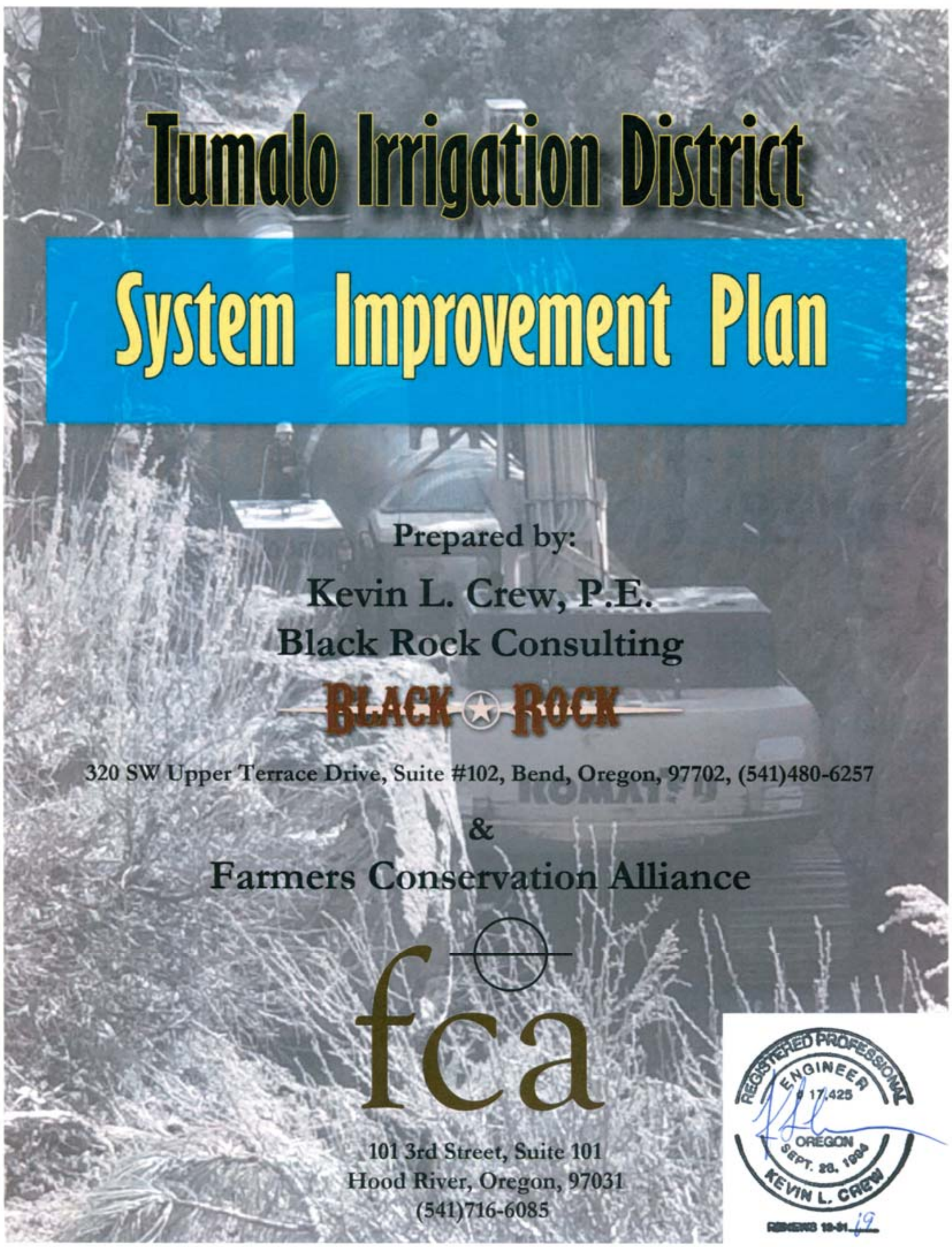
D.2 Engineering

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

System Improvement Plan



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Executive Summary

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

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

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

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

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

D.3 Capital Costs for Alternatives

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

HDPE Piping Alternative

Project Group	Canal/Lateral	Length (feet)	Piping & Turnout Construction Cost	Engineering, Construction Management, Survey (E,CM,S)	Construction Management, General Contractor (CM,GC)	Contin-gency	Total Costs (2017$)	Flow (gpm)	Diameter (in)	Pressure Rating Index	Upgraded Turnouts	Pressure Reducing Valves
1	Tumalo Feed Canal	9852	$6,350,796	$200,000	$0[2]	$0	$6,550,796	47,106-50,545	84	N/A	10	N/A
1	Kerns[8]	2864	N/A	N/A	N/A	N/A	N/A	224	6	32.5		
2	Tumalo Res. Feed	10784	$1,663,600	$165,881	$199,633	$608,736	$2,637,850	299-11,473	6-63	32.5	127	N/A
2	Steele	5010	$167,384	$23,108	$23,908	$64,320	$278,720	301-774	6-10	32.5		
2	Rock Springs	1516	$42,611	$6,392	$6,392	$16,618	$72,013	288-333	6	32.5		
2	Highline	26099	$937,794	$113,255	$113,255	$349,292	$1,513,596	800-3,756	6-24	17-32.5		
2	2 Rivers	5097	$93,094	$13,964	$13,964	$36,307	$157,329	-	6-12	32.5		
2	Parkhurst	17309	$740,803	$94,416	$94,416	$278,891	$1,208,526	672-2,761	6-18	21-32.5		
2	Gill	2635	$26,445	$3,967	$3,967	$10,313	$44,692	0	6	32.5		
2	Lacy	13146	$271,825	$40,774	$40,774	$106,012	$459,385	52-1,734	6-12	26-32.5		
3	Allen	17689	$2,043,318	$204,332	$245,198	$747,855	$3,240,703	7,698-11,492	28-34	26-32.5	46	N/A
3	Allen Sublateral West	2040	$46,279	$6,942	$6,942	$18,049	$78,212	290-316	6	32.5		
3	Allen Sublateral South	1899	$37,292	$5,594	$5,594	$14,544	$63,024	183-247	6	32.5		
3	McGinnis Ditch	3891	$67,236	$10,085	$10,085	$26,222	$113,628	147-312	6	32.5		
4	West Branch Columbia So. West	25979	$1,506,760	$151,476	$181,291	$551,858	$2,391,385	4,771-7,535	6-28	26-32.5	91	1
4	Beasley	6671	$211,322	$31,698	$25,359	$80,514	$348,893	153-687	6-8	26-32.5		
4	Spaulding	13462	$654,320	$98,148	$78,518	$249,296	$1,080,282	1,671-3,226	6-20	19-26		
4	N. Spaulding	15439	$177,090	$26,563	$26,563	$69,065	$299,281	142	6	19-32.5		
5	Couch	9421	$633,820	$95,073	$95,073	$247,190	$1,071,156	103-5,976	6-26	32.5	89	N/A
5	West Couch	24365	$825,973	$100,557	$100,557	$308,126	$1,335,213	696-3,416	6-20	15.5-32.5		
5	West Couch Sublateral East	4868	$130,584	$19,588	$19,588	$50,928	$220,688	384-1,166	6-10	26-32.5		

[8] The cost numbers for the Kerns lateral are included in the Tumalo Feed Canal numbers.

Project Group	Canal/Lateral	Length (feet)	Piping & Turnout Construction Cost	Engineering, Construction Management, Survey (E,CM,S)	Construction Management, General Contractor (CM,GC)	Contin-gency	Total Costs (2017$)	Flow (gpm)	Diameter (in)	Pressure Rating Index	Upgraded Turnouts	Pressure Reducing Valves
5	Chambers (Lafores) Ditch	2066	$78,462	$11,769	$11,769	$30,600	$132,600	52-322	6	32.5		
5	East Couch	11339	$347,144	$52,072	$41,657	$132,262	$573,135	202-672	6-16	32.5		
5	Gainsforth	3891	$59,237	$8,886	$8,886	$23,102	$100,111	161-282	6	32.5		
6	Columbia Southern TFC to PRV	14977	$3,565,144	$213,909	$427,817	$1,262,061	$5,468,931	18,555-33,899	48-63	21-32.5		
6	Columbia Southern PRV to Tail	22065	$2,573,064	$205,845	$308,768	$926,303	$4,013,980	10,280-17,760	6-42	26-32.5		
6	North Columbia So. East	8426	$248,086	$37,213	$37,213	$96,753	$419,265	37-1,794	6-24	32.5		
6	North Columbia So. West	6020	$301,383	$45,207	$45,207	$117,539	$509,336	334-2,615	6-16	32.5		
6	Jewett	7777	$326,384	$48,958	$48,958	$127,290	$551,590	880-2,256	10-16	26-32.5		
6	Conarn East	789	$22,315	$3,347	$3,347	$8,703	$37,712	75	6	26		
6	Putnam	5505	$124,651	$18,698	$18,698	$48,614	$210,661	1,297-1,757	6-14	21-32.5	221	2
6	West Branch Columbia So. East	6562	$293,554	$44,033	$44,033	$114,486	$496,106	37-1,193	6-12	26		
6	Conarn	2071	$96,567	$14,485	$14,485	$37,661	$163,198	85-355	6	26		
6	Phiffer	5011	$248,304	$37,246	$37,246	$96,839	$419,635	302-1,679	6-12	32.5		
6	Hooker Creek	2918	$154,395	$23,159	$23,159	$60,214	$260,927	888-1,260	10-12	32.5		
6	Hammond	7532	$200,061	$30,009	$30,009	$78,024	$338,103	368-1,808	6-14	26-32.5		
6	North Hammond	510	$43,803	$6,571	$6,571	$17,083	$74,028	300-710	6-8	32.5		
7	Hillburner	7345	$308,646	$46,297	$46,297	$120,372	$521,612	338-676	6-24	32.5		
7	Gerking	5255	$203,845	$30,577	$30,577	$79,500	$344,499	75-494	6-8	19-21		
7	Kickbush	5290	$108,701	$16,305	$16,305	$42,393	$183,704	461-574	6-8	21	79	N/A
7	West Branch Columbia So. South	7610	$245,676	$36,851	$36,851	$95,814	$415,192	561-1,215	6-8	26		
7	Flannery Ditch	2178	$47,248	$7,087	$7,087	$18,427	$79,849	162-452	6-12	26		
7	Tellin Ditch	7972	$130,619	$19,593	$19,593	$50,942	$220,747	202-589	6	32.5		
Totals:		**363,145**	**$26,355,635**	**$2,369,930**	**$2,555,610**	**$7,419,118**	**$38,700,293**				**663**	**3**

PVC & HDPE Piping Alternative

Project Group	Canal/Lateral	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/ Unit	Subtotal Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
1	Tumalo Feed Canal Phase V	PIPE	HDPE	84	9,852	NA	LF	$500	$4,926,000	6%	10%	8%	$295,560	$492,600	$457,133	$6,171,293
1	Tumalo Feed Canal Phase V	TURNOUT	HDPE	1	NA	4	EA	$8,000	$32,000	6%	10%	8%	$1,920	$3,200	$2,970	$40,090
1	Tumalo Feed Canal Final Phase(s) After Phase V	PIPE	HDPE	84	0	0	LF	$680	$0	4%	12%	30%	$0	$0	$0	$0
1	Tumalo Feed Canal Final Phase(s) After Phase V	TURNOUT	HDPE	1	NA	4	EA	$8,000	$32,000	4%	12%	30%	$1,280	$3,840	$11,136	$48,256
1	Kerns Lateral	PIPE	PVC	6	2,864	29	LF	$3	$37,955	15%	15%	30%	$5,693	$5,693	$14,803	$64,144
1	Kerns Lateral	TURNOUT	HDPE	1	NA	2	EA	$8,000	$16,000	15%	15%	30%	$2,400	$2,400	$6,240	$27,040
2	Tumalo Feed Canal Reservoir Feed and Sublateral	PIPE	HDPE	63	718	NA	LF	$196	$140,897	10%	12%	30%	$14,090	$16,908	$51,568	$223,463
2	Tumalo Feed Canal Reservoir Feed and Sublateral	PIPE	PVC	6	4,983	50	LF	$3	$66,037	10%	12%	30%	$6,604	$7,924	$24,170	$104,735
2	Tumalo Feed Canal Reservoir Feed and Sublateral	PIPE	PVC	48	177	2	LF	$180	$33,611	10%	12%	30%	$3,361	$4,033	$12,302	$53,307
2	Tumalo Feed Canal Reservoir Feed and Sublateral	PIPE	PVC	54	4,906	49	LF	$227	$1,162,855	10%	12%	30%	$116,285	$139,543	$425,605	$1,844,287
2	Tumalo Feed Canal Reservoir Feed and Sublateral	TURNOUT	HDPE	1	NA	16	EA	$8,000	$128,000	10%	12%	30%	$12,800	$15,360	$46,848	$203,008
2	Steele Lateral	PIPE	PVC	6	1,813	18	LF	$3	$24,027	15%	15%	30%	$3,604	$3,604	$9,370	$40,605
2	Steele Lateral	PIPE	PVC	8	2,916	29	LF	$6	$45,204	15%	15%	30%	$6,781	$6,781	$17,630	$76,395
2	Steele Lateral	PIPE	PVC	10	281	3	LF	$9	$5,210	15%	15%	30%	$781	$781	$2,032	$8,805
2	Steele Lateral	TURNOUT	HDPE	1	NA	16	EA	$8,000	$128,000	15%	15%	30%	$19,200	$19,200	$49,920	$216,320
2	Rock Springs Lateral	PIPE	PVC	6	1,516	15	LF	$3	$20,091	15%	15%	30%	$3,014	$3,014	$7,835	$33,953
2	Rock Springs Lateral	TURNOUT	HDPE	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
2	Highline Lateral	PIPE	PVC	6	1,819	18	LF	$3	$24,106	12%	12%	30%	$2,893	$2,893	$8,968	$38,859
2	Highline Lateral	PIPE	PVC	10	71	1	LF	$9	$1,316	12%	12%	30%	$158	$158	$490	$2,122
2	Highline Lateral	PIPE	PVC	12	7,884	79	LF	$12	$173,658	12%	12%	30%	$20,839	$20,839	$64,601	$279,937
2	Highline Lateral	PIPE	PVC	12	3,235	32	LF	$12	$71,256	12%	12%	30%	$8,551	$8,551	$26,507	$114,865
2	Highline Lateral	PIPE	PVC	16	4,727	47	LF	$21	$146,339	12%	12%	30%	$17,561	$17,561	$54,438	$235,899
2	Highline Lateral	PIPE	PVC	18	4,381	44	LF	$26	$159,159	12%	12%	30%	$19,099	$19,099	$59,207	$256,564
2	Highline Lateral	PIPE	PVC	20	2,131	21	LF	$32	$90,160	12%	12%	30%	$10,819	$10,819	$33,540	$145,338

Project Group	Canal/Lateral	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/ Unit	Subtotal Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
2	Highline Lateral	PIPE	PVC	24	1,851	19	LF	$46	$103,828	12%	12%	30%	$12,459	$12,459	$38,624	$167,370
2	Highline Lateral	TURNOUT	HDPE	1	NA	25	EA	$8,000	$200,000	12%	12%	30%	$24,000	$24,000	$74,400	$322,400
2	2 Rivers (Box S) Lateral	PIPE	PVC	6	2,426	24	LF	$3	$32,151	15%	15%	30%	$4,823	$4,823	$12,539	$54,334
2	2 Rivers (Box S) Lateral	PIPE	PVC	8	828	8	LF	$6	$12,836	15%	15%	30%	$1,925	$1,925	$5,006	$21,692
2	2 Rivers (Box S) Lateral	PIPE	PVC	12	1,843	18	LF	$12	$40,595	15%	15%	30%	$6,089	$6,089	$15,832	$68,606
2	2 Rivers (Box S) Lateral	TURNOUT	HDPE	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
2	Parkhurst Lateral	PIPE	PVC	6	2,519	25	LF	$3	$33,383	12%	12%	30%	$4,006	$4,006	$12,418	$53,813
2	Parkhurst Lateral	PIPE	PVC	6	474	5	LF	$3	$6,282	12%	12%	30%	$754	$754	$2,337	$10,126
2	Parkhurst Lateral	PIPE	PVC	8	982	10	LF	$6	$15,223	12%	12%	30%	$1,827	$1,827	$5,663	$24,540
2	Parkhurst Lateral	PIPE	PVC	10	5	0	LF	$9	$93	12%	12%	30%	$11	$11	$34	$149
2	Parkhurst Lateral	PIPE	PVC	12	3,666	37	LF	$12	$80,750	12%	12%	30%	$9,690	$9,690	$30,039	$130,169
2	Parkhurst Lateral	PIPE	PVC	14	1,380	14	LF	$16	$36,149	12%	12%	30%	$4,338	$4,338	$13,448	$58,273
2	Parkhurst Lateral	PIPE	PVC	16	8,000	80	LF	$21	$247,665	12%	12%	30%	$29,720	$29,720	$92,132	$399,237
2	Parkhurst Lateral	PIPE	PVC	18	283	3	LF	$26	$10,281	12%	12%	30%	$1,234	$1,234	$3,825	$16,573
2	Parkhurst Lateral	TURNOUT	HDPE	1	NA	43	EA	$8,000	$344,000	12%	12%	30%	$41,280	$41,280	$127,968	$554,528
2	Gill Lateral	PIPE	PVC	6	2,635	26	LF	$3	$34,920	15%	15%	30%	$5,238	$5,238	$13,619	$59,015
2	Gill Lateral	TURNOUT	HDPE	1	NA	1	EA	$8,000	$8,000	15%	15%	30%	$1,200	$1,200	$3,120	$13,520
2	Lacy Lateral and Lacy Sublateral	PIPE	PVC	6	952	10	LF	$3	$12,616	15%	15%	30%	$1,892	$1,892	$4,920	$21,322
2	Lacy Lateral and Lacy Sublateral	PIPE	PVC	6	5,611	56	LF	$3	$74,360	15%	15%	30%	$11,154	$11,154	$29,000	$125,668
2	Lacy Lateral and Lacy Sublateral	PIPE	PVC	8	1,327	13	LF	$6	$20,571	15%	15%	30%	$3,086	$3,086	$8,023	$34,765
2	Lacy Lateral and Lacy Sublateral	PIPE	PVC	10	1,447	14	LF	$9	$26,828	15%	15%	30%	$4,024	$4,024	$10,463	$45,339
2	Lacy Lateral and Lacy Sublateral	PIPE	PVC	12	3,809	38	LF	$12	$83,900	15%	15%	30%	$12,585	$12,585	$32,721	$141,790
2	Lacy Lateral and Lacy Sublateral	TURNOUT	HDPE	1	NA	17	EA	$8,000	$136,000	15%	15%	30%	$20,400	$20,400	$53,040	$229,840
3	Allen Lateral	PIPE	PVC	28	1,713	17	LF	$62	$123,866	10%	12%	30%	$12,387	$14,864	$45,335	$196,452
3	Allen Lateral	PIPE	PVC	30	1,743	17	LF	$71	$141,759	10%	12%	30%	$14,176	$17,011	$51,884	$224,830
3	Allen Lateral	PIPE	PVC	30	2,287	23	LF	$71	$186,003	10%	12%	30%	$18,600	$22,320	$68,077	$295,001
3	Allen Lateral	PIPE	PVC	32	5,096	51	LF	$81	$463,531	10%	12%	30%	$46,353	$55,624	$169,652	$735,160
3	Allen Lateral	PIPE	PVC	34	6,850	69	LF	$91	$693,200	10%	12%	30%	$69,320	$83,184	$253,711	$1,099,416
3	Allen Lateral	TURNOUT	HDPE	1	NA	34	EA	$8,000	$272,000	10%	12%	30%	$27,200	$32,640	$99,552	$431,392
3	Allen Sublateral West	PIPE	PVC	6	2,040	20	LF	$3	$27,035	15%	15%	30%	$4,055	$4,055	$10,544	$45,689
3	Allen Sublateral West	TURNOUT	HDPE	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
3	Allen Sublateral South	PIPE	PVC	6	1,899	19	LF	$3	$25,166	15%	15%	30%	$3,775	$3,775	$9,815	$42,531
3	Allen Sublateral South	TURNOUT	HDPE	1	NA	3	EA	$8,000	$24,000	15%	15%	30%	$3,600	$3,600	$9,360	$40,560
3	McGinnis Ditch	PIPE	PVC	6	3,891	39	LF	$3	$51,565	15%	15%	30%	$7,735	$7,735	$20,111	$87,146

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3	McGinnis Ditch	TURNOUT	HDPE	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
4	West Branch Columbia Southern West	PIPE	PVC	6	2,421	24	LF	$3	$32,084	10%	12%	30%	$3,208	$3,850	$11,743	$50,886
4	West Branch Columbia Southern West	PIPE	PVC	8	2,632	26	LF	$6	$40,802	10%	12%	30%	$4,080	$4,896	$14,933	$64,711
4	West Branch Columbia Southern West	PIPE	PVC	10	3,803	38	LF	$9	$70,508	10%	12%	30%	$7,051	$8,461	$25,806	$111,826
4	West Branch Columbia Southern West	PIPE	PVC	24	7,555	76	LF	$46	$423,780	10%	12%	30%	$42,378	$50,854	$155,104	$672,116
4	West Branch Columbia Southern West	PIPE	PVC	26	8,803	88	LF	$54	$562,486	10%	12%	30%	$56,249	$67,498	$205,870	$892,102
4	West Branch Columbia Southern West	PIPE	PVC	28	765	8	LF	$62	$55,317	10%	12%	30%	$5,532	$6,638	$20,246	$87,733
4	West Branch Columbia Southern West	TURNOUT	HDPE	1	NA	33	EA	$8,000	$264,000	10%	12%	30%	$26,400	$31,680	$96,624	$418,704
4	Beasley Lateral	PIPE	PVC	6	2,931	29	LF	$3	$38,843	15%	12%	30%	$5,826	$4,661	$14,799	$64,130
4	Beasley Lateral	PIPE	PVC	6	2,050	21	LF	$3	$27,168	15%	12%	30%	$4,075	$3,260	$10,351	$44,854
4	Beasley Lateral	PIPE	PVC	8	1,690	17	LF	$6	$26,199	15%	12%	30%	$3,930	$3,144	$9,982	$43,254
4	Beasley Lateral	TURNOUT	HDPE	1	NA	20	EA	$8,000	$160,000	15%	12%	30%	$24,000	$19,200	$60,960	$264,160
4	Spaulding Lateral	PIPE	PVC	6	4,899	49	LF	$3	$64,924	15%	12%	30%	$9,739	$7,791	$24,736	$107,189
4	Spaulding Lateral	PIPE	PVC	6	841	8	LF	$3	$11,145	15%	12%	30%	$1,672	$1,337	$4,246	$18,401
4	Spaulding Lateral	PIPE	PVC	10	3	0	LF	$9	$56	15%	12%	30%	$8	$7	$21	$92
4	Spaulding Lateral	PIPE	PVC	14	1,933	19	LF	$16	$50,635	15%	12%	30%	$7,595	$6,076	$19,292	$83,599
4	Spaulding Lateral	PIPE	PVC	16	2,347	23	LF	$21	$72,659	15%	12%	30%	$10,899	$8,719	$27,683	$119,960
4	Spaulding Lateral	PIPE	PVC	16	126	1	LF	$21	$3,901	15%	12%	30%	$585	$468	$1,486	$6,440
4	Spaulding Lateral	PIPE	PVC	18	3,029	30	LF	$26	$110,042	15%	12%	30%	$16,506	$13,205	$41,926	$181,679
4	Spaulding Lateral	PIPE	PVC	20	284	3	LF	$32	$12,016	15%	12%	30%	$1,802	$1,442	$4,578	$19,838
4	Spaulding Lateral	TURNOUT	HDPE	1	NA	34	EA	$8,000	$272,000	15%	12%	30%	$40,800	$32,640	$103,632	$449,072
4	North Spaulding Lateral	PIPE	PVC	6	9,376	94	LF	$3	$124,255	15%	15%	30%	$18,638	$18,638	$48,460	$209,992
4	North Spaulding Lateral	PIPE	PVC	6	4,446	44	LF	$3	$58,921	15%	15%	30%	$8,838	$8,838	$22,979	$99,576
4	North Spaulding Lateral	PIPE	PVC	6	1,617	16	LF	$3	$21,429	15%	15%	30%	$3,214	$3,214	$8,357	$36,215
4	North Spaulding Lateral	TURNOUT	HDPE	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
5	Couch Lateral	PIPE	PVC	6	355	4	LF	$3	$4,705	15%	15%	30%	$706	$706	$1,835	$7,951
5	Couch Lateral	PIPE	PVC	24	5,252	53	LF	$46	$294,599	15%	15%	30%	$44,190	$44,190	$114,894	$497,872
5	Couch Lateral	PIPE	PVC	26	3,814	38	LF	$54	$243,703	15%	15%	30%	$36,555	$36,555	$95,044	$411,859
5	Couch Lateral	TURNOUT	HDPE	1	NA	12	EA	$8,000	$96,000	15%	15%	30%	$14,400	$14,400	$37,440	$162,240
5	West Couch Lateral	PIPE	PVC	6	3,503	35	LF	$3	$46,423	12%	12%	30%	$5,571	$5,571	$17,270	$74,835

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5	West Couch Lateral	PIPE	PVC	6	1,771	18	LF	$3	$23,470	12%	12%	30%	$2,816	$2,816	$8,731	$37,834
5	West Couch Lateral	PIPE	PVC	6	611	6	LF	$3	$8,097	12%	12%	30%	$972	$972	$3,012	$13,053
5	West Couch Lateral	PIPE	PVC	8	349	3	LF	$6	$5,410	12%	12%	30%	$649	$649	$2,013	$8,721
5	West Couch Lateral	PIPE	PVC	8	4	0	LF	$6	$62	12%	12%	30%	$7	$7	$23	$100
5	West Couch Lateral	PIPE	PVC	10	11	0	LF	$9	$204	12%	12%	30%	$24	$24	$76	$329
5	West Couch Lateral	PIPE	PVC	10	3,165	32	LF	$9	$58,679	12%	12%	30%	$7,042	$7,042	$21,829	$94,591
5	West Couch Lateral	PIPE	PVC	10	2,754	28	LF	$9	$51,059	12%	12%	30%	$6,127	$6,127	$18,994	$82,308
5	West Couch Lateral	PIPE	PVC	16	3,235	32	LF	$21	$100,150	12%	12%	30%	$12,018	$12,018	$37,256	$161,441
5	West Couch Lateral	PIPE	PVC	18	8,943	89	LF	$26	$324,894	12%	12%	30%	$38,987	$38,987	$120,860	$523,729
5	West Couch Lateral	PIPE	PVC	20	19	0	LF	$32	$804	12%	12%	30%	$96	$96	$299	$1,296
5	West Couch Lateral	TURNOUT	HDPE	1	NA	29	EA	$8,000	$232,000	12%	12%	30%	$27,840	$27,840	$86,304	$373,984
5	West Couch Sublateral East	PIPE	PVC	6	1,104	11	LF	$3	$14,631	15%	15%	30%	$2,195	$2,195	$5,706	$24,726
5	West Couch Sublateral East	PIPE	PVC	8	890	9	LF	$6	$13,797	15%	15%	30%	$2,070	$2,070	$5,381	$23,317
5	West Couch Sublateral East	PIPE	PVC	8	409	4	LF	$6	$6,340	15%	15%	30%	$951	$951	$2,473	$10,715
5	West Couch Sublateral East	PIPE	PVC	10	2,465	25	LF	$9	$45,701	15%	15%	30%	$6,855	$6,855	$17,824	$77,235
5	West Couch Sublateral East	TURNOUT	HDPE	1	NA	10	EA	$8,000	$80,000	15%	15%	30%	$12,000	$12,000	$31,200	$135,200
5	Chambers (Lafores) Ditch	PIPE	PVC	6	2,066	21	LF	$3	$27,380	15%	15%	30%	$4,107	$4,107	$10,678	$46,272
5	Chambers (Lafores) Ditch	TURNOUT	HDPE	1	NA	8	EA	$8,000	$64,000	15%	15%	30%	$9,600	$9,600	$24,960	$108,160
5	East Couch Lateral	PIPE	PVC	6	6,600	66	LF	$3	$87,466	15%	12%	30%	$13,120	$10,496	$33,325	$144,407
5	East Couch Lateral	PIPE	PVC	8	1,052	11	LF	$6	$16,308	15%	12%	30%	$2,446	$1,957	$6,213	$26,925
5	East Couch Lateral	PIPE	PVC	10	590	6	LF	$9	$10,939	15%	12%	30%	$1,641	$1,313	$4,168	$18,060
5	East Couch Lateral	PIPE	PVC	14	1,806	18	LF	$16	$47,309	15%	12%	30%	$7,096	$5,677	$18,025	$78,107
5	East Couch Lateral	PIPE	PVC	16	1,291	13	LF	$21	$39,967	15%	12%	30%	$5,995	$4,796	$15,227	$65,986
5	East Couch Lateral	TURNOUT	HDPE	1	NA	26	EA	$8,000	$208,000	15%	12%	30%	$31,200	$24,960	$79,248	$343,408
5	Gainsforth Ditch	PIPE	PVC	6	3,891	39	LF	$3	$51,565	15%	15%	30%	$7,735	$7,735	$20,111	$87,146
5	Gainsforth Ditch	TURNOUT	HDPE	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
6	Columbia Southern Lateral TFC to Hillburner/PRV	PIPE	HDPE	63	256	NA	LF	$196	$50,236	6%	12%	30%	$3,014	$6,028	$17,784	$77,063
6	Columbia Southern Lateral TFC to Hillburner/PRV	PIPE	PVC	48	197	2	LF	$180	$37,409	6%	12%	30%	$2,245	$4,489	$13,243	$57,385
6	Columbia Southern Lateral TFC to Hillburner/PRV	PIPE	PVC	48	6,098	61	LF	$180	$1,157,956	6%	12%	30%	$69,477	$138,955	$409,916	$1,776,305

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6	Columbia Southern Lateral TFC to Hillburner/PRV	PIPE	PVC	48	8,426	84	LF	$180	$1,600,023	6%	12%	30%	$96,001	$192,003	$566,408	$2,454,435
6	Columbia Southern Lateral TFC to Hillburner/PRV	TURNOUT	HDPE	1	NA	42	EA	$8,000	$336,000	6%	12%	30%	$20,160	$40,320	$118,944	$515,424
6	North Columbia Southern West Lateral and Sublateral	PIPE	PVC	6	1,864	19	LF	$3	$24,703	15%	15%	30%	$3,705	$3,705	$9,634	$41,747
6	North Columbia Southern West Lateral and Sublateral	PIPE	PVC	8	639	6	LF	$6	$9,906	15%	15%	30%	$1,486	$1,486	$3,863	$16,741
6	North Columbia Southern West Lateral and Sublateral	PIPE	PVC	12	512	5	LF	$12	$11,278	15%	15%	30%	$1,692	$1,692	$4,398	$19,059
6	North Columbia Southern West Lateral and Sublateral	PIPE	PVC	14	426	4	LF	$16	$11,159	15%	15%	30%	$1,674	$1,674	$4,352	$18,859
6	North Columbia Southern West Lateral and Sublateral	PIPE	PVC	16	2,579	26	LF	$21	$79,841	15%	15%	30%	$11,976	$11,976	$31,138	$134,932
6	North Columbia Southern West Lateral and Sublateral	TURNOUT	HDPE	1	NA	23	EA	$8,000	$184,000	15%	15%	30%	$27,600	$27,600	$71,760	$310,960
6	Jewett Lateral	PIPE	PVC	10	59	1	LF	$9	$1,094	15%	15%	30%	$164	$164	$427	$1,849
6	Jewett Lateral	PIPE	PVC	10	2,644	26	LF	$9	$49,020	15%	15%	30%	$7,353	$7,353	$19,118	$82,844
6	Jewett Lateral	PIPE	PVC	14	3,056	31	LF	$16	$80,053	15%	15%	30%	$12,008	$12,008	$31,221	$135,289
6	Jewett Lateral	PIPE	PVC	16	2,018	20	LF	$21	$62,474	15%	15%	30%	$9,371	$9,371	$24,365	$105,580
6	Jewett Lateral	TURNOUT	HDPE	1	NA	21	EA	$8,000	$168,000	15%	15%	30%	$25,200	$25,200	$65,520	$283,920
6	Conarn East	PIPE	PVC	6	789	8	LF	$3	$10,456	15%	15%	30%	$1,568	$1,568	$4,078	$17,671
6	Conarn East	TURNOUT	HDPE	1	NA	2	EA	$8,000	$16,000	15%	15%	30%	$2,400	$2,400	$6,240	$27,040
6	Putnam Lateral	PIPE	PVC	6	2,468	25	LF	$3	$32,707	15%	15%	30%	$4,906	$4,906	$12,756	$55,275
6	Putnam Lateral	PIPE	PVC	12	423	4	LF	$12	$9,317	15%	15%	30%	$1,398	$1,398	$3,634	$15,746
6	Putnam Lateral	PIPE	PVC	12	1,375	14	LF	$12	$30,287	15%	15%	30%	$4,543	$4,543	$11,812	$51,185
6	Putnam Lateral	PIPE	PVC	14	1,239	12	LF	$16	$32,456	15%	15%	30%	$4,868	$4,868	$12,658	$54,850
6	Putnam Lateral	TURNOUT	HDPE	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
6	West Branch Columbia Southern East	PIPE	PVC	6	4,103	41	LF	$3	$54,375	15%	15%	30%	$8,156	$8,156	$21,206	$91,894
6	West Branch Columbia Southern East	PIPE	PVC	8	444	4	LF	$6	$6,883	15%	15%	30%	$1,032	$1,032	$2,684	$11,632
6	West Branch Columbia Southern East	PIPE	PVC	12	2,015	20	LF	$12	$44,384	15%	15%	30%	$6,658	$6,658	$17,310	$75,009

Project Group	Canal/Lateral	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/ Unit	Subtotal Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
6	West Branch Columbia Southern East	TURNOUT	HDPE	1	NA	27	EA	$8,000	$216,000	15%	15%	30%	$32,400	$32,400	$84,240	$365,040
6	Conarn Lateral	PIPE	PVC	6	2,071	21	LF	$3	$27,446	15%	15%	30%	$4,117	$4,117	$10,704	$46,384
6	Conarn Lateral	TURNOUT	HDPE	1	NA	10	EA	$8,000	$80,000	15%	15%	30%	$12,000	$12,000	$31,200	$135,200
6	Phiffer Lateral	PIPE	PVC	6	1,684	17	LF	$3	$22,317	15%	15%	30%	$3,348	$3,348	$8,704	$37,716
6	Phiffer Lateral	PIPE	PVC	8	2,089	21	LF	$6	$32,384	15%	15%	30%	$4,858	$4,858	$12,630	$54,729
6	Phiffer Lateral	PIPE	PVC	12	1,238	12	LF	$12	$27,269	15%	15%	30%	$4,090	$4,090	$10,635	$46,085
6	Phiffer Lateral	TURNOUT	HDPE	1	NA	25	EA	$8,000	$200,000	15%	15%	30%	$30,000	$30,000	$78,000	$338,000
6	Hooker Creek Lateral	PIPE	PVC	10	1,948	19	LF	$9	$36,116	15%	15%	30%	$5,417	$5,417	$14,085	$61,036
6	Hooker Creek Lateral	PIPE	PVC	12	970	10	LF	$12	$21,366	15%	15%	30%	$3,205	$3,205	$8,333	$36,108
6	Hooker Creek Lateral	TURNOUT	HDPE	1	NA	12	EA	$8,000	$96,000	15%	15%	30%	$14,400	$14,400	$37,440	$162,240
6	Hammond Lateral	PIPE	PVC	6	2,515	25	LF	$3	$33,330	15%	15%	30%	$5,000	$5,000	$12,999	$56,328
6	Hammond Lateral	PIPE	PVC	6	344	3	LF	$3	$4,559	15%	15%	30%	$684	$684	$1,778	$7,704
6	Hammond Lateral	PIPE	PVC	8	1,499	15	LF	$6	$23,238	15%	15%	30%	$3,486	$3,486	$9,063	$39,272
6	Hammond Lateral	PIPE	PVC	10	1,417	14	LF	$9	$26,271	15%	15%	30%	$3,941	$3,941	$10,246	$44,399
6	Hammond Lateral	PIPE	PVC	12	284	3	LF	$12	$6,256	15%	15%	30%	$938	$938	$2,440	$10,572
6	Hammond Lateral	PIPE	PVC	14	1,473	15	LF	$16	$38,586	15%	15%	30%	$5,788	$5,788	$15,048	$65,210
6	Hammond Lateral	TURNOUT	HDPE	1	NA	18	EA	$8,000	$144,000	15%	15%	30%	$21,600	$21,600	$56,160	$243,360
6	North Hammond Lateral	PIPE	PVC	6	278	3	LF	$3	$3,684	15%	15%	30%	$553	$553	$1,437	$6,226
6	North Hammond Lateral	PIPE	PVC	8	232	2	LF	$6	$3,596	15%	15%	30%	$539	$539	$1,403	$6,078
6	North Hammond Lateral	TURNOUT	HDPE	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	PVC	6	3,385	34	LF	$3	$44,860	15%	15%	30%	$6,729	$6,729	$17,495	$75,813
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	PVC	6	1,160	12	LF	$3	$15,373	15%	15%	30%	$2,306	$2,306	$5,995	$25,980
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	PVC	8	331	3	LF	$6	$5,131	15%	15%	30%	$770	$770	$2,001	$8,672
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	PVC	28	3,729	37	LF	$62	$269,643	15%	15%	30%	$40,446	$40,446	$105,161	$455,696
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	PVC	30	941	9	LF	$71	$76,532	15%	15%	30%	$11,480	$11,480	$29,847	$129,339
6	Columbia Southern Lateral	PIPE	PVC	32	315	3	LF	$81	$28,652	15%	15%	30%	$4,298	$4,298	$11,174	$48,422

Project Group	Canal/Lateral	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/ Unit	Subtotal Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
	TFC Hillburner/PRV to Tail															
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	PVC	36	943	9	LF	$102	$105,656	15%	15%	30%	$15,848	$15,848	$41,206	$178,559
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	PVC	36	5,162	52	LF	$102	$578,365	15%	15%	30%	$86,755	$86,755	$225,562	$977,437
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	PVC	42	6,099	61	LF	$138	$904,053	15%	15%	30%	$135,608	$135,608	$352,581	$1,527,850
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	TURNOUT	HDPE	1	NA	20	EA	$8,000	$160,000	15%	15%	30%	$24,000	$24,000	$62,400	$270,400
6	North Columbia Southern East Lateral and Sublateral	PIPE	PVC	6	909	9	LF	$3	$12,047	15%	15%	30%	$1,807	$1,807	$4,698	$20,359
6	North Columbia Southern East Lateral and Sublateral	PIPE	PVC	12	3,588	36	LF	$12	$79,032	15%	15%	30%	$11,855	$11,855	$30,822	$133,564
6	North Columbia Southern East Lateral and Sublateral	PIPE	PVC	14	3,407	34	LF	$16	$89,247	15%	15%	30%	$13,387	$13,387	$34,806	$150,828
6	North Columbia Southern East Lateral and Sublateral	PIPE	PVC	24	522	5	LF	$46	$29,280	15%	15%	30%	$4,392	$4,392	$11,419	$49,484
6	North Columbia Southern East Lateral and Sublateral	TURNOUT	HDPE	1	NA	11	EA	$8,000	$88,000	15%	15%	30%	$13,200	$13,200	$34,320	$148,720
7	Hillburner Lateral	PIPE	PVC	6	2,697	27	LF	$3	$35,742	15%	15%	30%	$5,361	$5,361	$13,939	$60,404
7	Hillburner Lateral	PIPE	PVC	6	968	10	LF	$3	$12,828	15%	15%	30%	$1,924	$1,924	$5,003	$21,680
7	Hillburner Lateral	PIPE	PVC	8	3,680	37	LF	$6	$57,048	15%	15%	30%	$8,557	$8,557	$22,249	$96,411
7	Hillburner Lateral	TURNOUT	HDPE	1	NA	24	EA	$8,000	$192,000	15%	15%	30%	$28,800	$28,800	$74,880	$324,480
7	Gerking Lateral	PIPE	PVC	6	2,629	26	LF	$3	$34,841	15%	15%	30%	$5,226	$5,226	$13,588	$58,881
7	Gerking Lateral	PIPE	PVC	8	2,626	26	LF	$6	$40,709	15%	15%	30%	$6,106	$6,106	$15,876	$68,797
7	Gerking Lateral	TURNOUT	HDPE	1	NA	13	EA	$8,000	$104,000	15%	15%	30%	$15,600	$15,600	$40,560	$175,760
7	Kickbush Lateral	PIPE	PVC	6	4,099	41	LF	$3	$54,322	15%	15%	30%	$8,148	$8,148	$21,186	$91,804
7	Kickbush Lateral	PIPE	PVC	8	1,191	12	LF	$6	$18,463	15%	15%	30%	$2,769	$2,769	$7,201	$31,202
7	Kickbush Lateral	TURNOUT	HDPE	1	NA	8	EA	$8,000	$64,000	15%	15%	30%	$9,600	$9,600	$24,960	$108,160
7	West Branch Columbia Southern South	PIPE	PVC	6	2,479	25	LF	$3	$32,853	15%	15%	30%	$4,928	$4,928	$12,813	$55,521

Project Group	Canal/Lateral	Feature	Material	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/ Unit	Subtotal Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
7	West Branch Columbia Southern South	PIPE	PVC	8	4,167	42	LF	$6	$64,597	15%	15%	30%	$9,690	$9,690	$25,193	$109,169
7	West Branch Columbia Southern South	PIPE	PVC	10	777	8	LF	$9	$14,406	15%	15%	30%	$2,161	$2,161	$5,618	$24,346
7	West Branch Columbia Southern South	PIPE	PVC	12	187	2	LF	$12	$4,119	15%	15%	30%	$618	$618	$1,606	$6,961
7	West Branch Columbia Southern South	TURNOUT	HDPE	1	NA	21	EA	$8,000	$168,000	15%	15%	30%	$25,200	$25,200	$65,520	$283,920
7	Flannery Ditch	PIPE	PVC	6	2,178	22	LF	$3	$28,864	15%	15%	30%	$4,330	$4,330	$11,257	$48,780
7	Flannery Ditch	TURNOUT	HDPE	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
7	Tellin Lateral	PIPE	PVC	6	5,152	52	LF	$3	$68,277	15%	15%	30%	$10,242	$10,242	$26,628	$115,388
7	Tellin Lateral	PIPE	PVC	8	2,820	28	LF	$6	$43,716	15%	15%	30%	$6,557	$6,557	$17,049	$73,880
7	Tellin Lateral	TURNOUT	HDPE	1	NA	9	EA	$8,000	$72,000	15%	15%	30%	$10,800	$10,800	$28,080	$121,680
															Capital Costs	**$38,482,392**

Steel Piping Alternative

Project Group	Canal/Lateral	Feature	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Subtotal Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
1	Tumalo Feed Canal Phase V	TURNOUT	1	NA	4	EA	$8,000	$32,000	6%	10%	30%	$1,920	$3,200	$11,136	$48,256
1	Tumalo Feed Canal Phase V	PIPE	84	9,852	98.52	LF	$361	$3,655,661	6%	10%	30%	$219,340	$365,566	$1,272,170	$5,512,737
1	Tumalo Feed Canal Final Phase(s) After Phase V	TURNOUT	1	NA	4	EA	$8,000	$32,000	4%	12%	30%	$1,280	$3,840	$11,136	$48,256
1	Tumalo Feed Canal Final Phase(s) After Phase V	PIPE	84	0	0	LF	$361	$0	4%	12%	30%	$0	$0	$0	$0
1	Kerns Lateral	TURNOUT	1	NA	2	EA	$8,000	$16,000	15%	15%	30%	$2,400	$2,400	$6,240	$27,040
1	Kerns Lateral	PIPE	6	2,864	28.64	LF	$40	$142,137	15%	15%	30%	$21,321	$21,321	$55,434	$240,212
2	Tumalo Feed Canal Reservoir Feed and Sublateral	TURNOUT	1	NA	16	EA	$8,000	$128,000	10%	12%	30%	$12,800	$15,360	$46,848	$203,008
2	Tumalo Feed Canal Reservoir Feed and Sublateral	PIPE	6	4,983	49.83	LF	$40	$247,301	10%	12%	30%	$24,730	$29,676	$90,512	$392,219
2	Tumalo Feed Canal Reservoir Feed and Sublateral	PIPE	48	177	1.77	LF	$329	$60,019	10%	12%	30%	$6,002	$7,202	$21,967	$95,191
2	Tumalo Feed Canal Reservoir Feed and Sublateral	PIPE	54	4,906	49.06	LF	$370	$1,866,459	10%	12%	30%	$186,646	$223,975	$683,124	$2,960,205
2	Tumalo Feed Canal Reservoir Feed and Sublateral	PIPE	63	718	7.18	LF	$432	$317,695	10%	12%	30%	$31,769	$38,123	$116,276	$503,864
2	Steele Lateral	TURNOUT	1	NA	16	EA	$8,000	$128,000	15%	15%	30%	$19,200	$19,200	$49,920	$216,320
2	Steele Lateral	PIPE	6	1,813	18.13	LF	$40	$89,977	15%	15%	30%	$13,497	$13,497	$35,091	$152,062
2	Steele Lateral	PIPE	8	2,916	29.16	LF	$53	$184,912	15%	15%	30%	$27,737	$27,737	$72,116	$312,501
2	Steele Lateral	PIPE	10	281	2.81	LF	$67	$21,692	15%	15%	30%	$3,254	$3,254	$8,460	$36,660
2	Rock Springs Lateral	TURNOUT	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
2	Rock Springs Lateral	PIPE	6	1,516	15.16	LF	$40	$75,237	15%	15%	30%	$11,286	$11,286	$29,343	$127,151
2	Highline Lateral	TURNOUT	1	NA	25	EA	$8,000	$200,000	12%	12%	30%	$24,000	$24,000	$74,400	$322,400
2	Highline Lateral	PIPE	6	1,819	18.19	LF	$40	$90,275	12%	12%	30%	$10,833	$10,833	$33,582	$145,523
2	Highline Lateral	PIPE	10	71	0.71	LF	$67	$5,481	12%	12%	30%	$658	$658	$2,039	$8,835
2	Highline Lateral	PIPE	12	7,884	78.84	LF	$81	$717,293	12%	12%	30%	$86,075	$86,075	$266,833	$1,156,276
2	Highline Lateral	PIPE	12	3,235	32.35	LF	$81	$294,323	12%	12%	30%	$35,319	$35,319	$109,488	$474,449
2	Highline Lateral	PIPE	16	4,727	47.27	LF	$109	$560,380	12%	12%	30%	$67,246	$67,246	$208,461	$903,333
2	Highline Lateral	PIPE	18	4,381	43.81	LF	$122	$579,750	12%	12%	30%	$69,570	$69,570	$215,667	$934,557
2	Highline Lateral	PIPE	20	2,131	21.31	LF	$136	$311,375	12%	12%	30%	$37,365	$37,365	$115,831	$501,936
2	Highline Lateral	PIPE	24	1,851	18.51	LF	$164	$321,490	12%	12%	30%	$38,579	$38,579	$119,594	$518,242
2	2 Rivers (Box S) Lateral	TURNOUT	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
2	2 Rivers (Box S) Lateral	PIPE	6	2,426	24.26	LF	$40	$120,400	15%	15%	30%	$18,060	$18,060	$46,956	$203,476
2	2 Rivers (Box S) Lateral	PIPE	8	828	8.28	LF	$53	$52,506	15%	15%	30%	$7,876	$7,876	$20,477	$88,735
2	2 Rivers (Box S) Lateral	PIPE	12	1,843	18.43	LF	$81	$167,678	15%	15%	30%	$25,152	$25,152	$65,394	$283,375
2	Parkhurst Lateral	TURNOUT	1	NA	43	EA	$8,000	$344,000	12%	12%	30%	$41,280	$41,280	$127,968	$554,528
2	Parkhurst Lateral	PIPE	6	2,519	25.19	LF	$40	$125,015	12%	12%	30%	$15,002	$15,002	$46,506	$201,525
2	Parkhurst Lateral	PIPE	6	474	4.74	LF	$40	$23,524	12%	12%	30%	$2,823	$2,823	$8,751	$37,921
2	Parkhurst Lateral	PIPE	8	982	9.82	LF	$53	$62,271	12%	12%	30%	$7,473	$7,473	$23,165	$100,382
2	Parkhurst Lateral	PIPE	10	5	0.05	LF	$67	$386	12%	12%	30%	$46	$46	$144	$622
2	Parkhurst Lateral	PIPE	12	3,666	36.66	LF	$81	$333,536	12%	12%	30%	$40,024	$40,024	$124,075	$537,660
2	Parkhurst Lateral	PIPE	14	1,380	13.8	LF	$95	$144,575	12%	12%	30%	$17,349	$17,349	$53,782	$233,056
2	Parkhurst Lateral	PIPE	16	8,000	80	LF	$109	$948,390	12%	12%	30%	$113,807	$113,807	$352,801	$1,528,805
2	Parkhurst Lateral	PIPE	18	283	2.83	LF	$122	$37,450	12%	12%	30%	$4,494	$4,494	$13,931	$60,370
2	Gill Lateral	TURNOUT	1	NA	1	EA	$8,000	$8,000	15%	15%	30%	$1,200	$1,200	$3,120	$13,520
2	Gill Lateral	PIPE	6	2,635	26.35	LF	$40	$130,772	15%	15%	30%	$19,616	$19,616	$51,001	$221,005
2	Lacy Lateral and Lacy Sublateral	TURNOUT	1	NA	17	EA	$8,000	$136,000	15%	15%	30%	$20,400	$20,400	$53,040	$229,840
2	Lacy Lateral and Lacy Sublateral	PIPE	6	952	9.52	LF	$40	$47,247	15%	15%	30%	$7,087	$7,087	$18,426	$79,847
2	Lacy Lateral and Lacy Sublateral	PIPE	6	5,611	56.11	LF	$40	$278,468	15%	15%	30%	$41,770	$41,770	$108,602	$470,611

Project Group	Canal/Lateral	Feature	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Subtotal Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
2	Lacy Lateral and Lacy Sublateral	PIPE	8	1,327	13.27	LF	$53	$84,149	15%	15%	30%	$12,622	$12,622	$32,818	$142,212
2	Lacy Lateral and Lacy Sublateral	PIPE	10	1,447	14.47	LF	$67	$111,704	15%	15%	30%	$16,756	$16,756	$43,565	$188,780
2	Lacy Lateral and Lacy Sublateral	PIPE	12	3,809	38.09	LF	$81	$346,546	15%	15%	30%	$51,982	$51,982	$135,153	$585,663
3	Allen Lateral	TURNOUT	1	NA	34	EA	$8,000	$272,000	10%	12%	30%	$27,200	$32,640	$99,552	$431,392
3	Allen Lateral	PIPE	28	1,713	17.13	LF	$191	$344,746	10%	12%	30%	$34,475	$41,369	$126,177	$546,767
3	Allen Lateral	PIPE	30	1,743	17.43	LF	$205	$374,809	10%	12%	30%	$37,481	$44,977	$137,180	$594,447
3	Allen Lateral	PIPE	30	2,287	22.87	LF	$205	$491,789	10%	12%	30%	$49,179	$59,015	$179,995	$779,977
3	Allen Lateral	PIPE	32	5,096	50.96	LF	$219	$1,166,070	10%	12%	30%	$116,607	$139,928	$426,781	$1,849,386
3	Allen Lateral	PIPE	34	6,850	68.5	LF	$233	$1,661,841	10%	12%	30%	$166,184	$199,421	$608,234	$2,635,680
3	Allen Sublateral South	PIPE	6	1,899	18.99	LF	$40	$94,245	15%	15%	30%	$14,137	$14,137	$36,756	$159,275
3	Allen Sublateral West	TURNOUT	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
3	Allen Sublateral West	PIPE	6	2,040	20.4	LF	$40	$101,243	15%	15%	30%	$15,186	$15,186	$39,485	$171,101
3	Allen Sublateral South	TURNOUT	1	NA	3	EA	$8,000	$24,000	15%	15%	30%	$3,600	$3,600	$9,360	$40,560
3	McGinnis Ditch	TURNOUT	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
3	McGinnis Ditch	PIPE	6	3,891	38.91	LF	$40	$193,106	15%	15%	30%	$28,966	$28,966	$75,311	$326,349
4	West Branch Columbia Southern West	TURNOUT	1	NA	33	EA	$8,000	$264,000	10%	12%	30%	$26,400	$31,680	$96,624	$418,704
4	West Branch Columbia Southern West	PIPE	6	2,421	24.21	LF	$40	$120,152	10%	12%	30%	$12,015	$14,418	$43,975	$190,560
4	West Branch Columbia Southern West	PIPE	8	2,632	26.32	LF	$53	$166,903	10%	12%	30%	$16,690	$20,028	$61,086	$264,708
4	West Branch Columbia Southern West	PIPE	10	3,803	38.03	LF	$67	$293,580	10%	12%	30%	$29,358	$35,230	$107,450	$465,617
4	West Branch Columbia Southern West	PIPE	24	7,555	75.55	LF	$164	$1,312,188	10%	12%	30%	$131,219	$157,463	$480,261	$2,081,130
4	West Branch Columbia Southern West	PIPE	26	8,803	88.03	LF	$177	$1,650,286	10%	12%	30%	$165,029	$198,034	$604,005	$2,617,354
4	West Branch Columbia Southern West	PIPE	28	765	7.65	LF	$191	$153,958	10%	12%	30%	$15,396	$18,475	$56,349	$244,178
4	Beasley Lateral	TURNOUT	1	NA	20	EA	$8,000	$160,000	15%	12%	30%	$24,000	$19,200	$60,960	$264,160
4	Beasley Lateral	PIPE	6	2,931	29.31	LF	$40	$145,462	15%	12%	30%	$21,819	$17,455	$55,421	$240,158
4	Beasley Lateral	PIPE	6	2,050	20.5	LF	$40	$101,739	15%	12%	30%	$15,261	$12,209	$38,763	$167,972
4	Beasley Lateral	PIPE	8	1,690	16.9	LF	$53	$107,168	15%	12%	30%	$16,075	$12,860	$40,831	$176,934
4	Spaulding Lateral	TURNOUT	1	NA	34	EA	$8,000	$272,000	15%	12%	30%	$40,800	$32,640	$103,632	$449,072
4	Spaulding Lateral	PIPE	6	4,899	48.99	LF	$40	$243,132	15%	12%	30%	$36,470	$29,176	$92,633	$401,411
4	Spaulding Lateral	PIPE	6	841	8.41	LF	$40	$41,738	15%	12%	30%	$6,261	$5,009	$15,902	$68,909
4	Spaulding Lateral	PIPE	10	3	0.03	LF	$67	$232	15%	12%	30%	$35	$28	$88	$382
4	Spaulding Lateral	PIPE	14	1,933	19.33	LF	$95	$202,510	15%	12%	30%	$30,377	$24,301	$77,156	$334,345
4	Spaulding Lateral	PIPE	16	2,347	23.47	LF	$109	$278,234	15%	12%	30%	$41,735	$33,388	$106,007	$459,364
4	Spaulding Lateral	PIPE	16	126	1.26	LF	$109	$14,937	15%	12%	30%	$2,241	$1,792	$5,691	$24,661
4	Spaulding Lateral	PIPE	18	3,029	30.29	LF	$122	$400,836	15%	12%	30%	$60,125	$48,100	$152,718	$661,780
4	Spaulding Lateral	PIPE	20	284	2.84	LF	$136	$41,497	15%	12%	30%	$6,225	$4,980	$15,810	$68,512
4	North Spaulding Lateral	TURNOUT	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
4	North Spaulding Lateral	PIPE	6	9,376	93.76	LF	$40	$465,321	15%	15%	30%	$69,798	$69,798	$181,475	$786,392
4	North Spaulding Lateral	PIPE	6	4,446	44.46	LF	$40	$220,650	15%	15%	30%	$33,098	$33,098	$86,054	$372,899
4	North Spaulding Lateral	PIPE	6	1,617	16.17	LF	$40	$80,250	15%	15%	30%	$12,037	$12,037	$31,297	$135,622
5	Couch Lateral	TURNOUT	1	NA	12	EA	$8,000	$96,000	15%	15%	30%	$14,400	$14,400	$37,440	$162,240
5	Couch Lateral	PIPE	6	355	3.55	LF	$40	$17,618	15%	15%	30%	$2,643	$2,643	$6,871	$29,775
5	Couch Lateral	PIPE	24	5,252	52.52	LF	$164	$912,192	15%	15%	30%	$136,829	$136,829	$355,755	$1,541,604
5	Couch Lateral	PIPE	26	3,814	38.14	LF	$177	$715,005	15%	15%	30%	$107,251	$107,251	$278,852	$1,208,359
5	West Couch Lateral	TURNOUT	1	NA	29	EA	$8,000	$232,000	12%	12%	30%	$27,840	$27,840	$86,304	$373,984
5	West Couch Lateral	PIPE	6	3,503	35.03	LF	$40	$173,850	12%	12%	30%	$20,862	$20,862	$64,672	$280,246
5	West Couch Lateral	PIPE	6	1,771	17.71	LF	$40	$87,893	12%	12%	30%	$10,547	$10,547	$32,696	$141,683

Project Group	Canal/Lateral	Feature	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Subtotal Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
5	West Couch Lateral	PIPE	6	611	6.11	LF	$40	$30,323	12%	12%	30%	$3,639	$3,639	$11,280	$48,881
5	West Couch Lateral	PIPE	8	349	3.49	LF	$53	$22,131	12%	12%	30%	$2,656	$2,656	$8,233	$35,675
5	West Couch Lateral	PIPE	8	4	0.04	LF	$53	$254	12%	12%	30%	$30	$30	$94	$409
5	West Couch Lateral	PIPE	10	11	0.11	LF	$67	$849	12%	12%	30%	$102	$102	$316	$1,369
5	West Couch Lateral	PIPE	10	3,165	31.65	LF	$67	$244,328	12%	12%	30%	$29,319	$29,319	$90,890	$393,857
5	West Couch Lateral	PIPE	10	2,754	27.54	LF	$67	$212,600	12%	12%	30%	$25,512	$25,512	$79,087	$342,711
5	West Couch Lateral	PIPE	16	3,235	32.35	LF	$109	$383,505	12%	12%	30%	$46,021	$46,021	$142,664	$618,211
5	West Couch Lateral	PIPE	18	8,943	89.43	LF	$122	$1,183,452	12%	12%	30%	$142,014	$142,014	$440,244	$1,907,724
5	West Couch Lateral	PIPE	20	19	0.19	LF	$136	$2,776	12%	12%	30%	$333	$333	$1,033	$4,475
5	West Couch Sublateral East	TURNOUT	1	NA	10	EA	$8,000	$80,000	15%	15%	30%	$12,000	$12,000	$31,200	$135,200
5	West Couch Sublateral East	PIPE	6	1,104	11.04	LF	$40	$54,790	15%	15%	30%	$8,219	$8,219	$21,368	$92,596
5	West Couch Sublateral East	PIPE	8	890	8.9	LF	$53	$56,437	15%	15%	30%	$8,466	$8,466	$22,011	$95,379
5	West Couch Sublateral East	PIPE	8	409	4.09	LF	$53	$25,936	15%	15%	30%	$3,890	$3,890	$10,115	$43,832
5	West Couch Sublateral East	PIPE	10	2,465	24.65	LF	$67	$190,290	15%	15%	30%	$28,544	$28,544	$74,213	$321,591
5	Chambers (Lafores) Ditch	TURNOUT	1	NA	8	EA	$8,000	$64,000	15%	15%	30%	$9,600	$9,600	$24,960	$108,160
5	Chambers (Lafores) Ditch	PIPE	6	2,066	20.66	LF	$40	$102,533	15%	15%	30%	$15,380	$15,380	$39,988	$173,281
5	East Couch Lateral	TURNOUT	1	NA	26	EA	$8,000	$208,000	15%	12%	30%	$31,200	$24,960	$79,248	$343,408
5	East Couch Lateral	PIPE	6	6,600	66	LF	$40	$327,551	15%	12%	30%	$49,133	$39,306	$124,797	$540,786
5	East Couch Lateral	PIPE	8	1,052	10.52	LF	$53	$66,710	15%	12%	30%	$10,007	$8,005	$25,417	$110,139
5	East Couch Lateral	PIPE	10	590	5.9	LF	$67	$45,546	15%	12%	30%	$6,832	$5,466	$17,353	$75,197
5	East Couch Lateral	PIPE	14	1,806	18.06	LF	$95	$189,205	15%	12%	30%	$28,381	$22,705	$72,087	$312,378
5	East Couch Lateral	PIPE	16	1,291	12.91	LF	$109	$153,046	15%	12%	30%	$22,957	$18,366	$58,311	$252,680
5	Gainsforth Ditch	TURNOUT	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
5	Gainsforth Ditch	PIPE	6	3,891	38.91	LF	$40	$193,106	15%	15%	30%	$28,966	$28,966	$75,311	$326,349
6	Columbia Southern Lateral TFC to Hillburner/PRV	TURNOUT	1	NA	42	EA	$8,000	$336,000	6%	12%	30%	$20,160	$40,320	$118,944	$515,424
6	Columbia Southern Lateral TFC to Hillburner/PRV	PIPE	48	197	1.97	LF	$329	$66,801	6%	12%	30%	$4,008	$8,016	$23,648	$102,473
6	Columbia Southern Lateral TFC to Hillburner/PRV	PIPE	48	6,098	60.98	LF	$329	$2,067,785	6%	12%	30%	$124,067	$248,134	$731,996	$3,171,982
6	Columbia Southern Lateral TFC to Hillburner/PRV	PIPE	48	8,426	84.26	LF	$329	$2,857,192	6%	12%	30%	$171,432	$342,863	$1,011,446	$4,382,933
6	Columbia Southern Lateral TFC to Hillburner/PRV	PIPE	63	256	2.56	LF	$432	$113,273	6%	12%	30%	$6,796	$13,593	$40,099	$173,761
6	North Columbia Southern West Lateral and Sublateral	TURNOUT	1	NA	23	EA	$8,000	$184,000	15%	15%	30%	$27,600	$27,600	$71,760	$310,960
6	North Columbia Southern West Lateral and Sublateral	PIPE	6	1,864	18.64	LF	$40	$92,508	15%	15%	30%	$13,876	$13,876	$36,078	$156,339
6	North Columbia Southern West Lateral and Sublateral	PIPE	8	639	6.39	LF	$53	$40,521	15%	15%	30%	$6,078	$6,078	$15,803	$68,480
6	North Columbia Southern West Lateral and Sublateral	PIPE	12	512	5.12	LF	$81	$46,582	15%	15%	30%	$6,987	$6,987	$18,167	$78,724
6	North Columbia Southern West Lateral and Sublateral	PIPE	14	426	4.26	LF	$95	$44,630	15%	15%	30%	$6,694	$6,694	$17,406	$75,424
6	North Columbia Southern West Lateral and Sublateral	PIPE	16	2,579	25.79	LF	$109	$305,737	15%	15%	30%	$45,861	$45,861	$119,238	$516,696
6	Jewett Lateral	TURNOUT	1	NA	21	EA	$8,000	$168,000	15%	15%	30%	$25,200	$25,200	$65,520	$283,920
6	Jewett Lateral	PIPE	10	59	0.59	LF	$67	$4,555	15%	15%	30%	$683	$683	$1,776	$7,697
6	Jewett Lateral	PIPE	10	2,644	26.44	LF	$67	$204,109	15%	15%	30%	$30,616	$30,616	$79,602	$344,943
6	Jewett Lateral	PIPE	14	3,056	30.56	LF	$95	$320,161	15%	15%	30%	$48,024	$48,024	$124,863	$541,073
6	Jewett Lateral	PIPE	16	2,018	20.18	LF	$109	$239,231	15%	15%	30%	$35,885	$35,885	$93,300	$404,301
6	Conarn East	TURNOUT	1	NA	2	EA	$8,000	$16,000	15%	15%	30%	$2,400	$2,400	$6,240	$27,040
6	Conarn East	PIPE	6	789	7.89	LF	$40	$39,157	15%	15%	30%	$5,874	$5,874	$15,271	$66,176
6	Putnam Lateral	TURNOUT	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
6	Putnam Lateral	PIPE	6	2,468	24.68	LF	$40	$122,484	15%	15%	30%	$18,373	$18,373	$47,769	$206,998
6	Putnam Lateral	PIPE	12	423	4.23	LF	$81	$38,485	15%	15%	30%	$5,773	$5,773	$15,009	$65,039
6	Putnam Lateral	PIPE	12	1,375	13.75	LF	$81	$125,099	15%	15%	30%	$18,765	$18,765	$48,788	$211,417

Project Group	Canal/Lateral	Feature	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Subtotal Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
6	Putnam Lateral	PIPE	14	1,239	12.39	LF	$95	$129,804	15%	15%	30%	$19,471	$19,471	$50,623	$219,368
6	West Branch Columbia Southern East	TURNOUT	1	NA	27	EA	$8,000	$216,000	15%	15%	30%	$32,400	$32,400	$84,240	$365,040
6	West Branch Columbia Southern East	PIPE	6	4,103	41.03	LF	$40	$203,627	15%	15%	30%	$30,544	$30,544	$79,415	$344,130
6	West Branch Columbia Southern East	PIPE	8	444	4.44	LF	$53	$28,155	15%	15%	30%	$4,223	$4,223	$10,981	$47,582
6	West Branch Columbia Southern East	PIPE	12	2,015	20.15	LF	$81	$183,326	15%	15%	30%	$27,499	$27,499	$71,497	$309,822
6	Conarn Lateral	TURNOUT	1	NA	10	EA	$8,000	$80,000	15%	15%	30%	$12,000	$12,000	$31,200	$135,200
6	Conarn Lateral	PIPE	6	2,071	20.71	LF	$40	$102,781	15%	15%	30%	$15,417	$15,417	$40,085	$173,701
6	Phiffer Lateral	TURNOUT	1	NA	25	EA	$8,000	$200,000	15%	15%	30%	$30,000	$30,000	$78,000	$338,000
6	Phiffer Lateral	PIPE	12	1,238	12.38	LF	$81	$112,634	15%	15%	30%	$16,895	$16,895	$43,927	$190,352
6	Phiffer Lateral	PIPE	8	2,089	20.89	LF	$53	$132,470	15%	15%	30%	$19,870	$19,870	$51,663	$223,874
6	Phiffer Lateral	PIPE	6	1,684	16.84	LF	$40	$83,575	15%	15%	30%	$12,536	$12,536	$32,594	$141,242
6	Hooker Creek Lateral	TURNOUT	1	NA	12	EA	$8,000	$96,000	15%	15%	30%	$14,400	$14,400	$37,440	$162,240
6	Hooker Creek Lateral	PIPE	10	1,948	19.48	LF	$67	$150,379	15%	15%	30%	$22,557	$22,557	$58,648	$254,141
6	Hooker Creek Lateral	PIPE	12	970	9.7	LF	$81	$88,251	15%	15%	30%	$13,238	$13,238	$34,418	$149,145
6	Hammond Lateral	TURNOUT	1	NA	18	EA	$8,000	$144,000	15%	15%	30%	$21,600	$21,600	$56,160	$243,360
6	Hammond Lateral	PIPE	6	2,515	25.15	LF	$40	$124,817	15%	15%	30%	$18,723	$18,723	$48,679	$210,940
6	Hammond Lateral	PIPE	6	344	3.44	LF	$40	$17,072	15%	15%	30%	$2,561	$2,561	$6,658	$28,852
6	Hammond Lateral	PIPE	8	1,499	14.99	LF	$53	$95,056	15%	15%	30%	$14,258	$14,258	$37,072	$160,645
6	Hammond Lateral	PIPE	10	1,417	14.17	LF	$67	$109,388	15%	15%	30%	$16,408	$16,408	$42,661	$184,866
6	Hammond Lateral	PIPE	12	284	2.84	LF	$81	$25,839	15%	15%	30%	$3,876	$3,876	$10,077	$43,667
6	Hammond Lateral	PIPE	14	1,473	14.73	LF	$95	$154,319	15%	15%	30%	$23,148	$23,148	$60,184	$260,798
6	North Hammond Lateral	TURNOUT	1	NA	5	EA	$8,000	$40,000	15%	15%	30%	$6,000	$6,000	$15,600	$67,600
6	North Hammond Lateral	PIPE	6	278	2.78	LF	$40	$13,797	15%	15%	30%	$2,070	$2,070	$5,381	$23,317
6	North Hammond Lateral	PIPE	8	232	2.32	LF	$53	$14,712	15%	15%	30%	$2,207	$2,207	$5,738	$24,863
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	TURNOUT	1	NA	20	EA	$8,000	$160,000	15%	15%	30%	$24,000	$24,000	$62,400	$270,400
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	42	6,099	60.99	LF	$288	$1,815,919	15%	15%	30%	$272,388	$272,388	$708,208	$3,068,903
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	36	5,162	51.62	LF	$246	$1,323,477	15%	15%	30%	$198,522	$198,522	$516,156	$2,236,677
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	36	943	9.43	LF	$246	$241,774	15%	15%	30%	$36,266	$36,266	$94,292	$408,599
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	32	315	3.15	LF	$219	$72,078	15%	15%	30%	$10,812	$10,812	$28,111	$121,813
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	30	941	9.41	LF	$205	$202,349	15%	15%	30%	$30,352	$30,352	$78,916	$341,971
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	28	3,729	37.29	LF	$191	$750,471	15%	15%	30%	$112,571	$112,571	$292,684	$1,268,296
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	8	331	3.31	LF	$53	$20,990	15%	15%	30%	$3,148	$3,148	$8,186	$35,473
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	6	1,160	11.6	LF	$40	$57,570	15%	15%	30%	$8,635	$8,635	$22,452	$97,293
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	PIPE	6	3,385	33.85	LF	$40	$167,994	15%	15%	30%	$25,199	$25,199	$65,518	$283,910
6	North Columbia Southern East Lateral and Sublateral	TURNOUT	1	NA	11	EA	$8,000	$88,000	15%	15%	30%	$13,200	$13,200	$34,320	$148,720
6	North Columbia Southern East Lateral and Sublateral	PIPE	6	909	9.09	LF	$40	$45,113	15%	15%	30%	$6,767	$6,767	$17,594	$76,240
6	North Columbia Southern East Lateral and Sublateral	PIPE	12	3,588	35.88	LF	$81	$326,439	15%	15%	30%	$48,966	$48,966	$127,311	$551,682
6	North Columbia Southern East Lateral and Sublateral	PIPE	14	3,407	34.07	LF	$95	$356,934	15%	15%	30%	$53,540	$53,540	$139,204	$603,218
6	North Columbia Southern East Lateral and Sublateral	PIPE	24	522	5.22	LF	$164	$90,663	15%	15%	30%	$13,600	$13,600	$35,359	$153,221
7	Hillburner Lateral	TURNOUT	1	NA	24	EA	$8,000	$192,000	15%	15%	30%	$28,800	$28,800	$74,880	$324,480
7	Hillburner Lateral	PIPE	6	2,697	26.97	LF	$40	$133,849	15%	15%	30%	$20,077	$20,077	$52,201	$226,205
7	Hillburner Lateral	PIPE	6	968	9.68	LF	$40	$48,041	15%	15%	30%	$7,206	$7,206	$18,736	$81,189
7	Hillburner Lateral	PIPE	8	3,680	36.8	LF	$53	$233,359	15%	15%	30%	$35,004	$35,004	$91,010	$394,377
7	Gerking Lateral	TURNOUT	1	NA	13	EA	$8,000	$104,000	15%	15%	30%	$15,600	$15,600	$40,560	$175,760
7	Gerking Lateral	PIPE	6	2,629	26.29	LF	$40	$130,474	15%	15%	30%	$19,571	$19,571	$50,885	$220,502
7	Gerking Lateral	PIPE	8	2,626	26.26	LF	$53	$166,522	15%	15%	30%	$24,978	$24,978	$64,944	$281,423

Project Group	Canal/Lateral	Feature	Diameter (in)	Length (ft)	Elbow/ Turnout Quantity	Unit	$/Unit	Subtotal Cost	Engineering, CM, Survey (%)	CMGC (%)	Contingency (%)	Engineering, CM, Survey	CMGC	Contingency	Total Cost
7	Kickbush Lateral	TURNOUT	1	NA	8	EA	$8,000	$64,000	15%	15%	30%	$9,600	$9,600	$24,960	$108,160
7	Kickbush Lateral	PIPE	6	4,099	40.99	LF	$40	$203,429	15%	15%	30%	$30,514	$30,514	$79,337	$343,795
7	Kickbush Lateral	PIPE	8	1,191	11.91	LF	$53	$75,525	15%	15%	30%	$11,329	$11,329	$29,455	$127,637
7	West Branch Columbia Southern South	TURNOUT	1	NA	21	EA	$8,000	$168,000	15%	15%	30%	$25,200	$25,200	$65,520	$283,920
7	West Branch Columbia Southern South	PIPE	6	2,479	24.79	LF	$40	$123,030	15%	15%	30%	$18,455	$18,455	$47,982	$207,921
7	West Branch Columbia Southern South	PIPE	8	4,167	41.67	LF	$53	$264,242	15%	15%	30%	$39,636	$39,636	$103,054	$446,568
7	West Branch Columbia Southern South	PIPE	10	777	7.77	LF	$67	$59,982	15%	15%	30%	$8,997	$8,997	$23,393	$101,370
7	West Branch Columbia Southern South	PIPE	12	187	1.87	LF	$81	$17,013	15%	15%	30%	$2,552	$2,552	$6,635	$28,753
7	Flannery Ditch	TURNOUT	1	NA	4	EA	$8,000	$32,000	15%	15%	30%	$4,800	$4,800	$12,480	$54,080
7	Flannery Ditch	PIPE	6	2,178	21.78	LF	$40	$108,092	15%	15%	30%	$16,214	$16,214	$42,156	$182,675
7	Tellin Lateral	TURNOUT	1	NA	9	EA	$8,000	$72,000	15%	15%	30%	$10,800	$10,800	$28,080	$121,680
7	Tellin Lateral	PIPE	6	5,152	51.52	LF	$40	$255,688	15%	15%	30%	$38,353	$38,353	$99,718	$432,113
7	Tellin Lateral	PIPE	8	2,820	28.2	LF	$53	$178,824	15%	15%	30%	$26,824	$26,824	$69,741	$302,213
														Capital Costs	**$80,600,000**

Groundwater Pumping Alternative

Construction Cost for 1 patron Well				
Item	**Unit**	**Quantity**	**Unit Cost**	**Total cost**
Install Conductor Casing	ft	50	$175	$8,750
Drill Pilot Hole	ft	268	$45	$12,038
E-log	ea	1	$1,500	$1,500
Ream Pilot Hole	ft	268	$60	$16,050
Install Blank Casing	ft	235	$7	$1,589
Install Screen	ft	268	$2	$535
Install Gravel Pack	ft	268	$15	$4,013
Grout Seal	ft	268	$15	$4,013
Plumb & Alignment Test	ea	1	$1,500	$1,500
Surge/Airflit Development	ea	1	$1,500	$1,500
Pumping Development	ea	1	$1,500	$1,500
Step Test	ea	1	$1,500	$1,500
Constant Q Test	ea	1	$1,500	$1,500
Pump Cost	ea	1	$24,000	$24,000
Install Pump	ea	1	$1,500	$1,500
Electric & Wellhead Finish	ea	1	$1,500	$1,500
			Total Cost per Well	**$82,986**

Total Construction Cost for All Patrons				
	Project Group 4	**Project Group 5**	**Project Group 6**	**Total**
Number of Patrons	54	59	6	119
Total Cost	**$4,481,261**	**$4,896,192**	**$497,918**	**$9,875,371**

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

Canal Lining Alternative

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
1	Tumalo Feed Canal Phase V	985200	NA	28	4	6	35	NA	$412,890	$1,913,034	$9,852	$2,335,776	15%	15%	30%	$350,366	$350,366	$910,952	$3,947,461
1	Tumalo Feed Canal Final Phase(s) After Phase V	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	12%	30%	$600	$480	$1,524	$6,604
1	Tumalo Feed Canal Phase V	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	15%	30%	$600	$600	$1,560	$6,760
1	Kerns Lateral	2863.19	NA	5	1	1	10	NA	$58,273	$156,598	$2,863	$217,735	15%	15%	30%	$32,660	$32,660	$84,916	$367,971
1	Kerns Lateral	NA	2	NA	NA	NA	NA	$2,000	NA	NA	NA	$2,000	15%	15%	30%	$300	$300	$780	$3,380
2	Gill Lateral	NA	1	NA	NA	NA	NA	$1,000	NA	NA	NA	$1,000	15%	15%	30%	$150	$150	$390	$1,690
2	Box S Lateral (2 Rivers)	517.84	NA	18	2	4	24	NA	$16,885	$69,382	$518	$86,784	15%	15%	30%	$13,018	$13,018	$33,846	$146,666
2	Box S Lateral (2 Rivers)	1909.96	NA	15	3	3	21	NA	$56,640	$219,429	$1,910	$277,979	15%	15%	30%	$41,697	$41,697	$108,412	$469,785
2	Box S Lateral (2 Rivers)	828.55	NA	15	3	3	21	NA	$24,571	$95,190	$829	$120,590	15%	15%	30%	$18,088	$18,088	$47,030	$203,796
2	Box S Lateral (2 Rivers)	1843.20	NA	12	4	2	17	NA	$49,221	$176,561	$1,843	$227,625	15%	15%	30%	$34,144	$34,144	$88,774	$384,686
2	Gill Lateral	2599.54	NA	5	1	1	10	NA	$52,907	$142,178	$2,600	$197,685	15%	15%	30%	$29,653	$29,653	$77,097	$334,087
2	Gill Lateral	264.07	NA	5	1	1	10	NA	$5,375	$14,443	$264	$20,082	15%	15%	30%	$3,012	$3,012	$7,832	$33,938
2	Gill Lateral	2634.98	NA	5	1	1	10	NA	$53,629	$144,116	$2,635	$200,380	15%	15%	30%	$30,057	$30,057	$78,148	$338,642
2	Highline Lateral	116.80	NA	12	4	2	17	NA	$3,119	$11,188	$117	$14,424	15%	15%	30%	$2,164	$2,164	$5,625	$24,377
2	Highline Lateral	478.21	NA	12	4	2	17	NA	$12,770	$45,808	$478	$59,056	15%	15%	30%	$8,858	$8,858	$23,032	$99,805
2	Highline Lateral	268.69	NA	12	4	2	17	NA	$7,175	$25,737	$269	$33,181	15%	15%	30%	$4,977	$4,977	$12,941	$56,076
2	Highline Lateral	940.52	NA	12	4	2	17	NA	$25,116	$90,092	$941	$116,148	15%	15%	30%	$17,422	$17,422	$45,298	$196,291
2	Highline Lateral	174.08	NA	12	4	2	17	NA	$4,649	$16,675	$174	$21,497	15%	15%	30%	$3,225	$3,225	$8,384	$36,331
2	Highline Lateral	269.34	NA	12	4	2	17	NA	$7,192	$25,800	$269	$33,261	15%	15%	30%	$4,989	$4,989	$12,972	$56,212
2	Highline Lateral	1311.70	NA	12	4	2	17	NA	$35,028	$125,648	$1,312	$161,987	15%	15%	30%	$24,298	$24,298	$63,175	$273,758
2	Highline Lateral	35.89	NA	12	4	2	17	NA	$958	$3,438	$36	$4,433	15%	15%	30%	$665	$665	$1,729	$7,491
2	Highline Lateral	242.83	NA	12	4	2	17	NA	$6,485	$23,261	$243	$29,988	15%	15%	30%	$4,498	$4,498	$11,695	$50,680
2	Highline Lateral	1425.53	NA	12	4	2	17	NA	$38,067	$136,552	$1,426	$176,044	15%	15%	30%	$26,407	$26,407	$68,657	$297,515
2	Highline Lateral	958.71	NA	12	4	2	17	NA	$25,601	$91,835	$959	$118,395	15%	15%	30%	$17,759	$17,759	$46,174	$200,088
2	Highline Lateral	406.40	NA	12	4	2	17	NA	$10,853	$38,930	$406	$50,189	15%	15%	30%	$7,528	$7,528	$19,574	$84,819
2	Highline Lateral	325.41	NA	12	4	2	17	NA	$8,690	$31,171	$325	$40,186	15%	15%	30%	$6,028	$6,028	$15,673	$67,914
2	Highline Lateral	9.61	NA	12	4	2	17	NA	$257	$920	$10	$1,187	15%	15%	30%	$178	$178	$463	$2,005

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

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
2	Highline Lateral	3652.63	NA	12	4	2	17	NA	$97,540	$349,886	$3,653	$451,079	15%	15%	30%	$67,662	$67,662	$175,921	$762,323
2	Highline Lateral	739.49	NA	12	4	2	17	NA	$19,747	$70,836	$739	$91,322	15%	15%	30%	$13,698	$13,698	$35,616	$154,335
2	Highline Lateral	4872.65	NA	12	4	2	17	NA	$130,119	$466,752	$4,873	$601,744	15%	15%	30%	$90,262	$90,262	$234,680	$1,016,947
2	Highline Lateral	2111.93	NA	12	4	2	17	NA	$56,397	$202,302	$2,112	$260,811	15%	15%	30%	$39,122	$39,122	$101,716	$440,771
2	Highline Lateral	905.73	NA	12	4	2	17	NA	$24,187	$86,760	$906	$111,852	15%	15%	30%	$16,778	$16,778	$43,622	$189,031
2	Highline Lateral	217.03	NA	12	4	2	17	NA	$5,796	$20,789	$217	$26,802	15%	15%	30%	$4,020	$4,020	$10,453	$45,295
2	Highline Lateral	3011.53	NA	12	4	2	17	NA	$80,420	$288,475	$3,012	$371,906	15%	15%	30%	$55,786	$55,786	$145,044	$628,522
2	Highline Lateral	71.26	NA	12	4	2	17	NA	$1,903	$6,826	$71	$8,800	15%	15%	30%	$1,320	$1,320	$3,432	$14,872
2	Highline Lateral	1819.30	NA	12	4	2	17	NA	$48,582	$174,271	$1,819	$224,673	15%	15%	30%	$33,701	$33,701	$87,622	$379,697
2	Lacy Lateral and Lacy Sublateral	1808.93	NA	5	1	1	10	NA	$36,816	$98,937	$1,809	$137,562	15%	15%	30%	$20,634	$20,634	$53,649	$232,480
2	Lacy Lateral and Lacy Sublateral	1999.87	NA	5	1	1	10	NA	$40,703	$109,380	$2,000	$152,082	15%	15%	30%	$22,812	$22,812	$59,312	$257,019
2	Lacy Lateral and Lacy Sublateral	431.51	NA	5	1	1	10	NA	$8,782	$23,601	$432	$32,815	15%	15%	30%	$4,922	$4,922	$12,798	$55,457
2	Lacy Lateral and Lacy Sublateral	181.47	NA	5	1	1	10	NA	$3,693	$9,925	$181	$13,800	15%	15%	30%	$2,070	$2,070	$5,382	$23,322
2	Lacy Lateral and Lacy Sublateral	834.32	NA	5	1	1	10	NA	$16,981	$45,632	$834	$63,447	15%	15%	30%	$9,517	$9,517	$24,744	$107,225
2	Lacy Lateral and Lacy Sublateral	578.28	NA	5	1	1	10	NA	$11,770	$31,628	$578	$43,976	15%	15%	30%	$6,596	$6,596	$17,151	$74,320
2	Lacy Lateral and Lacy Sublateral	1032.39	NA	5	1	1	10	NA	$21,012	$56,465	$1,032	$78,509	15%	15%	30%	$11,776	$11,776	$30,619	$132,681
2	Lacy Lateral and Lacy Sublateral	659.14	NA	5	1	1	10	NA	$13,415	$36,050	$659	$50,125	15%	15%	30%	$7,519	$7,519	$19,549	$84,711
2	Lacy Lateral and Lacy Sublateral	581.53	NA	5	1	1	10	NA	$11,836	$31,806	$582	$44,223	15%	15%	30%	$6,633	$6,633	$17,247	$74,736
2	Lacy Lateral and Lacy Sublateral	578.93	NA	5	1	1	10	NA	$11,783	$31,664	$579	$44,025	15%	15%	30%	$6,604	$6,604	$17,170	$74,403
2	Lacy Lateral and Lacy Sublateral	832.29	NA	5	1	1	10	NA	$16,939	$45,521	$832	$63,292	15%	15%	30%	$9,494	$9,494	$24,684	$106,964
2	Lacy Lateral and Lacy Sublateral	1096.32	NA	5	1	1	10	NA	$22,313	$59,961	$1,096	$83,371	15%	15%	30%	$12,506	$12,506	$32,515	$140,896
2	Lacy Lateral and Lacy Sublateral	830.57	NA	5	1	1	10	NA	$16,904	$45,427	$831	$63,161	15%	15%	30%	$9,474	$9,474	$24,633	$106,743

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
2	Lacy Lateral and Lacy Sublateral	952.34	NA	5	1	1	10	NA	$19,383	$52,087	$952	$72,422	15%	15%	30%	$10,863	$10,863	$28,244	$122,393
2	Rock Springs Lateral	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	12%	30%	$600	$480	$1,524	$6,604
2	Parkhurst Lateral	282.60	NA	5	1	1	10	NA	$5,752	$15,456	$283	$21,490	6%	12%	30%	$1,289	$2,579	$7,608	$32,966
2	Parkhurst Lateral	660.84	NA	5	1	1	10	NA	$13,450	$36,144	$661	$50,255	6%	12%	30%	$3,015	$6,031	$17,790	$77,091
2	Parkhurst Lateral	6480.00	NA	5	1	1	10	NA	$131,885	$354,414	$6,480	$492,779	6%	12%	30%	$29,567	$59,133	$174,444	$755,923
2	Parkhurst Lateral	857.50	NA	5	1	1	10	NA	$17,452	$46,900	$858	$65,210	6%	12%	30%	$3,913	$7,825	$23,084	$100,031
2	Parkhurst Lateral	1.53	NA	5	1	1	10	NA	$31	$84	$2	$116	6%	12%	30%	$7	$14	$41	$178
2	Parkhurst Lateral	1379.98	NA	5	1	1	10	NA	$28,086	$75,476	$1,380	$104,942	6%	12%	30%	$6,297	$12,593	$37,150	$160,981
2	Parkhurst Lateral	1037.39	NA	5	1	1	10	NA	$21,114	$56,738	$1,037	$78,889	6%	12%	30%	$4,733	$9,467	$27,927	$121,016
2	Parkhurst Lateral	471.29	NA	5	1	1	10	NA	$9,592	$25,776	$471	$35,840	6%	12%	30%	$2,150	$4,301	$12,687	$54,978
2	Parkhurst Lateral	625.48	NA	5	1	1	10	NA	$12,730	$34,210	$625	$47,565	6%	12%	30%	$2,854	$5,708	$16,838	$72,965
2	Parkhurst Lateral	571.53	NA	5	1	1	10	NA	$11,632	$31,259	$572	$43,463	6%	12%	30%	$2,608	$5,216	$15,386	$66,672
2	Parkhurst Lateral	4.84	NA	5	1	1	10	NA	$99	$265	$5	$368	6%	12%	30%	$22	$44	$130	$565
2	Parkhurst Lateral	72.85	NA	5	1	1	10	NA	$1,483	$3,984	$73	$5,540	6%	12%	30%	$332	$665	$1,961	$8,498
2	Parkhurst Lateral	796.59	NA	5	1	1	10	NA	$16,213	$43,568	$797	$60,578	6%	12%	30%	$3,635	$7,269	$21,444	$92,926
2	Parkhurst Lateral	112.59	NA	5	1	1	10	NA	$2,292	$6,158	$113	$8,562	6%	12%	30%	$514	$1,027	$3,031	$13,134
2	Parkhurst Lateral	86.49	NA	5	1	1	10	NA	$1,760	$4,730	$86	$6,577	6%	12%	30%	$395	$789	$2,328	$10,089
2	Rock Springs Lateral	20.98	NA	15	3	3	21	NA	$622	$2,410	$21	$3,053	15%	12%	30%	$458	$366	$1,163	$5,041
2	Rock Springs Lateral	1191.09	NA	15	3	3	21	NA	$35,322	$136,841	$1,191	$173,354	15%	12%	30%	$26,003	$20,802	$66,048	$286,207
2	Rock Springs Lateral	3.81	NA	15	3	3	21	NA	$113	$438	$4	$554	15%	12%	30%	$83	$67	$211	$915
2	Rock Springs Lateral	299.98	NA	15	3	3	21	NA	$8,896	$34,464	$300	$43,660	15%	12%	30%	$6,549	$5,239	$16,635	$72,083
2	Steele Lateral	280.61	NA	15	3	3	21	NA	$8,322	$32,238	$281	$40,841	15%	15%	30%	$6,126	$6,126	$15,928	$69,021
2	Steele Lateral	536.96	NA	15	3	3	21	NA	$15,924	$61,690	$537	$78,151	15%	15%	30%	$11,723	$11,723	$30,479	$132,074
2	Steele Lateral	285.25	NA	15	3	3	21	NA	$8,459	$32,771	$285	$41,515	15%	15%	30%	$6,227	$6,227	$16,191	$70,161
2	Steele Lateral	7.05	NA	15	3	3	21	NA	$209	$809	$7	$1,025	15%	15%	30%	$154	$154	$400	$1,733
2	Steele Lateral	77.54	NA	15	3	3	21	NA	$2,299	$8,908	$78	$11,285	15%	15%	30%	$1,693	$1,693	$4,401	$19,072
2	Steele Lateral	712.91	NA	15	3	3	21	NA	$21,142	$81,905	$713	$103,759	15%	15%	30%	$15,564	$15,564	$40,466	$175,353
2	Steele Lateral	1079.26	NA	15	3	3	21	NA	$32,006	$123,993	$1,079	$157,078	15%	15%	30%	$23,562	$23,562	$61,260	$265,462
2	Steele Lateral	217.07	NA	15	3	3	21	NA	$6,437	$24,939	$217	$31,593	15%	15%	30%	$4,739	$4,739	$12,321	$53,393
2	Steele Lateral	852.05	NA	15	3	3	21	NA	$25,268	$97,889	$852	$124,009	15%	15%	30%	$18,601	$18,601	$48,363	$209,575
2	Steele Lateral	3.20	NA	15	3	3	21	NA	$95	$368	$3	$466	15%	15%	30%	$70	$70	$182	$787
2	Steele Lateral	957.40	NA	15	3	3	21	NA	$28,392	$109,992	$957	$139,342	15%	15%	30%	$20,901	$20,901	$54,343	$235,487

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
2	Tumalo Feed Canal Reservoir Feed and Sublateral	26.74	NA	15	3	3	21	NA	$793	$3,072	$27	$3,892	10%	12%	30%	$389	$467	$1,424	$6,172
2	Tumalo Feed Canal Reservoir Feed and Sublateral	132.70	NA	15	3	3	21	NA	$3,935	$15,246	$133	$19,313	10%	12%	30%	$1,931	$2,318	$7,069	$30,631
2	Tumalo Feed Canal Reservoir Feed and Sublateral	1833.01	NA	15	3	3	21	NA	$54,358	$210,589	$1,833	$266,780	10%	12%	30%	$26,678	$32,014	$97,642	$423,114
2	Tumalo Feed Canal Reservoir Feed and Sublateral	3016.81	NA	15	3	3	21	NA	$89,464	$346,592	$3,017	$439,073	10%	12%	30%	$43,907	$52,689	$160,701	$696,370
2	Tumalo Feed Canal Reservoir Feed and Sublateral	589.03	NA	15	3	3	21	NA	$17,468	$67,672	$589	$85,729	10%	12%	30%	$8,573	$10,287	$31,377	$135,966
2	Tumalo Feed Canal Reservoir Feed and Sublateral	937.44	NA	15	3	3	21	NA	$27,800	$107,700	$937	$136,437	10%	12%	30%	$13,644	$16,372	$49,936	$216,389
2	Tumalo Feed Canal Reservoir Feed and Sublateral	43.29	NA	15	3	3	21	NA	$1,284	$4,973	$43	$6,301	10%	12%	30%	$630	$756	$2,306	$9,993
2	Tumalo Feed Canal Reservoir Feed and Sublateral	20.78	NA	15	3	3	21	NA	$616	$2,387	$21	$3,024	10%	12%	30%	$302	$363	$1,107	$4,797
2	Tumalo Feed Canal Reservoir Feed and Sublateral	1228.87	NA	15	3	3	21	NA	$36,442	$141,181	$1,229	$178,853	10%	12%	30%	$17,885	$21,462	$65,460	$283,660
2	Tumalo Feed Canal Reservoir Feed and Sublateral	11.54	NA	15	3	3	21	NA	$342	$1,326	$12	$1,680	10%	12%	30%	$168	$202	$615	$2,664
2	Tumalo Feed Canal Reservoir Feed and Sublateral	504.79	NA	15	3	3	21	NA	$14,970	$57,994	$505	$73,468	10%	12%	30%	$7,347	$8,816	$26,889	$116,521
2	Tumalo Feed Canal Reservoir Feed and Sublateral	263.66	NA	15	3	3	21	NA	$7,819	$30,291	$264	$38,374	10%	12%	30%	$3,837	$4,605	$14,045	$60,861
2	Tumalo Feed Canal Reservoir Feed and Sublateral	530.90	NA	15	3	3	21	NA	$15,744	$60,994	$531	$77,268	10%	12%	30%	$7,727	$9,272	$28,280	$122,548
2	Tumalo Feed Canal Reservoir Feed and Sublateral	279.32	NA	15	3	3	21	NA	$8,283	$32,090	$279	$40,653	10%	12%	30%	$4,065	$4,878	$14,879	$64,475
2	Box S Lateral (2 Rivers)	NA	5	NA	NA	NA	NA	$5,000	NA	NA	NA	$5,000	12%	12%	30%	$600	$600	$1,860	$8,060

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
2	Steele Lateral	NA	11	NA	NA	NA	NA	$11,000	NA	NA	NA	$11,000	15%	15%	30%	$1,650	$1,650	$4,290	$18,590
2	Tumalo Feed Canal Reservoir Feed and Sublateral	NA	15	NA	NA	NA	NA	$15,000	NA	NA	NA	$15,000	10%	12%	30%	$1,500	$1,800	$5,490	$23,790
2	Lacy Lateral and Lacy Sublateral	NA	16	NA	NA	NA	NA	$16,000	NA	NA	NA	$16,000	15%	15%	30%	$2,400	$2,400	$6,240	$27,040
2	Parkhurst Lateral	NA	20	NA	NA	NA	NA	$20,000	NA	NA	NA	$20,000	6%	12%	30%	$1,200	$2,400	$7,080	$30,680
2	Highline Lateral	NA	22	NA	NA	NA	NA	$22,000	NA	NA	NA	$22,000	15%	15%	30%	$3,300	$3,300	$8,580	$37,180
3	Allen Sublateral South	NA	3	NA	NA	NA	NA	$3,000	NA	NA	NA	$3,000	15%	15%	30%	$450	$450	$1,170	$5,070
3	Allen Sublateral West	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	15%	30%	$600	$600	$1,560	$6,760
3	Allen Lateral	3947.15	NA	15	3	3	21	NA	$117,054	$453,476	$3,947	$574,477	15%	15%	30%	$86,172	$86,172	$224,046	$970,866
3	Allen Lateral	1.62	NA	15	3	3	21	NA	$48	$186	$2	$236	15%	15%	30%	$35	$35	$92	$399
3	Allen Lateral	588.13	NA	15	3	3	21	NA	$17,441	$67,568	$588	$85,598	15%	15%	30%	$12,840	$12,840	$33,383	$144,660
3	Allen Lateral	261.83	NA	15	3	3	21	NA	$7,765	$30,081	$262	$38,108	15%	15%	30%	$5,716	$5,716	$14,862	$64,402
3	Allen Lateral	673.42	NA	15	3	3	21	NA	$19,971	$77,368	$673	$98,011	15%	15%	30%	$14,702	$14,702	$38,224	$165,639
3	Allen Lateral	404.80	NA	15	3	3	21	NA	$12,004	$46,506	$405	$58,915	15%	15%	30%	$8,837	$8,837	$22,977	$99,566
3	Allen Lateral	273.78	NA	15	3	3	21	NA	$8,119	$31,454	$274	$39,847	15%	15%	30%	$5,977	$5,977	$15,540	$67,342
3	Allen Lateral	418.98	NA	15	3	3	21	NA	$12,425	$48,135	$419	$60,979	15%	15%	30%	$9,147	$9,147	$23,782	$103,054
3	Allen Lateral	18.00	NA	15	3	3	21	NA	$534	$2,068	$18	$2,619	15%	15%	30%	$393	$393	$1,022	$4,427
3	Allen Lateral	314.39	NA	15	3	3	21	NA	$9,323	$36,119	$314	$45,757	15%	15%	30%	$6,864	$6,864	$17,845	$77,329
3	Allen Lateral	567.31	NA	15	3	3	21	NA	$16,824	$65,177	$567	$82,568	15%	15%	30%	$12,385	$12,385	$32,201	$139,540
3	Allen Lateral	4.31	NA	15	3	3	21	NA	$128	$495	$4	$627	15%	15%	30%	$94	$94	$244	$1,059
3	Allen Lateral	6.03	NA	15	3	3	21	NA	$179	$693	$6	$878	15%	15%	30%	$132	$132	$342	$1,484
3	Allen Lateral	3.85	NA	15	3	3	21	NA	$114	$442	$4	$560	15%	15%	30%	$84	$84	$218	$947
3	Allen Lateral	1910.27	NA	15	3	3	21	NA	$56,650	$219,466	$1,910	$278,026	15%	15%	30%	$41,704	$41,704	$108,430	$469,863
3	Allen Lateral	0.44	NA	15	3	3	21	NA	$13	$50	$0	$64	15%	15%	30%	$10	$10	$25	$108
3	Allen Lateral	438.36	NA	15	3	3	21	NA	$13,000	$50,361	$438	$63,799	15%	15%	30%	$9,570	$9,570	$24,882	$107,821
3	Allen Lateral	563.78	NA	15	3	3	21	NA	$16,719	$64,772	$564	$82,054	15%	15%	30%	$12,308	$12,308	$32,001	$138,672
3	Allen Lateral	668.28	NA	15	3	3	21	NA	$19,818	$76,776	$668	$97,263	15%	15%	30%	$14,589	$14,589	$37,932	$164,374
3	Allen Lateral	643.65	NA	15	3	3	21	NA	$19,088	$73,947	$644	$93,678	15%	15%	30%	$14,052	$14,052	$36,534	$158,316
3	Allen Lateral	239.77	NA	15	3	3	21	NA	$7,110	$27,546	$240	$34,896	15%	15%	30%	$5,234	$5,234	$13,610	$58,975
3	Allen Lateral	273.19	NA	15	3	3	21	NA	$8,101	$31,386	$273	$39,760	15%	15%	30%	$5,964	$5,964	$15,506	$67,195
3	Allen Lateral	128.49	NA	15	3	3	21	NA	$3,810	$14,762	$128	$18,701	15%	15%	30%	$2,805	$2,805	$7,293	$31,604
3	Allen Lateral	1.90	NA	15	3	3	21	NA	$56	$219	$2	$277	15%	15%	30%	$42	$42	$108	$468
3	Allen Lateral	530.41	NA	15	3	3	21	NA	$15,729	$60,937	$530	$77,197	15%	15%	30%	$11,579	$11,579	$30,107	$130,462
3	Allen Lateral	0.28	NA	15	3	3	21	NA	$8	$32	$0	$40	15%	15%	30%	$6	$6	$16	$68
3	Allen Lateral	1087.70	NA	15	3	3	21	NA	$32,256	$124,963	$1,088	$158,306	15%	15%	30%	$23,746	$23,746	$61,739	$267,538
3	Allen Lateral	5.52	NA	15	3	3	21	NA	$164	$635	$6	$804	15%	15%	30%	$121	$121	$314	$1,359
3	Allen Lateral	1059.48	NA	15	3	3	21	NA	$31,419	$121,721	$1,059	$154,199	15%	15%	30%	$23,130	$23,130	$60,138	$260,597
3	Allen Lateral	900.46	NA	15	3	3	21	NA	$26,703	$103,451	$900	$131,055	15%	15%	30%	$19,658	$19,658	$51,111	$221,483
3	Allen Lateral	108.32	NA	15	3	3	21	NA	$3,212	$12,445	$108	$15,766	15%	15%	30%	$2,365	$2,365	$6,149	$26,644
3	Allen Lateral	569.66	NA	15	3	3	21	NA	$16,893	$65,446	$570	$82,909	15%	15%	30%	$12,436	$12,436	$32,335	$140,116

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
3	Allen Lateral	812.69	NA	15	3	3	21	NA	$24,101	$93,368	$813	$118,281	15%	15%	30%	$17,742	$17,742	$46,130	$199,895
3	Allen Lateral	470.11	NA	15	3	3	21	NA	$13,941	$54,009	$470	$68,420	15%	15%	30%	$10,263	$10,263	$26,684	$115,630
3	Allen Lateral	673.20	NA	15	3	3	21	NA	$19,964	$77,342	$673	$97,979	15%	15%	30%	$14,697	$14,697	$38,212	$165,585
3	Allen Lateral	638.57	NA	15	3	3	21	NA	$18,937	$73,363	$639	$92,939	15%	15%	30%	$13,941	$13,941	$36,246	$157,067
3	Allen Lateral	538.34	NA	15	3	3	21	NA	$15,965	$61,848	$538	$78,351	15%	15%	30%	$11,753	$11,753	$30,557	$132,413
3	Allen Lateral	98.93	NA	15	3	3	21	NA	$2,934	$11,366	$99	$14,398	15%	15%	30%	$2,160	$2,160	$5,615	$24,333
3	Allen Sublateral South	262.35	NA	18	2	4	24	NA	$8,554	$35,151	$262	$43,968	15%	15%	30%	$6,595	$6,595	$17,147	$74,305
3	Allen Sublateral South	1508.67	NA	18	2	4	24	NA	$49,193	$202,137	$1,509	$252,838	15%	15%	30%	$37,926	$37,926	$98,607	$427,297
3	Allen Sublateral South	18.90	NA	18	2	4	24	NA	$616	$2,532	$19	$3,167	15%	15%	30%	$475	$475	$1,235	$5,352
3	Allen Sublateral South	4.56	NA	18	2	4	24	NA	$149	$611	$5	$764	15%	15%	30%	$115	$115	$298	$1,292
3	Allen Sublateral South	366.75	NA	18	2	4	24	NA	$11,958	$49,138	$367	$61,464	15%	15%	30%	$9,220	$9,220	$23,971	$103,873
3	McGinnis Ditch	NA	5	NA	NA	NA	NA	$5,000	NA	NA	NA	$5,000	15%	15%	30%	$750	$750	$1,950	$8,450
3	McGinnis Ditch	758.99	NA	18	2	4	24	NA	$24,748	$101,692	$759	$127,199	15%	15%	30%	$19,080	$19,080	$49,608	$214,967
3	McGinnis Ditch	708.36	NA	18	2	4	24	NA	$23,097	$94,908	$708	$118,714	15%	15%	30%	$17,807	$17,807	$46,298	$200,626
3	McGinnis Ditch	812.93	NA	18	2	4	24	NA	$26,507	$108,920	$813	$136,240	15%	15%	30%	$20,436	$20,436	$53,134	$230,245
3	McGinnis Ditch	413.49	NA	18	2	4	24	NA	$13,482	$55,400	$413	$69,296	15%	15%	30%	$10,394	$10,394	$27,026	$117,111
3	McGinnis Ditch	196.00	NA	18	2	4	24	NA	$6,391	$26,261	$196	$32,848	15%	15%	30%	$4,927	$4,927	$12,811	$55,514
3	McGinnis Ditch	1001.08	NA	18	2	4	24	NA	$32,642	$134,128	$1,001	$167,771	15%	15%	30%	$25,166	$25,166	$65,431	$283,533
3	Allen Lateral	NA	34	NA	NA	NA	NA	$34,000	NA	NA	NA	$34,000	15%	15%	30%	$5,100	$5,100	$13,260	$57,460
4	North Spaulding Lateral	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	15%	30%	$600	$600	$1,560	$6,760
4	Beasley Lateral	13.82	NA	5	1	1	10	NA	$281	$756	$14	$1,051	15%	15%	30%	$158	$158	$410	$1,776
4	Beasley Lateral	80.68	NA	5	1	1	10	NA	$1,642	$4,413	$81	$6,135	15%	15%	30%	$920	$920	$2,393	$10,369
4	Beasley Lateral	164.16	NA	5	1	1	10	NA	$3,341	$8,979	$164	$12,484	15%	15%	30%	$1,873	$1,873	$4,869	$21,098
4	Beasley Lateral	681.91	NA	5	1	1	10	NA	$13,879	$37,296	$682	$51,857	15%	15%	30%	$7,779	$7,779	$20,224	$87,638
4	Beasley Lateral	104.12	NA	5	1	1	10	NA	$2,119	$5,694	$104	$7,918	15%	15%	30%	$1,188	$1,188	$3,088	$13,381
4	Beasley Lateral	555.73	NA	5	1	1	10	NA	$11,311	$30,395	$556	$42,261	15%	15%	30%	$6,339	$6,339	$16,482	$71,422
4	Beasley Lateral	1.67	NA	5	1	1	10	NA	$34	$91	$2	$127	15%	15%	30%	$19	$19	$50	$215
4	Beasley Lateral	685.93	NA	5	1	1	10	NA	$13,960	$37,516	$686	$52,162	15%	15%	30%	$7,824	$7,824	$20,343	$88,154
4	Beasley Lateral	117.04	NA	5	1	1	10	NA	$2,382	$6,401	$117	$8,900	15%	15%	30%	$1,335	$1,335	$3,471	$15,041
4	Beasley Lateral	689.80	NA	5	1	1	10	NA	$14,039	$37,728	$690	$52,457	15%	15%	30%	$7,868	$7,868	$20,458	$88,652
4	Beasley Lateral	463.90	NA	5	1	1	10	NA	$9,442	$25,372	$464	$35,278	15%	15%	30%	$5,292	$5,292	$13,758	$59,619
4	Beasley Lateral	336.81	NA	5	1	1	10	NA	$6,855	$18,421	$337	$25,613	15%	15%	30%	$3,842	$3,842	$9,989	$43,286
4	Beasley Lateral	181.33	NA	5	1	1	10	NA	$3,691	$9,918	$181	$13,790	15%	15%	30%	$2,068	$2,068	$5,378	$23,304

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
4	Beasley Lateral	1144.91	NA	5	1	1	10	NA	$23,302	$62,619	$1,145	$87,066	15%	15%	30%	$13,060	$13,060	$33,956	$147,142
4	Beasley Lateral	315.96	NA	5	1	1	10	NA	$6,431	$17,281	$316	$24,028	15%	15%	30%	$3,604	$3,604	$9,371	$40,607
4	North Spaulding Lateral	1616.60	NA	12	4	2	17	NA	$43,170	$154,855	$1,617	$199,641	15%	15%	30%	$29,946	$29,946	$77,860	$337,394
4	North Spaulding Lateral	4445.76	NA	12	4	2	17	NA	$118,719	$425,860	$4,446	$549,025	15%	15%	30%	$82,354	$82,354	$214,120	$927,852
4	North Spaulding Lateral	3924.89	NA	12	4	2	17	NA	$104,810	$375,966	$3,925	$484,701	15%	15%	30%	$72,705	$72,705	$189,033	$819,144
4	North Spaulding Lateral	5451.29	NA	12	4	2	17	NA	$145,571	$522,180	$5,451	$673,203	15%	15%	30%	$100,980	$100,980	$262,549	$1,137,712
4	North Spaulding Lateral	284.06	NA	12	4	2	17	NA	$7,585	$27,210	$284	$35,079	15%	15%	30%	$5,262	$5,262	$13,681	$59,284
4	Spaulding Lateral	435.21	NA	12	4	2	17	NA	$11,622	$41,689	$435	$53,746	15%	15%	30%	$8,062	$8,062	$20,961	$90,830
4	Spaulding Lateral	5.12	NA	12	4	2	17	NA	$137	$491	$5	$632	15%	15%	30%	$95	$95	$247	$1,069
4	Spaulding Lateral	575.41	NA	12	4	2	17	NA	$15,366	$55,119	$575	$71,060	15%	15%	30%	$10,659	$10,659	$27,713	$120,091
4	Spaulding Lateral	120.99	NA	12	4	2	17	NA	$3,231	$11,590	$121	$14,942	15%	15%	30%	$2,241	$2,241	$5,827	$25,251
4	Spaulding Lateral	2346.99	NA	12	4	2	17	NA	$62,674	$224,819	$2,347	$289,839	15%	15%	30%	$43,476	$43,476	$113,037	$489,829
4	Spaulding Lateral	388.61	NA	12	4	2	17	NA	$10,378	$37,225	$389	$47,992	15%	15%	30%	$7,199	$7,199	$18,717	$81,106
4	Spaulding Lateral	1629.32	NA	12	4	2	17	NA	$43,509	$156,073	$1,629	$201,212	15%	15%	30%	$30,182	$30,182	$78,473	$340,048
4	Spaulding Lateral	1069.75	NA	12	4	2	17	NA	$28,566	$102,471	$1,070	$132,107	15%	15%	30%	$19,816	$19,816	$51,522	$223,262
4	Spaulding Lateral	860.04	NA	12	4	2	17	NA	$22,966	$82,383	$860	$106,209	15%	15%	30%	$15,931	$15,931	$41,422	$179,494
4	Spaulding Lateral	3.70	NA	12	4	2	17	NA	$99	$355	$4	$457	15%	15%	30%	$69	$69	$178	$773
4	Spaulding Lateral	2.76	NA	12	4	2	17	NA	$74	$265	$3	$341	15%	15%	30%	$51	$51	$133	$577
4	Spaulding Lateral	339.30	NA	12	4	2	17	NA	$9,061	$32,502	$339	$41,902	15%	15%	30%	$6,285	$6,285	$16,342	$70,814
4	Spaulding Lateral	1695.07	NA	12	4	2	17	NA	$45,265	$162,371	$1,695	$209,332	15%	15%	30%	$31,400	$31,400	$81,639	$353,770
4	Spaulding Lateral	440.98	NA	12	4	2	17	NA	$11,776	$42,241	$441	$54,458	15%	15%	30%	$8,169	$8,169	$21,239	$92,034
4	Spaulding Lateral	1033.09	NA	12	4	2	17	NA	$27,587	$98,960	$1,033	$127,580	15%	15%	30%	$19,137	$19,137	$49,756	$215,610
4	Spaulding Lateral	60.92	NA	12	4	2	17	NA	$1,627	$5,835	$61	$7,523	15%	15%	30%	$1,128	$1,128	$2,934	$12,713
4	Spaulding Lateral	2171.05	NA	12	4	2	17	NA	$57,975	$207,965	$2,171	$268,112	15%	15%	30%	$40,217	$40,217	$104,564	$453,109
4	West Branch Columbia Southern West	765.00	NA	15	3	3	21	NA	$22,686	$87,889	$765	$111,340	15%	15%	30%	$16,701	$16,701	$43,423	$188,164
4	West Branch Columbia Southern West	2444.81	NA	15	3	3	21	NA	$72,501	$280,877	$2,445	$355,823	15%	15%	30%	$53,373	$53,373	$138,771	$601,341

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4	West Branch Columbia Southern West	670.91	NA	15	3	3	21	NA	$19,896	$77,079	$671	$97,646	15%	15%	30%	$14,647	$14,647	$38,082	$165,022
4	West Branch Columbia Southern West	141.38	NA	15	3	3	21	NA	$4,193	$16,243	$141	$20,577	15%	15%	30%	$3,087	$3,087	$8,025	$34,775
4	West Branch Columbia Southern West	1788.95	NA	15	3	3	21	NA	$53,052	$205,527	$1,789	$260,367	15%	15%	30%	$39,055	$39,055	$101,543	$440,021
4	West Branch Columbia Southern West	616.33	NA	15	3	3	21	NA	$18,278	$70,809	$616	$89,703	15%	15%	30%	$13,455	$13,455	$34,984	$151,597
4	West Branch Columbia Southern West	21.17	NA	15	3	3	21	NA	$628	$2,432	$21	$3,081	15%	15%	30%	$462	$462	$1,202	$5,207
4	West Branch Columbia Southern West	77.78	NA	15	3	3	21	NA	$2,307	$8,936	$78	$11,321	15%	15%	30%	$1,698	$1,698	$4,415	$19,132
4	West Branch Columbia Southern West	1272.56	NA	15	3	3	21	NA	$37,738	$146,201	$1,273	$185,211	15%	15%	30%	$27,782	$27,782	$72,232	$313,007
4	West Branch Columbia Southern West	1336.91	NA	15	3	3	21	NA	$39,647	$153,594	$1,337	$194,578	15%	15%	30%	$29,187	$29,187	$75,885	$328,836
4	West Branch Columbia Southern West	8.76	NA	15	3	3	21	NA	$260	$1,006	$9	$1,275	15%	15%	30%	$191	$191	$497	$2,155
4	West Branch Columbia Southern West	423.59	NA	15	3	3	21	NA	$12,562	$48,665	$424	$61,650	15%	15%	30%	$9,247	$9,247	$24,043	$104,188
4	West Branch Columbia Southern West	727.16	NA	12	4	2	17	NA	$19,418	$69,655	$727	$89,800	15%	15%	30%	$13,470	$13,470	$35,022	$151,762
4	West Branch Columbia Southern West	854.50	NA	12	4	2	17	NA	$22,819	$81,853	$855	$105,526	15%	15%	30%	$15,829	$15,829	$41,155	$178,339
4	West Branch Columbia Southern West	0.48	NA	12	4	2	17	NA	$13	$46	$0	$59	15%	15%	30%	$9	$9	$23	$100
4	West Branch Columbia Southern West	8.38	NA	12	4	2	17	NA	$224	$803	$8	$1,035	15%	15%	30%	$155	$155	$404	$1,749
4	West Branch Columbia Southern West	490.27	NA	12	4	2	17	NA	$13,092	$46,963	$490	$60,545	15%	15%	30%	$9,082	$9,082	$23,613	$102,322
4	West Branch Columbia Southern West	1369.00	NA	12	4	2	17	NA	$36,558	$131,137	$1,369	$169,063	15%	15%	30%	$25,360	$25,360	$65,935	$285,717
4	West Branch Columbia Southern West	1815.52	NA	12	4	2	17	NA	$48,481	$173,909	$1,816	$224,206	15%	15%	30%	$33,631	$33,631	$87,440	$378,908
4	West Branch Columbia Southern West	816.70	NA	12	4	2	17	NA	$21,809	$78,232	$817	$100,857	15%	15%	30%	$15,129	$15,129	$39,334	$170,449
4	West Branch Columbia Southern West	2.18	NA	12	4	2	17	NA	$58	$209	$2	$269	15%	15%	30%	$40	$40	$105	$455

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
4	West Branch Columbia Southern West	842.76	NA	12	4	2	17	NA	$22,505	$80,728	$843	$104,076	15%	15%	30%	$15,611	$15,611	$40,590	$175,888
4	West Branch Columbia Southern West	345.68	NA	12	4	2	17	NA	$9,231	$33,112	$346	$42,689	15%	15%	30%	$6,403	$6,403	$16,649	$72,144
4	West Branch Columbia Southern West	401.22	NA	12	4	2	17	NA	$10,714	$38,433	$401	$49,548	15%	15%	30%	$7,432	$7,432	$19,324	$83,737
4	West Branch Columbia Southern West	694.19	NA	12	4	2	17	NA	$18,538	$66,497	$694	$85,729	15%	15%	30%	$12,859	$12,859	$33,434	$144,881
4	West Branch Columbia Southern West	1239.81	NA	12	4	2	17	NA	$33,108	$118,762	$1,240	$153,110	15%	15%	30%	$22,966	$22,966	$59,713	$258,756
4	West Branch Columbia Southern West	1385.17	NA	12	4	2	17	NA	$36,990	$132,686	$1,385	$171,061	15%	15%	30%	$25,659	$25,659	$66,714	$289,093
4	West Branch Columbia Southern West	435.85	NA	12	4	2	17	NA	$11,639	$41,751	$436	$53,825	15%	15%	30%	$8,074	$8,074	$20,992	$90,965
4	West Branch Columbia Southern West	2562.74	NA	12	4	2	17	NA	$68,435	$245,485	$2,563	$316,483	15%	15%	30%	$47,472	$47,472	$123,428	$534,856
4	Spaulding Lateral	NA	17	NA	NA	NA	NA	$17,000	NA	NA	NA	$17,000	15%	15%	30%	$2,550	$2,550	$6,630	$28,730
4	Beasley Lateral	NA	20	NA	NA	NA	NA	$20,000	NA	NA	NA	$20,000	15%	15%	30%	$3,000	$3,000	$7,800	$33,800
4	West Branch Columbia Southern West	NA	31	NA	NA	NA	NA	$31,000	NA	NA	NA	$31,000	15%	15%	30%	$4,650	$4,650	$12,090	$52,390
5	Gainsforth Ditch	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	15%	30%	$600	$600	$1,560	$6,760
5	Chambers (Lafores) Ditch	NA	7	NA	NA	NA	NA	$7,000	NA	NA	NA	$7,000	15%	15%	30%	$1,050	$1,050	$2,730	$11,830
5	Chambers (Lafores) Ditch	12.70	NA	5	1	1	10	NA	$258	$694	$13	$966	15%	15%	30%	$145	$145	$377	$1,632
5	Chambers (Lafores) Ditch	12.81	NA	5	1	1	10	NA	$261	$701	$13	$974	15%	15%	30%	$146	$146	$380	$1,647
5	Chambers (Lafores) Ditch	509.50	NA	5	1	1	10	NA	$10,370	$27,866	$510	$38,746	15%	15%	30%	$5,812	$5,812	$15,111	$65,480
5	Chambers (Lafores) Ditch	642.90	NA	5	1	1	10	NA	$13,085	$35,162	$643	$48,890	15%	15%	30%	$7,334	$7,334	$19,067	$82,624
5	Chambers (Lafores) Ditch	215.19	NA	5	1	1	10	NA	$4,380	$11,769	$215	$16,364	15%	15%	30%	$2,455	$2,455	$6,382	$27,655
5	Chambers (Lafores) Ditch	390.87	NA	5	1	1	10	NA	$7,955	$21,378	$391	$29,724	15%	15%	30%	$4,459	$4,459	$11,592	$50,234
5	Chambers (Lafores) Ditch	282.09	NA	5	1	1	10	NA	$5,741	$15,428	$282	$21,452	15%	15%	30%	$3,218	$3,218	$8,366	$36,253
5	Couch Lateral	2462.91	NA	12	4	2	17	NA	$65,769	$235,923	$2,463	$304,155	15%	15%	30%	$45,623	$45,623	$118,620	$514,022
5	Couch Lateral	1350.97	NA	12	4	2	17	NA	$36,076	$129,410	$1,351	$166,837	15%	15%	30%	$25,026	$25,026	$65,066	$281,954
5	Couch Lateral	354.71	NA	12	4	2	17	NA	$9,472	$33,978	$355	$43,805	15%	15%	30%	$6,571	$6,571	$17,084	$74,031
5	Couch Lateral	1494.79	NA	12	4	2	17	NA	$39,917	$143,186	$1,495	$184,598	15%	15%	30%	$27,690	$27,690	$71,993	$311,970
5	Couch Lateral	872.98	NA	12	4	2	17	NA	$23,312	$83,623	$873	$107,809	15%	15%	30%	$16,171	$16,171	$42,045	$182,196
5	Couch Lateral	320.08	NA	12	4	2	17	NA	$8,547	$30,660	$320	$39,528	15%	15%	30%	$5,929	$5,929	$15,416	$66,802
5	Couch Lateral	1095.21	NA	12	4	2	17	NA	$29,246	$104,911	$1,095	$135,252	15%	15%	30%	$20,288	$20,288	$52,748	$228,577
5	Couch Lateral	301.52	NA	12	4	2	17	NA	$8,052	$28,882	$302	$37,236	15%	15%	30%	$5,585	$5,585	$14,522	$62,928

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5	Couch Lateral	97.20	NA	12	4	2	17	NA	$2,596	$9,311	$97	$12,004	15%	15%	30%	$1,801	$1,801	$4,682	$20,287
5	Couch Lateral	14.86	NA	12	4	2	17	NA	$397	$1,424	$15	$1,835	15%	15%	30%	$275	$275	$716	$3,102
5	Couch Lateral	699.60	NA	12	4	2	17	NA	$18,682	$67,015	$700	$86,396	15%	15%	30%	$12,959	$12,959	$33,695	$146,010
5	Couch Lateral	1106.72	NA	12	4	2	17	NA	$29,554	$106,013	$1,107	$136,673	15%	15%	30%	$20,501	$20,501	$53,302	$230,977
5	Couch Lateral	29.63	NA	12	4	2	17	NA	$791	$2,838	$30	$3,659	15%	15%	30%	$549	$549	$1,427	$6,183
5	Couch Lateral	605.56	NA	12	4	2	17	NA	$16,171	$58,007	$606	$74,783	15%	15%	30%	$11,217	$11,217	$29,165	$126,383
5	Couch Lateral	159.02	NA	12	4	2	17	NA	$4,247	$15,233	$159	$19,639	15%	15%	30%	$2,946	$2,946	$7,659	$33,189
5	Couch Lateral	337.38	NA	12	4	2	17	NA	$9,009	$32,318	$337	$41,665	15%	15%	30%	$6,250	$6,250	$16,249	$70,414
5	Couch Lateral	497.21	NA	12	4	2	17	NA	$13,278	$47,628	$497	$61,403	15%	15%	30%	$9,210	$9,210	$23,947	$103,771
5	Couch Lateral	95.12	NA	12	4	2	17	NA	$2,540	$9,112	$95	$11,747	15%	15%	30%	$1,762	$1,762	$4,581	$19,853
5	Couch Lateral	361.83	NA	12	4	2	17	NA	$9,662	$34,660	$362	$44,684	15%	15%	30%	$6,703	$6,703	$17,427	$75,517
5	Couch Lateral	94.14	NA	12	4	2	17	NA	$2,514	$9,018	$94	$11,626	15%	15%	30%	$1,744	$1,744	$4,534	$19,648
5	Couch Lateral	1169.70	NA	12	4	2	17	NA	$31,236	$112,046	$1,170	$144,452	15%	15%	30%	$21,668	$21,668	$56,336	$244,123
5	Couch Lateral	13.71	NA	12	4	2	17	NA	$366	$1,313	$14	$1,693	15%	15%	30%	$254	$254	$660	$2,862
5	Couch Lateral	603.93	NA	12	4	2	17	NA	$16,127	$57,851	$604	$74,582	15%	15%	30%	$11,187	$11,187	$29,087	$126,044
5	Couch Lateral	9.41	NA	12	4	2	17	NA	$251	$902	$9	$1,163	15%	15%	30%	$174	$174	$453	$1,965
5	Couch Lateral	823.56	NA	12	4	2	17	NA	$21,992	$78,889	$824	$101,705	15%	15%	30%	$15,256	$15,256	$39,665	$171,882
5	Couch Lateral	0.15	NA	12	4	2	17	NA	$4	$14	$0	$18	15%	15%	30%	$3	$3	$7	$31
5	East Couch Lateral	560.45	NA	5	1	1	10	NA	$11,407	$30,653	$560	$42,620	15%	15%	30%	$6,393	$6,393	$16,622	$72,028
5	East Couch Lateral	47.09	NA	5	1	1	10	NA	$958	$2,575	$47	$3,581	15%	15%	30%	$537	$537	$1,397	$6,052
5	East Couch Lateral	222.72	NA	5	1	1	10	NA	$4,533	$12,181	$223	$16,937	15%	15%	30%	$2,541	$2,541	$6,605	$28,623
5	East Couch Lateral	17.68	NA	5	1	1	10	NA	$360	$967	$18	$1,345	15%	15%	30%	$202	$202	$524	$2,272
5	East Couch Lateral	1082.62	NA	5	1	1	10	NA	$22,034	$59,212	$1,083	$82,329	15%	15%	30%	$12,349	$12,349	$32,108	$139,136
5	East Couch Lateral	16.44	NA	5	1	1	10	NA	$335	$899	$16	$1,250	15%	15%	30%	$188	$188	$488	$2,113
5	East Couch Lateral	890.62	NA	5	1	1	10	NA	$18,126	$48,711	$891	$67,728	15%	15%	30%	$10,159	$10,159	$26,414	$114,460
5	East Couch Lateral	10.94	NA	5	1	1	10	NA	$223	$599	$11	$832	15%	15%	30%	$125	$125	$325	$1,407
5	East Couch Lateral	229.97	NA	5	1	1	10	NA	$4,681	$12,578	$230	$17,488	15%	15%	30%	$2,623	$2,623	$6,820	$29,555
5	East Couch Lateral	202.99	NA	5	1	1	10	NA	$4,131	$11,102	$203	$15,436	15%	15%	30%	$2,315	$2,315	$6,020	$26,087
5	East Couch Lateral	159.97	NA	5	1	1	10	NA	$3,256	$8,749	$160	$12,165	15%	15%	30%	$1,825	$1,825	$4,744	$20,559
5	West Couch Sublateral East	NA	10	NA	NA	NA	NA	$10,000	NA	NA	NA	$10,000	15%	15%	30%	$1,500	$1,500	$3,900	$16,900
5	Gainsforth Ditch	2307.47	NA	5	1	1	10	NA	$46,963	$126,204	$2,307	$175,475	15%	15%	30%	$26,321	$26,321	$68,435	$296,552
5	Gainsforth Ditch	847.10	NA	5	1	1	10	NA	$17,241	$46,331	$847	$64,418	15%	15%	30%	$9,663	$9,663	$25,123	$108,867
5	Gainsforth Ditch	570.14	NA	5	1	1	10	NA	$11,604	$31,183	$570	$43,357	15%	15%	30%	$6,504	$6,504	$16,909	$73,274
5	Gainsforth Ditch	166.24	NA	5	1	1	10	NA	$3,383	$9,092	$166	$12,642	15%	15%	30%	$1,896	$1,896	$4,930	$21,365
5	West Couch Lateral	445.56	NA	12	4	2	17	NA	$11,898	$42,680	$446	$55,023	15%	15%	30%	$8,254	$8,254	$21,459	$92,990

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5	West Couch Lateral	3951.10	NA	12	4	2	17	NA	$105,510	$378,477	$3,951	$487,938	15%	15%	30%	$73,191	$73,191	$190,296	$824,616
5	West Couch Lateral	4.52	NA	12	4	2	17	NA	$121	$433	$5	$558	15%	15%	30%	$84	$84	$218	$943
5	West Couch Lateral	771.78	NA	12	4	2	17	NA	$20,609	$73,929	$772	$95,310	15%	15%	30%	$14,296	$14,296	$37,171	$161,073
5	West Couch Lateral	594.89	NA	12	4	2	17	NA	$15,886	$56,985	$595	$73,466	15%	15%	30%	$11,020	$11,020	$28,652	$124,157
5	West Couch Lateral	2608.22	NA	12	4	2	17	NA	$69,650	$249,842	$2,608	$322,100	15%	15%	30%	$48,315	$48,315	$125,619	$544,348
5	West Couch Lateral	1351.80	NA	12	4	2	17	NA	$36,098	$129,490	$1,352	$166,940	15%	15%	30%	$25,041	$25,041	$65,107	$282,128
5	West Couch Lateral	571.03	NA	12	4	2	17	NA	$15,249	$54,699	$571	$70,518	15%	15%	30%	$10,578	$10,578	$27,502	$119,176
5	West Couch Lateral	1413.37	NA	12	4	2	17	NA	$37,743	$135,387	$1,413	$174,543	15%	15%	30%	$26,181	$26,181	$68,072	$294,978
5	West Couch Lateral	469.71	NA	12	4	2	17	NA	$12,543	$44,993	$470	$58,006	15%	15%	30%	$8,701	$8,701	$22,622	$98,030
5	West Couch Lateral	2226.19	NA	12	4	2	17	NA	$59,448	$213,247	$2,226	$274,921	15%	15%	30%	$41,238	$41,238	$107,219	$464,617
5	West Couch Lateral	3149.72	NA	12	4	2	17	NA	$84,110	$301,713	$3,150	$388,972	15%	15%	30%	$58,346	$58,346	$151,699	$657,363
5	West Couch Lateral	13.40	NA	12	4	2	17	NA	$358	$1,284	$13	$1,655	15%	15%	30%	$248	$248	$646	$2,797
5	West Couch Lateral	1.48	NA	12	4	2	17	NA	$39	$141	$1	$182	15%	15%	30%	$27	$27	$71	$308
5	West Couch Lateral	0.90	NA	12	4	2	17	NA	$24	$86	$1	$111	15%	15%	30%	$17	$17	$43	$187
5	West Couch Lateral	348.55	NA	12	4	2	17	NA	$9,308	$33,388	$349	$43,044	15%	15%	30%	$6,457	$6,457	$16,787	$72,745
5	West Couch Lateral	111.70	NA	12	4	2	17	NA	$2,983	$10,699	$112	$13,794	15%	15%	30%	$2,069	$2,069	$5,380	$23,311
5	West Couch Lateral	1659.27	NA	12	4	2	17	NA	$44,309	$158,942	$1,659	$204,911	15%	15%	30%	$30,737	$30,737	$79,915	$346,299
5	West Couch Lateral	3502.96	NA	12	4	2	17	NA	$93,543	$335,549	$3,503	$432,595	15%	15%	30%	$64,889	$64,889	$168,712	$731,086
5	West Couch Lateral	1291.35	NA	12	4	2	17	NA	$34,484	$123,699	$1,291	$159,474	15%	15%	30%	$23,921	$23,921	$62,195	$269,512
5	West Couch Sublateral East	551.54	NA	5	1	1	10	NA	$11,225	$30,166	$552	$41,942	15%	15%	30%	$6,291	$6,291	$16,358	$70,883
5	West Couch Sublateral East	6.16	NA	5	1	1	10	NA	$125	$337	$6	$468	15%	15%	30%	$70	$70	$183	$791
5	West Couch Sublateral East	1907.27	NA	5	1	1	10	NA	$38,818	$104,315	$1,907	$145,040	15%	15%	30%	$21,756	$21,756	$56,566	$245,118
5	West Couch Sublateral East	8.25	NA	5	1	1	10	NA	$168	$451	$8	$628	15%	15%	30%	$94	$94	$245	$1,061
5	West Couch Sublateral East	210.32	NA	5	1	1	10	NA	$4,281	$11,503	$210	$15,994	15%	15%	30%	$2,399	$2,399	$6,238	$27,030
5	West Couch Sublateral East	190.39	NA	5	1	1	10	NA	$3,875	$10,413	$190	$14,479	15%	15%	30%	$2,172	$2,172	$5,647	$24,469
5	West Couch Sublateral East	541.35	NA	5	1	1	10	NA	$11,018	$29,608	$541	$41,167	15%	15%	30%	$6,175	$6,175	$16,055	$69,573
5	West Couch Sublateral East	348.45	NA	5	1	1	10	NA	$7,092	$19,058	$348	$26,498	15%	15%	30%	$3,975	$3,975	$10,334	$44,782
5	West Couch Sublateral East	132.13	NA	5	1	1	10	NA	$2,689	$7,227	$132	$10,048	15%	15%	30%	$1,507	$1,507	$3,919	$16,981
5	West Couch Sublateral East	972.21	NA	5	1	1	10	NA	$19,787	$53,173	$972	$73,932	15%	15%	30%	$11,090	$11,090	$28,834	$124,946

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5	Couch Lateral	NA	12	NA	NA	NA	NA	$12,000	NA	NA	NA	$12,000	15%	15%	30%	$1,800	$1,800	$4,680	$20,280
5	West Couch Lateral	NA	23	NA	NA	NA	NA	$23,000	NA	NA	NA	$23,000	15%	15%	30%	$3,450	$3,450	$8,970	$38,870
5	East Couch Lateral	NA	26	NA	NA	NA	NA	$26,000	NA	NA	NA	$26,000	15%	15%	30%	$3,900	$3,900	$10,140	$43,940
6	Conarn East	NA	2	NA	NA	NA	NA	$2,000	NA	NA	NA	$2,000	15%	15%	30%	$300	$300	$780	$3,380
6	North Hammond Lateral	NA	5	NA	NA	NA	NA	$5,000	NA	NA	NA	$5,000	15%	15%	30%	$750	$750	$1,950	$8,450
6	Putnam Lateral	NA	5	NA	NA	NA	NA	$5,000	NA	NA	NA	$5,000	10%	12%	30%	$500	$600	$1,830	$7,930
6	West Branch Columbia Southern East	NA	7	NA	NA	NA	NA	$7,000	NA	NA	NA	$7,000	15%	15%	30%	$1,050	$1,050	$2,730	$11,830
6	Phiffer Lateral	NA	9	NA	NA	NA	NA	$9,000	NA	NA	NA	$9,000	12%	12%	30%	$1,080	$1,080	$3,348	$14,508
6	West Branch Columbia Southern East	NA	9	NA	NA	NA	NA	$9,000	NA	NA	NA	$9,000	15%	15%	30%	$1,350	$1,350	$3,510	$15,210
6	North Columbia Southern East Lateral and Sublateral	NA	11	NA	NA	NA	NA	$11,000	NA	NA	NA	$11,000	15%	15%	30%	$1,650	$1,650	$4,290	$18,590
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	197.00	NA	18	2	4	24	NA	$6,423	$26,395	$197	$33,015	15%	15%	30%	$4,952	$4,952	$12,876	$55,796
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	21.02	NA	18	2	4	24	NA	$685	$2,816	$21	$3,523	15%	15%	30%	$528	$528	$1,374	$5,953
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1921.29	NA	18	2	4	24	NA	$62,647	$257,421	$1,921	$321,989	15%	15%	30%	$48,298	$48,298	$125,576	$544,161
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1043.16	NA	18	2	4	24	NA	$34,014	$139,766	$1,043	$174,824	15%	15%	30%	$26,224	$26,224	$68,181	$295,452
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	874.97	NA	18	2	4	24	NA	$28,530	$117,232	$875	$146,636	15%	15%	30%	$21,995	$21,995	$57,188	$247,816
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	25.17	NA	18	2	4	24	NA	$821	$3,373	$25	$4,219	15%	15%	30%	$633	$633	$1,645	$7,130
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	202.69	NA	18	2	4	24	NA	$6,609	$27,157	$203	$33,969	15%	15%	30%	$5,095	$5,095	$13,248	$57,407

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	0.67	NA	18	2	4	24	NA	$22	$89	$1	$112	15%	15%	30%	$17	$17	$44	$189
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	2.52	NA	18	2	4	24	NA	$82	$337	$3	$422	15%	15%	30%	$63	$63	$164	$713
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1930.50	NA	18	2	4	24	NA	$62,947	$258,655	$1,930	$323,533	15%	15%	30%	$48,530	$48,530	$126,178	$546,770
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1330.41	NA	18	2	4	24	NA	$43,380	$178,253	$1,330	$222,964	15%	15%	30%	$33,445	$33,445	$86,956	$376,809
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	215.58	NA	18	2	4	24	NA	$7,029	$28,884	$216	$36,129	15%	15%	30%	$5,419	$5,419	$14,090	$61,058
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	76.82	NA	18	2	4	24	NA	$2,505	$10,292	$77	$12,874	15%	15%	30%	$1,931	$1,931	$5,021	$21,757
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	565.40	NA	18	2	4	24	NA	$18,436	$75,755	$565	$94,756	15%	15%	30%	$14,213	$14,213	$36,955	$160,138
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1079.96	NA	18	2	4	24	NA	$35,214	$144,697	$1,080	$180,991	15%	15%	30%	$27,149	$27,149	$70,587	$305,875
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1123.03	NA	18	2	4	24	NA	$36,618	$150,468	$1,123	$188,210	15%	15%	30%	$28,231	$28,231	$73,402	$318,074
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	695.59	NA	18	2	4	24	NA	$22,681	$93,198	$696	$116,575	15%	15%	30%	$17,486	$17,486	$45,464	$197,012
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1000.00	NA	15	3	3	21	NA	$29,655	$114,887	$1,000	$145,542	15%	15%	30%	$21,831	$21,831	$56,761	$245,966
6	Columbia Southern Lateral TFC	715.99	NA	15	3	3	21	NA	$21,233	$82,258	$716	$104,206	15%	15%	30%	$15,631	$15,631	$40,640	$176,109

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
	Hillburner/PR V to Tail																		
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	7.95	NA	15	3	3	21	NA	$236	$913	$8	$1,157	15%	15%	30%	$174	$174	$451	$1,955
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	143.85	NA	15	3	3	21	NA	$4,266	$16,526	$144	$20,936	15%	15%	30%	$3,140	$3,140	$8,165	$35,381
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	226.53	NA	15	3	3	21	NA	$6,718	$26,025	$227	$32,969	15%	15%	30%	$4,945	$4,945	$12,858	$55,718
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	457.16	NA	15	3	3	21	NA	$13,557	$52,522	$457	$66,536	15%	15%	30%	$9,980	$9,980	$25,949	$112,446
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	0.15	NA	15	3	3	21	NA	$4	$17	$0	$22	15%	15%	30%	$3	$3	$9	$37
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	1.40	NA	15	3	3	21	NA	$41	$160	$1	$203	15%	15%	30%	$30	$30	$79	$343
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	2.19	NA	15	3	3	21	NA	$65	$252	$2	$319	15%	15%	30%	$48	$48	$125	$540
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	403.78	NA	15	3	3	21	NA	$11,974	$46,389	$404	$58,767	15%	15%	30%	$8,815	$8,815	$22,919	$99,316
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	117.74	NA	15	3	3	21	NA	$3,491	$13,526	$118	$17,135	15%	15%	30%	$2,570	$2,570	$6,683	$28,959
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	496.83	NA	15	3	3	21	NA	$14,734	$57,080	$497	$72,310	15%	15%	30%	$10,847	$10,847	$28,201	$122,204
6	Columbia Southern Lateral TFC Hillburner/PR V to Tail	2216.39	NA	15	3	3	21	NA	$65,728	$254,635	$2,216	$322,579	15%	15%	30%	$48,387	$48,387	$125,806	$545,158
6	Columbia Southern	694.12	NA	15	3	3	21	NA	$20,584	$79,746	$694	$101,024	15%	15%	30%	$15,154	$15,154	$39,399	$170,731

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
	Lateral TFC Hillburner/PRV to Tail																		
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1888.49	NA	15	3	3	21	NA	$56,004	$216,963	$1,888	$274,855	15%	15%	30%	$41,228	$41,228	$107,193	$464,504
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	2.83	NA	15	3	3	21	NA	$84	$326	$3	$413	15%	15%	30%	$62	$62	$161	$697
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	1.99	NA	15	3	3	21	NA	$59	$229	$2	$290	15%	15%	30%	$44	$44	$113	$490
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	128.19	NA	15	3	3	21	NA	$3,801	$14,727	$128	$18,656	15%	15%	30%	$2,798	$2,798	$7,276	$31,529
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	31.46	NA	15	3	3	21	NA	$933	$3,615	$31	$4,579	15%	15%	30%	$687	$687	$1,786	$7,739
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	161.55	NA	15	3	3	21	NA	$4,791	$18,560	$162	$23,512	15%	15%	30%	$3,527	$3,527	$9,170	$39,735
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	566.40	NA	15	3	3	21	NA	$16,797	$65,072	$566	$82,436	15%	15%	30%	$12,365	$12,365	$32,150	$139,316
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	372.24	NA	15	3	3	21	NA	$11,039	$42,766	$372	$54,177	15%	15%	30%	$8,127	$8,127	$21,129	$91,559
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	492.30	NA	15	3	3	21	NA	$14,599	$56,559	$492	$71,650	15%	15%	30%	$10,748	$10,748	$27,944	$121,089
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	153.19	NA	15	3	3	21	NA	$4,543	$17,599	$153	$22,295	15%	15%	30%	$3,344	$3,344	$8,695	$37,679
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	417.72	NA	15	3	3	21	NA	$12,387	$47,990	$418	$60,795	15%	15%	30%	$9,119	$9,119	$23,710	$102,744

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	548.18	NA	15	3	3	21	NA	$16,256	$62,978	$548	$79,783	15%	15%	30%	$11,967	$11,967	$31,115	$134,833
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	820.10	NA	15	3	3	21	NA	$24,320	$94,219	$820	$119,360	15%	15%	30%	$17,904	$17,904	$46,550	$201,718
6	Columbia Southern Lateral TFC Hillburner/PRV to Tail	0.03	NA	15	3	3	21	NA	$1	$3	$0	$4	15%	15%	30%	$1	$1	$2	$7
6	Columbia Southern Lateral TFC to Hillburner/PRV	256.25	NA	20	4	4	26	NA	$8,791	$37,152	$256	$46,199	4%	12%	30%	$1,848	$5,544	$16,077	$69,668
6	Columbia Southern Lateral TFC to Hillburner/PRV	2777.79	NA	20	4	4	26	NA	$95,297	$402,735	$2,778	$500,809	4%	12%	30%	$20,032	$60,097	$174,282	$755,220
6	Columbia Southern Lateral TFC to Hillburner/PRV	30.32	NA	20	4	4	26	NA	$1,040	$4,396	$30	$5,466	4%	12%	30%	$219	$656	$1,902	$8,243
6	Columbia Southern Lateral TFC to Hillburner/PRV	1410.28	NA	20	4	4	26	NA	$48,382	$204,468	$1,410	$254,260	4%	12%	30%	$10,170	$30,511	$88,483	$383,424
6	Columbia Southern Lateral TFC to Hillburner/PRV	1368.31	NA	20	4	4	26	NA	$46,942	$198,382	$1,368	$246,693	4%	12%	30%	$9,868	$29,603	$85,849	$372,013
6	Columbia Southern Lateral TFC to Hillburner/PRV	1060.74	NA	20	4	4	26	NA	$36,390	$153,790	$1,061	$191,242	4%	12%	30%	$7,650	$22,949	$66,552	$288,392
6	Columbia Southern Lateral TFC to Hillburner/PRV	148.97	NA	20	4	4	26	NA	$5,111	$21,599	$149	$26,859	4%	12%	30%	$1,074	$3,223	$9,347	$40,503
6	Columbia Southern Lateral TFC to Hillburner/PRV	709.84	NA	20	4	4	26	NA	$24,352	$102,915	$710	$127,977	4%	12%	30%	$5,119	$15,357	$44,536	$192,989
6	Columbia Southern Lateral TFC to	761.78	NA	20	4	4	26	NA	$26,134	$110,446	$762	$137,342	4%	12%	30%	$5,494	$16,481	$47,795	$207,111

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

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

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
6	Jewett Lateral	288.69	NA	5	1	1	10	NA	$5,876	$15,790	$289	$21,954	15%	15%	30%	$3,293	$3,293	$8,562	$37,102
6	Jewett Lateral	342.41	NA	5	1	1	10	NA	$6,969	$18,728	$342	$26,039	15%	15%	30%	$3,906	$3,906	$10,155	$44,006
6	Jewett Lateral	545.82	NA	5	1	1	10	NA	$11,109	$29,853	$546	$41,507	15%	15%	30%	$6,226	$6,226	$16,188	$70,147
6	Jewett Lateral	58.22	NA	5	1	1	10	NA	$1,185	$3,184	$58	$4,428	15%	15%	30%	$664	$664	$1,727	$7,483
6	Jewett Lateral	0.30	NA	5	1	1	10	NA	$6	$16	$0	$23	15%	15%	30%	$3	$3	$9	$38
6	Jewett Lateral	0.03	NA	5	1	1	10	NA	$1	$2	$0	$3	15%	15%	30%	$0	$0	$1	$4
6	North Columbia Southern East Lateral and Sublateral	39.16	NA	15	3	3	21	NA	$1,161	$4,499	$39	$5,699	15%	15%	30%	$855	$855	$2,223	$9,632
6	North Columbia Southern East Lateral and Sublateral	420.38	NA	15	3	3	21	NA	$12,466	$48,296	$420	$61,183	15%	15%	30%	$9,177	$9,177	$23,861	$103,399
6	North Columbia Southern East Lateral and Sublateral	909.05	NA	15	3	3	21	NA	$26,958	$104,438	$909	$132,306	15%	15%	30%	$19,846	$19,846	$51,599	$223,596
6	North Columbia Southern East Lateral and Sublateral	1566.85	NA	15	3	3	21	NA	$46,465	$180,011	$1,567	$228,043	15%	15%	30%	$34,206	$34,206	$88,937	$385,393
6	North Columbia Southern East Lateral and Sublateral	1.30	NA	15	3	3	21	NA	$39	$150	$1	$190	15%	15%	30%	$28	$28	$74	$321
6	North Columbia Southern East Lateral and Sublateral	1.11	NA	15	3	3	21	NA	$33	$128	$1	$162	15%	15%	30%	$24	$24	$63	$274
6	North Columbia Southern East Lateral and Sublateral	2694.50	NA	15	3	3	21	NA	$79,906	$309,563	$2,695	$392,164	15%	15%	30%	$58,825	$58,825	$152,944	$662,756
6	North Columbia Southern East Lateral and Sublateral	1419.21	NA	15	3	3	21	NA	$42,087	$163,049	$1,419	$206,555	15%	15%	30%	$30,983	$30,983	$80,556	$349,078
6	North Columbia Southern East Lateral and Sublateral	1207.21	NA	15	3	3	21	NA	$35,800	$138,692	$1,207	$175,699	15%	15%	30%	$26,355	$26,355	$68,523	$296,932
6	North Columbia Southern East Lateral and Sublateral	262.13	NA	15	3	3	21	NA	$7,773	$30,115	$262	$38,151	15%	15%	30%	$5,723	$5,723	$14,879	$64,475

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6	North Columbia Southern East Lateral and Sublateral	12.55	NA	15	3	3	21	NA	$372	$1,442	$13	$1,827	15%	15%	30%	$274	$274	$712	$3,087
6	North Columbia Southern East Lateral and Sublateral	1025.50	NA	15	3	3	21	NA	$30,412	$117,817	$1,026	$149,254	15%	15%	30%	$22,388	$22,388	$58,209	$252,239
6	North Columbia Southern East Lateral and Sublateral	521.23	NA	15	3	3	21	NA	$15,457	$59,882	$521	$75,861	15%	15%	30%	$11,379	$11,379	$29,586	$128,205
6	North Columbia Southern East Lateral and Sublateral	0.43	NA	15	3	3	21	NA	$13	$49	$0	$63	15%	15%	30%	$9	$9	$24	$106
6	North Columbia Southern East Lateral and Sublateral	344.38	NA	15	3	3	21	NA	$10,213	$39,565	$344	$50,122	15%	15%	30%	$7,518	$7,518	$19,547	$84,705
6	North Columbia Southern East Lateral and Sublateral	3.23	NA	15	3	3	21	NA	$96	$371	$3	$470	15%	15%	30%	$71	$71	$183	$795
6	North Columbia Southern East Lateral and Sublateral	441.51	NA	15	3	3	21	NA	$13,093	$50,724	$442	$64,259	15%	15%	30%	$9,639	$9,639	$25,061	$108,597
6	North Columbia Southern East Lateral and Sublateral	1691.22	NA	15	3	3	21	NA	$50,153	$194,299	$1,691	$246,144	15%	15%	30%	$36,922	$36,922	$95,996	$415,983
6	North Columbia Southern East Lateral and Sublateral	235.34	NA	15	3	3	21	NA	$6,979	$27,037	$235	$34,252	15%	15%	30%	$5,138	$5,138	$13,358	$57,885
6	North Columbia Southern East Lateral and Sublateral	513.85	NA	15	3	3	21	NA	$15,238	$59,034	$514	$74,786	15%	15%	30%	$11,218	$11,218	$29,167	$126,389
6	North Columbia Southern East Lateral and Sublateral	2275.77	NA	15	3	3	21	NA	$67,489	$261,457	$2,276	$331,221	15%	15%	30%	$49,683	$49,683	$129,176	$559,763
6	North Columbia Southern East	187.13	NA	15	3	3	21	NA	$5,549	$21,498	$187	$27,235	15%	15%	30%	$4,085	$4,085	$10,622	$46,027

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	Lateral and Sublateral																		
6	North Columbia Southern East Lateral and Sublateral	772.24	NA	15	3	3	21	NA	$22,901	$88,721	$772	$112,394	15%	15%	30%	$16,859	$16,859	$43,834	$189,946
6	North Columbia Southern East Lateral and Sublateral	4.72	NA	15	3	3	21	NA	$140	$543	$5	$688	15%	15%	30%	$103	$103	$268	$1,162
6	North Columbia Southern East Lateral and Sublateral	1867.37	NA	15	3	3	21	NA	$55,377	$214,536	$1,867	$271,781	15%	15%	30%	$40,767	$40,767	$105,994	$459,309
6	North Columbia Southern East Lateral and Sublateral	2299.67	NA	15	3	3	21	NA	$68,197	$264,202	$2,300	$334,698	15%	15%	30%	$50,205	$50,205	$130,532	$565,640
6	North Columbia Southern East Lateral and Sublateral	17.27	NA	15	3	3	21	NA	$512	$1,985	$17	$2,514	15%	15%	30%	$377	$377	$981	$4,249
6	North Columbia Southern West Lateral and Sublateral	426.03	NA	5	1	1	10	NA	$8,671	$23,301	$426	$32,398	6%	10%	30%	$1,944	$3,240	$11,274	$48,856
6	North Columbia Southern West Lateral and Sublateral	89.25	NA	5	1	1	10	NA	$1,816	$4,881	$89	$6,787	6%	10%	30%	$407	$679	$2,362	$10,235
6	North Columbia Southern West Lateral and Sublateral	3.72	NA	5	1	1	10	NA	$76	$203	$4	$283	6%	10%	30%	$17	$28	$98	$427
6	North Columbia Southern West Lateral and Sublateral	874.53	NA	5	1	1	10	NA	$17,799	$47,831	$875	$66,504	6%	10%	30%	$3,990	$6,650	$23,143	$100,288
6	North Columbia Southern West Lateral and Sublateral	419.48	NA	5	1	1	10	NA	$8,537	$22,943	$419	$31,899	6%	10%	30%	$1,914	$3,190	$11,101	$48,104
6	North Columbia Southern West Lateral and Sublateral	8.37	NA	5	1	1	10	NA	$170	$458	$8	$636	6%	10%	30%	$38	$64	$221	$960
6	North Columbia	466.39	NA	5	1	1	10	NA	$9,492	$25,509	$466	$35,467	6%	10%	30%	$2,128	$3,547	$12,343	$53,485

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	Southern West Lateral and Sublateral																		
6	North Columbia Southern West Lateral and Sublateral	410.37	NA	5	1	1	10	NA	$8,352	$22,444	$410	$31,207	6%	10%	30%	$1,872	$3,121	$10,860	$47,060
6	North Columbia Southern West Lateral and Sublateral	0.51	NA	5	1	1	10	NA	$10	$28	$1	$39	6%	10%	30%	$2	$4	$14	$59
6	North Columbia Southern West Lateral and Sublateral	1.17	NA	5	1	1	10	NA	$24	$64	$1	$89	6%	10%	30%	$5	$9	$31	$134
6	North Columbia Southern West Lateral and Sublateral	5.40	NA	5	1	1	10	NA	$110	$295	$5	$410	6%	10%	30%	$25	$41	$143	$619
6	North Columbia Southern West Lateral and Sublateral	1139.24	NA	5	1	1	10	NA	$23,187	$62,309	$1,139	$86,635	6%	10%	30%	$5,198	$8,664	$30,149	$130,646
6	North Columbia Southern West Lateral and Sublateral	4.28	NA	5	1	1	10	NA	$87	$234	$4	$325	6%	10%	30%	$20	$33	$113	$491
6	North Columbia Southern West Lateral and Sublateral	0.68	NA	5	1	1	10	NA	$14	$37	$1	$52	6%	10%	30%	$3	$5	$18	$78
6	North Columbia Southern West Lateral and Sublateral	5.12	NA	5	1	1	10	NA	$104	$280	$5	$389	6%	10%	30%	$23	$39	$136	$587
6	North Columbia Southern West Lateral and Sublateral	2.98	NA	5	1	1	10	NA	$61	$163	$3	$227	6%	10%	30%	$14	$23	$79	$342
6	North Columbia Southern West Lateral and Sublateral	511.58	NA	5	1	1	10	NA	$10,412	$27,980	$512	$38,904	6%	10%	30%	$2,334	$3,890	$13,539	$58,667
6	North Columbia Southern West Lateral and Sublateral	0.93	NA	5	1	1	10	NA	$19	$51	$1	$70	6%	10%	30%	$4	$7	$25	$106

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6	North Columbia Southern West Lateral and Sublateral	639.39	NA	5	1	1	10	NA	$13,013	$34,970	$639	$48,623	6%	10%	30%	$2,917	$4,862	$16,921	$73,323
6	North Columbia Southern West Lateral and Sublateral	591.43	NA	5	1	1	10	NA	$12,037	$32,347	$591	$44,976	6%	10%	30%	$2,699	$4,498	$15,652	$67,824
6	North Columbia Southern West Lateral and Sublateral	415.24	NA	5	1	1	10	NA	$8,451	$22,711	$415	$31,578	6%	10%	30%	$1,895	$3,158	$10,989	$47,619
6	Hooker Creek Lateral	NA	18	NA	NA	NA	NA	$18,000	NA	NA	NA	$18,000	15%	15%	30%	$2,700	$2,700	$7,020	$30,420
6	Phiffer Lateral	556.65	NA	5	1	1	10	NA	$11,329	$30,445	$557	$42,331	12%	12%	30%	$5,080	$5,080	$15,747	$68,237
6	Phiffer Lateral	367.40	NA	5	1	1	10	NA	$7,478	$20,094	$367	$27,939	12%	12%	30%	$3,353	$3,353	$10,393	$45,038
6	Phiffer Lateral	45.79	NA	5	1	1	10	NA	$932	$2,504	$46	$3,482	12%	12%	30%	$418	$418	$1,295	$5,613
6	Phiffer Lateral	351.08	NA	5	1	1	10	NA	$7,145	$19,202	$351	$26,698	12%	12%	30%	$3,204	$3,204	$9,932	$43,037
6	Phiffer Lateral	589.21	NA	5	1	1	10	NA	$11,992	$32,226	$589	$44,807	12%	12%	30%	$5,377	$5,377	$16,668	$72,230
6	Phiffer Lateral	434.27	NA	5	1	1	10	NA	$8,838	$23,752	$434	$33,024	12%	12%	30%	$3,963	$3,963	$12,285	$53,235
6	Phiffer Lateral	155.84	NA	5	1	1	10	NA	$3,172	$8,523	$156	$11,851	12%	12%	30%	$1,422	$1,422	$4,408	$19,103
6	Phiffer Lateral	418.10	NA	5	1	1	10	NA	$8,510	$22,868	$418	$31,795	12%	12%	30%	$3,815	$3,815	$11,828	$51,254
6	Phiffer Lateral	0.65	NA	5	1	1	10	NA	$13	$36	$1	$50	12%	12%	30%	$6	$6	$18	$80
6	Jewett Lateral	NA	19	NA	NA	NA	NA	$19,000	NA	NA	NA	$19,000	15%	15%	30%	$2,850	$2,850	$7,410	$32,110
6	Putnam Lateral	1238.60	NA	5	1	1	10	NA	$25,209	$67,743	$1,239	$94,190	10%	12%	30%	$9,419	$11,303	$34,474	$149,386
6	Putnam Lateral	1339.18	NA	5	1	1	10	NA	$27,256	$73,245	$1,339	$101,840	10%	12%	30%	$10,184	$12,221	$37,273	$161,518
6	Putnam Lateral	36.24	NA	5	1	1	10	NA	$738	$1,982	$36	$2,756	10%	12%	30%	$276	$331	$1,009	$4,371
6	Putnam Lateral	423.19	NA	5	1	1	10	NA	$8,613	$23,145	$423	$32,182	10%	12%	30%	$3,218	$3,862	$11,778	$51,040
6	Putnam Lateral	2468.23	NA	5	1	1	10	NA	$50,235	$134,996	$2,468	$187,700	10%	12%	30%	$18,770	$22,524	$68,698	$297,692
6	West Branch Columbia Southern East	352.49	NA	5	1	1	10	NA	$7,174	$19,279	$352	$26,805	15%	15%	30%	$4,021	$4,021	$10,454	$45,301
6	West Branch Columbia Southern East	0.13	NA	5	1	1	10	NA	$3	$7	$0	$10	15%	15%	30%	$2	$2	$4	$17
6	West Branch Columbia Southern East	882.08	NA	5	1	1	10	NA	$17,953	$48,244	$882	$67,079	15%	15%	30%	$10,062	$10,062	$26,161	$113,363
6	West Branch Columbia Southern East	265.58	NA	5	1	1	10	NA	$5,405	$14,526	$266	$20,197	15%	15%	30%	$3,029	$3,029	$7,877	$34,132
6	West Branch Columbia Southern East	443.66	NA	5	1	1	10	NA	$9,030	$24,265	$444	$33,738	15%	15%	30%	$5,061	$5,061	$13,158	$57,018
6	West Branch Columbia Southern East	466.34	NA	5	1	1	10	NA	$9,491	$25,506	$466	$35,464	15%	15%	30%	$5,320	$5,320	$13,831	$59,933
6	West Branch Columbia Southern East	2014.62	NA	5	1	1	10	NA	$41,003	$110,187	$2,015	$153,204	15%	15%	30%	$22,981	$22,981	$59,750	$258,915

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6	West Branch Columbia Southern East	91.41	NA	5	1	1	10	NA	$1,860	$4,999	$91	$6,951	15%	15%	30%	$1,043	$1,043	$2,711	$11,747
6	West Branch Columbia Southern East	326.84	NA	5	1	1	10	NA	$6,652	$17,876	$327	$24,855	15%	15%	30%	$3,728	$3,728	$9,693	$42,005
6	West Branch Columbia Southern East	396.91	NA	5	1	1	10	NA	$8,078	$21,709	$397	$30,184	15%	15%	30%	$4,528	$4,528	$11,772	$51,010
6	West Branch Columbia Southern East	432.18	NA	5	1	1	10	NA	$8,796	$23,638	$432	$32,866	15%	15%	30%	$4,930	$4,930	$12,818	$55,543
6	West Branch Columbia Southern East	502.21	NA	5	1	1	10	NA	$10,221	$27,468	$502	$38,191	15%	15%	30%	$5,729	$5,729	$14,895	$64,544
6	West Branch Columbia Southern East	312.65	NA	5	1	1	10	NA	$6,363	$17,100	$313	$23,776	15%	15%	30%	$3,566	$3,566	$9,273	$40,181
6	West Branch Columbia Southern East	4.09	NA	5	1	1	10	NA	$83	$223	$4	$311	15%	15%	30%	$47	$47	$121	$525
6	West Branch Columbia Southern East	4.60	NA	5	1	1	10	NA	$94	$252	$5	$350	15%	15%	30%	$52	$52	$136	$591
6	Columbia Southern Lateral TFC to Hillburner/PRV	NA	20	NA	NA	NA	NA	$20,000	NA	NA	NA	$20,000	4%	12%	30%	$800	$2,400	$6,960	$30,160
6	North Columbia Southern West Lateral and Sublateral	NA	23	NA	NA	NA	NA	$23,000	NA	NA	NA	$23,000	6%	10%	30%	$1,380	$2,300	$8,004	$34,684
7	Flannery Ditch	NA	4	NA	NA	NA	NA	$4,000	NA	NA	NA	$4,000	15%	15%	30%	$600	$600	$1,560	$6,760
7	Kickbush Lateral	NA	6	NA	NA	NA	NA	$6,000	NA	NA	NA	$6,000	15%	15%	30%	$900	$900	$2,340	$10,140
7	Tellin Lateral	NA	9	NA	NA	NA	NA	$9,000	NA	NA	NA	$9,000	15%	12%	30%	$1,350	$1,080	$3,429	$14,859
7	Gerking Lateral	NA	11	NA	NA	NA	NA	$11,000	NA	NA	NA	$11,000	10%	12%	30%	$1,100	$1,320	$4,026	$17,446
7	West Branch Columbia Southern South	NA	11	NA	NA	NA	NA	$11,000	NA	NA	NA	$11,000	15%	15%	30%	$1,650	$1,650	$4,290	$18,590
7	Hillburner Lateral	NA	17	NA	NA	NA	NA	$17,000	NA	NA	NA	$17,000	12%	12%	30%	$2,040	$2,040	$6,324	$27,404
7	Flannery Ditch	32.03	NA	5	1	1	10	NA	$652	$1,752	$32	$2,436	15%	15%	30%	$365	$365	$950	$4,116
7	Flannery Ditch	1358.45	NA	5	1	1	10	NA	$27,648	$74,298	$1,358	$103,305	15%	15%	30%	$15,496	$15,496	$40,289	$174,585
7	Flannery Ditch	770.60	NA	5	1	1	10	NA	$15,684	$42,147	$771	$58,601	15%	15%	30%	$8,790	$8,790	$22,855	$99,036
7	Flannery Ditch	17.25	NA	5	1	1	10	NA	$351	$944	$17	$1,312	15%	15%	30%	$197	$197	$512	$2,217
7	Hillburner Lateral	820.24	NA	5	1	1	10	NA	$16,694	$44,862	$820	$62,376	12%	12%	30%	$7,485	$7,485	$23,204	$100,550
7	Hillburner Lateral	19.98	NA	5	1	1	10	NA	$407	$1,093	$20	$1,519	12%	12%	30%	$182	$182	$565	$2,449
7	Hillburner Lateral	549.86	NA	5	1	1	10	NA	$11,191	$30,074	$550	$41,814	12%	12%	30%	$5,018	$5,018	$15,555	$67,405

Project Group	Name	Length	Turnout Quantity	Channel Top Width (ft)	Channel Base Width (ft)	Channel Depth (ft)	Perimeter with Freeboard (ft)	Turnout Cost	Geotextile Cost	Shotcrete Cost	Fence Cost	Subtotal Cost	Engineering, CM, Survey	CMGC	Contingency	Engineering, CM, Survey	CMGC	Contingency	Total Cost[9]
7	Hillburner Lateral	589.69	NA	5	1	1	10	NA	$12,002	$32,252	$590	$44,844	12%	12%	30%	$5,381	$5,381	$16,682	$72,288
7	Hillburner Lateral	310.65	NA	5	1	1	10	NA	$6,323	$16,991	$311	$23,624	12%	12%	30%	$2,835	$2,835	$8,788	$38,082
7	Hillburner Lateral	458.95	NA	5	1	1	10	NA	$9,341	$25,102	$459	$34,902	12%	12%	30%	$4,188	$4,188	$12,983	$56,262
7	Hillburner Lateral	1.67	NA	5	1	1	10	NA	$34	$92	$2	$127	12%	12%	30%	$15	$15	$47	$205
7	Hillburner Lateral	305.83	NA	5	1	1	10	NA	$6,225	$16,727	$306	$23,258	12%	12%	30%	$2,791	$2,791	$8,652	$37,491
7	Hillburner Lateral	527.73	NA	5	1	1	10	NA	$10,741	$28,864	$528	$40,132	12%	12%	30%	$4,816	$4,816	$14,929	$64,693
7	Hillburner Lateral	3.91	NA	5	1	1	10	NA	$80	$214	$4	$297	12%	12%	30%	$36	$36	$111	$479
7	Hillburner Lateral	3.04	NA	5	1	1	10	NA	$62	$166	$3	$231	12%	12%	30%	$28	$28	$86	$373
7	Hillburner Lateral	704.17	NA	5	1	1	10	NA	$14,332	$38,513	$704	$53,549	12%	12%	30%	$6,426	$6,426	$19,920	$86,321
7	Hillburner Lateral	220.09	NA	5	1	1	10	NA	$4,479	$12,037	$220	$16,737	12%	12%	30%	$2,008	$2,008	$6,226	$26,980
7	Hillburner Lateral	6.72	NA	5	1	1	10	NA	$137	$367	$7	$511	12%	12%	30%	$61	$61	$190	$823
7	Hillburner Lateral	124.02	NA	5	1	1	10	NA	$2,524	$6,783	$124	$9,431	12%	12%	30%	$1,132	$1,132	$3,508	$15,203
7	Hillburner Lateral	694.03	NA	5	1	1	10	NA	$14,125	$37,959	$694	$52,778	12%	12%	30%	$6,333	$6,333	$19,633	$85,078
7	Hillburner Lateral	2002.81	NA	5	1	1	10	NA	$40,763	$109,541	$2,003	$152,306	12%	12%	30%	$18,277	$18,277	$56,658	$245,517
7	Hillburner Lateral	1.56	NA	5	1	1	10	NA	$32	$85	$2	$118	12%	12%	30%	$14	$14	$44	$191
7	Tellin Lateral	210.97	NA	5	1	1	10	NA	$4,294	$11,539	$211	$16,043	15%	12%	30%	$2,407	$1,925	$6,113	$26,488
7	Tellin Lateral	2608.58	NA	5	1	1	10	NA	$53,091	$142,672	$2,609	$198,372	15%	12%	30%	$29,756	$23,805	$75,580	$327,513
7	Tellin Lateral	1118.27	NA	5	1	1	10	NA	$22,760	$61,162	$1,118	$85,040	15%	12%	30%	$12,756	$10,205	$32,400	$140,401
7	Tellin Lateral	1068.21	NA	5	1	1	10	NA	$21,741	$58,424	$1,068	$81,233	15%	12%	30%	$12,185	$9,748	$30,950	$134,116
7	Tellin Lateral	1288.48	NA	5	1	1	10	NA	$26,224	$70,472	$1,288	$97,984	15%	12%	30%	$14,698	$11,758	$37,332	$161,772
7	Tellin Lateral	36.90	NA	5	1	1	10	NA	$751	$2,018	$37	$2,806	15%	12%	30%	$421	$337	$1,069	$4,632
7	Tellin Lateral	6.61	NA	5	1	1	10	NA	$135	$362	$7	$503	15%	12%	30%	$75	$60	$192	$830
7	Tellin Lateral	525.21	NA	5	1	1	10	NA	$10,689	$28,725	$525	$39,940	15%	12%	30%	$5,991	$4,793	$15,217	$65,941
7	Tellin Lateral	1108.19	NA	5	1	1	10	NA	$22,555	$60,611	$1,108	$84,273	15%	12%	30%	$12,641	$10,113	$32,108	$139,135
																		Capital Costs	**$70,226,629**

D.4 Net Present Value of Eliminated Alternatives

This section presents the calculations used to estimate the net present value of the HDPE Piping Alternative and the eliminated alternatives.

Discount Rate: 2.750%

Period of Analysis: 100 years

Project Groups	Alternatives			
	HDPE Piping	PVC & HDPE Piping	Steel Piping	Groundwater and & HDPE Piping
Design Life	100	33	50	50
Capital Costs				
1	$6,551,000	$6,351,000	$5,877,000	$6,551,000
2	$6,372,000	$6,553,000	$15,848,000	$6,372,000
3	$3,496,000	$3,320,000	$7,657,000	$3,496,000
4	$4,120,000	$4,101,000	$10,949,000	$4,481,000
5	$3,433,000	$3,696,000	$10,076,000	$4,896,000
6	$12,963,000	$12,531,000	$25,749,000	$12,965,000
7	$1,766,000	$1,931,000	$4,445,000	$1,766,000
Replacement Costs				
1	N/A	$37,000	$1,514,000	N/A
2	N/A	$2,686,000	$4,082,000	N/A
3	N/A	$1,569,000	$1,972,000	N/A
4	N/A	$1,677,000	$2,820,000	$2,033,000
5	N/A	$1,449,000	$2,595,000	$2,221,000
6	N/A	$5,477,000	$6,632,000	$226,000
7	N/A	$497,000	$1,145,000	N/A
Annual Operation and Maintenance Costs				
1	$27,000	$27,000	$27,000	$27,000
2	$171,000	$171,000	$171,000	$171,000
3	$53,000	$53,000	$53,000	$53,000
4	$129,000	$129,000	$129,000	$149,000
5	$117,000	$117,000	$117,000	$120,000
6	$188,000	$188,000	$188,000	$195,000
7	$74,000	$74,000	$74,000	$74,000
Total Percent Change in O&M:	-16%	-16%	-16%	-13%
Total Net Present Value of O&M Costs				
1	$917,000	$917,000	$917,000	$917,000
2	$5,806,000	$5,806,000	$5,806,000	$5,806,000

Project Groups	Alternatives			
	HDPE Piping	**PVC & HDPE Piping**	**Steel Piping**	**Groundwater and & HDPE Piping**
3	$1,799,000	$1,799,000	$1,799,000	$1,799,000
4	$4,380,000	$4,380,000	$4,380,000	$5,059,000
5	$3,972,000	$3,972,000	$3,972,000	$4,074,000
6	$6,383,000	$6,383,000	$6,383,000	$6,620,000
7	$2,512,000	$2,512,000	$2,512,000	$2,512,000
Total Net Present Value of Project				
1	$7,468,000	$7,305,000	$8,308,000	$7,468,000
2	$12,178,000	$15,045,000	$25,736,000	$12,178,000
3	$5,295,000	$6,688,000	$11,428,000	$5,295,000
4	$8,500,000	$10,158,000	$18,149,000	$11,573,000
5	$7,405,000	$9,117,000	$16,643,000	$11,191,000
6	$19,346,000	$24,391,000	$38,764,000	$19,811,000
7	$4,278,000	$4,940,000	$8,102,000	$4,278,000

D.5 Hydrology Report

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

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

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

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

Hydrologic Resources

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

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

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

Crooked River. The northern border then traverses along the northern side of the Deschutes River with as little as a mile distance in some locations.

The basin's geology composition of porous volcanic rock and soil allows surface water to infiltrate into the subsurface and recharge groundwater aquifers (Gannet et al. 2001). This is one of the most significant traits of the watershed, establishing a profound connection between groundwater and surface water flow. Average annual runoff of $5.1x10^9$m is equivalent to about 0.19 meters over the entire basin with most of this water derived from the Cascade Range (O'Connor et. al2003).

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

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

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

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

The hydrology of Tumalo Creek is largely influenced by snowmelt and precipitation from its tributaries and groundwater discharge from springs. Tumalo Creek and its tributaries (Bottle Creek, Bridge Creek, Happy Valley Creek, Middle Fork, North Fork, Rock Creek, South Fork, and Spring

Creek) are unusual in the area due to their response to rain-on-snow events, which result in large increases of streamflow. This is in part to the geography of the creek's basin which includes steep valley slopes. Streamflows typically peak at 200-300 cfs during the spring due to snow melt.

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

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

Analysis Framework

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

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

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

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

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

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Appendix E

Other Supporting Information

E.1 Intensity Threshold Table

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

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

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

Resource	Intensity Threshold Negligible	Minor	Moderate	Major
		on soils classified as not highly erodible. Short-term disturbance to the soil profile or underlying geology.	on soils classified as highly erodible. Short-term changes to previously undisturbed soil profiles or underlying geology.	soils classified as highly erodible, as defined by NRCS. Permanent changes to previously undisturbed soil profiles or underlying geology.
Fish and Aquatic Species	No discernable short or long-term impacts to fish life or habitat.	Changes in watershed conditions that cause minor change in existing hydrology or sediment functions. Direct or indirect habitat changes that result only in low, short-term change in risk to ESA-listed and other fish species at the population or ESU scale.	Changes in watershed conditions that cause moderate impairment to hydrology or sediment functions. Direct or indirect habitat changes that cause moderate, short or long-term change in risk to ESA-listed or other fish species at the population or ESU scale.	Changes in watershed conditions that cause high impairment to hydrology or sediment functions that affects population viability. When, through consultation, a proposed action would likely jeopardize a species' continued existence or destroy or adversely affect a species' critical habitat
Land Use	Existing land uses or ownership would continue as before.	A short-term change in or interruption to land use or access to existing land uses. A short-term or permanent change in landowner property (but very minor) use within an existing easement or where new right-of-way or easements are required.	A permanent change in land use that is compatible with existing land use. A permanent change to landowner property use within an existing easement. Permanently limited access to agricultural or timber production areas (stranded use). An increase in unauthorized land use or access that may or may	A permanent change resulting in a modification to greater than 50 percent of a tax lot. A new unauthorized land use or access that may or may not be compatible with existing land use.

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
			not be compatible with existing land use. A short-term (more than one month at a time) change in or interruption to land use or access to existing land uses. A permanent change in land ownership.	
Public Safety	No change in risk to human health and safety.	Create a risk to health and safety that could largely be mitigated. Eliminate a known health and safety condition in localized areas	Create a known but short-term or infrequent health and safety condition. Eliminate a known health and safety condition on the study area level	Create a permanent and known health and safety condition. Eliminate a known health and safety condition on a regional level.
Recreation	No effect on the location, timing, or quality of recreation facilities and uses during and after construction.	Temporarily preclude or limit dispersed and dedicated recreational opportunities during off-peak use periods during project construction. Require relocation of dispersed recreational activities to an equal or better location after project construction. Expand to a limited degree existing recreational areas or opportunities.	Temporarily preclude or limit dispersed and dedicated recreational opportunities during peak use periods during project construction. Create or encourage new unauthorized land uses along the right-of-way for recreational purposes, such as ATV use in unauthorized areas. Create limited dispersed new recreational areas or opportunities.	Obstruct legally existing or planned dispersed recreational uses after project construction. Alter or eliminate dedicated recreation opportunities after project construction. Create extensive new recreational opportunities or areas

Resource	Intensity Threshold Negligible	Minor	Moderate	Major
Socioeconomics	No reduction in the yield of agricultural products or timber, household income, or where project activities create an imperceptible change to the unemployment rate.	Little effect on the yield of agricultural products or timber. A 1/10 of 1 percent increase in the unemployment rate. A small change in farm household incomes.	A change to the yield of agricultural products or timber at the local level A moderate change in farm household incomes. A half percentage point increase to the rate of unemployment.	A change to the yield of agricultural products or timber at the regional or national level. A large change in farm household incomes. A full percentage point of change to the rate of unemployment.
Vegetation	Project activities would not affect vegetation or it is limited to small areas.	Effects would be localized on one or more species or populations. Any adverse effects can be effectively mitigated.	A large segment of one or more species populations show effects that are of importance, but relatively localized. Mitigation could be extensive, but likely effective.	Considerable effects on plant populations over large areas. Impact is severe or of exceptional benefit to native species. Extensive mitigation required offsetting adverse effects to native species, but success not assured.
Visual Resources	Project features are visually negligible or not visible.	Landscape is a designated scenic area and project features do not attract attention to the landscape. The majority of project features do not attract attention to the landscape. Short-term visual changes during project construction.	Landscape is a designated scenic area and some project features attract attention to the landscape. A majority of project features attract attention to the landscape.	Landscape is a designated scenic area and the majority of project features attract attention to the landscape. Project features create a disruptive change and dominate the landscape.

	Intensity Threshold			
Resource	**Negligible**	**Minor**	**Moderate**	**Major**
Water Resources	Project activities would not disturb or alter water quantity, water quality, groundwater quantity, and water rights.	*Surface Water Quantity:* Less than 10 percent change in volume of annual discharge in the study area. *Ground Water:* Long-term, less than 10 percent change in depth to groundwater. *Water Rights:* Not Applicable; any change that is more than negligible would be considered moderate or major effect. *Water Quality:* Short-term measurable degradation to water quality in waterbodies that is unlikely to result in excursions to water quality standards on the Oregon's 303(d) list. Short-term measurable changes to water quality in waterbodies that are 303d listed.	*Surface Water Quantity:* Greater than 10 percent and less than 20 percent change in volume of annual discharge in the study area. *Ground Water:* Short-term, greater than 10 percent change in depth to groundwater. *Water Rights:* Short-term change in the availability of water to fulfill water rights. *Water Quality:* Permanent measurable changes to water quality in waterbodies that is unlikely to result in excursions to water quality standards on the Oregon's 303(d) list. Permanent measurable changes to water quality in waterbodies that are 303d listed.	*Surface Water Quantity:* Greater than 20 percent change in volume of annual discharge in the study area. *Ground Water:* Long-term, greater than 10 percent change in depth to groundwater. *Water Rights:* Permanent change in the availability of water to fulfill water rights. *Water Quality:* Permanent measurable changes to water quality in waterbodies that results in excursions to water quality standards on the Oregon's 303(d) list. Permanent measurable changes to the delisting of waterbodies that are 303d listed.
Wetland, Flood Plains, Riparian Zones	Doesn't alter wetlands or change the hydraulic capacity of floodplains.	Alteration of non-jurisdictional wetland hydrology, vegetation, and/or soils changes	Short-term alteration of jurisdictional wetland hydrology, vegetation, and/or soils that	Permanent alteration of jurisdictional wetland hydrology, vegetation, and/or soils that causes

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

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

E.2 Supporting Information for Fish and Aquatic Resources

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

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

Primary Constituent Element Number	Habitat Description	Characteristics
PCE 1	Nonbreeding (N), Breeding (B), Rearing (R), and Overwintering Habitat (O). Ephemeral or permanent bodies of fresh water, including, but not limited to natural or manmade ponds, springs, lakes, slow-moving streams, or pools within or oxbows adjacent to streams, canals, and ditches.	Inundated for a minimum of 4 months per year (B, R) (timing varies by elevation but may begin as early as February and last as long as September);
		Inundated from October through March (O)
		If ephemeral, areas are hydrologically connected by surface water flow to a permanent water body (e.g., pools, springs, ponds, lakes, streams, canals, or ditches) (B, R);
		Shallow water areas (less than or equal to 30 centimeters (12 inches), or water of this depth over vegetation in deeper water (B, R);
		Total surface area with less than 50 percent vegetative cover (N);
		Gradual topographic gradient (less than 3 percent slope) from shallow water toward deeper, permanent water (B, R);
		Herbaceous wetland vegetation (i.e., emergent, submergent, and floating-leaved aquatic plants), or vegetation that can structurally mimic emergent wetland vegetation through manipulation (B, R);
		Shallow water areas with high solar exposure or low (short) canopy cover (B, R);
		An absence or low density of nonnative predators (B, R, N)
PCE 2	Aquatic movement corridors. Ephemeral or permanent bodies of fresh water.	Less than or equal to 3.1 mi (5 km) linear distance from breeding areas

Primary Constituent Element Number	Habitat Description	Characteristics
		Impediment free (including, but not limited to, hard barriers such as dams, impassable culverts, lack of water, or biological barriers such as abundant predators, or lack of refugia from predators).
PCE 3	Refugia Habitat	Nonbreeding, breeding, rearing, or overwintering habitat or aquatic movement corridors with habitat characteristics (e.g., dense vegetation and/or an abundance of woody debris) that provide refugia from predators (e.g., nonnative fish or bullfrogs).

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

Primary Constituent Element Number	Habitat Description and Characteristics
PCE 1	Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.
PCE 2	Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.
PCE 3	An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
PCE 4	Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.
PCE 5	Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.
PCE 6	In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

Primary Constituent Element Number	Habitat Description and Characteristics
PCE 7	A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.
PCE 8	Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
PCE 9	Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

E.3 Supporting Calculations for Geology and Soils

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

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

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

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

				Pipe Trench Volume Calcs		Canal Volume Calcs			Total Volume Disturbed (CY) ~excluding volume of pipe~
Diameter (ft)	Sum of Length (ft)	Excavation Width (ft)	Bedding Volume (CY)	Pipe Trench Depth	Pipe Trench Volume (CY)	Canal Top Width (ft)	Canal Bottom Width (ft)	Canal Volume (CY)	
0.50	122,101	4	7,914	0.3	3,513	1.7	1.0	3,040	13,579
0.67	31,969	4	2,171	0.3	1,241	2.3	1.3	1,415	4,413
0.83	21,442	4	1,522	0.4	1,052	2.8	1.7	1,483	3,624
1.00	29,216	4	2,164	0.5	1,739	3.4	2.0	2,909	5,963
1.17	14,721	4	1,136	0.6	1,034	3.9	2.3	1,995	3,582
1.33	24,323	4	1,952	0.7	1,974	4.5	2.7	4,306	6,974
1.50	16,635	5	1,386	0.8	1,535	5.1	3.0	3,727	5,560
1.67	2,434	5	210	0.8	252	5.6	3.3	673	939
2.00	15,179	5	1,405	1.0	1,928	6.8	4.0	6,046	7,613
2.17	12,617	5	1,207	1.1	1,754	7.3	4.3	5,898	7,137
2.33	6,207	5	613	1.2	939	7.9	4.7	3,365	3,934
2.50	4,971	6	506	1.3	814	8.4	5.0	3,094	3,510
2.67	5,410	6	568	1.3	954	9.0	5.3	3,831	4,234
2.83	6,850	6	740	1.4	1,297	9.6	5.7	5,476	5,913
3.00	6,104	6	678	1.5	1,236	10.1	6.0	5,471	5,787
3.50	6,099	7	734	1.8	1,483	11.8	7.0	7,440	7,483
4.00	17,871	7	2,317	2.0	5,108	13.5	8.0	28,474	27,581
4.50	2,825	8	392	2.3	934	15.2	9.0	5,697	5,359
5.25	3,700	8	565	2.6	1,485	17.7	10.5	10,156	9,239
7.00	9,852	10	1,562	3.5	5,750	23.6	14.0	48,073	41,604
								Total	**174,028**

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

E.4 Supporting Calculations for Land Use

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

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

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

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

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

Zoning	Acres	Percentage of total area
EFUSC	3,625	13%
EFUTRB	13,975	50%
F1	1,322	5%
F2	559	2%
FP	473	2%
MUA10	2,587	9%
OS&C	1,684	6%
PF	12	0%
RL	36	0%
RM	23	0%
RR10	1,031	4%
RS	554	2%

Zoning	Acres	Percentage of total area
SM	1,547	6%
SR2-1/2	155	1%
TUC	51	0%
TUI	32	0%
TUR	77	0%
TUR5	129	0%
TURE	34	0%
UAR10	59	0%
Grand Total	**27,964**	**100%**

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

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

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

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

E.5 Supporting Calculations for Vegetation

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

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

System Element	Proposed Piping (ft)	Land affected on both sides of the canal (ft)	Additional affected land between canal affected area and maintenance road (ft)	Subtotal affected area (sq ft)
Canals	9,852	16	15	305,412
Laterals	353,293	10	8	6,359,274
System Element	**Units**	**Land affected width (ft)**	**Land affected length (ft)**	**Subtotal affected area**
Turnouts	663	10	30	198,900
Total (sq ft)				**6,863,586**
Total (acres)				**158**

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

Pipe Diameter (ft)	Sum of Length (ft)	Canal Top Width (ft)	Total Area Converted (sq ft)
0.50	122,101	1.7	206,191
0.67	31,969	2.3	72,341
0.83	21,442	2.8	60,107
1.00	29,216	3.4	98,674
1.17	14,721	3.9	58,171
1.33	24,323	4.5	109,257
1.50	16,635	5.1	84,274
1.67	2,434	5.6	13,728
2.00	15,179	6.8	102,531
2.17	12,617	7.3	92,469

Pipe Diameter (ft)	Sum of Length (ft)	Canal Top Width (ft)	Total Area Converted (sq ft)
2.33	6,207	7.9	48,845
2.50	4,971	8.4	41,972
2.67	5,410	9.0	48,785
2.83	6,850	9.6	65,472
3.00	6,104	10.1	61,847
3.50	6,099	11.8	72,095
4.00	17,871	13.5	241,429
4.50	2,825	15.2	42,935
5.25	3,700	17.7	65,606
7.00	9,852	23.6	232,918
		TOTAL	**1,819,646**

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

E.6 Supporting Calculations for Water Resources

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

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

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

Tumalo Creek

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in Tumalo Creek. Data for historic stream flow represent the 1998 through 2016 water years. Data is sourced from OWRD Gauge No. 14073520. Following the precedent of previous Allocation of Conserved Water applications by the District, an estimated 38 percent (approximately 18 cfs) of the conserved water would be allocated to Crescent Creek, and 62 percent (approximately 30 cfs) would be allocated to Tumalo Creek. Please note that these allocations by source and by season are estimates based on conserved water applications that were associated with similar, completed projects in TID that have already completed the State of Oregon's administrative process for the allocation of conserved water (see ORS 545.470). The allocations presented in the Plan-EA may change following a thorough review of the application by OWRD who may order a different allocation in attempt to avoid impacting other water users at either source.

Table E-12. Tumalo Creek - Stream Flow Prior to the 2016 Settlement Agreement (cfs).

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

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

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

Notes:

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

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

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

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

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

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

Crescent Creek

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in Crescent Creek. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions following the Stipulated Settlement Agreement. Data is source from OWRD Gauge No. 14060000. Following the precedent of previous Allocation of Conserved Water applications by the District, an estimated 38 percent (approximately 18 cfs) of the conserved water would be allocated to Crescent Creek, and 62 percent (approximately 30 cfs) would be allocated to Tumalo Creek. These allocations by source and by season are estimates based on conserved water applications that were associated with similar, completed projects in TID and that have already completed the State of Oregon's administrative process for the allocation of conserved water (see ORS 545.470). These allocations may change following a thorough review of the application by OWRD who may order a different allocation in attempt to avoid impacting other water users at either source.

Table E-15. Crescent Creek – Stream Flow Prior to the 2016 Settlement Agreement and Daily Average Stream Flow (cfs) following Volunteer Instream Stipulations from the 2016 Settlement Agreement (cfs).

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

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

Month	Daily Average Stream Flow following the 2016 Stipulated Settlement Agreement	5 cfs Management Agreement	Stream Flow Restored Through Project (cfs)	Projected Daily Average Stream Flow (cfs) [2]	ODFW Instream Water Right[1]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge [3]
Oct	20.0	5.0	16.4	21.4	50	0.3%
Nov	20.0	5.0	16.4	21.4	108.0	0.3%
Dec	20.0	5.0	16.4	21.4	125.0	0.3%
Jan	20.0	5.0	16.4	21.4	75.0	0.3%
Feb	20.0	5.0	16.4	21.4	75.0	0.3%
Mar	20.0	5.0	16.4	21.4	125.0	0.3%
Apr	7.0	5.0	16.4	28.4	125	0.3%
May	9.0	0.0	0.0	9.0	125.0	0.0%
Jun	34.0	0.0	0.0	34.0	75.0	0.0%
Jul	111.0	0.0	0.0	111.0	50.0	0.0%
Aug	138.0	0.0	0.0	138.0	50.0	0.0%
Sep	102.0	0.0	0.0	102.0	50.0	0.0%

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

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

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

Month	Daily Average Stream Flow following the 2016 Settlement Agreement (cfs)	5 cfs Management Agreement	Stream Flow Restored Through Project (cfs)	Projected Daily Average Stream Flow instream (cfs) [2]	ODFW Instream Water Right[1]	Restored Stream Flow Percentage Increase in the upper Deschutes Basin Annual Discharge [3]
Oct	20.0	5	18.2	23.2	50	0.3%
Nov	20.0	5	18.2	23.2	108	0.3%
Dec	20.0	5	18.2	23.2	125	0.3%
Jan	20.0	5	18.2	23.2	75	0.3%
Feb	20.0	5	18.2	23.2	75	0.3%
Mar	20.0	5	18.2	23.2	125	0.3%
April	7.0	5	18.2	30.2	125	0.3%
May	9.0	0	0.0	9.0	125	0.0%
Jun	34.0	0	0.0	34.0	75	0.0%
Jul	111.0	0	0.0	111.0	50	0.0%
Aug	138.0	0	0.0	138.0	50	0.0%
Sep	102.0	0	0.0	102.0	50	0.0%

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

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

Little Deschutes River

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in the Little Deschutes River. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions following the Stipulated Settlement Agreement with the Center for Biological Diversity. Data is source from OWRD Gauge No. 1406300. Following the precedent of previous Allocation of Conserved Water applications by the District, an estimated 38 percent (approximately 18 cfs) of the conserved water would be allocated to Crescent Creek, and 62 percent (approximately 30 cfs) would be allocated to Tumalo Creek. These allocations by source and by season are estimates based on conserved water applications that were associated with similar, completed projects in TID and that have already completed the State of Oregon's administrative process for the allocation of conserved water (see ORS 545.470). These allocations may change following a thorough review of the application by OWRD who may order a different allocation in attempt to avoid impacting other water users at either source.

Table E-18. Little Deschutes River - Stream Flow Prior to the 2016 Settlement Agreement and Daily Average Stream Flow (cfs) following Volunteer Instream Stipulations from the 2016 Settlement Agreement (cfs).

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

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

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

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

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

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

Notes:

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

Upper Deschutes River at Benham Falls

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in the Upper Deschutes River at Benham Falls. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions following the Stipulated Settlement Agreement with the Center for Biological Diversity. Data is source from OWRD Gauge No. 14064500. Following the precedent of previous Allocation of Conserved Water applications by the District, an estimated 38 percent (approximately 18 cfs) of the conserved water would be allocated to Crescent Creek, and 62 percent (approximately 30 cfs) would be allocated to Tumalo Creek. These allocations by source and by season are estimates based on conserved water applications that were associated with similar, completed projects in TID and that have already completed the State of Oregon's administrative process for the allocation of conserved water (see ORS 545.470). These allocations may change following a thorough review of the application by OWRD who may order a different allocation in attempt to avoid impacting other water users at either source.

Table E-21. Deschutes River at Benham Falls - Stream Flow Prior to the 2016 Settlement Agreement and Daily Average Stream Flow (cfs) following Volunteer Instream Stipulations from the 2016 Settlement Agreement (cfs).

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

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

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

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

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

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

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

Upper Deschutes River at Bend, Below North Canal Dam

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in the Upper Deschutes River at Bend, below North Canal Dam. Streamflows from 1984 to 2014 represent historical baseline conditions. Streamflows in 2016 and 2017 represent modified baseline conditions following the Stipulated Settlement Agreement with the Center for Biological Diversity. Data is sourced from OWRD Gauge No. 14070500. Following the precedent of previous Allocation of Conserved Water applications by the District, an estimated 38 percent (approximately 18 cfs) of the conserved water would be allocated to Crescent Creek, and 62 percent (approximately 30 cfs) would be allocated to Tumalo Creek. These allocations by source and by season are estimates based on conserved water applications that were associated with similar, completed projects in TID and that have already completed the State of Oregon's administrative process for the allocation of conserved water (see ORS 545.470). These allocations may change following a thorough review of the application by OWRD who may order a different allocation in attempt to avoid impacting other water users at either source.

Table E-24. Upper Deschutes River Below North Canal Dam - Stream Flow Prior to the 2016 Settlement Agreement and Daily Average Stream Flow (cfs) following Volunteer Instream Stipulations from the 2016 Settlement Agreement (cfs).

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

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

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

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

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

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

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

Deschutes River Downstream Tumalo Creek Confluence

This appendix subsection presents supporting calculations used when evaluating effects of the proposed action with respect to water resources in the Deschutes River past the Tumalo Creek confluence. There is no OWRD stream gage near the confluence, therefore, data was extrapolated using the historic daily average stream flow from OWRD Gauge No. 14073520 below the TFC diversion and the historic daily average stream flow from OWRD Gauge No. 14070500 below North Canal Dam. Following the precedent of previous Allocation of Conserved Water applications by the District, an estimated 38 percent (approximately 18 cfs) of the conserved water would be allocated to Crescent Creek, and 62 percent (approximately 30 cfs) would be allocated to Tumalo Creek. These allocations by source and by season are estimates based on conserved water applications that were associated with similar, completed projects in TID and that have already completed the State of Oregon's administrative process for the allocation of conserved water (see ORS 545.470). These allocations may change following a thorough review of the application by OWRD who may order a different allocation in attempt to avoid impacting other water users at either source.

Table E-27. Deschutes River Downstream of the Tumalo Creek Confluence - - Stream Flow Prior to the 2016 Settlement Agreement and Daily Average Stream Flow (cfs) following Volunteer Instream Stipulations from the 2016 Settlement Agreement (cfs).

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

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

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

Notes:

1. Assumes that restored stream flow from the Upper Deschutes extends from October 15 through April 15 and that restored stream flow from Tumalo Creek extends from April 15 through October 15.
2. Pending ODFW instream Water Right with Priority Date 9/24/1990.
3. Takes into account stream flow prior to the 2016 Settlement Agreement in Tumalo Creek and in the Deschutes River.
4. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs.

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

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

Notes:

1. Assumes that restored stream flow from the Upper Deschutes extends from October 15 through April 15 and that restored stream flow from Tumalo Creek extends from April 15 through October 15.
2. Pending ODFW instream Water Right with Priority Date 9/24/1990.
3. Takes into account stream flow prior to the 2016 Settlement Agreement in Tumalo Creek and in the Deschutes River.
4. According to "Groundwater Hydrology of the Upper Deschutes Basin and its Influence on Streamflow" by Marshall Gannett, Michael Manga, and Kenneth Lite, Jr., the upper Deschutes Basin has a mean annual discharge of 6003.5 cfs.

E.7 Allocation of Conserved Water Program

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

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

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

References

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

E.8 Agency Consultation Letters

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Bend Field Office
20310 Empire Avenue, Suite A100
Bend, Oregon 97701
(541) 383-7146 FAX: (541) 383-7638

Reply to: 8330.I0579
File Name: TIDirrigation2018LOC.doc
TS Number: 18-531
TAILS: 13420-2018-I-0579
Doc type: Final

August 15, 2018

Mr. Ron Alvarado, State Conservationist
Natural Resource Conservation District
1201 NE Lloyd Blvd.
Portland, OR 97232

Subject: Informal consultation on the effects of the Tumalo Irrigation District Modernization Project on Oregon spotted frog (1-7-18-I-0579)

Dear Mr. Alvarado:

The U.S. Fish and Wildlife Service (Service) has reviewed the Tumalo Irrigation District Modernization Project proposed by the Natural Resource Conservation Service (NRCS). Your August 6, 2018 request for informal consultation and biological assessment were received in our office on August 13, 2018. This document represents the Service's concurrence on the effects of that action, as outlined in the biological assessment (BA), on Oregon spotted frog (*Rana pretiosa*) (spotted frog) and spotted frog critical habitat in accordance with Section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.).

Summary of the Proposed Action

The Tumalo Irrigation District (TID) Irrigation Modernization Project (Project) is an agricultural water conveyance efficiency project located in the Deschutes River basin. The actions proposed in this project include modernizing up to 68.8 miles of canals and laterals within TID. High Density Polyethylene (HDPE) pipe will be installed within the District's right-of-way and replace the canals and laterals that provide water to patrons in the district. The purpose of the project is to improve water conservation, increase water delivery reliability to farms, reduce operation and maintenance costs, enhance streamflow and habitat conditions for fish and aquatic species in the Deschutes Basin, and improve public safety. To complete this project, TID is seeking federal funds under 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).

Figure 1 in the BA depicts the TID Watershed Planning Area and the Tumalo Irrigation District service area where the piping will occur. The TID is located north of Bend, OR in the northern half of Deschutes County (Figure 2 in the BA). Spotted frogs do not inhabit the canals where piping will occur and there is no designated critical habitat within canals.

Under the proposed action, TID will replace canals and laterals with HDPE pipe, and existing turnouts will be upgraded to pressurized delivery systems with additional turnouts added. Construction will occur within TID's existing rights-of-way (ROW) in seven project groups over the course of 11 years. In total, implementation of the proposed action could conserve up to 48 cfs that is currently lost through seepage and evaporation. The conserved water will be allocated between Crescent Creek (approximately 18 cfs during the non-irrigation season) and Tumalo Creek (approximately 30 cfs during the irrigation season) as each phase of the Project is completed.

Spotted Frog Background

Within the Upper Deschutes River Basin, Oregon spotted frogs and designated critical habitat are within the Upper and Little Deschutes River subbasins and include Crane Prairie and Wickiup Reservoirs, the Deschutes River, and the Little Deschutes River and tributaries (i.e., Crescent Creek and Long Prairie Creek). The current distribution of Oregon spotted frogs in the Deschutes River Basin extends from headwaters downstream to Bend, Oregon. Spotted frogs primarily inhabit lakes, ponds, sloughs, riverine oxbows and floodplain wetlands in the Upper Deschutes River basin. Much of the Oregon spotted frog habitat within the Deschutes River Basin is affected by the storage and release of water for irrigation. Storage of water in reservoirs results in the dewatering of spotted frog habitat during winter months, limiting the availability of suitable overwintering habitat (i.e., deep pools that do not freeze solid). Therefore, spotted frogs may be forced to overwinter in creeks and rivers where they are at increased risk of predation by nonnative brown trout. Ongoing water management in the Deschutes Basin and the effects to Oregon spotted frogs are described in the Service's Biological Opinion for the Bureau of Reclamation (Bureau)(USFWS 2017) which is valid through July 2019.

Effects to spotted frog and critical habitat

The proposed Tumalo Irrigation District Modernization Project will likely result in long term beneficial effects to spotted frog habitat and is not likely to adversely affect spotted frogs or critical habitat in the short-term. The proposed Project will not result in direct effects to spotted frogs since there are no spotted frogs or designated critical habitat where earth moving work will occur in the canals.

The Project proposes to pipe canals and allocate conserved water to Crescent Creek (i.e., 18 cfs during non irrigation season) as winter flow. Historical operation of Crescent Lake Dam has resulted in diminished winter flows of 6 cfs in Crescent Creek and dewatering of riverine wetlands inhabited by spotted frogs (i.e., designated critical habitat). Through ESA consultation with the Bureau, winter flows have been temporarily increased to up to 30 cfs in Crescent Creek through the winter of 2018 (USFWS 2017). Therefore, the proposed Project is likely to result in a beneficial effect to spotted frog habitat and critical habitat within Crescent Creek in the long-term by improving winter flows.

Conclusion

Based on information contained within the biological assessment, and conversations with NRCS staff, the Service concurs with the NRCS's determination that this project is wholly beneficial and is not likely to adversely affect Oregon spotted frog and spotted frog critical habitat. The Service's rationale for concurrence on your effects determination for spotted frog and critical habitat is based on the fact that there are no spotted frogs or critical habitat within the area where piping will occur. We believe there will be a long-term beneficial effect to spotted frog habitat and critical habitat in Crescent Creek where winter flows will be improved over time.

This concludes informal consultation on the actions outlined in your biological assessment. The requirements established under section 7(a)(2) and 7(C) of the Endangered Species Act of 1973, as amended (16 USC 1531 *et seq.*), have been met, thereby concluding the consultation process. However, if future events result in the reassessment of the proposed action, then re-initiation of consultation may be warranted.

If you have any questions or concerns regarding this letter, please contact Jennifer O'Reilly or me at the Bend Field office at 541-383-7146.

Sincerely,

Bridget Moran
Field Supervisor

Cc: Gary Diridoni

References:

Bureau of Reclamation (BO R). (2017). Biological Opinion: Approval of Contract Changes to the 1938 Inter-District Agreement for Operation of Crane Prairie and Wickiup Dams and Implementation of Review of Operations and Maintenance and Safety Evaluation of Existing Dams Programs at Crane Prairie and Wickiup Dams. BOR US Fish and Wildlife Service, Bend, Oregon.

USDA
United States Department of Agriculture

Natural
Resources
Conservation
Service

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503-414-3200

April 16, 2018

Anita Andazola
US Army Corps of Engineers Portland District Regulatory Branch
211 East Seventh Avenue, Ste. 105
Eugene, Oregon 97401-2722

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

Dear Ms. Andazola,

A copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Tumalo Irrigation District Irrigation Modernization Project, located in Deschutes County, OR has been uploaded to your FTP site (AMRDEC) located at https://safe.amrdec.army.mil/safe/ for review. This Draft Plan-EA was prepared by Farmers Conservation Alliance for the United States Department of Agriculture, Natural Resources Conservation Service in cooperation with the Deschutes Basin Board of Control and Tumalo Irrigation District (TID) under 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, water delivery reliability, and public safety on TID-owned canals and laterals. The preferred alternative would include converting 68.8 miles of TID's canals and laterals to a buried and pressurized pipeline.

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 May 22, 2018. If your comments are not received by the due date, we will assume you do not wish to comment.

In addition to the above request, NRCS is requesting guidance regarding the process of applying Regulatory Guidance Letter (RGL) 07-02, which provides guidance on application of permitting exemptions for irrigation ditches under Clean Water Act Section 404(f), to the project.

The Draft Plan-EA is available for public review and comment. Copies may be obtained by contacting Tom Makowski, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3202 or tom.makowski@or.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 May 22, 2018. Comments received will be made available for public inspection.

Sincerely,

Acting

RONALD ALVARADO
State Conservationist

Enclosures:
Tumalo Irrigation District Irrigation Modernization Project Draft Watershed Plan–Environmental Assessment Outreach Flyer

Tumalo Irrigation District Irrigation Modernization Project Draft Watershed Plan–Environmental Assessment

Regulatory Guidance Letter (RGL) 07-02

US Army Corps of Engineers®

REGULATORY GUIDANCE LETTER

No. 07-02 **Date: July 4, 2007**

SUBJECT: Exemptions for Construction or Maintenance of Irrigation Ditches and Maintenance of Drainage Ditches Under Section 404 of Clean Water Act

1. Purpose and Applicability.

The purpose of this Regulatory Guidance Letter ("RGL" or "guidance") is to provide a reasonable and predictable national approach for conducting exemption determinations for the construction and maintenance of irrigation ditches and the maintenance of drainage ditches consistent with Section 404(f) of the Clean Water Act (CWA) (also known as the Federal Water Pollution Control Act or FWPCA) Pub. L. 92-500, as amended by Pub. L. 95-217, Pub. L. 100-4, Pub. L. 104-66, 33 U.S.C. § 1251, et seq., and with associated regulations (33 C.F.R. 320-330, 40 C.F.R. Part 232). This guidance is intended to clarify when 404(f) exempts from permitting requirements discharges of dredged or fill material into waters of the U.S. associated with the construction and maintenance of irrigation ditches and maintenance of drainage ditches. This RGL was developed and is endorsed by the U.S. Army Corps of Engineers (Corps) and the Environmental Protection Agency (EPA). EPA has the ultimate authority for interpreting the scope of exemptions under CWA Section 404(f).

This document supercedes RGL 87-07, which addresses the Section 404(f)(1)(C) Statutory Exemption for Drainage Ditch Maintenance. Other documents, such as the 1989 MOA addressing 404(f) coordination, are unaffected. As indicated above, this RGL addresses statutory exemptions for both irrigation and drainage ditches. In this effort to provide greater clarity, the following terms are defined for purposes of Subsection 404(f): irrigation ditch, drainage ditch, construction, and maintenance. This document also provides a framework for determining the applicability of the exemptions and the recapture provision. (See Figure 1). While providing greater clarity, both the framework and the definitions are consistent with the agencies' current practice in interpreting the Section 404(f) exemption.

2. Background.

a. Under Section 404(f)(1)(C) of the CWA (see also 33 CFR 323.4(a)(3) and 40 CFR 232.3(c)(3)), discharges of dredged or fill material associated with construction or maintenance of irrigation ditches, or the maintenance (but not construction) of drainage ditches, are not prohibited by or otherwise subject to regulation under Section 404 of the CWA (i.e., these activities are exempt from the need to obtain a Section 404 permit from the Department of the

Army (DA)). Discharges of dredged or fill material associated with siphons, pumps, headgates, wingwalls, weirs, diversion structures, and such other facilities as are appurtenant to and functionally related to irrigation ditches are included in the exemption for irrigation ditches.

b. Section 404(f)(2) of the CWA states that "[a]ny discharge of dredged or fill material into the navigable waters incidental to any activity having as its purpose bringing an area of navigable waters into a use to which it was not previously subject, where the flow or circulation of navigable waters may be impaired or the reach of such waters be reduced, shall be required to have a permit under this section." This is commonly referred to as the "recapture provision." See Section c, below.

c. Under 33 CFR 323.4(c) and 40 CFR 232.3(b), exemptions under 33 CFR 323.4(a)(1-6) and 40 CFR 232.3(c)(1-6) do not apply if the discharge into a water of the U.S. "is part of an activity whose purpose is to convert an area of the waters of the U.S. into a use to which it was not previously subject, where the flow or circulation of waters of the U.S. may be impaired or the reach of such waters reduced. Where the proposed discharge will result in significant discernable alterations to flow or circulation, the presumption is that flow or circulation may be impaired by such alteration."

d. Under 33 CFR 323.4(a)(1)(iii)(C)*(1))(i)*, "[c]onstruction and maintenance of upland (dryland) facilities such as ditching and tiling, incidental to the planting, cultivating, protecting, or harvesting of crops, involve no discharge of dredged or fill material into waters of the U.S., and as such never require a section 404 permit."

The CWA Subsection 404(f)(1)(A) exemption for "minor drainage" covers "(t)he discharge of dredged or fill material incidental to connecting upland drainage facilities to waters of the U.S., adequate to effect the removal of excess soil moisture from upland crops." (See 33 CFR 323.4(a)(1)(iii)(C) *(1)(i))*

e. The construction and maintenance of irrigation ditches and maintenance of drainage ditches may require the construction and/or maintenance of a farm road. In those circumstances, the Subsection 404(f)(1)(E) exemption for discharges of dredged or fill material associated with the construction or maintenance of farm roads applies where such related farm roads are constructed and maintained in accordance with best management practices (BMPs), 33 CFR 323.4(a)(6) and 40 CFR 232.3(c)(6), to assure that flow and circulation patterns and chemical and biological characteristics of waters of the U.S. are not impaired, that the reach of the waters of the U.S. is not reduced, and that any adverse effect on the aquatic environment will be otherwise minimized. All of the limitations and conditions mandated by the current Section 404(f) regulations relating to farm roads apply.

3. Guidance for Ditches.

General Guidance: Before carrying out ditch maintenance or construction activities, the following issues should be analyzed:

2

a. Is there a discharge of dredged or fill material into a water of the U.S.? To make that determination, the statute, regulations, and guidance provided by the Corps and EPA regarding what areas constitute "waters of the United States" subject to CWA jurisdiction must be consulted and followed. Corps and EPA guidance on the extent of CWA geographic jurisdiction define certain categories of "upland ditches" and "upland swales" that generally are not subject to CWA jurisdiction. Discharges of dredged or fill material into those defined categories of upland ditches and upland swales are not subject to either CWA permitting requirements or the subsection 404(f) exemptions.

b. Identify the type of ditch and activity, and whether the activity is eligible for the exemptions at Subsection 404(f)(1). An analysis of the CWA statute and existing EPA and Corps regulations indicates that there are differences between irrigation ditches and drainage ditches for purposes of applying the Subsection 404(f)(1)(C) exemption. The Subsection 404(f)(1)(C) exemption applies to the *construction* and *maintenance* of irrigation ditches, but it applies only to the *maintenance* of drainage ditches.

For purposes of this RGL, wetlands include all wetlands that meet the definition in 33 CFR 328.3. Guidance for applying the regulation is contained in the 1987 Wetland Delineation Manual, and the regional supplements and supplemental guidance, as appropriate, except where the wetland plants were established as a result of the irrigation process. Wetlands established solely due to the presence of irrigation water, irrigated fields, or irrigation ditches do not qualify as wetlands for purposes of applying the 404(f) exemption for construction and maintenance of irrigation ditches and for maintenance of drainage ditches.[1] Where sufficient information is not available to determine the hydrological contribution of irrigation waters to a particular wetlands (i.e., whether the wetland existed at the location prior to the presence of irrigation activities), such wetlands are not removed from consideration as wetlands or waters of the U.S.

For purposes of this RGL, the following definitions apply:

Definition of "Irrigation Ditch:" For purposes of this RGL, an irrigation ditch is a man-made feature and/or an upland swale that either conveys water to an ultimate irrigation use or place of use, or that moves and/or conveys irrigation water (e.g., "run-off" from irrigation) away from irrigated lands. Irrigation ditches may include the distribution system or parts thereof, consisting of manmade canals, laterals, ditches, siphons, and/or pipes, or pump systems. If a ditch carries only irrigation water, irrigation return flows, and overland flow (precipitation and/or snowmelt) that moves from an irrigated field either to or away from an area subject to irrigated agriculture (e.g., an irrigated field), that ditch would be considered an irrigation ditch, not a drainage ditch.

Where a natural or man-altered water body is used as part of an irrigation ditch system, such as where the water body is used to transport irrigation water between manmade ditches, that segment generally is not considered an irrigation ditch for purposes of this exemption, except

[1] As stated in the preamble to the Corps' Final Rule of November 13, 1986: ". . .we generally do not consider the following waters to be 'Waters of the United States' . . . (b) Artificially irrigated areas which would revert to upland if the irrigation ceased." 51 Federal Register 41217, November 13, 1986. Thus, waters, including wetlands, created as a result of irrigation would not be considered waters of the US even when augmented on occasion by precipitation.

where the Section 404(f)(1) exemption has been determined to apply based on a case-by-case evaluation. Following a case-by-case evaluation, such a natural or man-altered water body may be considered an irrigation ditch eligible for this exemption if it has characteristics suggesting a limited functional role in the broader aquatic ecosystem, such as infrequent or low volume flow, minimal habitat value, or small channel size.

Definition of "Drainage Ditch:" For purposes of this RGL, a drainage ditch is a ditch that conveys water (other than irrigation related flows) from one place to another. Where a ditch would have the effect of more than minor drainage[2] of wetlands (other than wetlands established due to the presence of irrigation water), the ditch would be considered a drainage ditch, not an irrigation ditch, even if used for irrigation. However, a ditch that diverts water from an open body of water (e.g., stream, lake, or reservoir) for irrigation purposes is an irrigation ditch, even if a substantial portion of the flow or volume is diverted.

A ditch determined to be either an irrigation ditch or a drainage ditch would then need to be evaluated on a case-by-case basis to determine if the recapture provision of Section 404(f)(2) applies (see below).

Definition of "Construction:" For purposes of this RGL, construction includes new work or work that results in an extension or expansion of an existing structure. Ditch construction generally includes, but is not limited to, activities such as:

- Ditch relocation.
- Ditch conversion into pipe.
- Lining, which means placing impervious material such as concrete, clay, or geotextile within the flow perimeter of an open canal, lateral, or ditch with the intent of reducing seepage losses and improving conveyance efficiency. All new lining of ditches, where the ditch had not previously been lined, is considered construction.
- Placement of new control structures.

Definition of "Maintenance:" For purposes of this RGL, maintenance includes a repair to an existing structure or feature to keep the ditch in its existing state or proper condition, or to preserve it from failure or decline.[3] Maintenance generally includes, but is not limited to, activities such as:

- Excavation of accumulated sediments back to original contours.
- Re-shaping of the side-slopes.

[2]See 33 CFR 323.4(a)(1)(iii)(C)(1) and (C)(2).

[3]Maintenance means the physical preservation of the original, as-built configuration of the ditch and appurtenant structures, to restore the original function and the approximate capacity of the ditch. In many cases, accurate historical records are not available to determine the exact "as-built" specifications of the original ditch. In these cases, districts should work closely with the project proponent to establish an appropriate maintenance depth to restore the ditch's original function and approximate capacity, while meeting the spirit of the exemption and ensuring adequate protection of aquatic resources. Districts should allow maintenance of ditches to be performed to the level of current engineering standards where more graduated side-slopes result in greater stability, so long as those modifications of the ditch will not result in the drainage, degradation, or destruction of additional natural wetlands or other waters of the U.S., as referenced above. Removal of material and re-contouring of the ditch should be in accordance with the historical design and function of that ditch (i.e., the ditch must not be substantially deepened so as to drain additional areas).

- Bank stabilization to prevent erosion where reasonably necessary using best management practices. For maintenance of drainage ditches as defined in this guidance, materials used for stabilization should be compatible with existing bank materials.
- Armoring, lining and/or piping. These activities qualify as maintenance only where a previously armored, lined, or piped section is being repaired and all work occurs within the footprint of the previous work.
- Replacement of existing control structures, where the original function is not changed and original approximate capacity is not increased.

Maintenance is generally viewed as involving activities that keep something in its existing state or proper condition or preserve it from failure or decline. If a drainage ditch has not been serving a drainage function for an extended period of time, drainage ditch re-establishment would be considered construction, not maintenance, and would thus be ineligible for the exemption. However, a ditch that has not been regularly maintained should not automatically be considered ineligible for the ditch maintenance exemption. Some ditches require little or no periodic maintenance to remain functional. Lack of periodic maintenance in these situations does not preclude the ditch from being maintained under the exemption.

c. The third step is to determine if the Recapture Provision applies:

Part 1: Is the discharge part of an activity whose purpose is to convert an area of the waters of the U.S. into a use to which it was not previously subject?

The regulations guiding implementation of CWA Section 404(f) specify that a change in use occurs when there is a "conversion of a section 404 wetland to a non-wetland" and in addition "a permit will be required for the conversion of a cypress swamp to some other use or the conversion of a wetland from silvicultural to agricultural use when there is a discharge of dredged or fill material into waters of the United States in conjunction with construction of dikes, drainage ditches or other works or structures used to effect such conversion." 33 C.F.R. 323.4(c).

Part 1 of the test is met if there would be a change of use. For example, any time an irrigation ditch would cut through (or across) a natural or man-altered water body, including wetlands, this would qualify as a change in use and Part 1 of the Section 404(f)(2) test is met.

Part 2: If Part 1 of the test is met, may the activity also impair the flow or circulation of waters of the U.S. or reduce the reach of such waters?

The regulations guiding implementation of the CWA Section 404(f) specify that "(w)here the proposed discharge will result in significant discernible alterations to flow or circulation, the presumption is that flow or circulation may be impaired by such alteration." "A discharge which elevates the bottom of waters of the United States without converting it to dry land does not thereby reduce the reach of, but may alter the flow or circulation of, waters of the United States." 33 C.F.R. 323.4(c).

The determination as to whether construction or maintenance of an irrigation ditch, or maintenance of a drainage ditch, would result in a significant discernible alteration in flow or circulation, or a reduction in reach, of waters of the U.S. should be made on a case-by-case basis using the factors such as the following: (1) whether the proposed construction or maintenance of the ditch would harmfully sever or fragment the wetland or water body; (2) whether the proposed construction or maintenance of the ditch would significantly and discernibly alter flow or circulation or reduce reach through sidecasting into the wetland or waterbody; (3) whether the proposed construction or maintenance of the ditch would harm the wetland or water body by substantially increasing or decreasing water levels; (4) the relative size of the ditch compared to the wetland or water body; and (5) whether the proposed construction or maintenance employs techniques and best management practices designed to minimize impacts and ensure that there is not significant discernible alteration of flow or circulation or reduction of reach.

Because the Section 404(f)(1) exemption for maintenance of irrigation or drainage ditches applies only to maintenance activities that would maintain existing capacity and functionality (not to construction activities), it is unlikely that the recapture provision in Section 404(f)(2) would apply to ditch maintenance activities as defined above. However, if a question arises as to whether ditch maintenance activities would trigger the Section 404(f)(2) recapture provision (e.g., if the maintenance is "incidental" to a larger activity that triggers the provision – see footnote 4 below), this should be evaluated on a case-by-case basis using the factors such as those listed above.

This recapture provision is a two-part test. If the answers to both parts are "yes," a (DA) permit is required for the activity. If one part of the test is not satisfied and that activity qualifies for an exemption under 404(f)(1), it is not "recaptured" under 404(f)(2).[4]

In situations where the potential eligibility of a proposed discharge of dredged or fill material for an exemption under Section 404(f)(1)(C) has been raised to the district, and where the district cannot make a determination due to a lack of pertinent factual information, it is incumbent on those seeking exemption to provide the documentation necessary to establish the facts on a case-by-case basis.

If the proposed activity is not exempt under Section 404(f)(1), the work may be authorized under one or more Nationwide General Permits (NWPs), or under a Regional General Permit (RGP), or pursuant to a Standard Individual Permit. The NWPs can be found at: http://www.usace.army.mil/cw/cecwo/reg/ and the RGPs can be found on the local Corps District regulatory web pages. Additional guidance on the NWPs/RGPs may be obtained from the local Corps District office.

[4]The discharge of dredged or fill material itself does not need to be the sole cause of the destruction of the waters of the United States (e.g., wetlands) or other change in use or the sole cause of the reduction in or impairment of, reach flow, or circulation of such waters. The discharge need only be "incidental to" or "part of" an activity that is intended to or will foreseeably bring about that result.

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4. **Duration.** This guidance rescinds and supersedes RGL 87-7. This guidance remains in effect unless revised or rescinded. Additional guidance may be issued in the near future to further define irrigation ditch, drainage ditch, construction, and maintenance.

DON T. RILEY
Major General, US Army
Director of Civil Works

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USDA
United States Department of Agriculture

Natural Resources Conservation Service

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

April 16, 2018

Gregg Garnett, Field Office Manager
U.S. Bureau of Reclamation
Bend Field Office
1375 SE Wilson Ave, Suite 100
Bend, OR 97702-1435

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

Dear Mr. Garnett,

Embedded in this letter is a website link to the copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Tumalo Irrigation District Irrigation Modernization Project, located in Deschutes County, OR. This Draft Plan-EA was prepared by Farmers Conservation Alliance for the United States Department of Agriculture, Natural Resources Conservation Service in cooperation with the Deschutes Basin Board of Control and Tumalo Irrigation District (TID) under 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, water delivery reliability, and public safety on TID-owned canals and laterals. The preferred alternative would include converting 68.8 miles of TID's canals and laterals to a buried and pressurized pipeline.

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 May 22, 2018. 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 Tom Makowski, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3202 or tom.makowski@or.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 May 22, 2018. Comments received will be made available for public inspection.

Sincerely,

RONALD ALVARADO Acting
State Conservationist

Enclosure:
Tumalo Irrigation District Irrigation Modernization Project Draft Watershed Plan–Environmental Assessment Outreach Flyer

ECC:
Elizabeth Heether

USDA United States Department of Agriculture

Natural Resources Conservation Service

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

April 16, 2018

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

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

Dear Ms. Curran,

A copy of the draft watershed plan–environmental assessment (Draft Plan-EA) for the Tumalo Irrigation District Irrigation Modernization Project, located in Deschutes County, OR has been provided for your review utilizing the Go Digital submittal process. This Draft Plan-EA was prepared by Farmers Conservation Alliance for the United States Department of Agriculture, Natural Resources Conservation Service in cooperation with the Deschutes Basin Board of Control and Tumalo Irrigation District (TID) under 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, water delivery reliability, and public safety on TID-owned canals and laterals. The preferred alternative would include converting 68.8 miles of TID's canals and laterals to a buried and pressurized pipeline.

The draft watershed plan does not address the Agency's responsibilities for Section 106 of the National Historic Preservation Act (NHPA). While consultation has been completed on a portion of the Project, the Tumalo Feed Canal (SHPO Case No. 06-1778), further consultation on the remaining canals and laterals will be addressed, in fulfillment of Section 106 of the NHPA, as funding for those portions is allocated.

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 May 22, 2018. 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 Tom Makowski, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3202 or tom.makowski@or.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 May 22, 2018. Comments received will be made available for public inspection.

Sincerely,

RONALD ALVARADO
State Conservationist

Enclosure:
Tumalo Irrigation District Irrigation Modernization Project Draft Watershed Plan–Environmental Assessment Outreach Flyer

Tumalo Irrigation District Irrigation Modernization Project Draft Watershed Plan–Environmental Assessment

ECC:
Dr. Dennis Griffin, OR SHPO
Ian Johnson, OR SHPO
Jessica Gabriel, OR SHPO

USDA United States Department of Agriculture

Natural Resources Conservation Service

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

April 16, 2018

The Honorable Katherine Brown
Governor
State of Oregon
Office of the Governor
900 Court Street NE, Suite 254
Salem, OR 97301-4047

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

Dear Governor Brown,

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 Tumalo Irrigation District Irrigation Modernization Project, OR. This Draft Plan-EA was prepared by Farmers Conservation Alliance (FCA) for the United States Department of Agriculture, Natural Resources Conservation Service in cooperation with the Deschutes Basin Board of Control and Tumalo Irrigation District under 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 application for assistance in the preparation of the Draft Plan-EA was approved by NRCS on July 6, 2017.

We are requesting that you review this Draft Plan-EA 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 May 22, 2018. 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 Tom Makowski, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3202 or tom.makowski@or.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 May 22, 2018. Comments received will be made available for public inspection.

Sincerely,

Acting

RONALD ALVARADO
State Conservationist

Enclosure:
Tumalo Irrigation District Irrigation Modernization Project Draft Watershed Plan–Environmental Assessment Outreach Flyer

Tumalo Irrigation District Irrigation Modernization Project Draft Watershed Plan–Environmental Assessment

ECC:
Lauri Aunan, Water Policy Advisor to Governor Katherine Brown
Jason Miner, Natural Resources Policy Director to Governor Katherine Brown

USDA

United States Department of Agriculture

Natural
Resources
Conservation
Service

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

April 16, 2018

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

Subject: Tumalo Irrigation District Irrigation 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 Tumalo Irrigation District Irrigation Modernization Project, located in Deschutes County, OR. This Draft Plan-EA was prepared by Farmers Conservation Alliance for the United States Department of Agriculture, Natural Resources Conservation Service in cooperation with the Deschutes Basin Board of Control and Tumalo Irrigation District (TID) under 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, water delivery reliability, and public safety on TID-owned canals and laterals. The preferred alternative would include converting 68.8 miles of TID's canals and laterals to a buried and pressurized pipeline.

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 May 22, 2018. If your comments are not received by the due date, we will assume you do not wish to comment.

Additionally, please submit any reports with recommendations on the conservation and development of fish and wildlife as identified in the Watershed Protection and Flood Prevention Act of 1954, Section 12, Consultation Request letter dated July 20, 2017 if any surveys or investigations have been conducted.

The Draft Plan-EA is available for public review and comment. Copies may be obtained by contacting Tom Makowski, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland,

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Oregon, 97232, phone 503-414-3202 or tom.makowski@or.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 May 22, 2018. Comments received will be made available for public inspection.

Sincerely,

Acting

RONALD ALVARADO
State Conservationist

Enclosure:
Tumalo Irrigation District Irrigation Modernization Project Draft Watershed Plan–Environmental Assessment Outreach Flyer

Watershed Protection and Flood Prevention Act of 1954, Section 12, Consultation Request for the Irrigation Infrastructure Improvement projects in the Tumalo, Swalley, and Central Oregon Irrigation Districts

ECC:
Bridget Moran

USDA

United States Department of Agriculture

Natural
Resources
Conservation
Service

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

July 20, 2017

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

Subject: Watershed Protection and Flood Prevention Act of 1954, Section 12, Consultation Request for the Irrigation Infrastructure Improvement Projects in the Tumalo, Swalley, and Central Oregon Irrigation Districts

Dear Mr. Henson:

Aging infrastructure, growing populations, shifting rural economies, and changing climate conditions have increased pressure on water resources across the western United States (US). Within the Deschutes Basin, irrigated agriculture (one of the primary out-of-stream water uses in the area) relies on infrastructure that is over 100-years old to divert, store, and deliver water to farms and ranches across the region. System water losses and the need to minimize those losses have been an ongoing concern of the Tumalo, Central Oregon, and Swalley Irrigation Districts (herein referred to as the Irrigation Districts). Starting in the mid-1990s, the Irrigation Districts have pursued a water conservation program to provide a permanent solution to system-wide water losses. A significant portion of the water diverted through irrigation canals currently seeps into the area's porous, volcanic soil prior to reaching farms. Improving aging irrigation infrastructure offers an opportunity to enhance aquatic species habitat, reduce public safety risks, support and maintain existing agricultural land use through enhanced water supply reliability, and provide financial stability to irrigation districts in the Deschutes Basin.

The United States Department of Agriculture Natural Resources Conservation Service (NRCS), in cooperation with the Deschutes Basin Board of Control (DBBC) as the project sponsor, is proposing to partially fund through the Watershed Protection and Flood Prevention Act of 1954 (PL83-566) three separate projects for the improvement of aging irrigation infrastructure in the Tumalo, Swalley, and Central Oregon Irrigation Districts. Watershed plans will be developed that will help irrigators conserve water, reduce energy consumption, increase irrigation delivery efficiency, improve public safety, and benefit instream habitat for threatened and endangered aquatic species.

The purposes of these projects are to:

- Enhance habitat for aquatic species through increased stream flows through the storage season by creating senior instream water rights benefiting the Endangered Species Act (ESA)-listed Oregon spotted frog and other fish and wildlife;

- By restoring flows with water lost in transportation, habitat can be improved without taking water from small farms and reliability of irrigation deliveries can be improved;
- Providing farmers with pressurized water will encourage small farms to modernize irrigation systems to take advantage of the lower operating costs;
- Improve public safety by replacing dangerous open canals with buried pipes, which is particularly important as residential populations expand into areas that previously supported primarily agriculture;
- Support and maintain existing agriculture with improvements in water supply reliability, speed of delivery, and system durability; and
- Provide financial stability to the Irrigation Districts through reduced operation and maintenance cost, conserved energy and reduced on-farm expenses through reduction of irrigation, and energy generation through installation of small hydropower facilities.

Consistent with these purposes, the project would address the following needs:

- Enhanced habitat for fish and wildlife.
- Support agriculture and family farms.
- New opportunities for farmers to modernize irrigation infrastructure.
- Improved public safety.
- Increased reliability of water supplies to farms.

The Watershed Protection and Flood Prevention Act of 1954 (often referred to as P.L.83-566 or PL 566) authorizes the NRCS to assist state and local agencies in the development of water resources development projects (projects) in watersheds of 250,000 acres or less. NRCS provides technical, financial, and credit assistance to local sponsors to develop projects. Project purposes include watershed protection, flood prevention, agricultural water management, ground water recharge, water quality management, and municipal and domestic water supply.

These projects are 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.

Please provide any information, comments, or concerns you feel are appropriate on the scope of the proposed action. Comments should be submitted to:

Margi Hoffmann
Community Relations Director
Farmers Conservation Alliance
11 Third Street, Suite 101
Hood River, OR 97031

Or by telephone at 503-550-3556
Or by email at margi.hoffmann@fcasolutions.or.

If you have any questions concerning the environmental compliance process on the draft Plan-EA, please contact Tom Makowski, Assistant State Conservationist for Watershed Resources and Planning, by phone at 503-621-7626 or by email at tom.makowski@or.usda.gov.

Sincerely,

RONALD ALVARADO
State Conservationist

cc:
Margi Hoffmann, Community Relations Director, Farmers Conservation Alliance, Hood River, Oregon
Bridget Moran, Field Supervisor, U.S. Fish and Wildlife Service, Bend, Oregon
Tom Makowski, Assistant State Conservationist for Watershed Resources and Planning, NRCS, Portland, Oregon
Kevin Conroy, Assistant State Conservationist for Field Operations, NRCS, Klamath Falls, Oregon

USDA

United States Department of Agriculture

Natural Resources Conservation Service

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

April 16, 2018

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: Tumalo Irrigation District Irrigation 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 Tumalo Irrigation District Irrigation Modernization Project, located in Deschutes County, OR. This Draft Plan-EA was prepared by Farmers Conservation Alliance for the United States Department of Agriculture, Natural Resources Conservation Service in cooperation with the Deschutes Basin Board of Control and Tumalo Irrigation District (TID) under 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, water delivery reliability, and public safety on TID-owned canals and laterals. The preferred alternative would include converting 68.8 miles of TID's canals and laterals to a buried and pressurized pipeline.

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 May 22, 2018. NRCS will consider all comments received, and will respond to those received by May 22, 2018. Comments received will be made available for public inspection. 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 Tom Makowski, Assistant State Conservationist (Watershed Resource Planning), USDA, NRCS, 1201 NE Lloyd Blvd, Portland, Oregon, 97232, phone 503-414-3202 or tom.makowski@or.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 May 22, 2018. Comments received will be made available for public inspection.

Sincerely,

ACTING

RONALD ALVARADO
State Conservationist

Enclosures:
Tumalo Irrigation District Irrigation Modernization Project Draft Watershed Plan–Environmental Assessment Outreach Flyer

E.9 Prehistoric and Historical Background

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

Prehistoric Background

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

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

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

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

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

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

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

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

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

Boulder Village Period (3,000 – Historic Contact)

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

Euro-American History

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

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

References

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

E.10 District Board Resolutions

TUMALO IRRIGATION DISTRICT

TUMALO IRRIGATION DISTRICT
RESOLUTION #2017-03

The Board of Directors of Tumalo Irrigation District hereby resolves as follows:

1. Tumalo Irrigation District has had a long term goal of piping the entire district to improve efficiencies of its delivery system. Currently the District has completed piping over 65% of the main canals placing 100% of the conserved water instream for the benefit of fish and wildlife. The District intends to continue piping its open canals until the entire District is complete.

2. TID board resolves that they are committed to developing State and private funding to match Federal PL566 funds for FY17-18 for up to $5 Million.

Adopted by the Board of Directors of the Tumalo Irrigation District on May 09, 2017.

Shirley DeMaris

Wally Zimmerman

Ron Cochran

Steve Putnam

Martin Warbington

64697 Cook Ave, Bend, OR 97703: (541) 382-3053: Email: staff@tumalo.org

TUMALO IRRIGATION DISTRICT

TUMALO IRRIGATION DISTRICT
RESOLUTION #2018-01

The Board of Directors of Tumalo Irrigation District hereby resolves as follows:

Whereas Tumalo Irrigation District has a goal of piping the entire district to improve the efficiencies of its delivery system.

Whereas the District has completed piping over 70% of the main canals and is developing conserved water from the saved seepage and evaporation losses.

- It is the District's intent to pipe the remainder of the District and
- in addition to the State of Oregon conserved water statute (ORS 537.455-500) mandated seventy-five percent in-stream portion, the District intends to donate its twenty-five percent portion of conserved water to instream flows concomitant with one-hundred percent public funding and up to 48 cubic foot per second or equivalent in volume.

Adopted by the Board of Directors of the Tumalo Irrigation District on May 08, 2018.

Steve Putnam

Wally Zimmerman

Ron Cochran

Jack Farley

Martin Warbington

64697 Cook Ave, Bend, OR 97703: (541) 382-3053: Email: staff@tumalo.org