Appendix A

Comments and Responses

All acronyms used in the responses in Table A-2, unless defined herein, are defined in and can be found in Section 12 of the Plan-EA. All references used in the responses in Table A-2, unless listed herein, are listed in Section 9 of the Plan-EA.

Table A-1. Topics and Associated Codes.

Topic	Topic Code	Topic	Topic Code
Alternative Analysis	ALT	Patron Delivery	PATD
Construction Practices	CONS	Public Process	PUB
Project Cost	COST	Purpose and Need	PURP
Cultural Resources	CUL	Recreation	REC
Fish and Aquatic	FISH	Resource Concerns	RES
General	GEN	System Design	SYS
Maps	MAP	Vegetation	VEG
National Economic Efficiency	NEE	Water	WAT
Non-economic Development	NONV	Wildlife	WILD

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

Comment ID	Topic Code	Comment	Response
1.01	SYS	About a 100 years ago or so the East Fork Irrigation Canal was built through property on Miller Road owned by my wife and I today. In order to convey and deliver water, the irrigation district holds a legal right of way for a ditch, canal or flume for irrigation water to flow through our property. We also have rights to draw certain water from the Canal. The irrigation district does NOT hold a legal right of way for a pipeline through our property. Therefore, there is no legal right allowing construction of piping by the irrigation district through our property. Since piping is not a legal option for the district, at least through our property (and I suspect many others in this area), leaving the Canal as is and/or other options must be revisited.	The Plan-EA adopts a tiered approach to evaluating potential effects associated with the proposed project under the National Environmental Policy Act. The Plan-EA describes potential effects to resources within the greater project area, while site-specific effects are described in subsequent site-specific studies. Additional information on tiering is available in Section 1.4 of the Plan-EA and in the National Environmental Compliance Handbook Title 190 Part 610 (NRCS 2016). Following this approach, EFID would work with landowners to resolve property-specific design questions during the design process for the associated project group.

Comment ID	Topic Code	Comment	Response
			As a general rule in Oregon, an easement owner has the right to improve its easement to the extent that the improvement does not substantially increase the burden on the servient property (i.e. the landowner). Regarding a legal dispute involving a similar project in the Swalley Irrigation District, the U.S. District Court for the District of Oregon determined that the conversion of an irrigation canal to an irrigation pipeline was lawful, where the right-of-way at issue had been granted for irrigation purposes, and where the conversion from canal to pipeline did not increase the burden on the servient properties (Swalley v. Alvis, 2006). Thus, piping open canals and ditches may be allowed even when an express, written easement does not explicitly identify piping as the specific means for conveying water. Reference: Swalley Irrigation District v. Gary Clement Alvis, et al. Civ. No. 04-1721-AA. (Oregon March 1, 2006 opinion and order).
1.02	ALT	In the winter the Canal acts as a catch basin for snow. In the spring and fall the Canal acts as a catch basin for rain. Keeping the surface open to capture the snow and rain – as well as seepage into the Canal from the mountainside above – can all be collected down by the Hanel Mill area for later use.	Please see Section 6.7.2 in the Plan-EA for a discussion of the potential effects of the proposed project to stormwater and surface water management.
1.03	WILD	The Canal has morphed into the landscape as a natural resource unto itself and should continue providing water and serving as a swimming hole for the ducks, geese and birds that have come to call the Canal home now for many generations.	The phasing of the project is expected to allow waterfowl and other avian wildlife ample time to adapt to other water sources. Please see Sections 4.10, 6.10.2, and 8.3 in the Plan-EA for further information about wildlife and BMPs regarding wildlife.
1.04	CUL	This section of the Canal is a historic, cultural, recreational and natural resource that should be preserved.	The Plan-EA is a programmatic document that addresses resources in the project area and the watershed planning area as a whole, and not at the level of a specific canal or pipeline. Please see Section 6.1.2 in the Plan-EA for a discussion of the potential effects of the proposed project on cultural resources. Language was added to Section 4.6.2 and Section 6.6.2 in the Plan-EA to identify the cultural value that private landowners

Comment ID	Topic Code	Comment	Response
			adjacent to the project area gain from the canal system and how the Piping Alternative would effect that value. Although the maintenance roads and trails along the District's canals and pipelines are used for recreation by some area residents, the District's easements are only for maintaining irrigation infrastructure and conveying irrigation water. Public use of the property alongside the District's canals and laterals is not a purpose of the District's easements and occurs at the discretion of each property owner.
1.05	NON V	The Canal in this area is used, precisely because it is open, for hiking by many property owners, and others. There is a historical walking trail along the Canal. Anyone who's walked along this portion of the Canal knows it is a natural resource, as it is, with the beauty of a river – and that this will no longer be the case if it is piped.	The District's canals and laterals, rather than being natural features, were constructed for the specific purposes of conveying irrigation water and are subject to District operations and maintenance for that purpose. The District's easements are associated with that purpose, and that purpose does not include recreational trail use. People who access the maintenance roads and trails, whether trespassing or otherwise, would continue to do so but would walk along a rural landscape rather than a water feature. See Section 6.6.2 in the Plan-EA for a discussion of how the view in the easement would change if the canal were piped.
1.06	GEN	For the span of the Canal from Tollbridge Park/Hwy 35 down to Pinemont Drive/Hwy 35, the heart of which is through the Miller Road section, it does not make sense to manufacture miles and miles of plastic for the proposed side-by-side pipes, plus creating industrial waste and waste water in the manufacture of these unnecessary pipes. Other smaller sections of the Canal may have different issues whereby piping is appropriate. But in the Miller Road area the Canal is 30' wide, or so, and has taken on a natural life cycle and majesty akin to a brook in the non-irrigation season, and a river in the irrigation season.	Please see the response to Comment ID 1.04 regarding the cultural value associated with the canal system.
1.07	WAT	Seepage has not been accurately measured and is speculative. Evaporation has not been accurately measured and is speculative.	The estimated water savings in the Plan-EA are based on end spill losses in the conveyance system rather than on seepage or evaporative losses. Available studies of seepage in District canals

Comment ID	Topic Code	Comment	Response
			were determined to be inconclusive, and seepage could not be reliably estimated. Evaporative losses are not included in the water savings estimate. See Section 2.1.1 in the Plan-EA for a summary of water losses. More detailed information on water losses can be found in the District's SIP (FCA 2018a).
1.08	PURP	While the District cites danger, to my knowledge no one has ever drowned in the Canal over its 100 year history. Property owners with the risk of young children accessing the Canal are able to fence off their own property to provide a safety barrier. The District's threat to fence the Canal is an unnecessary waste of money. Fencing would also interfere with its maintenance of the Canal, and quickly become dilapidated by falling trees. Fencing would deprive the owners of their right to enjoy sharing the path along the Canal.	New text was added to Section 2.1.4 in the Plan-EA noting that the drowning of a child occurred in the Main Canal. Fencing was included in the Canal Lining Alternative to address the increase in public safety risk associated with an increase in canal water velocities after lining (Section 5.2.2 in the Plan-EA). However, no fencing is proposed in the Preferred Alternative (Section 8.2 in the Plan-EA). Please see the response to Comment ID 1.04 related to the public's use of the roads and trails along the District's canals and laterals.
1.09	WILD	Wildlife crosses the Canal regularly and an environmental impact study would be warranted.	After the proposed project, wildlife crossings would not be impeded over the buried pipeline. See Sections 4.10.1 and 6.10.2 in the Plan-EA for discussion of existing wildlife resources in the project area and effects of the proposed project on wildlife. NRCS has elected to prepare an EA as allowed under the 1969 NEPA. The finding of the EA regarding the significance of environmental effects would determine whether an EIS is required.
1.10	GEN	But the reality is that the District only has a legal right of way for a ditch, canal or flume -- not fencing. So just like the pipeline, fencing is not allowed.	Please see the response to Comment ID 1.01.
1.11	GEN	Also pressurized irrigation isn't needed in the Miller Road section of the Canal for the most part. Most irrigation is on the down side of the Canal, which is also part of its beauty in that this irrigation is gravity fed and does not require electric pumps.	Piping the Main Canal from the proposed sedimentation basin to its terminus would build up gravity pressure for those patrons who may not have adequate elevation change on their property to avoid the need to pump water, providing system-wide benefits to meet the purpose and need of the proposed project.

Comment ID	Topic Code	Comment	Response
1.12	ALT	Is it possible to leave the Miller Road section open and pressurize the Canal starting around Hanel Mill? It seems the same concept is being proposed with an open river further up, and that process can begin the pressurized portion from an open canal in the Hanel Mill area.	A "Piping Alternative with Open Canal upstream of Hanel Mill" alternative was added to the Alternatives Considered During Formulation section in Appendix D.3.9 of the Plan-EA.
1.13	GEN	It's concerning that this proposed $69M project presumed easements that don't exist, trampling on the property rights of owners and inviting legal challenges. Determining that legal rights for the proposed project don't exist should have been done before jumping to an environmental impact statement. Throwing more money in the wrong direction is wasteful to the District and its partners.	Please see response to Comment ID 1.01.
2.01	WILD	How can you mitigate loss of water for wildlife? Can something be added to provide water?	Please see Section 6.10.2 in the Plan-EA for a discussion of potential effects of the proposed project on wildlife.
3.01	CONS	Fill in old ditches. Do not want ditches left; fill them into avoid safety issues and to prevent mosquitoes.	Most of the open canals would be backfilled after piping. The District would seek input from affected landowner(s) in those locations where engineering plans recommend leaving any decommissioned canal segment open for local stormwater management. See Sections 4.7.2.4 and 6.7.2 in the Plan-EA for a description of existing canals and stormwater, and the effects of piping on stormwater.
3.02	WILD	How will project affect wildlife? Will a nipple be added to the pipe to provide water for wildlife?	Please see Section 6.10.2 in the Plan-EA for a discussion of potential effects of the proposed project on wildlife.
3.03	GEN	No ATVs on trail.	New text was added to Section 6.2.2 in the Plan-EA about the potential effects of the proposed project on the unauthorized vehicle use of maintenance roads or trails. New text was also added to Section 8.3 that describes BMPs that would be employed to address such use.
4.01	PURP	The biggest effect for most growers is removing silt and sediment so that we can be more efficient and economical with the water we do use.	Thank you for your comment.
5.01	PATD	How are the breakout points determined and do they assess the property size when doing?	Assuming that breakout points refer to turnouts along the District's conveyance, each turnout would be sized based on the

Comment ID	Topic Code	Comment	Response
			irrigated acreage served during the detailed engineering design process.
5.02	PATD	If private laterals coming off the turnout go through multiple property owners to reach a single property, how is that managed? How do we ensure existing private laterals match up with new laterals?	No private laterals would be replaced as part of the proposed project. Patrons who want to upgrade private laterals that extend through several properties should work with those respective landowners and with the District for any necessary assistance. Proposed piping would follow existing alignments as much as possible to ensure they are properly tied to any existing private laterals.
5.03	PATD	Can turnouts be located to optimize pressurization of a property (i.e. put turnout on the up slope side of property vs. down slope)?	The District would be able to discuss this type of request if contacted prior to its completing engineering designs for a pipeline.
6.01	COST	Whose responsibility will it be to cover costs of tapping into the turnout?	The District would connect existing private laterals to the newly installed, updated District turnouts.
6.02	GEN	Property line goes half way into canal line, how does the maintenance of trail change after piped?	New text was added to Section 6.2.2 in the Plan-EA to clarify that the District would continue to maintain its access to buried pipeline via a trail, track, or gravel road within its easement.
6.03	CONS	Will the new pipe be a gully or match landscape contours?	The new pipeline would be buried and the trench would be backfilled and contoured to match the existing landscape. See Section 6.5.2 in the Plan-EA for photos of past piping projects in the District. Also, see response to Comment ID 3.01.
6.04	COST	How will patron bills be affected? How will the District find match?	Please see Section 8.6.6 in the Plan-EA for details of how the District would provide match funding and the potential effects on patron bills.
7.01	SYS	If pipe will be pressurized will pump be needed?	Please see Section 5.3.2 in the Plan-EA for details on pressurized water deliveries.
8.01	GEN	Concerned about gate from Fir Mountain, that ATV will use the new buried pipe.	Please see the response to Comment ID 3.03.
8.02	CONS	Interested in crossing the piped area; wants to make sure it can support any heavy vehicle that would cross.	Site-specific pipeline designs would be evaluated and addressed by the responsible design engineer assigned to the project.

Comment ID	Topic Code	Comment	Response
			Subsequent site-specific evaluations would occur prior to construction based on the Plan-EA's tiered approach. See response to Comment ID 1.01 for information on tiering. The design engineer would insure adequate backfill, backfill compaction, and depth of cover over the pipeline. For high traffic pipeline crossings, or crossings where very heavy vehicles are expected, a steel carrier pipe may be necessary. Generally, the pressure from cars and other light vehicles would have little impact to properly installed HDPE pipe (Plastics Pipe Institute 2008). Reference: Plastics Pipe Institute. (2008). Chapter 6: Design of PE Piping Systems. Handbook of Polyethylene Pipe (2nd Edition pp. 191-241). Retrieved from: https://plasticpipe.org/publications/pe-handbook.html.
8.03	CONS	Mistake on 10% stormwater design off of ditch to Thomsen Rd, don't show going off of road. If heavy rain, how will stormwater in seasonal Shelley Creek be affected?	Site-specific stormwater design would be evaluated and addressed in subsequent site-specific evaluations prior to construction based on the Plan-EA's tiered approach. See response to Comment ID 1.01 for information on tiering.
8.04	WILD	Owl nests where Eastside lateral route is. Swyers Drive & Fir Mountain Rd on county property.	Please see Section 8.3 in the Plan-EA for description of BMPs related to wildlife and nesting birds.
9.01	WAT	Plan should include evaporation and seepage losses.	Please see response to Comment ID 1.07.
10.01	MAP	Can you show a closer image of pipe location?	Larger-scale maps of the proposed pipeline alignments have been added to Appendix C.
11.01	MAP	We need a closer map of the project area around the realignment area.	Please see response to Comment ID 10.01.
11.02	CONS	What is the approximate time for construction?	Construction would occur during the non-irrigation season. Please see Section 8.2 for a construction timeline.

Comment ID	Topic Code	Comment	Response
11.03	CONS	We want to have a turnout put in.	Landowners interested in a new turnout should contact the District. As a programmatic environmental document for the proposed project, the Plan-EA does not address this matter.
12.01	GEN	I applaud the efforts to upgrade EFID infrastructure. The increases in irrigation efficiencies are needed, and will help maintain the viability of our area's agriculture.	Thank you for your comment.
12.02	VEG	My comment is with regard to the loss of the long-established, open waterway and the effects it will have on forest trees adjacent to the decommissioned canal. As I have several hundred linear feet of previously decommissioned EFID canal along my property above Neal Creek, I have been dealing with the decline and death of large conifers, some in excess of 100 years old, due to changes in the subsurface hydrology after canal rerouting. I would be happy to send photos, if you might find them helpful. Property owners should be made aware of the gradual decline to established trees adjacent to the existing open canal once it is decommissioned. Perhaps a cost-share program could be considered to aid in tree removal as these declining trees will eventually present a hazard.	The District would not remove potential hazard trees that could fall within its easement. However, the District would continue to remove any fallen trees within its easement to maintain access. Please see updated language in Section 6.5.2 in the Plan-EA for additional discussion of the potential effects of the proposed project to vegetation. Please see updated language in Section 8.3 for discussion of BMPs related to vegetation.
12.03	WILD	Another consideration is that these well-established, open canals have served as a water source for local deer and elk populations for many generations. Possible incorporation of a few open water sources (i.e. ponds) would help prevent movement of local Cervid populations onto agricultural and rural residential properties in their efforts to reach available water sources.	Please see Section 6.10.2 in the Plan-EA for a discussion about the potential effects of the proposed project to wildlife. Water is not considered to be a limiting factor for terrestrial wildlife in the project area and vicinity (J. Thompson, ODFW District Wildlife Biologist, personal communication December 6, 2018). The District's water rights are for irrigation, agricultural spraying, frost, fire protection, and industrial uses only. The water rights do not provide authorization for the creation of ponds for wildlife.
13.01	COST	It was stated that funding for this project will come from a combination of NRCS funding and grants and/or loans that East Fork Irrigation will need to procure. Will any part of this project be funded by increasing rates for East Fork Irrigation patrons who pay for irrigation rights on their property?	Please see Section 8.6.6 in the Plan-EA for details of how the District would provide match funding and the potential effects on patron bills.

Comment ID	Topic Code	Comment	Response
14.01	GEN	My name is Daryl Roberts and I am calling about the EFID project with some questions about how the EF District part of the funding will be handled. My number is 541-XXX-XXXX. I already called the EFID and talked to John Buckley, and he referred me to you guys. Talk to you later.	Thank you for your comment. Two phone calls were made to the number provided, and two messages were left.
15.01	FISH	The Oregon Department of the Fish and Wildlife (ODFW) submits these comments on the East Fork Irrigation District (EA). As the EA correctly identifies, the Hood River and its tributaries support a diversity of fish species, including several species which are listed as either state sensitive, or as threatened under the Endangered Species Act (ESA). Low streamflow in the Hood River basin, associated with water diversions, has been identified as critical limiting factor for recovery of listed fish species (ODFW, 2010). The ODFW commends the East Fork Irrigation District (EFID) Modernization Project for its proposal to improve efficiency, divert less water, and leave additional water instream flow through voluntary water savings and through permanent instream transfer through the Conserved Water Program. Water quality is also an important factor for fish, and aquatic health in Hood River. Increased temperature, turbidity, toxics, and nutrients have all been identified as factors limiting water quality in the Hood River basin. And many of these currently do not meet federal and state standards. Again, the ODFW commends the Modernization Project for decreasing diversion rates thus having less effect on stream temperatures, and reducing end spills to decrease sedimentation and other associated negative water quality impacts. Water diversions generally negatively affect water quality, and the EA mostly describes EFID's operational effects on water quality.	Thank you for your comment.
15.02	FISH	The document does, however, fail to address the significant increase in sedimentation in the East Fork Hood River downstream from the diversion site resulting from the operation of the sand settling basin. As we understand the operation of the sand settling basin, turbidity (sand) is removed from the diverted flow at the settling basin and relatively sediment free water is delivered downstream through the irrigation infrastructure. The diversion site takes approximately 75 to 85 percent of the flow in the East Fork of the Hood River and its associated sediment, the sediment is settled out in the settling basin, but the	Thank you for your comment. Language has been added to Sections 4.7.3.3, 4.8.1., 6.7.1.4, 6.7.2.4, and 6.8.1.2 in the Plan-EA to describe current sediment management operations at the EFID sand trap and their potential effects on the aquatic environment and expected sediment management under the proposed project and their potential effects on the aquatic environment.

Comment ID	Topic Code	Comment	Response
		remaining sediment is then regularly flushed back to the diverted reach of the East Fork Hood River at the sand settling basin. This flushing of sediment back to the 15 to 25 percent of remaining flow in the diverted section of East Fork greatly spikes the sedimentation in the East Fork Hood River far exceeding sedimentation standards, and likely substantially negatively affecting aquatic health in the East Fork Hood River below the diversion site. We ask to please better describe the current operation of the sand settling basin, potential effects on water quality and aquatic health, and any future operational procedures associated with the Modernization Project that may limit sedimentation from this site.	
16.01	GEN	I live in Bowling Green, Kentucky, but I was born and raised in the upper Hood River valley; on a beautiful property on Miller Road, adjacent to the East Fork Irrigation District's main canal. Both of my parents were also born and raised in Hood River, and bought the property in the late 1970's. I can directly credit the maintenance road access to the canal, and the wildlife viewing opportunities that came with it, for a good deal of the development of my passion for wildlife and conservation in childhood. This early interest in wildlife ultimately led me to where I am today: teaching Biology at a community college. When my mother informed me of the East Fork Irrigation District's proposed plan to pipe the canal, I was devastated. When I go home to visit, my first outing is a visit to the canal. Before I leave, I take one last walk along that maintenance path. The canal's maintenance road may be no formal recreation trail; bicycling, hiking, and wildlife photography may not be sanctioned activities; but for many who call this stretch of the east Hood River Valley home, it has become a central part of the joy of life. Though I've lived in several towns in Oregon, Montana, and now Kentucky, and have visited southern Africa twice, the one landscape photograph I have hanging in my office is of the humble irrigation canal behind our home. A line of vegetation overhangs the bank, creating a stark contrast between green leaves and brown soil. The lazy meandering canal sparkles in the sunlight. And in the distance, a glimpse of the newly constructed bridge hints toward paths few take. Those of us who are lucky enough to know those paths have come to appreciate the canal and it holds a special place in our	Please see Section 6.6.2 in the Plan-EA for a discussion of the effects of the proposed project to visual resources. Language has been added in Section 4.6.2 to more accurately describe conditions that may be present in canals during the non-irrigation season. Language was added to Section 6.2.2 to note that the District would continue to maintain a trail, track, or gravel road within its easement to access the buried pipeline following construction. Please see the response to Comment ID 1.04 regarding the cultural value associated with the canal system. A new section has been added to the NEE in Appendix D of the Plan-EA that analyzes the effect of piping the canal on property values.

Comment ID	Topic Code	Comment	Response
		hearts. That may sound saccharine, but it is true. I am afraid I just cannot agree with the statement that "the Piping Alternative would have a minor, long-term effect on visual resources in the project area." I did appreciate the addition of "some residents consider the presence of open channels with flowing water to be an amenity that provides a unique water feature on or near their property or an enjoyable view when they walk along maintenance roads aside the canals." Yes, absolutely. I cannot overstate how much walks along the canal have become a part of my life and the lives of my family members. Ask anyone who lives along Miller Road who use the canal's maintenance trail for walking, hiking, horseback riding, bicycling, jogging, and cross-country skiing whether they think this will be a minor effect. Eliminating the open canal will have significant long-term impacts and completely change the character of the land and may even affect property values. Currently, a real estate listing for a home for sale on Miller Road includes the following in its description: "hike out your back door near the canal running through the back of the property"! This is a huge draw for locals and even visitors in the area and is likely a selling point for these properties. Over the years, pedestrian traffic has increased as more homes have been built with access to the maintenance road. It is rare now to walk for any length of time on a clear day and not meet a few neighbors out for a walk as well. There is even a community "Christmas tree" along the path, maintained by multiple families who reside along Hess and Miller Roads that has morphed into an "any holiday" tree with decorations year-round.	
16.02	WILD	Aside from the concerns I have for locals and the disappearance of this water feature, I also have concerns for the flora and fauna that call the habitats that include the canal home. The canal has been a part of the landscape for 70+ years. Though it is not technically "natural," it still provides ecological benefits that generations of wildlife have relied upon. Not only is it a significant water source for birds, mammals, and reptiles, it creates habitat for many species of native plants and their pollinators. Eliminating what has become a year-round source of water and habitat for wildlife is one of the concerns I have with this project. Though the report states that "From November through February, the canals do not carry water except during large storms and are usually	Section 4.6.2 in the Plan-EA has been revised to more accurately describe conditions that may be present in canals during the non-irrigation season. Please see Section 6.10.2 in the Plan-EA for a discussion of the potential effects of the proposed project on wildlife.

Comment ID	Topic Code	Comment	Response
		empty with occasional puddles or pools in low-lying areas and at locations where spring water enters the canals," I can attest that this is demonstrably false. The only times I have seen significant areas of the canal "dry" is when the remaining water freezes solid during the coldest parts of winter. At least within the main canal, there is substantial water year-round that provides habitat and water for wildlife. Even in the middle of winter, water depths range from a few inches to 6" or more in the deeper pools. The canal is never completely drained of water, and snow melt and precipitation add to its value as a year-round low-lying area; a water source for wildlife and plants. Hence, one of my primary concerns with this project on the main canal is its potential to negatively affect local populations of many native species of wildlife. From a biologist's perspective, I can certainly appreciate the desire to attempt to return conditions to more "natural" parameters. But after nearly a hundred years of use by native flora and fauna in the area, to me, it seems difficult to weigh costs and benefits ecologically.	
16.03	FISH	From what I understand in the report, even with all of the modernization projects going forward in addition to unspecified future conservation efforts, instream flow and water temperatures, especially downstream from the diversion point, will still be insufficient to support viable spawning populations of anadromous fishes. If even in the best of circumstances this saved water will be insufficient to support aquatic species thriving in the East Fork, is there really going to be a net ecological benefit once the open canal is eliminated? It certainly provides quality habitat for wildlife currently; piping it renders this water completely inaccessible and useless for any wildlife and plants established in the area.	Please see Section 6.8.2 in the Plan-EA for a discussion of the potential effects of the proposed project on anadromous fish populations. For additional information, see the response to Comment ID 16.06.
16.04	WILD	Many sources of water further down in the valley have already been co-opted for use by residents and agriculture. Natural streams and ponds within the valley are not as accessible to wildlife due to human encroachment, so for many populations, the only viable alternative will be to seek out less dependable small streams within the foothills below Bald Butte. Having hiked this territory for much of my childhood and adult life, I can say that what little water I have come across (in the form of small springs and streams) is in fact largely ephemeral in nature	Please see Section 6.10.2 in the Plan-EA for a discussion about the effects of the proposed project to wildlife.

Comment ID	Topic Code	Comment	Response
		and not likely to support as many species or as many individuals as currently use the area. To my knowledge, many of the large hillsides to the east of the main canal do not have any permanent source of water; hence the removal of the canal will undoubtedly cause considerable disturbance to wildlife, emigration from the area, and lower populations and productivity.	
16.05	WILD	The report states that "the effect of the Piping Alternative on any resident fish populations or macroinvertebrates and amphibians that may utilize the irrigation canals is expected to be minor. The habitat function provided by the canals is low given the absence of year-round flow, the annual mortality resulting from canal dewatering, canal maintenance activities, and because a fish salvage effort would be conducted in the canal prior to construction." As I have addressed earlier, even after irrigation season has ended, there remains in the canal sufficient water to provide habitat for amphibians, macroinvertebrates, and other animals. There are rough skin newts in the canal year-round and during certain times of the year, dozens to hundreds can be counted in and around the canal on an afternoon walk. The construction would certainly cause direct mortality to many of these amphibians due to crushing and other injuries by use of heavy equipment. There are also Pacific tree frogs that utilize the canals, and probably other amphibians that are less common. Bird species including varied thrush, Swainson's and hermit thrush, American robin, yellow bellied sapsuckers, pileated woodpeckers, belted kingfishers, wild turkeys, ruffed grouse, brown creepers, red breasted nuthatches, red-tailed hawks, great horned owls, American dippers, and many others have been observed directly adjacent to the canal. Mallards nest along the canal's banks and their downy offspring find shelter from predators in the horsetails and reeds. Small mammals including chipmunks, western gray squirrels (a species of concern in Oregon), snowshoe hares, etc. have been observed utilizing the canal for a water source. Larger mammals including coyotes, bobcats, black bears, mountain lions, blacktail deer, elk, raccoon, opossum, striped skunk, and even river otters have been observed in and directly adjacent to the canal. Even though the wetland conditions may be deemed unnatural along the main canal, I have personally observed many pollinators,	As a programmatic environmental document, the Plan-EA analyzes potential project effects on species at the population level, rather than at an individual or local level. Please see updated language in Section 6.10.2 for discussion about the effects of the proposed project to wildlife.

Comment ID	Topic Code	Comment	Response
		including native bumblebees, European honeybees, wasps, butterflies, hummingbirds, etc. utilizing the canal as a source of water. Some areas in particular predictably draw in colonies of honeybees that are either naturalized populations or housed within nearby bee boxes. The wildflowers that grow along the canal only as a result of these wetland conditions will be eliminated, and with them, the pollinators which benefit local gardeners, orchardists, and native flora, will be displaced. Mt. Hood lilies, tiger lilies, calypso orchids, bog rein orchids, lupine, and myriad other species of native flora will also experience direct mortality as a result of the canal being piped during the construction, and the subsequent drying of the soils as seepage is eliminated.	
16.06	FISH	I would like some additional clarification regarding the statements concerning proper spawning temperatures and flow. The report states that "The applicable temperature criteria for protection of salmonid fish rearing is 64.4 degrees Fahrenheit (ºF) in the East Fork Hood River, Whiskey Creek, and Neal Creek and 60.8 °F in the Hood River (ODEQ 2017). The 64.4 ºF criterion is typically exceeded in the East Fork Hood River during the summer, with 7-day average daily maximum temperatures reaching 68º F upstream of the Middle Fork Hood River confluence (ODEQ 2017). Irrigation diversion greatly reduces streamflow in the lower river during the summer, contributing to the warm temperatures. Modeling simulations conducted by ODEQ indicated that without EFID's diversion, the East Fork Hood River would be cooler by approximately 3.5 ºF above the confluence with the Middle Fork Hood River, and the Hood River at its mouth would be cooler by 2 ºF (ODEQ 2001)." So, without the diversion – any diversion? – temperatures above the East Fork's confluence with the Middle Fork would still exceed the proper temperature by 0.1 degree? How then will saving the relatively small percentage of water by eliminating end spills be sufficient to cool the water to proper fish rearing temperatures? Basically, will what is saved on average from the elimination of end spills actually provide the quantity and quality of fish habitat needed for viable populations? Or is it a battle already lost, and will piping the open canal simply take yet more water away from other species?	Please see updated language in Section 6.7.2.4 in the Plan-EA related to the potential effect of the proposed project on water temperatures. Please see updated language in Section 6.10.2 for more discussion about the effects of the proposed project on wildlife.

Comment ID	Topic Code	Comment	Response
16.07	NONV	Losing the canal as a source of recreation and beauty is hard to fathom, but I understand that costs and benefits must be weighed in these times of overuse of natural resources. If there is a net benefit to wildlife and ecosystem services, then the decision must be made in favor of the data over personal feelings. And realistically, it will be human demands that supersede any ecological concerns. Ultimately, agriculture in the Hood River Valley as it exists today is unsustainable, especially considering the impacts of climate change. The root problem seems to be we are simply using too much water, and a pipeline may provide a temporary Band-Aid in the form of some water savings and help for orchardists struggling with silt in the irrigation water, but it will not be a permanent solution. I do not have the first-hand knowledge to say whether the benefits of piping the canal outweigh the social and ecological costs; I don't know if anyone truly does because it comes down to personal values and subjective analyses for some variables. Maybe dedicating that 16-odd cubic feet per second of additional flow that will potentially be conserved due to the end spills being eliminated will be exactly what the salmon and steelhead need within the East Fork. I just hate to see the beauty of the open canal and benefits it provides to native plants and wildlife simply vanish. I sincerely appreciate the consideration of my letter.	Please see the response to Comment ID 1.04 regarding the cultural value associated with the canal system.
17.01	CONS	The canal runs right on my property line, how would I be informed of when construction is in progress? Do you ask for permission when working on private land? If so, am I allowed to say no?	The District would complete all work within its easements. The District would contact each landowner to inform them of the specific construction schedule for their property. As a general rule in Oregon, an easement owner has the right to improve its easement to the extent that the improvement does not increase the burden on the landowner or injure the rights of others.
17.02	COST	I am aware that there is some funding in place but for the funding that is not yet, what would happen if the funding runs out during construction? How can we know that each of the 3 separate plans will be complete? Would it even be beneficial to only have the plan 1 and/or plan 1 and 2 complete without plan 3?	The proposed project would be constructed in phases to complete each of the project groups identified in the Plan-EA. PL 83-566 and non-federal match funding would be secured for each phase prior to starting construction of that phase. Each phase could be constructed independently of the other phases. Each phase would provide water conservation, pressurized delivery, and/or District O&M benefits if constructed alone.

Comment ID	Topic Code	Comment	Response
			Additional water conservation, pressurized delivery, and District O&M benefits would be realized if all phases are constructed. Sedimentation basin benefits would not occur in the absence of the Main Canal piping. See Appendix D.1.4 of the Plan-EA for discussion of incremental analysis, which identifies how total costs and benefits change as project groups are added. The District would continue to deliver water to patrons in the event that funding ran out during the construction of a phase.
17.03	COST	Placing a new system requires new equipment for each intake, who is expected to pay for these upgrades?	Please see response to Comment ID 6.01.
18.01	COST	How will secondary irrigation (ex: Mt Hood Irr District) districts be affected and held responsible for funding?	The proposed project would not affect the MHID, which would not be held responsible for funding the proposed project.
18.02	COST	Please provide more detailed funding expectations for matching the federal $31 million grant, as well as the additional $7 million needed to cover total of ~$69 million?	Please see Section 8.6.6 in the Plan-EA for details of how the District would provide match funding.
18.03	PATD	Has on-time and correct amount of water delivery ever been an issue for farmers, examples?	Please see Section 2.1.2 in the Plan-EA for updated information related to District deliveries.
18.04	GEN	Why are environmental studies cited not more current (2012)?	The Plan-EA considered available, relevant environmental studies for the Hood River basin. The publication dates of these studies vary. Refer to Section 9 in the Plan-EA for a complete list of references.
18.05	GEN	In the event of funding running out, what will suspended construction mean for land owners mid-project?	Please see response to Comment ID 17.02.
18.06	CONS	Who is providing insurance coverage in the event of any construction damage to private property, or in the event of an issue leading to crop failure?	The construction contractor would carry insurance coverage for construction damage to property. Construction would occur outside of the irrigation season; therefore, no interruption of irrigation deliveries would occur as a result of construction.
18.07	COST	Have you solicited or considered contractor bids on actual cost of work to compare to numbers in proposal?	The District has not solicited or considered bids this early in the engineering design process. The cost estimates in the Plan-EA are high-level estimates based on the Plan-EA's tiered approach. The District would refine these cost estimates following the

Comment ID	Topic Code	Comment	Response
			completion of the detailed engineering design process for each project group. See the response to Comment ID 1.01 for information on tiering.
18.08	ALT	Could a system of water towers throughout the irrigation district pumping water upward provide both pressurization and water filtration through sediment settling?	A water tower alternative was added to the Alternatives Considered During Formulation section in Appendix D.3 of the Plan-EA.
18.09	GEN	What are land use plans for the area where the canal currently runs and the adjacent walking paths?	No changes in land use would occur as a result of the proposed project. The District would continue to maintain a trail or gravel access road along the former canal alignment for system maintenance purposes as authorized by its easements.
19.01	COST	Currently we pay for irrigation rights. It is not written but there has been talk of raising the price of the rate 5-10% per year, please address this.	Please see Section 8.6.6 in the Plan-EA for details of how the District would provide match funding and the potential effects on patron bills.
19.02	WILD	Have you considered the affects the piping will have on wildlife? What will be done to support the wildlife that have made this their home?	Please see Section 6.10.2 in the Plan-EA for a discussion of potential effects of the proposed project on wildlife.
19.03	ALT	Looking at the proposal on how the piping will make irrigation more efficient because of how it will save water, is rain water taken into consideration?	This question was understood to ask whether capturing rainwater was considered as an alternative to the proposed project. A rainwater alternative was added to the Alternatives Considered During Formulation section in Appendix D.3 of the Plan-EA.
19.04	COST	What happens if you finish Plan 1 but lose funding for Plan 2 and/or Plan 3?	The District would continue to seek other funding sources required to complete Project Groups 2 and 3. Please see the response to Comment ID 17.02 for additional discussion.
20.01	GEN	My wife and I are farmers on the east fork. We use irrigation close to daily Spring, Summer and Fall. I have serious concerns about the piping plan. I do not see the cost benefit. Filtration is our biggest issue. We have invested in filtration systems to combat this and have generally mitigated our issues. The piping plan does included an extra	Please see Section 2.1 of the Plan-EA for a discussion of the watershed problems and resource concerns that the proposed project is intended to address. These include a range of needs and resources in addition to sediment management. The NEE Analysis provides a cost benefit analysis for the

Comment ID	Topic Code	Comment	Response
		settling pond, but that is the last project. I am concerned by that time money will be dried up.	proposed project and is included as Appendix D.1 of the Plan-EA.
20.02	WAT	I am also very concerned with the pH fluctuation. My crops are sensitive to pH. Will I now need to invest in a testing and remediation systems for pH?	The proposed project would not be expected to affect the pH of water delivered by the District. This language was added to Section 6.7.2.4 in the Plan-EA.
20.03	VEG	I am also a hydro-seeding contractor. The revegetation of 56 miles of a piped canal would be a massive logistical issue. Access to the canal with our trucks would not be possible. Our hydro-seeders are mounted on flatbed semis. Our clearance is over 15'. Our smaller machines that are gooseneck trailers have a clearance over 10'. 56 miles of area only 10-15' wide would mean the trucks would constantly have to move. Trying to revegetate without hydro-seeding would ensure a very low success rate while creating an ideal situation for invasive species.	The use of hydro-seeding is not part of the proposed revegetation plan. Please see Section 6.5.2 of the Plan-EA for discussion of revegetation after the proposed project.
20.04	NEE	Cost benefits of this project do not seem to make sense.	Please see Appendix D for a description of the methods for and results of the NEE Analysis prepared for the proposed project.
20.05	COST	I am concerned money will dry up without the project finishing.	Please see response to Comment ID 17.02.
20.06	REC	I am concerned about losing an amazing natural trail to walk along.	Please see response to Comment ID 1.04.

20.07	WAT	I understand the benefit from increased efficiency, but an 18% increase does not pencil out. Water being re-released into groundwater and the aquifer is not lost water.	The proposed project would eliminate end spills from District infrastructure into natural drainages in the lower Hood River basin. Please see Sections 4.7.2 and 6.7.2 of the Plan-EA for more information on water resources. Precipitation is the primary source of groundwater recharge in the basin (Keller 2011; Reclamation 2015). Please see Section 4.7.4 of the Plan-EA for more information on groundwater recharge.
21.01	CONS	As a property owner which the EDID is on, by easement, will more land be required during construction, if so, how much, and when project is completed on my land, will the easement width be reduced from its current width.	The need for temporary construction easements would be determined prior to construction of each project group. Temporary construction easements would be coordinated with affected landowners. These temporary construction easements would only be in place for the duration needed for the construction of the associated project group. Following construction, the easement width would be maintained at its pre-project width. Please see Section 8 in the Plan-EA for BMPs associated with construction.
22.01	ALT	While the irrigation canal pipeline project may modernize the way water is delivered to orchards and other agribusiness that depends on the water of the East Fork of the Hood River I do not believe it is the best course of action to assist in preserving water for instream use. The main issue with the water use is the irrigation practices throughout the valley. This should be the primary focus of the modernization throughout the district. I know that this was addressed in the Draft Plan as an alternative and then quickly discarded as not possible. If the orchardists are struggling with silt issues in their irrigation system, they should be the ones to invest in better ways to remove the silt from the water. This can be done using technology for wells with high silt loads including cyclonic separation systems. The district could also still implement the settlement pond to assist with this, or orchardists could implement settlement tanks for their irrigation systems. For fine sediments a pool filter could be used or something similar. If the orchards are bringing in over 72 million dollars/year annually, the	Please see Section 5.2.2 in the Plan-EA for a discussion of on-farm efficiency upgrades as an alternative. Please see Section 6.4.2 in the Plan-EA and the NEE Analysis in Appendix D for a discussion of the economic effects of the proposed project.

		orchardists having to spend a few thousand dollars to improve their irrigation infrastructure locally would be a better option than spending at minimum (since construction costs are never actually what is initially quoted) 69 million dollars, much of which will not remain in the community as implied in the draft plan, to implement a project that is at its source designed to benefit the orchardists.	
22.02	FISH	The slight and possibly nonexistent benefits to fish species mentioned seem to be an afterthought since even in the best-case scenario (12.45 cfs) the minimum temperature and flow rate will not be met. The 12.45cfs is even less likely to be delivered back into instream use as climate change continues and the snowpack and glaciers become smaller. Is the Salmon population that has been threatened and damaged by the 70 years of the use of the irrigation canal even a viable breeding population at this point? This is one of the major questions that was not even asked in regard to the slight amount of water that this project may save in a good year. This omission coupled with the fact that even this amount of water saved will not be enough to lower the temperature to the maximum temperature tolerable, or the minimum necessary flow rate for the Salmon seems to indicate that this is not a priority for this project and is only being used as a way to justify money savings with disregard to the damage the removal of the open water source canals will cause. The water in the open canals can and does benefit the ecosystem surrounding it while water contained in a pipeline will offer no benefit to the surrounding ecosystem because it is closed off to any use but human.	The ESA Recovery Plan for Lower Columbia River salmon and steelhead identified low streamflow as a key limiting factor for threatened populations in the Hood River basin (ODFW 2010; NMFS 2013). Streamflow restoration resulting from the proposed project would be expected to help improve the viability of listed fish populations. Water savings allocated to instream use through the proposed project would be permanently protected instream and would increase the minimum streamflow at the District's diversion regardless of the effects of climate change. ODFW has assigned an extinction risk goal of "low" or "very low" to each of the listed salmon and steelhead populations in the basin. By addressing the limiting factors and threats to these populations, these goals are expected to be achieved or exceeded for spring Chinook and winter steelhead populations (ODFW 2010). Please see Section 6.8.2 in the Plan-EA for more information on the effects of proposed project on fish and aquatic species.
22.03	WILD	While there may be other water sources available near the canal, are they easily accessible to animals or are they in open exposed areas with nearby human habitation? Along the main canal branch, while wildlife is potentially near human habitation, there is at least seclusion due to the presence of mature trees and brush which helps guard against disturbance by human activity. There are also few if any substantial permanent water sources within the east hills and the main branch of the canal is the best accessible source for many of the animals living in this area. The 70-year existence of the canal has turned it from being an artificial construction into part of the landscape of the valley. To use the fact that it is a manmade artificial creation as a justification for its	Please see updated language in Section 6.10.2 in the Plan-EA related to the potential effects of the proposed project on wildlife resources.

		removal and to justify the installation of a pipeline is laughable. A pipeline is more artificial and less beneficial to the ecosystem than a stream running through a section of woodland and field even if that stream was initially created by something other than erosion.	
22.04	RES	The pipeline will also not cause limited harm along the path of its installation. As evidenced in the preliminary plan in the archives the idea is to lay two pipes as large at 48" and 54" in diameter along the main portion of the canal. Installation of large diameter piping such as this requires heavy machinery which requires large amounts of room to operate leading to the destruction of many mature trees, disturbance of prolific wildlife along the main portions of the canal, and the probable fatality of many smaller animal species such as rough skinned newts, pacific tree frogs, voles, and many other mammal, amphibian, insect, and plant species. The draft plan majorly downplays the effects that the construction of such a pipeline will have on the area in which it is constructed for decades and the disturbances and damages to local flora and fauna from the lack of accessible water.	Construction of the proposed project would include short- and long-term effects on wildlife and their habitat, including some unavoidable construction-related mortality of organisms. See Sections 6.5.2, 6.8.2, 6.9.2, and 6.10.2 in the Plan-EA for discussion of the effects of the proposed project on vegetation, wildlife, aquatic species, and wetlands, respectively. As a programmatic environmental document, the Plan-EA analyzes potential project effects on species at the population level, rather than at an individual or local level. Section 8.3 includes BMPs that would be followed to minimize these effects. See response to Comment ID 16.05 for information related to water availability for wildlife after the proposed project.
22.05	PURP	The public safety issue also seems to be overstated in this article. While it is very tragic that people have lost their lives in the canal system it has been in operation for 70 years. Any open water source can be a danger to unsupervised children and impaired adults, but the slow-moving canal is not difficult for a non-impaired person above the age of 13 to remove themselves from. The opposite of this is stated in the draft plan. The areas along the canal are used by many people every day for a multitude of activities such as walking, horseback riding, and biking and have been since the canal was first installed 70 years ago. This use creates a sense of community among those who inhabit the areas near it. The canal is used as a selling point for homes and land throughout the valley and increases property values for those with property nearby. While the trail along the canal may not be a tourist attraction it provides a needed location for residents to enjoy the beauty of the valley without disturbance from tourists.	Please see Section 2.1.4 in the Plan-EA for a discussion of the public safety risk of the open canal. The NEE Analysis, included as Appendix D.1 of the Plan-EA, quantifies the costs and benefits of the proposed project (see Appendix D.1). Aesthetic, emotional, and experiential values of the open canal could not be quantified due to insufficient data. A new section has been added to the NEE that analyzes the effect of piping the canal on property values. Please see the response to Comment ID 1.04 regarding the cultural value associated with the canal system.
22.06	PUB	As a final comment, the length of time given to the public for comment on this project is entirely too short. The draft plan for this project has been worked on for more than two years and the public, many of which did not know this plan was being developed, were only given 30 days to read, understand, and attempt to research alternatives to a document that is 160 pages long. These 160 pages do not include	Public participation for the proposed project has occurred in accordance with applicable federal CEQ regulations for implementing NEPA (40 CFR 1500–1508), USDA's NEPA regulations (7 CFR Part 650), and NRCS' National Watershed Program Manual (NRCS 2015) and National Watershed Program Handbook (NRCS 2014).

		the multitude of sources that were sited and were not made readily available to the public for review. The review of these sources for methodology applicable to this situation, accurate and non-misleading representation of the findings in the draft plan and potential for finding other research that could invalidate or support the claims made by these sources in integral to a proper review and analysis of any plan such as this.	For details on public participation activities related to the scoping meeting, Draft Plan-EA public review, and public meeting see Sections 3.1 and 7.2 of the Plan-EA.
23.01	WILD	In general, the Plan EA does not adequately identify or explain adverse impacts. It glosses over what is being lost, in order to present the project in the best light. "Artificial" or not, the proposed project will remove 36 acres of wetlands and over 17 miles of riparian habitat along the canals. The Plan does not adequately explain how the lost wetland and riparian habitat will be offset by "enhancement of naturally functioning wetland and riparian habitat in the East Fork Hood River". Walk along the canals (as seen from the roadside) on any day of the year and you will see that the riparian areas are full of many species of birds. I have been a birder all my life, and I notice the arrival of migratory species, as well as the everyday residents. Neo-tropical migratory birds are imperiled worldwide. We should be making more habitat, not removing riparian habitat, which is so vital to many.	Further explanation of the effects of the proposed project to wetlands and riparian habitat was added in Section 6.9.2.3 in the Plan-EA.
23.02	ALT	I suggest that the Project should be altered to include 1) wetland enhancement projects (blackberry removal and native plantings) along streams, ditches and ponds on public and private property on the east side of the Valley to compensate for wetland loss. 2) There should be a mix of open canals and pipe in order to preserve some of the wetland habitat and scenic values.	Effects from the proposed project to wetlands and wildlife are discussed in Section 6.9.2 and 6.10.2 of the Plan-EA. Prior to construction, consultation with USACE would occur and measures would be taken as required to identify and mitigate for potential effects on jurisdictional wetlands. A "Mix of Open Canal and Pipe Alternative" was added to the Alternatives Considered During Formulation section in Appendix D.3 of the Plan-EA.
23.03	NONV	My last comment is harder to articulate, but I will try. I have lived in the Valley for over 30 years. Many people love this place and feel viscerally connected. The landscape is a big part of why we feel this way. There is a mix of open space and agriculture, of forest lands and houses. Subtle things contribute to a pastoral landscape. But if you look closely, you realize how much of the natural environment has been converted to orchards. The East Fork canals are a historic and beautiful feature of our treasured landscape, and in much of the Valley,	Thank you for your comment.

		they are a last refuge for birds, frogs and other species. People use the ditches too, as a place for quiet respite, and they have done so for generations. But as we put all of the open water into pipes, and do away with the sedimentation ponds, we are converting our pastoral landscape into an industrial agriculture landscape. There is nothing left for nature. While I do understand the water conservation benefits, piping all of the canals will be detrimental to the upland wildlife that use the riparian corridor and wetlands. It will cause people to lose landscapes that they love. A better option is to keep some open canals, and include wetland restoration on public and private lands in affected areas to compensate for the wetlands that will be destroyed.	
24.01	REC	There have been rumors of a pipeline for many years now, so it's with mixed feelings I make my comments. I walk the canal daily and have lived on Miller Rd. since 1978. I would disagree, with the claim on page 31 that "No trails occur in the project area." There is a good trail maintained and although I don't walk the whole length, one could walk it from the Pinemont Rd. area all the way to Hess Rd.	Section 3.4 and Section 6.6.2 in the Plan-EA has been updated to differentiate between public recreation trails and the maintenance roads/trails alongside the District's canals that are also used for recreation by local residents.
24.02	WILD	To take a key aspect explored in the proposal the canal "barrier" has pros and cons. Yes, it can be a place for human-wildlife conflicts. But it also acts as a barrier, keeping many animals on the east side of the canal only coming down for water. I'm concerned about the generations of wildlife that have habituated and come to rely on that drinking water. In my immediate area, across from my property and across the canal at Zemans, there are 2 dry, old creek beds. How long have they been dry? Many, many years ago perhaps that was a natural water source for the wildlife, but it is no more. From this angle, there could actually be an increase in human-wildlife conflict too, as a land bridge/mass would now "allow," or make easier, the passage of wildlife onto properties at any point along the pipeline length.	Please see Section 6.10.2 in the Plan-EA for information about the potential effects of the proposed project to wildlife.
24.03	WILD	I'm concerned more large animals will be killed on Hwy 35 as they make their way to the East Fork of the Hood River. This puts drivers in danger too.	Please see updated language in Section 6.10.2 in the Plan-EA about the effects of the proposed project on wildlife.
24.04	NON V	So far, I've concentrated on the logistical concerns raised by the proposal. But I want to return to the way this canal has functioned in our community as a source of pleasure, exercise, and neighborly interaction. Many of us use this trail and have for decades. Since many folks use the trail for walking, biking, horseback riding, etc. there is rather an unwritten rule that allows people to walk the canal even	Please see updated language in Section 6.2.2 in the Plan-EA about effects of the project on land use. Please see the response to Comment ID 1.04 regarding the cultural value associated with the canal system.

		though it is, in most places, private property. There's even a legal term for this: prescriptive easement. Once that right-of-way has been established, reverting it out of that usage is legally a challenge. So even though the walk will not be the visual resource it now is, people & pets will continue to use this area.	
24.05	VEG	I see mention in the proposal of 'invasive species, implementation of BMPs and the spread of noxious weeds during construction would be avoided.' "The net gain in native vegetation would occur' (?), and 'weeds managed according to NRCS OR & WA Guide for Conservation Seedlings & Plantings.' So what are those guidelines? On page 110 of the PDF, 'herbicide applications'—-vegetation control activities' make me question the quote 'beneficial cumulative effects on all ecosystems.' Herbicides to me are not a benefit. I don't want to walk with my dog through vegetation treated with pesticides. Dogs get cancer, and my husband got leukemia/lymphoma from Roundup and is currently in a case against Monsanto. Currently there is an amazing, functioning, sustainable ecosystem in place up there. The wildflowers are in profusion—-lupine, aster, goldenrod, pearly everlasting, Indian paintbrush, bog rein orchids—-all are a very visual resource to many of us—-as is the water that reflects the colors of the seasons all year round.	Please see updated language in Section 6.5.2 related to a net gain in vegetation as an effect of the proposed project. A brief summary of NRCS Guidelines for Conservation Seedlings and Plantings (NRCS 2000) was added to Section 6.5.2 of the Plan-EA. Section 6.11.3 addresses the cumulative effect of the proposed project together with past and ongoing vegetation control activities by many parties in the project area and the Hood River basin.
24.06	WAT	This brings me to another factual error in the proposal: yes, there is water in the canal year round even after it is drained in the fall. It is more than puddles. The only time it is dry is when it's so cold the water freezes. So it is a great source of water year round for wildlife and flowers, flora and fauna. The salamander population is impressive, the babies emerging in the fall, unfortunately about the time construction would begin. Salamanders, basically amphibians in general, speak of the most healthy of ecosystems. The wild flowers are a great attractant for our pollinators. So when the report states "It is a 'beneficial cumulative effect on all ecosystems," I don't know. Even the writers of this report seem to have their doubts, as they mention that some mature trees might possibly die from lack of seepage water. Perhaps water isn't "lost" along the canal so much as reclaimed at every step by the natural system.	Please see response to Comment ID 16.02.
24.07	WAT	Even the writers of this report seem to have their doubts, as they mention that some mature trees might possibly die from lack of	The water losses in the District's conveyance system were estimated based on end spills. These spills represent water lost to the natural system of the East Fork Hood River and to

		seepage water. Perhaps water isn't "lost" along the canal so much as reclaimed at every step by the natural system.	irrigation water supply. Please see Sections 4.7.2 and 6.7.2 in the Plan-EA for information about water losses in District infrastructure and effects on water resources and natural waterbodies.
24.08	VEG	I'm curious about the 50' on either side of the canal. We own a forested 2 acre plot here and wonder if we will lose any trees during the construction, whether immediately if they are cut down for the project to proceed, or over time thru lack of seepage water. If any of our trees in close proximity are cut down, will home owners like us be reimbursed for the timber value, to say nothing of the aesthetic value?	Please see Section 6.5.2 in the Plan-EA for a discussion of the effects of the proposed project on vegetation, Section 8.3 for BMPs related to vegetation, and Section 6.6.2 for effects on visual resources. Landowners would not be reimbursed for lost timber or aesthetic value of trees removed within the District's easements.
24.09	WILD	I'd be remiss not to mention the mallard ducks in the spring, the great blue herons & kingfishers who make appearances in the fall/winter, and the great horned owls with their night-long vocalizations. Of particular concern are the paired ducks, their secretive nests producing annual fleets of tiny ducklings. Of course these bird species aren't endangered, but do rely on the canal for remote, secluded, and uncrowded spaces in the increasingly populated world. The thrill these species gives us nature lovers is immeasurable.	Thank you for your comment.
24.10	CONS	I suppose it's a moot point whose land the trees are on, but my next concern is the construction access points of which East Fork Irrigation & us share a common easement/driveway, at the north end of land owned by Kyle Gray. Smaller douglas trees with overhanging branches would either need trimming or cutting down. I'd hope we'd have input on options.	Site-specific evaluations would be completed prior to the construction of each phase of the project, based on the Plan-EA's tiered approach. The District would work with landowners to request their input concerning specific access and construction issues at each site prior to construction. See response to Comment ID 1.01 for information on tiering.
24.11	VEG	In my canal neighborhood several landowners are thinning/logging to remove underbrush & possibly fuel sources to inhibit forest fire spread, and most likely for timber revenue/money. I'm not forestry educated but much controversy exists on the science of forest and fire management. As trees are cut, their ability to sequester carbon is lost. From this source, Forterra, 'CUFR Calculator estimates a Douglas Fir sequesters 13.9 tons of CO2 by its 100th birthday.' So saving as many trees during the construction seems important, in light of what is being removed. As far as visual aesthetics, the broadleaf maples turning golden in autumn provide us recreationists another layer of appreciation. In my vicinity those include maples lining the canal just	No unnecessary removal of trees would occur during the construction of the proposed project. Please see Section 8.3 for a revised description of BMPs related to vegetation.

		south of our property, (between Kyle Gray's orchard & the ditch), a landmark maple just north of Cunningham Rd, and of course the beauties just south at N. Hess Bridge. Their falling leaves provide mulch that improves soil quality & microbial interactions. I would hope there will not be indiscriminate removal of trees.	
24.12	NON V	These are my concerns for now. I feel fortunate to have enjoyed the canal most of my adult life. I may not be able to halt "progress." But I must speak for the living things, currently thriving in this balanced, beneficial, and beautiful landscape I cherish so much. My daughters Becky & Merrie Richardson are quite disheartened over the pipeline project too, equally compelled to share their concerns and sentiments. As for the memories, I guess we must give East Fork Irrigation some due credit and thanks!	Thank you for your comment.
25.01	VEG	Although unfortunately unable to attend any of the local meetings (family illness, out of state, personal injury), I have tried to stay up on news and to read the posted documents, including the Draft Plan-EA. I have just a brief comment of continuing concerns, which I hope will prove not to be issues of concern, or which are positively resolved as the project progresses. I continue to have concerns about the piping work affecting the spread of invasive plants. Among the growing number of invasives in our area is an increasing number of poison hemlock plants.	The District would follow BMPs to avoid the spread of weeds and invasive plants. Please see Section 8.3 for a description of these BMPs.
25.02	WAT	I also worry greatly about year-round water availability for wildlife, birds, and reptiles. It seems that some springs and small wetland areas have disappeared in recent years. In addition to general climate warming and drying, I've wondered if it was also due to lowering water tables and ground water from an increasing number of wells.	Please see Sections 6.7.2.5, 6.9.2, 6.10.2 of the Plan-EA for discussions of the effects of the proposed project on groundwater resources, wetlands, and wildlife, respectively.
25.03	WAT	I also hope that the hook-up process by small properties to the new system goes smoothly, and that storm run-off provisions work well. Thank you.	Thank you for your comment.
26.01	WILD	My job is to teach students how to conduct scholarly research and craft persuasive as well as ethical arguments. Every term, my students worry about seeming "biased." I remind them that we all have positions and preferences ¾ the important thing isn't to shed those but to acknowledge them. Going through this report on the proposal to "modernize" the East Fork irrigation system I was struck by how clearly the framers of this Assessment already have a position. I'm concerned about how much of this position was there from the	The level of detail included in the Plan-EA is in accordance with applicable federal guidance and regulations. Per CEQ (1981), "Since the EA is a concise document, it should not contain long descriptions or detailed data". Similarly, NRCS (2016) states, "The detail provided about a specific resource should be commensurate with the degree of potential impact to that resource" (NRCS 2016). Since the proposed project would have a minor impact to wildlife (see Section 6.10.2 of the Plan-EA),

		beginning, leading to confirmation bias across the research process. In short, I found myself concerned by how the District's position has colored not only to writing of this report, but the research behind it. There are strange gaps, uncertainties, and elisions in the draft. For example: A variety of birds, mammals, reptiles, and other wildlife have the potential to occur in the project area and its vicinity. "Have the potential to occur"? Was this research not done, or was this language purposefully obscured to ward off concerns about the in fact very present wildlife populations? In addition to fish, other aquatic, semi-aquatic, and amphibious species occur in waterbodies that are associated with District operations. These likely include water shrew, water vole, newt, and salamander species, and may also include Pacific tree frog and Cascades frog (C. Fiedler, Fish and Wildlife Biologist, U.S. Forest Service, personal communication, July 25, 2018). These species are native to Oregon and may be present in irrigation canals and adjacent banks in the project area at locations with suitable vegetation and hydrology. Again "likely include" and "may also include" and "may be present" strangely obscure the facts of these species' presence. I'm not a biologist, but by sister, Merrie Richardson, is both a biology teacher and a wildlife enthusiast. I'll leave the details of all this to her which species are in fact definitively living along the irrigation canal. For now, I want to restrict myself to the language of the report.	additional detail on wildlife is not required. The language choice and descriptions included in the Plan-EA reflect the tiered nature of the document. Please see the response to Comment ID 1.01 for information on tiering. Please see the response to Comment ID 22.04 for information regarding the Plan-EA's focus on population-level effects on wildlife, fish, and aquatic species. Reference: Council on Environmental Quality (CEQ). (1981). Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations. *Federal Register* 46(18026). March 23, 1981.
26.02	GEN	Another concern I had with the research and writing of the report is the troubling lack of knowledge about the local conditions of the irrigation canal. There's an irony in my pointing this out, as I live in California now and only get to spend a few months out of the year with my family in Hood River County. But even I could have told the writers of this Assessment that the canal does in fact always have water year round. I can tell you this because I have the lived experience of traversing the path along the canal for the past 36 years, and especially the few miles in either direction of the Miller Road intersection. With this lived experience, I can attest that this passage is frankly false: From November through February, the canals do not carry water except during large storms and are usually empty with occasional puddles or pools in low-lying areas and at locations where spring water enters the canals. These "occasional puddles or pools" are more like a consistent creek, not flowing but certainly not "empty" either. Except for the	Please see Section 4.6.2 in the Plan-EA for revised language describing the conditions in canals outside of the irrigation season.

		coldest days, when this water freezes, one would have to use waterproof boots to cross, or find one of the occasional sandbars or outcroppings of rocks to serve as steps.	
26.03	REC	As is probably already evident from my points above about walking along the canal, another blatant falsehood in the report is the following: No trails occur in the project area. Again, decades of lived experience contradicts this. My family has lived on Miller Road since the 70s, and my mother took me for outings along the canal since before I could walk. I came of age exploring the muddy banks for salamanders, tucking myself behind the gnarly old Douglas Fir that grows along the canal and that we dubbed the "hide and go seek tree," and hiking the old logging roads with friends and family.	Please see the response to Comment ID 24.01 and response to Comment ID 1.04 regarding the cultural value associated with the canal system.
26.04	NONV	This landscape inspired me to value the natural world and its systems and to write about it. This place inspired my sister to pursue degrees in biology and, later, to teach the subject and pass on her love of wildlife. While she and I have left the area for our jobs, we delight in returning regularly. I love visiting and joining my mother and stepfather in their daily walks along the canal. I love that we regularly encounter our neighbors around the community-decorated "holiday tree," which grows along the canal at the intersection with Hess Road. I love that we can watch the light play on the water through the trees as we have for decades. That we sometimes see the owls and deer and myriad species that cluster close to a source of water they have relied on for over 70 years. Much of our world is far from "natural." But at this point, the canal has become naturalized a feature of the landscape that wildlife as well as people have come to frame their lives around.	Please see the response to Comment ID 1.04 regarding the cultural value associated with the canal system.
26.05	NONV	If my own positions and commitments what my students like to call "bias" are not clear yet, I'll state them even more clearly: the canal has become one of the valued characters in the neighborhood, the foreground more than the background of our lives. It is not only a "visual resource," as the Assessment so unpoetically puts it. It is also a "cultural service." As my family members have already written in their responses, the presence of the canal is something that people tout in official real estate ads as something that makes this place one where "people want to live." When I was given the assignment in college to write about something meaningful to me, I chose the canal (essay attached). In an increasingly crowded Hood River County, in a time when everyone seems to know our hidden gems via guidebooks like	Please see the response to Comment ID 1.04 regarding the cultural value associated with the canal system.

		The Curious Gorge, the canal was one secret we kept among our neighbors. All this leads me to the other troubling gap in this Assessment. Passages like the following are the result of either not doing much research, or obscuring the facts in favor of the project, or a combination of both: Overall, the Piping Alternative would have a minor, long-term effect on visual resources in the project area because there are relatively few public viewpoints of the canals and the vegetated project area would blend in with the natural landscape. There would be minor effects on the developed and rural visual character of the landscape in the project area, resulting in minor cumulative effects when combined with other past, present, and reasonably foreseeable future actions. These passages do not represent the actual views of those living near the canal at least not those of us in the stretch near Miller Road. There are in fact many viewpoints, and for those of us who have called this canal part of our backyard for decades, these are not "minor effects" in the landscape. To pipe the canal would amount to losing a favorite place. Perhaps in geological time this canal is a blip. But we think in human terms: the canal has been here for a human lifetime. Perhaps the framers of this project didn't bother talking to residents while assessing the so-called "visual resources." I fear they hardly bothered to visit our stretch of the canal at all, given that the draft includes the following note: "This visual analysis was based on evaluations of aerial and ground-based photographs of the proposed project sites and preliminary design information." How can one assess a "cultural resource" without speaking to the people or visiting the landscapes that form a culture? Perhaps all of this sounds like so much self-interest. But as even the Assessment admits, cultural and visual aspects need to be taken into consideration what role does this space play in our local culture? What are its particular beauties? And yet these are the least well-researched components of this draft. I suspect this has to do with the fact that industry and money are involved. We're always already primed to think in terms of dollars and cents, not wellbeing and pleasure. I hope I've made the case for why the canal, particularly the stretch running between Pine Mont Drive and Hess Road, deserves to be accounted a place of beauty and local significance. But I'd also like to close with an appeal to think of "dollars and cents" in different terms.	

26.06	WAT	While reading the draft, I was struck by how little consideration there was of the agricultural practices leading to so much draining of water in the first place. As the climate changes, some farmers are going to be forced to change their practices. The draft seems to be at pains to avoid this. Why? Why not shift our growing practices and even which crops are grown in the first place? I'll leave the technical questions about water flow and temperature and their effects on fish for my sister's letter. Here I want to question the underlying premise. The draft includes statements like the following, which seem intended to paint a bleak picture of "business as usual": Water supplies would continue to be unreliable, and agriculture producers may irrigate fewer acres of land or grow different crops in the future. Compounded with anticipated population growth and potential developmental pressures, agricultural lands could be increasingly vulnerable to transitioning to a different land use. Why should we delay this inevitable outcome? Why spend so much money and alter the landscape that generations of animals and plants and people have come to depend on for this Band-Aid solution? I would argue that, in fact, the "business as usual" scenario isn't so terrible: Perhaps the District should "continue to call on its patrons to curtail irrigation during drought years, and as the climate warms, the frequency of curtailment requests may increase."	Consistent with NRCS Statement of Vision and Mission (NRCS 2019) and an authorized agricultural water management purpose of PL 83-566 (NRCS 2015), the proposed project would support the economic viability of working agricultural lands with ensuring a healthy environment. Additionally, the project would provide net economic benefits as described in the NEE Analysis in Appendix D.1 of the Plan-EA. On-farm improvements, voluntary duty reduction, and conversion to dryland farming were considered as alternatives. See Section 5.2.2 of the Plan-EA for a discussion of on-farm efficiency upgrades as an alternative. See Appendix D.3 of the Plan-EA for a description of how potential alternatives were analyzed and why voluntary duty reduction and conversion to dryland farming were eliminated from further study. Reference: U.S. Department of Agriculture Natural Resources Conservation Service (NRCS). (2019). Vision and Mission Statement and Guiding Principles. Retrieved from: https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=19117
26.07	NON V	I fear this entire project is likely to have unintended consequences. I'm reminded of two paradoxes. First, the Jevons paradox. This describes a phenomenon common to environmental economics: often, when an agency increases the efficiency around a natural resource's use, demand increases, thereby wiping out any gains. Typically, those working at the junction of economics and environmentalism propose counteracting such effects by increasing price. Second, there's an analogy here with recent counterintuitive studies of traffic congestion: you'd think that building more roads would help, but in fact, they just encourage more people to drive (see Gilles Duranton and Matthew A. Turner's "The Fundamental Law of Road Congestion: Evidence from US Cities" published in American Economic Review in 2011).	Under the proposed project, 75 percent of the conserved water would be permanently allocated instream and would not be available to serve any increased irrigation demand given the associated reduction in District water rights. Please see Section 6.7 in the Plan-EA for more information about the effects of the proposed project on water resources.
26.08	WAT	Perhaps the solution isn't to try to shore up a few more years of "business as usual" agriculture. Perhaps the District would do better to make our County "climate resilient" by encouraging us all to adopt more sustainable growing practices now rather than later.	Section 2 in the Plan-EA describes the purpose and need of the proposed project. While making Hood River County "climate resilient" is not the purpose of the project, the Hood River Basin Study (Reclamation 2015) has previously identified water

			conservation in District canals and laterals as a potential approach to mitigate for the effects of climate change on water supplies in the basin. Additionally, on-farm efficiency upgrades were considered as an alternative in the Plan-EA (see Section 5.2.1).
26.09	WAT	Perhaps we should reframe the entire situation: the water "lost" along the open canal is used and reclaimed by other natural processes, which have just as much a right to that water as the orchardists do.	The proposed project would allocate 75 percent of the conserved water created by the project instream under Oregon water law to support natural processes in the East Fork Hood River. The District diverts water from the East Fork Hood River under its existing water right for irrigation purposes. Correspondingly, the District operates its canals and laterals for the purposes of delivering irrigation water. If water that leaks out of the District's canals and laterals is used by natural processes, that use is incidental to its purpose of irrigation. Please see Section 6.5 in the Plan-EA for more information about the effects of the proposed project on vegetation; Section 6.7 in the Plan-EA for more information about the effects of the proposed project on water rights, surface water, and groundwater resources; and Section 6.9 in the Plan-EA for more information about the effects of the proposed project on wetlands.

Appendix B

Project Maps

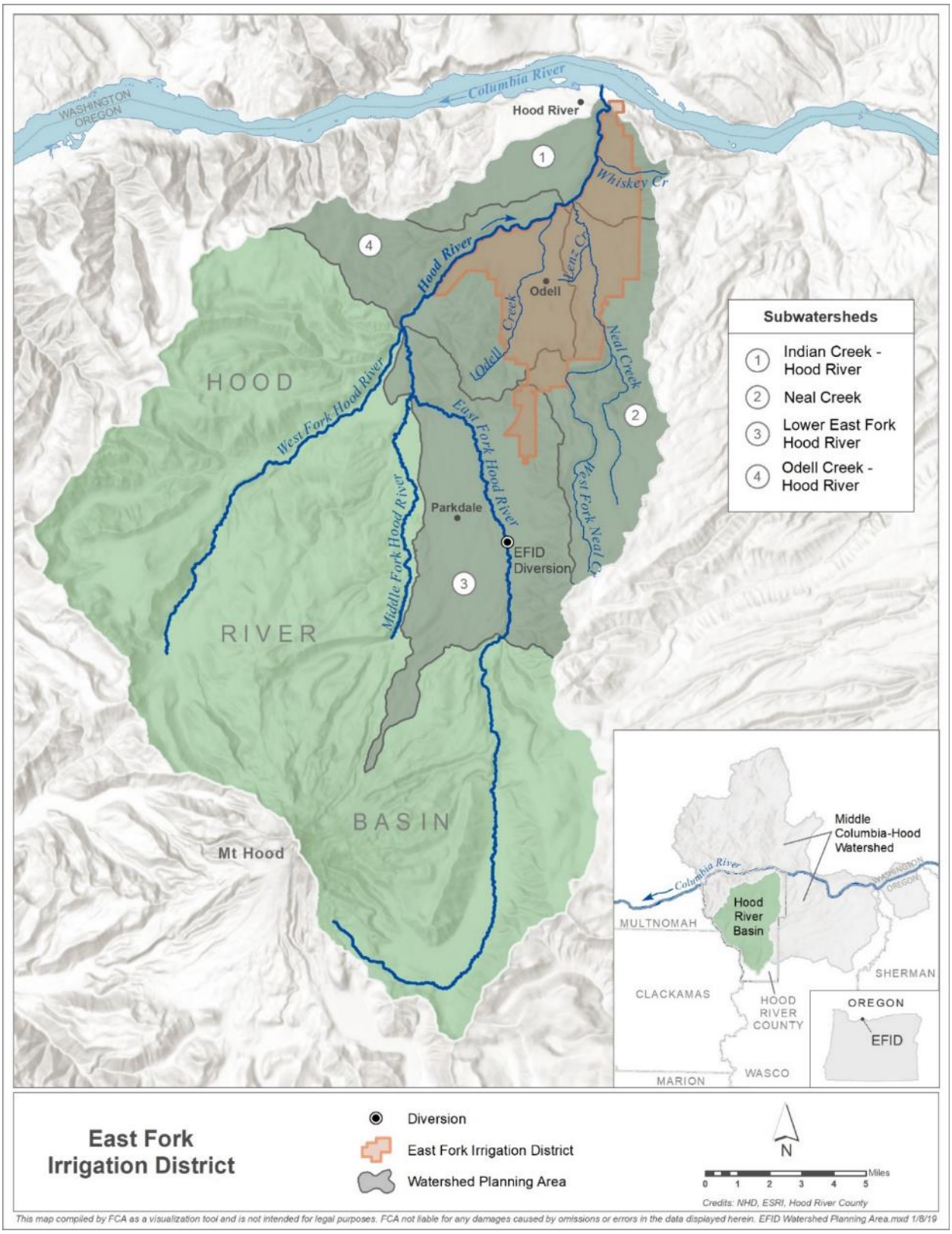


Figure B-1. The four watersheds within the East Fork Irrigation District watershed planning area.

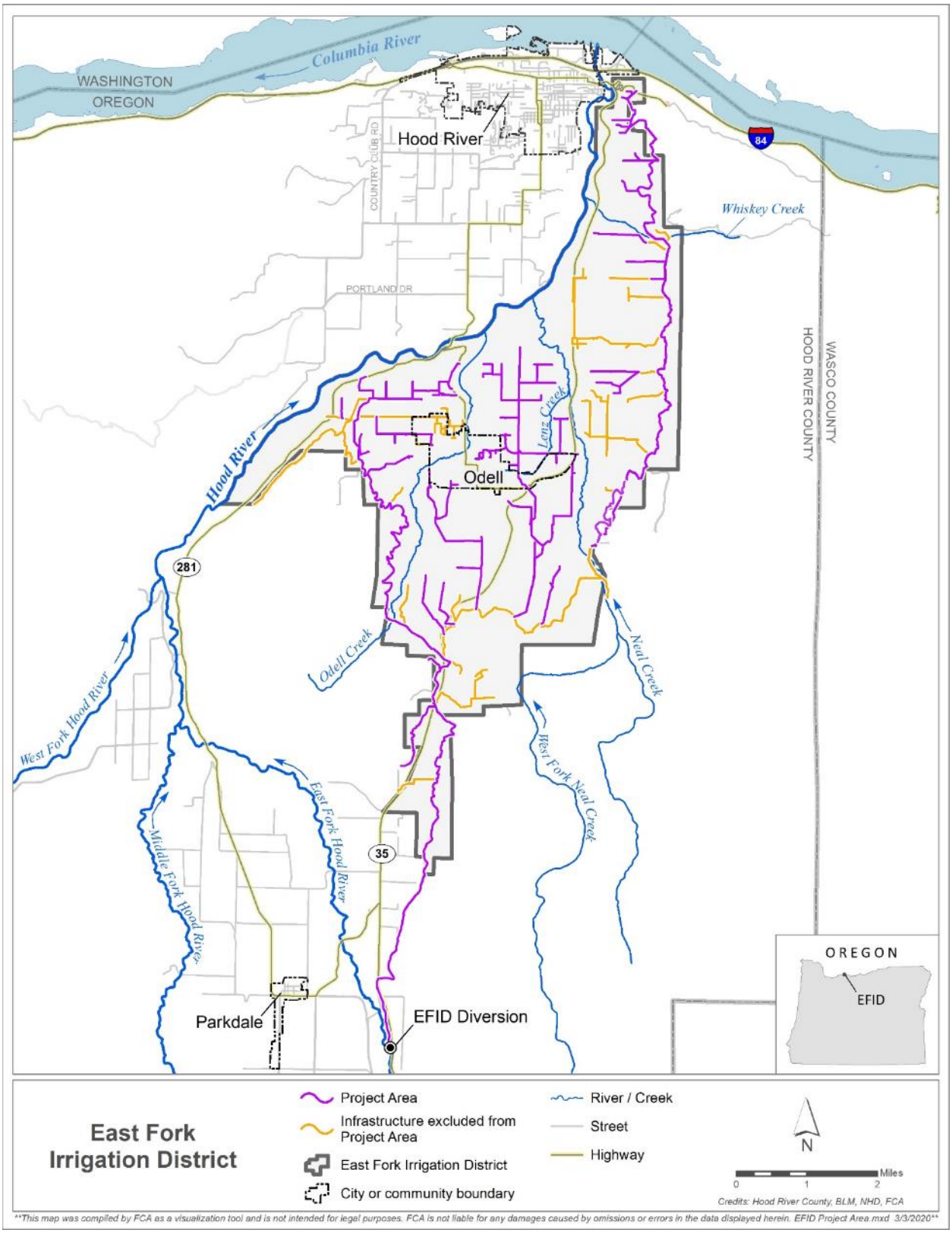


Figure B-2. Location of the East Fork Irrigation District Infrastructure Modernization Project area.

Appendix C

Supporting Maps

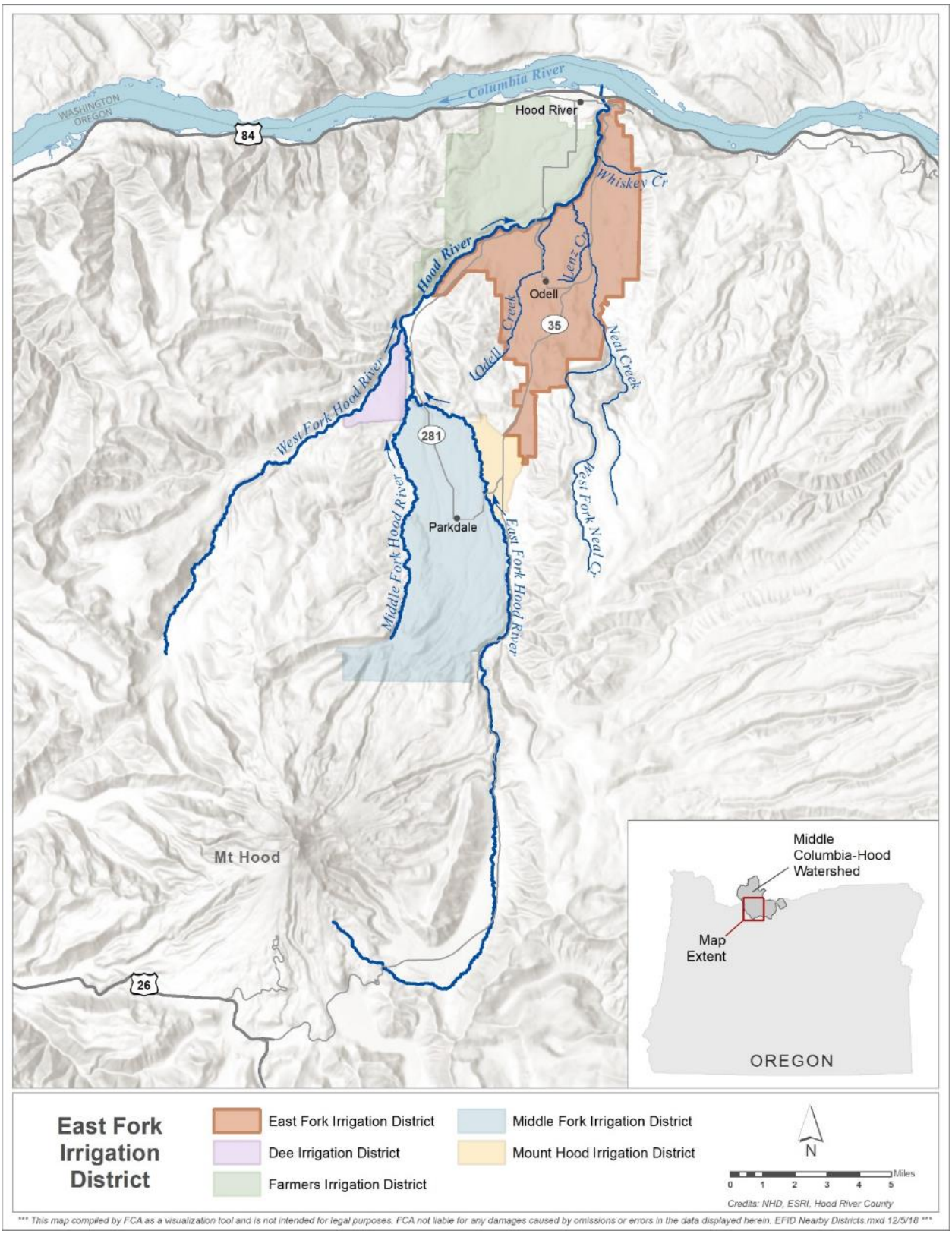
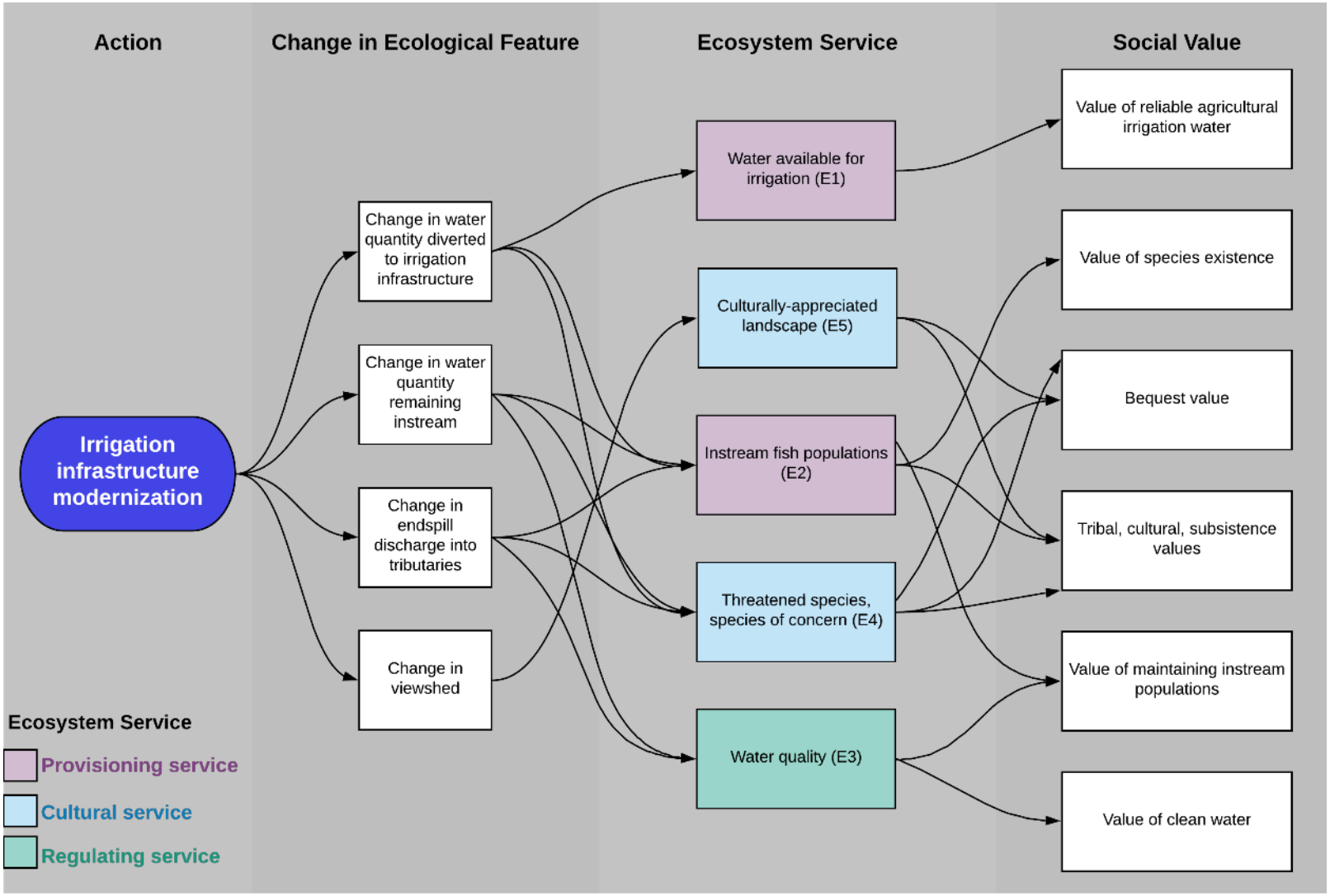


Figure C-1. Irrigation districts within the Hood River basin.



Note: E1 to E5 refer to ecosystem services 1 to 5. These services are referenced and explained in more detail throughout Sections 4 and 6 in the Plan-EA.

Figure C-2. Ecosystem services concept diagram for the East Fork Irrigation District Infrastructure Modernization Project.

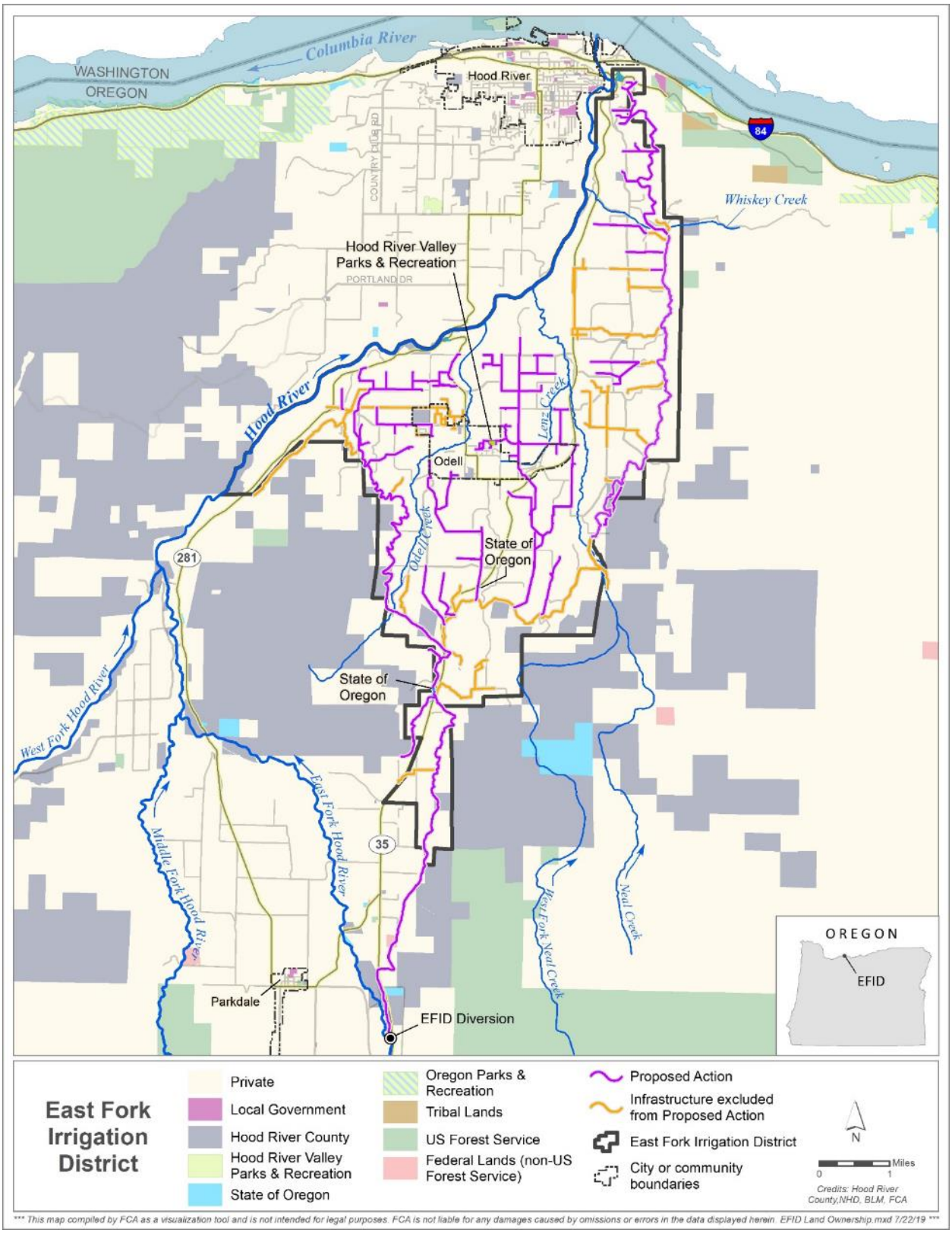


Figure C-3. Land ownership within and in the vicinity of East Fork Irrigation District.

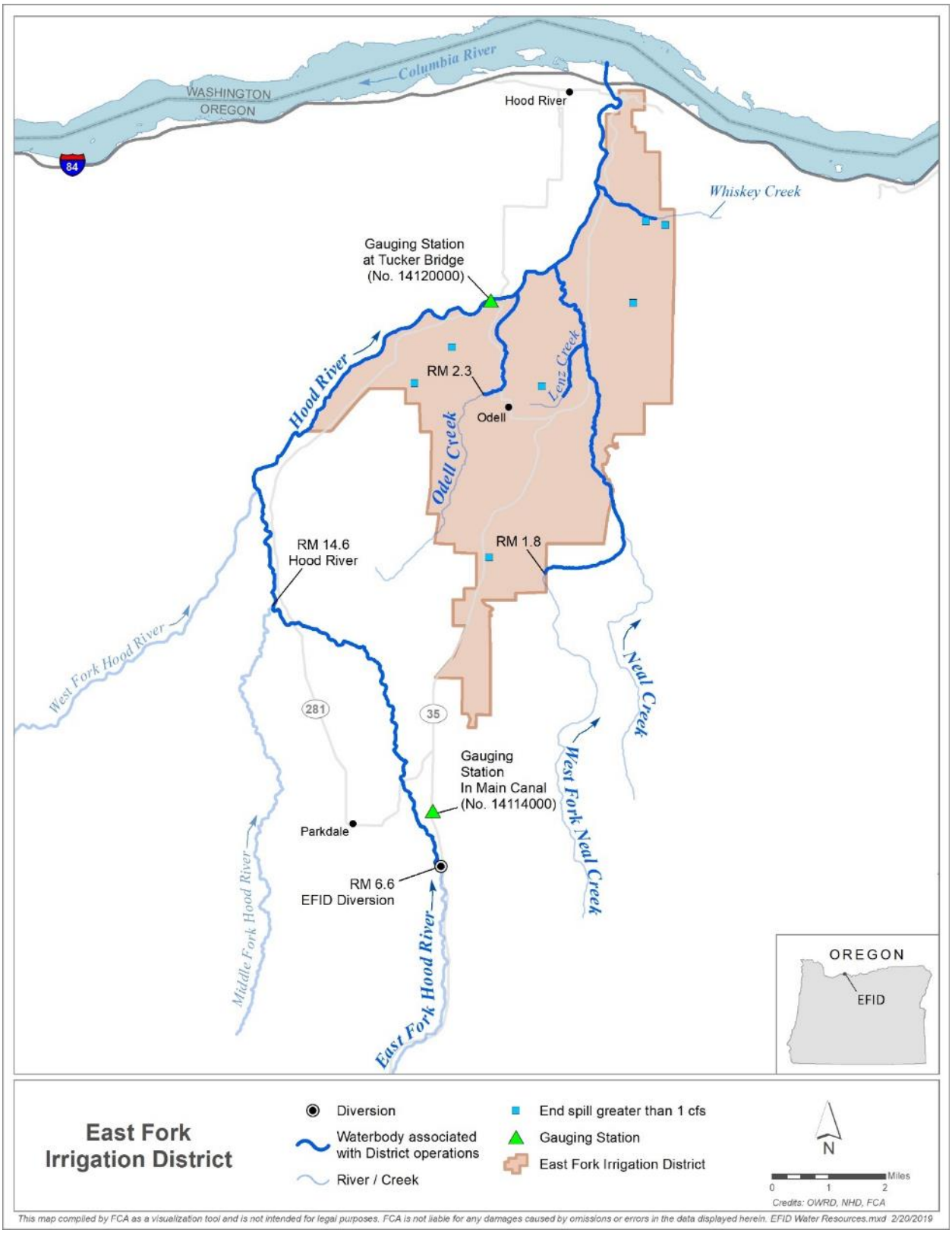


Figure C-4. Waterbodies associated with District operations and locations of streamflow gaging stations.

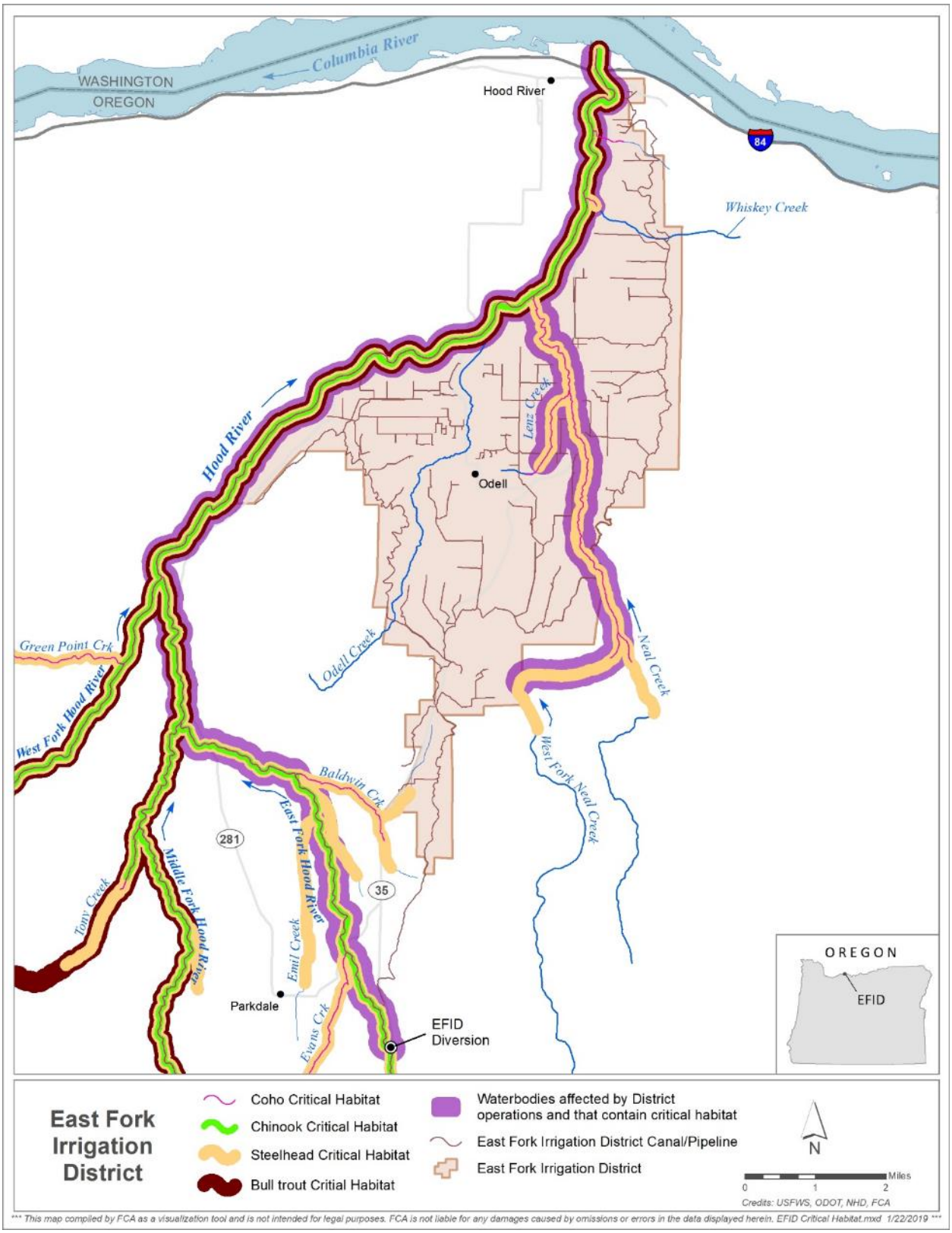


Figure C-5. Critical habitat designated for bull trout, coho, steelhead, and Chinook in the East Fork Irrigation District watershed planning area.

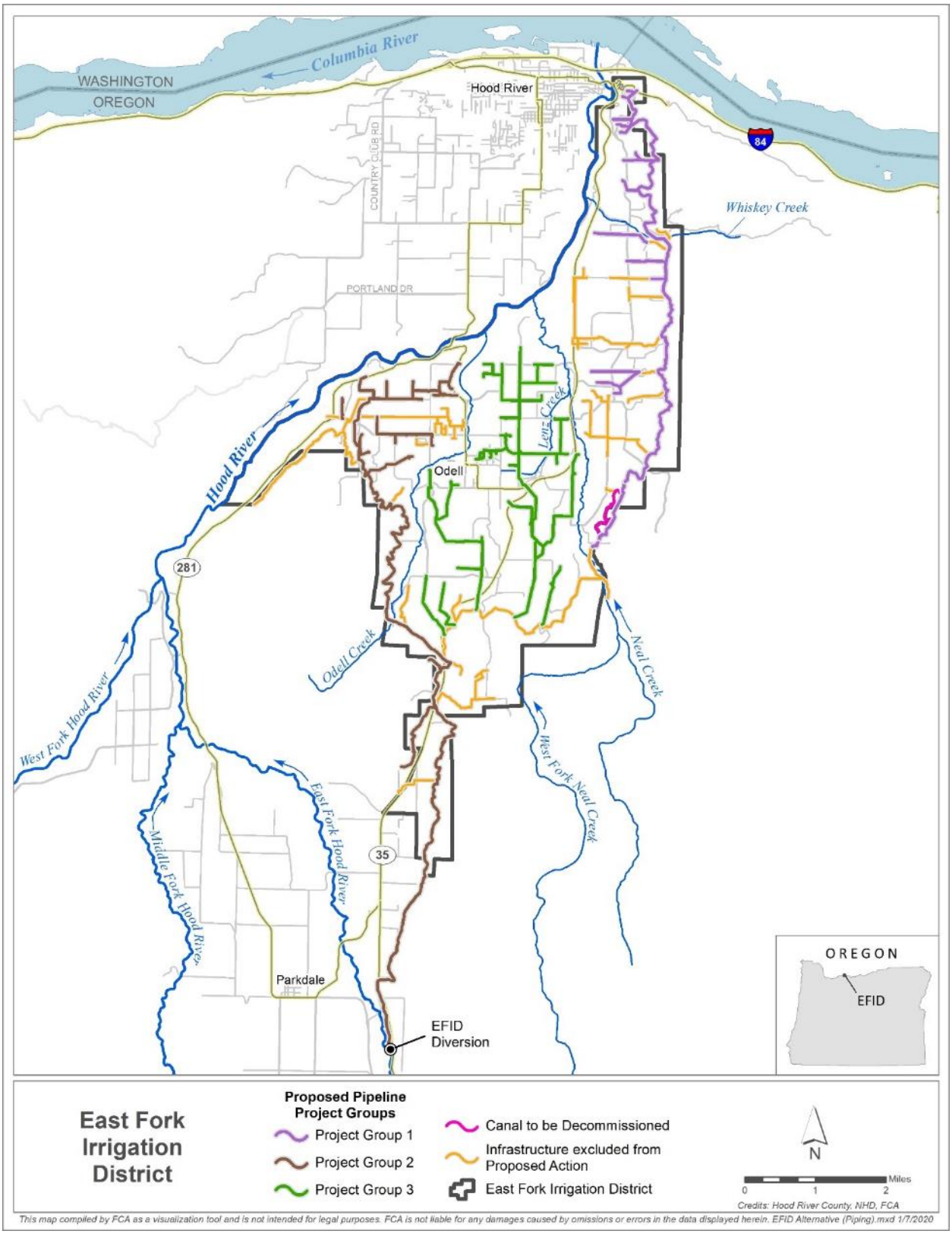


Figure C-6. The Piping Alternative project groups for the East Fork Irrigation District Infrastructure Modernization Project.

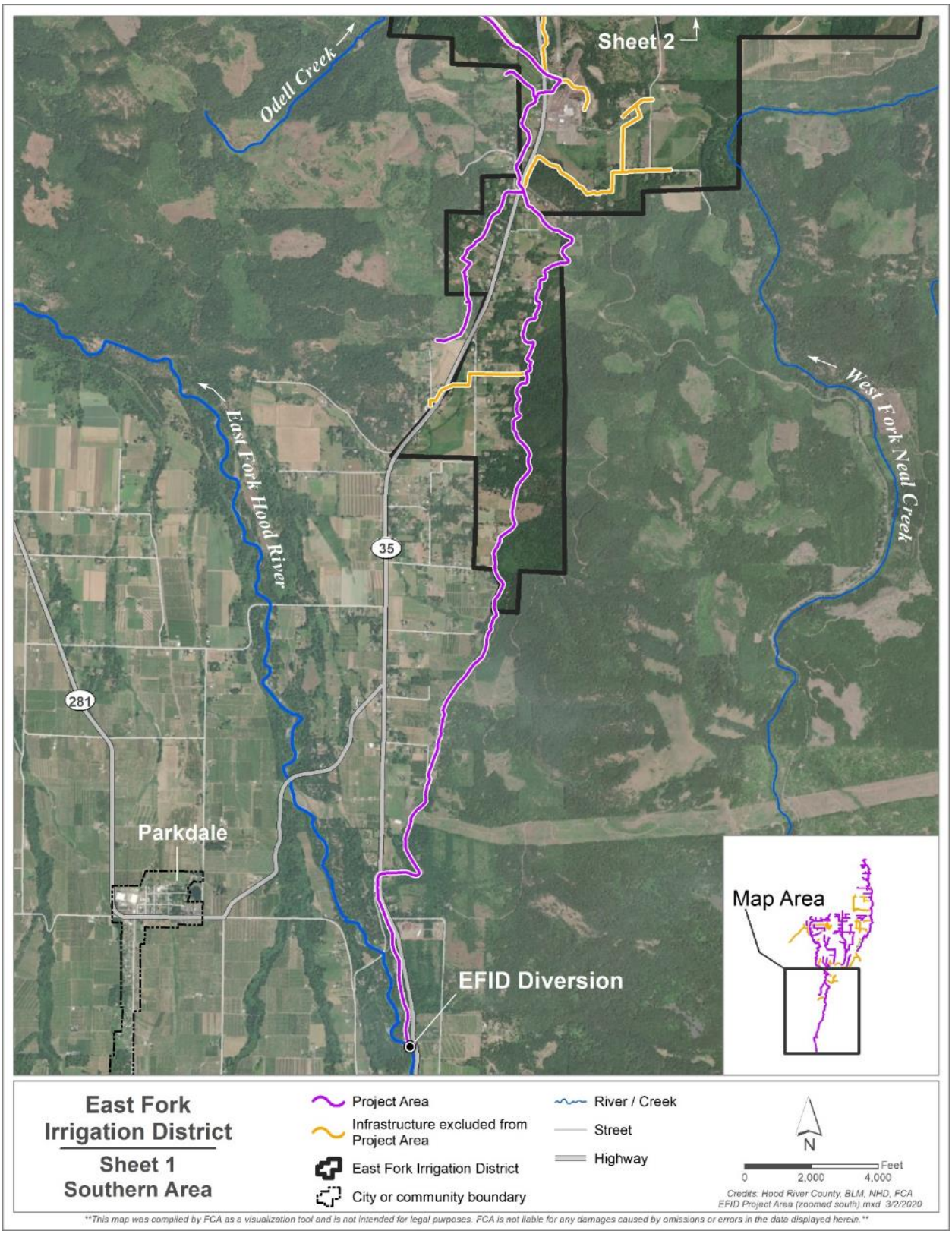


Figure C-7. The Piping Alternative Southern Area for the East Fork Irrigation District Infrastructure Modernization Project.

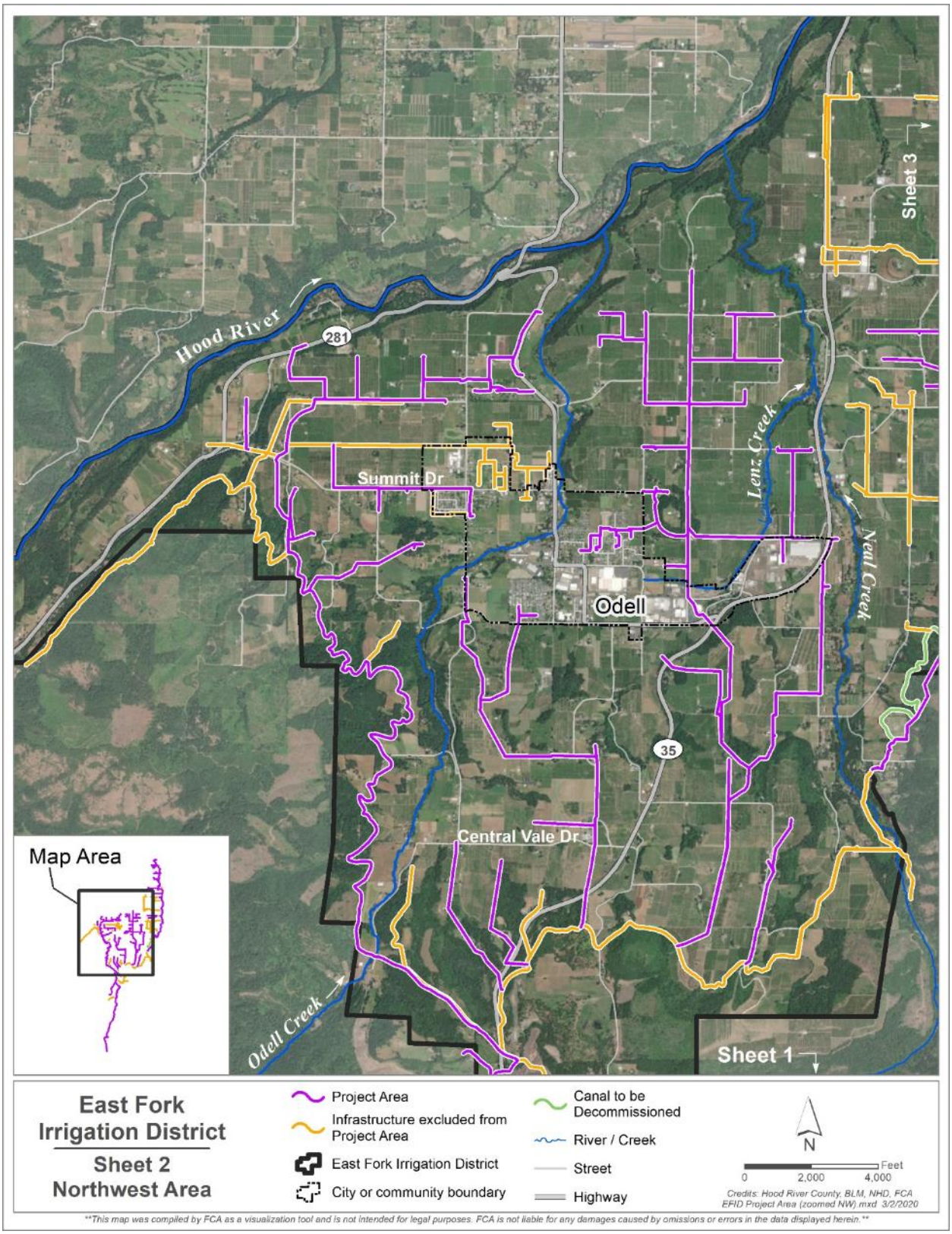


Figure C-8. The Piping Alternative Northwest Area for the East Fork Irrigation District Infrastructure Modernization Project.

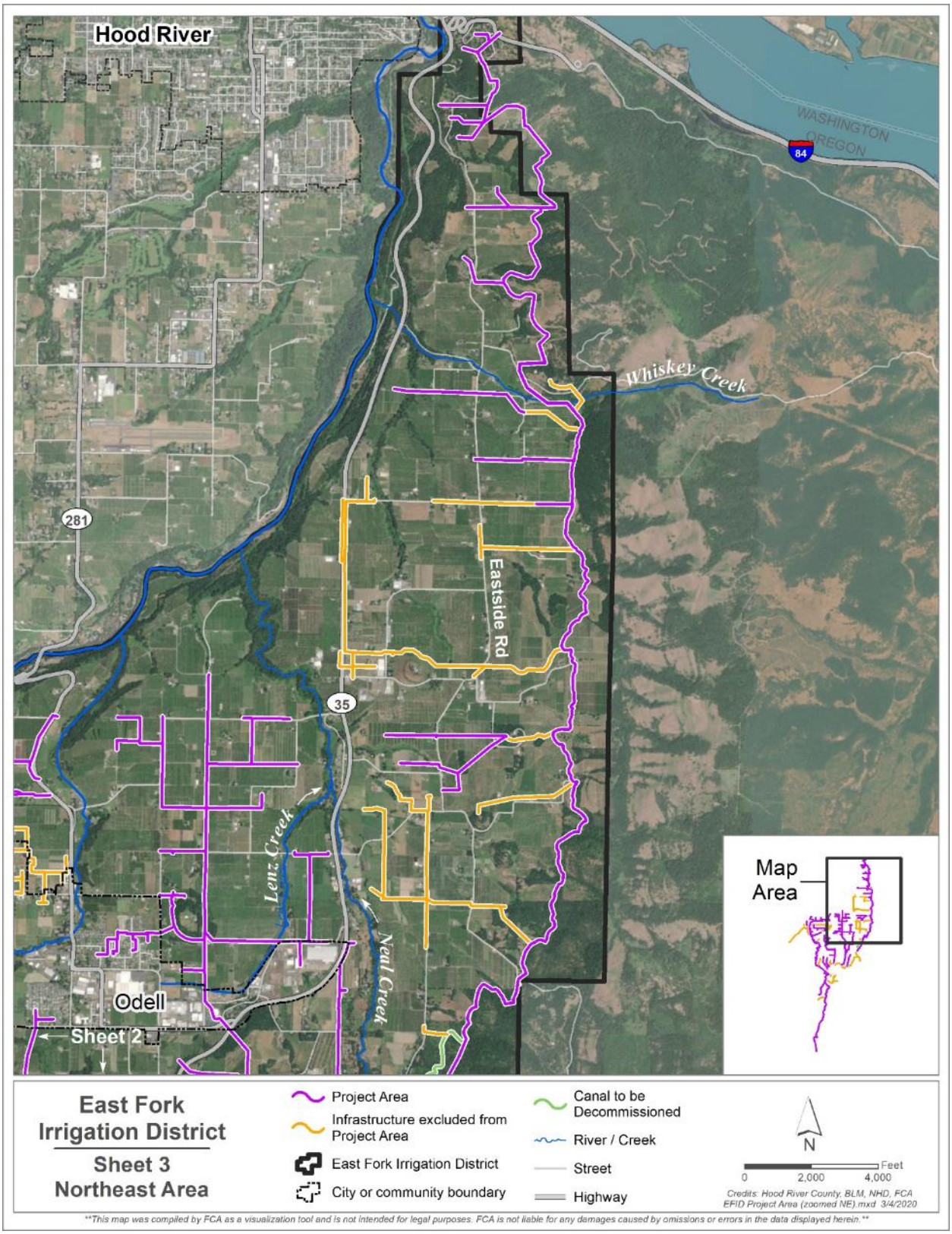


Figure C-9. The Piping Alternative Northeast Area for the East Fork Irrigation District Infrastructure Modernization Project.

Appendix D

Investigation and Analysis Report

Highland Economics LLC

National Economic Efficiency Analysis

Barbara Wyse and Winston Oakley
12/23/2019

Table of Contents

List of Tables

List of Figures

Acronyms, Abbreviations, and Short-Forms

AF	acre-foot
BOR	United States Bureau of Reclamation
cfs	cubic feet per second
EA	Environmental Assessment
EFID	East Fork Irrigation District
FCA	Farmers Conservation Alliance
gpm	gallon per minute
HDPE	high-density polyethylene
hp	horsepower
IWG	Interagency Working Group
kWh	kilowatt hour
Mt	metric ton
MWh	megawatt hour
NASS	National Agricultural Statistics Services
NEE	National Economic Efficiency
NRCS	Natural Resources Conservation Service
O&M	operation and maintenance
OMR	operate, maintain, and replace
OSU	Oregon State University
PPI	Producer Price Indices
project	East Fork Irrigation District Infrastructure Modernization Project
PR&G	Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies
PRV	pressure reducing valve
SCC	social cost of carbon
SIP	System Improvement Plan
U.S./US	United States
USDA	United States Department of Agriculture
WSU	Washington State University

D.1 Piping Alternative

D.1.1 Costs of the Piping Alternative

This section provides a National Economic Efficiency (NEE) analysis that evaluates the costs and benefits of the Piping Alternative over the No Action Alternative for the East Fork Irrigation District (EFID) Infrastructure Modernization Project (herein referred to as project). The analysis uses Natural Resources Conservation Service (NRCS) guidelines for evaluating NEE benefits as outlined in the NRCS Natural Resources Economics Handbook and the U.S. Department of Agriculture's (USDA) Guidance for Conducting Analyses Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water Resource Investments (DM 9500-013).

All economic benefits and costs are provided in 2019 dollars and have been discounted and amortized to average annualized value using the fiscal year 2019 federal water resources planning rate of 2.75 percent.

D.1.1.1 Analysis Parameters

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

EVALUATION UNIT

The proposed project is divided into three 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, each 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 constructed.

PROJECT TIMELINE

Construction is expected to begin in October 2020 and be completed in 10 years. For all Works of Improvement, the analysis assumes that full benefits would be realized the following year after construction is completed (e.g., for Project Group 1 construction begins in Year 0, is completed in Year 2, and full benefits are realized in Year 3). 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). A table showing the order of installation and timeframes can be found in Section 8.6.2 of the Watershed Plan-Environmental Assessment (Plan-EA).

ANALYSIS PERIOD

The analysis period for each individual project group is defined as 102 to 105 years since the installation period is 2 to 5 years for each project group, and 100 years is the expected project life of buried high-density polyethylene (HDPE) pipe. Across the three project groups, the installation period is anticipated to be 10 years and the overall analysis period is thus defined as 110 years (Year 0 to Year 109).

PROJECT PURPOSE

The piping infrastructure is multipurpose: it provides habitat benefits, agricultural production benefits, energy cost saving benefits, and operation and maintenance (O&M) cost savings. Because no project cost items serve a single purpose separately, this analysis does not allocate costs or benefits by purpose.

D.1.1.2 Proposed Project Costs

NWPM 506.11, Economic Table 1, NWPM 506.12, Economic Table 2, and NWPM 506.18, Economic Table 4 found in Section 8.8 of the Plan-EA summarize installation costs, distribution of costs, and total annual average costs for the Piping Alternative. (Note that Economic Table 3, Structural Data—Dams with planned storage capacity, is omitted as dams are not proposed). In addition to the installation costs, the Piping Alternative would entail costs to maintain and replace the sedimentation basin and costs to replace steel pipe. These costs are included as "Other Direct Costs." The subsections included in this report provide details on the derivation of the values in the tables found in the Plan-EA. Based on East Fork Irrigation District's (EFID or District) past experience of piping irrigation canals, the District expects cost savings, not cost increases for infrastructure maintenance, repair, and replacement of the Piping Alternative (Buckley, 2019c).

D.1.1.3 Project Installation Costs

According to the most recent estimates by engineering professionals at Watershed Professional Network LLC and Black Rock Consulting, the cost of piping and associated farm turnouts is roughly $60,232,000 (in 2018 dollars). We adjusted this price to 2019 dollars using the RSMeans construction cost index (an effective increase of 2 percent) (RSMeans, 2019). With the cost adjustment and the additional cost of the sedimentation basin ($767,000), the total construction cost is $62,189,000 in 2019 dollars. See Appendix D.3 for detailed cost derivation by pipe size, cost category, etc. All values in this analysis are presented in 2019-dollar values and rounded to the nearest $1,000 value. Of total estimated costs, Farmers Conservation Alliance (FCA) estimated that roughly 96 percent would go to construction and the remaining 4 percent would go to engineering.

Adding an additional 3 percent for in-kind project administration from EFID, 8 percent technical assistance from NRCS, and permitting costs of $1,866,000, the total cost for the Piping Alternative in 2019 dollars is estimated at $67,029,000. The average annual cost by project group is shown in Section 8 of the Plan-EA, in 2019 dollars, with an average annual cost of $1,763,000 for the Piping Alternative (assuming piping projects are completed in order).

D.1.1.4 Other Direct Costs

Other direct costs under the Piping Alternative consist of the costs to operate, maintain, and replace (OMR) the sedimentation basin, and the costs to replace steel pipe.

SEDIMENTATION BASIN OMR COSTS

Since the Piping Alternative would eliminate three existing in-canal settling basins, a new sedimentation basin would be installed immediately downstream of the sand trap. To continue to function properly, the sedimentation basin would require regular removal of sediment. The labor, logistic, and replacement costs of the basin would depend on its design, which has not yet been finalized. However, the EFID District Manager estimated the potential costs of maintaining the basin based on the historic costs of maintaining the District's existing sand trap (which requires similar maintenance). The District Manager estimated the annual costs of maintaining the basin, which due to its larger size, could be as much as three times the cost of maintaining the sand trap, which requires 6 labor hours every 2.5 weeks from March to October, which totals 67.2 hours per year (Buckley, 2019b). In years where sediment levels are extraordinarily high, the sand trap requires an

excavator. We assume that the sedimentation basin would require an excavator for the same number of hours as normal labor (67.2 hours per year), which is likely an overestimate (Buckley, 2019b). Maintenance labor costs the District $39.46 per hour, while excavator work costs $84.46 per hour.[1] Allowing for excavator work, this brings the total maintenance cost estimate of the sand trap to roughly $14,000 per year.

In addition to the O&M costs, the sedimentation basin would require replacement before the end of the 100-year project period. Because the final design has not been established, the costs to replace the sedimentation basin are uncertain. Therefore, in order to estimate the replacement costs, we used the full cost of constructing the basin ($767,000, including contingency costs), which is likely to be an overestimate of the replacement costs. We assume the basin would have a useful life of 50 years, based on an estimate by an NRCS Engineer (Cronin, 2019). The sedimentation basin is expected to be completed in Year 5, with a replacement needed in Year 56. As such, annual costs begin in Year 6 and the replacement cost of the sedimentation basin is assumed to be incurred in Year 56, with annual costs then being incurred again after that. We apportion both the maintenance and replacement costs among the project groups using the proportion of irrigated acres in each project group, as shown in Table 1. When discounted and annualized, the cost of maintaining and replacing the sedimentation basin totals approximately $18,000 per year.

Table 1. Costs of Maintaining and Replacing the Sedimentation Basin Under the Piping Alternative, Hood River Watershed, Oregon, 2019$.[1]

Project Group	Irrigated Acres	Apportioned Cost of Replacement	Apportioned Annual Cost of Maintenance[2]	Total Annualized Costs
1	599	$48,000	$1,000	$1,000
2	5,196	$414,000	$8,000	$10,000
3	3,820	$305,000	$6,000	$7,000
Total	**9,615**	**$767,000**	**$14,000**	**$18,000**

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

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

[2] Total maintenance costs were estimated by the EFID District Manager (Buckley, 2019b).

STEEL PIPE REPLACEMENT

The Piping Alternative would require a relatively short section of steel piping. Unlike HDPE pipe, steel pipe has an expected life of 50 years, and would therefore need to be replaced during the period of this analysis (Crew, Black Rock Consulting, 2018a). Experts estimate that around 25 percent of the total steel pipe would need to be replaced in Year 50, and the remaining 75 percent would need to be replaced in Year 75 (Crew, Black Rock Consulting, 2018b). We assume that these costs would be incurred 50 and 75 years after the construction of each project group, and the cost to replace the steel pipe would be the same as the cost to install it in 2019. **Error! Reference source not found.** shows the costs of replacing steel pipe under the Piping Alternative. Because the replacement costs are relatively small and would occur in the distant future, the present value of the replacement cost is effectively zero when discounted and rounded to the nearest $1,000 (as shown in the last column of the table).

[1] The District pays maintenance labor about $26 per hour and incurs another $13.46 per hour in benefits and other labor costs. An excavator costs $71 per hour plus the same additional labor costs.

Table 2. Other Direct Costs of Steel Pipe Replacement Under the Piping Alternative, Deschutes Watershed, Oregon, 2019$.[1]

Works of Improvement	Feet of Steel Pipe Replaced	Total Replacement Cost in 2019	Annual Average NED Cost
Project Group 1	-	$0	$0
Project Group 2	38	$32,500	$0
Project Group 3	-	$0	$0
Total	**38**	**$32,500**	**$0**

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

PROPERTY VALUE EFFECTS DUE TO THE LOSS OF OPEN CANALS

Numerous economic studies of residential property values have shown that people tend to value having views of or access to waterbodies such as rivers, streams, and lakes from their property (Nicholls & Crompton, 2017; Mooney & Eisgruber, 2001; Nelson, Hansz, & Cypher, 2005). This preference or value for proximity to waterbodies is reflected in higher property values for parcels that are proximate to water (assuming all other property characteristics are the same). While there are a few available studies of the positive effects of canals on property values, the known, available studies are of boat-able canals in urban settings, which are quite different from irrigation canals in a rural setting on which boating is not feasible (Nelson, Hansz, & Cypher, 2005; Conner, Gibbs, & Reynolds, 1973). Not only is the recreational value of the irrigation canal likely less, but the rural setting of the study area may also limit the impact of water features on a property's value. One review of the economic literature found that water features had less of an impact to rural properties values than urban ones (Nicholls & Crompton, 2017).

In EFID, there are 30-40 residential properties that are proximate to the irrigation canals. If current and prospective homeowners in the area generally positively value proximity to the irrigation canals, removal of the canals through the Piping Alternative may result in a potential cost to these property owners. According to one real estate agent in the area, individuals in the area may value the canals for both aesthetic reasons as well as for sentimental reasons (Josephson, 2020). On the other hand, not all residents or real estate buyers value the canals. According to two local real estate agents, some people view them as dangerous; others as unattractive (Nunamaker, 2020; Josephson, 2020). According to one real estate agent, property buyers from outside areas are less likely than current residents to value the canals (Josephson, 2020). The mixture of preferences on the proximity of irrigation canals suggests that the net effect on property values may be either positive or negative and is likely small.

While individual properties may experience positive or negative impacts depending on the owner or buyer, the effect on the average home is likely no net change (Nunamaker, 2020). Because the impact of irrigation canals on property values in the study area is uncertain and expected to be small, this analysis does not quantify the potential cost to property values of piping the canals.

D.1.2 Benefits of the Piping Alternative

The Plan-EA, Section 8.8 (NWPM 506.21, Economic Table 6), compares the project benefits (over baseline conditions) to the annual average project costs presented in NWPM 506.18, Economic Table 4. The remainder of this section provides detail on these project benefits.

The on-site benefits that would accrue to agriculture and the local rural community include increased agricultural production, reduced power costs, and reduced O&M costs. The off-site quantified benefits

include the value of reduced carbon emissions and the value of instream flow for enhanced fish and wildlife habitat. Other benefits not included in the analysis that may result indirectly from the Piping Alternative include the potential for increased on-farm investment in irrigation efficiency (as patrons would have more funds available due to increased yields and reduced pumping costs) and potential recreation benefits.

D.1.2.1 Benefits Considered and Included in Analysis

AGRICULTURAL DAMAGE REDUCTION BENEFIT

Of the 5,287 acre-feet (AF) projected to be conserved under the Piping Alternative, 75 percent would be dedicated to instream flow (approximately 3,965 AF per year) and the remaining 25 percent would be available for use within the District (approximately 1,322 AF per year). The conserved water going to the District would be used in dry water years (approximately 10 percent of the time) to enhance the reliability of water supply for existing irrigated lands. In this section, we model the benefits of this conserved water that would be available to District patrons to supplement existing irrigation waters supplies.

During previous dry periods, the EFID District Manager has requested voluntary irrigation cutbacks, which to-date have proven sufficient to avoid mandatory water curtailments within the District (Buckley, 2019b). In these voluntary curtailments, grass hay growers in particular have cut back their water use, often missing the last cutting of hay (Buckley, 2019c; Nakamura, 2019).

To date, this management response has minimized the adverse effect of dry years on orchards, which can be significantly affected by insufficient irrigation. Insufficient irrigation water to orchards can adversely affect yield and quality in the year of insufficient water and in future years. Young trees in the establishment period can be particularly affected, so growers typically prioritize water application to these young trees (Buckley, 2019b; Nakamura, 2019; Marsal, Girona, & Naor, 2012). However, as discussed in more detail below, a recent study from the U.S. Bureau of Reclamation (BOR) projects that future streamflow volumes and irrigation water supplies will be lower in the East Fork of the Hood River, resulting in greater shortages to EFID in dry water years (i.e., in 10 percent or more of years) (Bureau of Reclamation, 2014). The conserved water from piping, both by reducing District end-spill losses and increasing the amount of water available to irrigators by 1,322 AF per year, would reduce the adverse effects of these projected future dry year shortages and provide a crop damage reduction benefit. However, as the District is projected to have a shortfall only in approximately 10 percent of water years, the District would likely keep this 1,322 AF of conserved water instream for approximately 90 percent of water years (Buckley, 2019b).

According to the BOR study, by the year 2030, climate change is expected to cause water supply shortages in EFID of 10 to 12 percent from July to September in the 10th percentile water year (i.e., a dry water year will occur roughly 1 out of every 10 years) (Bureau of Reclamation, 2014), with even greater shortages in the 0 to 10th percentile water years.[2] EFID water rights total 117 cubic feet per second (cfs). The BOR report thus indicates that the District will face shortages of roughly 12.87 cfs (11 percent of 117 cfs) in at least 1 year every decade. The actual shortage is expected to be larger since the BOR study did not account for a recent agreement between EFID and the Confederated Tribes of the Warm Springs Reservation to maintain 15 cfs instream in the East Fork Hood River. The BOR study did account for a 2.1 cfs instream water right, so the currently agreed-upon instream flow is 12.9 cfs larger than was projected in the BOR study (Christensen, 2019). Adding together these effects (12.87 cfs and 12.9 cfs), and in absence of the Piping Alternative, the total EFID water supply shortage in 1 out of 10 years will be 25.77 cfs beginning in 2030. This would bring the District's total water supply down from 117 cfs to 91.2 cfs (a 22 percent reduction).

[2] There would also be shortages of a smaller magnitude in slightly wetter water years (i.e., water years in the 10th to 20th percentiles). We conservatively apply the 10th percentile shortages to just the driest 10 percent of water years.

As noted above, some EFID growers have voluntarily reduced their total water consumption by 20 to 25 percent in past water shortages, with low-value crops, such as hay and pasture, bearing a large share of the reductions (Buckley, 2019b). We conservatively assume that all growers of low-value crops will reduce their total water consumption by 30 percent, which the EFID District Manager agrees is plausible (Buckley, 2019b). We model the economic returns to low-value crops using grass hay a representative crop. The impact of losing 30 percent of their water would likely cause grass hay growers to forego their third and final cutting of the season, which has an average yield of roughly 1 ton per acre in EFID (Buckley, 2019b). We estimate the impact to growers' net returns using crop enterprise budgets developed by Oregon State University (OSU) and Washington State University (WSU), which we inflated to current dollars and slightly adapted to match EFID conditions (a process described in detail in Appendix D.2). Based on the crop enterprise budgets for grass hay (shown in Table 19 and Table 20), this loss is expected to reduce net returns by $105 on each acre of low-value crops. Since low-value crops are estimated to comprise 1,635 acres in the District,[3] the economic impact of these water shortages will be to reduce net returns of low-value crops by roughly $172,000 in the 10 percent of years this water shortage occurs.

With the low-value crop growers absorbing a 30 percent water curtailment, this would leave high-value crop growers with an overall water deficit of 20 percent.[4] We used pears to estimate the reduced net returns to high-value crops in the District. A compilation of studies has shown that, on average, decreasing the water available to producing pear trees by 1 percentage point results in a 1.3 percent decrease in gross revenue (Marsal, Girona, & Naor, 2012). Incorporating this relationship into the crop budget for pears (shown in Table 17) indicates that, in the absence of the Piping Alternative, the 20 percent water shortages facing high-value crop growers would result in a loss of just under $2,758 for each acre of high-value crops. As high-value crops comprise approximately 7,981 acres in the District, the loss of net returns to all high-value crops is projected to be $22,012,000 in the 10 percent of years this water shortage is expected to occur. When combined with the loss to low-value crops ($172,000), the total economic loss from climate change is expected to be $22.184 million in 10 percent of years starting in the year 2030 if the Piping Alternative is not implemented. The summary of this analysis is presented in Table 3 under the No Action Alternative. In this analysis, we assume that the projected decreased yield in EFID would not affect pear prices received by EFID farmers.[5]

[3] Low-value crops occupy roughly 17 percent of the District's 9,615 total acres, as explained in the section above. (17 percent x 9,615 acres = 1,635 acres).

[4] A total shortage of 22 percent, subtracting a 30 percent cutback on 17 percent of acres, leaves a 20 percent cutback on the remaining 83 percent of acres. (0.22 - 0.17 x 0.3) / 0.83 = 0.2.

[5] There is no historic data from the area for the relationship between price and production levels, and interviews indicate that water reliability to-date has not reduced orchard yield. The pear market is an international market with significant U.S. fresh pear production exports and imports from other countries (imports of fresh pears comprise about 21 percent of U.S. production, while exports represent about 44 percent of national production). Considering just the national pear market, the projected change in yield for EFID under No Action as a percent of national pear production is under 5 percent, while the projected change in yield under the Piping Alternative represents approximately 2 percent of national production. Given that this is a relatively small change and that there is not a clear relationship between changes in national production and price over the last several years (it is a complex market with many factors affecting price), we assume no price change for pears due to this level of change in EFID production.

Table 3. Climate Change Impacts to EFID Agricultural Production.

	No Action Alternative		Piping Alternative	
EFID demand	117 cfs		100.4 cfs	
EFID supply	91.2 cfs		91.2 cfs	
EFID total water shortage	22%		9%	
	Low-value crops	High-value crops	Low-value crops	High-value crops
Acreage	1,635	7,981	1,635	7,981
Irrigation deficit by crop type	30%	20%	30%	5%
Loss of net returns per acre	$105	$2,758	$105	$657
Total loss in net returns by crop	$172,000	$22,012,000	$172,000	$5,244,000
EFID loss in net returns	$22,184,000		$5,416,000	
Avoided loss in net returns under piping in 10% of years[1]	$16,768,000			
Annual average net benefit under piping	$1,676,000			

[1] Full climate change impacts are projected to begin in the year 2030 (Marsal, Girona, & Naor, 2012), with benefits phasing in between 2020 and 2030.

The Piping Alternative would reduce the effect of future water shortages, reducing yield losses and providing economic benefits. Under the Piping Alternative, the District would face the same water supply that is available for diversion as under No Action: 91.2 cfs. However, under the Piping Alternative, the District's total water demands would experience a net decline of 16.6 cfs as a result of water conserved from piping (decreasing the total demand to 100.4 cfs).[6] This suggests that EFID would face a total supply shortage of approximately 9.2 cfs (100.4 cfs to 91.2 cfs), or 9 percent.[7] This compares to a 22 percent water supply shortage in the No Action Alternative.

As in the No Action Alternative, we assume that low-value crop growers would curtail their total water use by 30 percent in extremely dry years. With each of the 1,635 acres of low-value crops losing a little over $100 in net returns, the total economic loss to low-value crops is projected to be the same as in the No Action Alternative: $172,000 in 10 percent of years.

With the low-value crop growers curtailing their water use by 30 percent, high-value crop growers would face total water shortages of 5 percent.[8] Given the water deficit/gross revenue relationship of pears described above (1.3 percent reduction in gross revenue per 1 percent reduction in water), this shortage is expected to decrease pear yield revenues by 5 percent. Incorporating the change into the pear crop budget (shown in Table 18.), the water shortage will cause net returns to decline by $657 for each acre of high-value crop. As in the No Action Alternative, the District's total area of high-value crops is expected to be 7,981 acres. Accordingly, the total loss of net revenues to high-value crops is projected to be roughly $5.244 million.

[6] Because EFID uses all of its water rights in dry years, when piping conserves 16.6 cfs, the District would no longer need that water for conveyance (i.e., the water lots to seepage or end losses would no longer be required in order to supply District patrons).
[7] 9.2 cfs/100.4 cfs = 9 percent
[8] A total shortage of 9 percent, subtracting a 30 percent cutback on 17 percent of acres, leaves a 5 percent cutback on the remaining 83 percent of acres. (0.09 - 0.17 x 0.3) / 0.83 = 0.05

When combined with the impacts to low-value crops ($172,000), the total economic loss resulting from climate change under the Piping Alternative is around $5.416 million, which is expected to occur in 10 percent of years beginning in the year 2030.

Given that the total annual economic loss in a dry water year under No Action is projected to be $22.184 million, while the corresponding total economic loss under the Piping Alternative is projected to be reduced to $5.416 million, the total economic loss avoided by piping (i.e., the net benefit of piping) is approximately $16.768 million per dry water year. These net benefits are expected to be realized in the driest 10 percent of years. Therefore, the average annual net benefit of piping is expected to be $1.676 million beginning in the year 2030 (10 percent of $16.768 million). We assume that the impacts of climate change will gradually increase from 2020 to the 2030 predicted levels; as such we linearly increase the risk of climate change from the year 2020 to 2030 (i.e., 2021 has 10 percent of the damage projected in 2030, 2022 has 20 percent of the damage projected in 2030, etc.). When discounted and annualized, the avoided damage of climate change under the Piping Alternative is expected to bring average annual benefits of $1.37 million (as shown in Table 4 below).

Table 4. Annual Avoided Loss in Agricultural Production Under the Piping Alternative by Project Group, Hood River Watershed, Oregon, 2019$.[1]

Works of Improvement	Total Future Acres by Project Group	Average Annual Avoided Climate Change Impacts in the year 2030	Average Annual NEE Benefit
Project Group 1	599	$104,000	$91,000
Project Group 2	5,196	$906,000	$760,000
Project Group 3	3,820	$666,000	$522,000
Total	**9,615**	**$1,676,000**	**$1,372,000**

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

As noted above, when the District is not using its full 25 percent allocation of the water conserved by piping, it expects the water would be kept instream (Buckley, 2019b). Because we only model the District using its full allotment of conserved water rights in the 10 percent of years that EFID is expected to face a severe water shortage, we model the District's water going instream the remaining 90 percent of years. The value of this water is further described in the section below, titled the Value of Conserved Water.

OPERATION AND MAINTENANCE COST SAVINGS BENEFIT

The District currently incurs a number of costs associated with the O&M of open canals, which would be avoided under the Piping Alternative. These costs include the expense of manually adjusting water deliveries and end spills, inspecting and repairing canals, maintaining stormwater drains, dredging District-owned sediment ponds, and cleaning and excavating canals. Including consideration of the O&M costs of the piped canals, the EFID District Manager estimates that piping the canals would reduce total canal O&M expenses by roughly $282,000 each year (Buckley, 2019c), of which nearly all expenses are labor cost savings.

Should the Piping Alternative be implemented, the District does not plan to reduce staff or staff time in response to the avoided O&M costs. Instead, the District plans to assign staff to other activities that would benefit the District and its patrons. We assume that these activities will generate additional benefits that are at least equal to the cost of the staff's time, implying that the value of avoiding canal O&M will bring benefits at least equal to its current cost. In other words, if the District no longer has to pay $282,000 to maintain canals, it will be able to generate at least $282,000 in benefits by reallocating that labor to other valuable tasks. We

apportioned the benefits among the project groups using the relative lengths of open canal that would be piped in each project group. As shown in Table 5, when discounted over the study period, these O&M savings are expected to average $250,000 annually.

Table 5. Annual Reduced Operation and Maintenance Costs to EFID Under the Piping Alternative by Project Group, Hood River Watershed, Oregon, 2019$.[1]

Works of Improvement	Length of Open Canal Being Piped	Percent of Total Open Canal Being Piped	Undiscounted O&M Cost Savings Per Year	Discounted Annualized Benefit (OMR Cost Reduction)
Project Group 1	6.1	35%	$98,000	$93,000
Project Group 2	11.4	65%	$184,000	$157,000
Project Group 3	0	0%	$0	$0
Total	**17.5**	**100%**	**$282,000**	**$250,000**

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

District patrons also engage in O&M activities for the canals, primarily cleaning algae from screens. There are approximately 25 canal screens in the District that require regular maintenance by patrons, and each screen takes roughly 4 hours to clean every day from about June through the first week in September (Buckley, 2019b). In total, the effort requires an estimated 9,800 hours per year. We value this time at the average wage for farmworkers in Central Oregon: $15.89 per hour.[9] At this rate, the value of reduced patron O&M costs is roughly $156,000 per year. The Piping Alternative is expected to reduce the need for this maintenance by 50 percent (Buckley, 2019b). Accordingly, the potential savings from piping is approximately $78,000 per year. We apportion this total among the piping groups according to the length each group would be piped under the Piping Alternative (see Table 6 below). When discounted, the annualized value of O&M savings to EFID patrons is roughly $69,000.

[9] This is based on the mean hourly wage for the Farmworkers and Laborers, Crop, Nursery, and Greenhouse occupation (45-2092) in the Central OR non-metropolitan area in May 2017 ($12.84) (Bureau of Labor Statistics, 2017). This was the closest geography to Hood River County with available data. We adjusted the wage upward 20 percent to account for non-wage costs of labor and adjusted for inflation to 2019 dollars using the Consumer Price Index.

Table 6. Annual Reduced Operation and Maintenance Costs to EFID Patrons Under the Piping Alternative by Project Group, Hood River Watershed, Oregon, 2019$.[1]

Works of Improvement	Length of Open Canal Being Piped	Percent of Total Open Canal Being Piped	Undiscounted O&M Cost Savings Per Year	Discounted Annualized Benefit (O&M Cost Reduction)
Project Group 1	6.1	35%	$27,000	$26,000
Project Group 2	11.4	65%	$51,000	$43,000
Project Group 3	0	0%	$0	$0
Total	**17.5**	**100%**	**$78,000**	**$69,000**

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

IRRIGATION PUMPING COST SAVINGS

Compared to the No Action Alternative, the system improvements associated with the Piping Alternative are estimated to reduce patron energy needs by 1,169,706 kilowatt hours (kWh) per year (due to patrons receiving pressurized water rather than pressurizing it themselves) (Farmers Conservation Alliance, 2018). The cost associated with this energy is estimated at $0.0830 per kWh, which is the marginal cost of electricity to irrigators using electricity from the Hood River Electric Cooperative (the power company with the greatest coverage in the District) (Hood River Electric Co-op, 2019). Table 7 presents the estimated savings to EFID patrons for each project group under the Piping Alternative. Once all project groups are complete, the average annual NEE savings to EFID patrons would be approximately $86,000 each year.

Table 7. Annual Increased Average Energy Cost Savings to EFID Patrons Under the Piping Alternative by Project Group, Hood River Watershed, Oregon, 2019$.[1]

Works of Improvement	Annual Energy Savings Under Piping Alternative (kWh)	Undiscounted Annual Energy Cost Savings	Average Annual NEE Benefits (Avoided Energy Costs)
Project Group 1	614,911	$51,000	$48,000
Project Group 2	253,041	$21,000	$18,000
Project Group 3	301,754	$25,000	$20,000
Total	**1,169,706**	**$97,000**	**$86,000**

Note: Totals may not sum due to rounding. Prepared April 2019
[1] Price Base: 2019 dollars amortized over 100 years at a discount rate of 2.75 percent.
[2] As estimated by FCA (Farmers Conservation Alliance, 2018).

By providing a pressurized piping conveyance system, the Piping Alternative would allow some irrigators to eliminate the need for pumping altogether. This would reduce pump maintenance costs to irrigators. An analysis by FCA estimated that there are 457 total irrigation pumps within EFID; of those, 287 would be eliminated after pressurization. Table 8 shows the distribution of those pumps by project group.

To estimate the avoided maintenance costs of pumping, we add the average annual power company fixed service charge and the estimated annual repair costs. Hood River Electric Co-op charges $29 per horsepower (hp) of the irrigation pump. With an average irrigation pump size in EFID of 10 hp, the average annual charge is $290 (Hood River Electric Co-op, 2019; Walker C. , 2019). For annual repair costs, interviews with

irrigation pump professionals indicated that surface irrigation pumps typically require maintenance every 3 to 5 years, which costs $300 to $800 per instance (Scarborough, 2019; Mark, 2019). From this, we assume the average irrigation pump receives maintenance once every 4 years, costing $550 (the midpoint of the cost range), resulting in an average annual cost of approximately $140 per year. Based on interviews with irrigation pump experts and published sources, we estimate replacement costs for a 10-hp irrigation pump at $3,000 (including installation), and assume replacement is required on average every 10 years (Haun, 2019; Fey, 2019). Amortizing this at the 2.75 annual rate, the annualized cost of replacing a 10-hp pump is about $350.

Combining the service charge, repair costs, and annualized replacement costs, we get an estimated total annual cost of approximately $780 per year per pump. We apply this cost to each eliminated pump to derive the annual benefit. Using this method, the 287 pumps eliminated would provide annual benefits of roughly $222,000, as shown in Table 8. When discounted, the avoided maintenance cost would provide annualized benefits of $193,000 over the No Action Alternative.

Table 8. Annual Increased Pump Maintenance Cost Savings to EFID Patrons Under the Piping Alternative by Project Group, Hood River Watershed, Oregon, 2019$.[1]

Works of Improvement	Total Irrigation Pumps under Baseline Conditions [2]	Pumps Eliminated under the Piping Alternative [2]	Undiscounted Annual Maintenance and Replacement Costs Avoided	Discounted Annualized Maintenance and Replacement Costs Avoided
Project Group 1	131	118	$91,000	$86,000
Project Group 2	225	114	$88,000	$73,000
Project Group 3	101	55	$43,000	$34,000
Total	**457**	**287**	**$222,000**	**$193,000**

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

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

[2] As estimated by FCA (Farmers Conservation Alliance, 2018).

CARBON BENEFITS

Reduced energy use also reduces carbon dioxide emissions from power generation. Every megawatt hour (MWh) of reduced on-farm energy use is estimated to translate into an estimated reduction of 0.75251 metric ton (Mt) of carbon emissions.[10] Accordingly, on average, compared to Baseline conditions, the annual net energy savings of the Piping Alternative would reduce carbon dioxide emissions by approximately 880 Mt (approximately 1,169 MWh multiplied by 0.7525).

To value the reduced carbon emissions, this analysis uses an estimate of the social cost of carbon (SCC), which is the estimated total cost to society of emitting carbon related to the expected damages associated with

[10] This assumes that marginal changes in energy demand are met with fossil fuel-based production (renewable energy is typically used first and then fossil-fuel powered generation is used), such that 100 percent of energy use reduction and green energy production results in reduced fossil fuel-powered generation. Furthermore, this estimate assumes 0.75251 metric tons of carbon emitted from 1 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 carbon dioxide produced per MWh powered by each fossil fuel source, as reported by the Energy Information Administration.

future climate change. There are many estimates of the SCC, and the estimates vary based on what types of damages are included, the discount rate chosen, the geographic area under consideration (such as global damages versus U.S. domestic damages), and the projected level of global warming and associated damages. SCC damage values used by federal agencies have varied over the years. At first, federal agencies developed and applied their own estimates. Then, the Office of Management and Budget convened an Interagency Working Group (IWG) on the Social Costs of Greenhouse Gases, which developed a set of SCC estimates that could be used across federal agencies. In the year 2020 (the closest estimate available for the current year), the IWG estimate for SCC was estimated to be approximately $51.20 per Mt (2019 dollars) (Interagency Working Group on Social Cost of Greenhouse Gases, 2013).[11] However, in 2017, Executive Order 13783 disbanded the IWG, indicated that IWG estimates were not representative of government policy, and removed the requirement for a harmonized federal policy for SCC estimates in regulatory analysis. Since this time, the U.S. Environmental Protection Agency (USEPA) and other federal agencies have developed interim alternative estimates of the SCC, largely relying on the methodology used by the IWG, but using different discount rates and focusing on direct damages projected to occur within the borders of the United States. For example, the USEPA developed interim SCC values for the *Regulatory Impact Analysis for the Repeal of the Clean Power Plan, and the Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units* published in June of 2019 (Environmental Protection Agency, 2019). As these interim USEPA SCC estimates are indicative of current federal agency policy on SCC applications for federal cost benefit analysis, they are employed in this analysis. This analysis uses the USEPA interim value of the SCC for 2020 based on a 3 percent discount rate, $7 per metric ton of carbon. At this value, the avoided carbon emissions from the Piping Alternative provide an estimated average annual benefit of approximately $5,000, as shown in Table 9.

Table 9. Annual Increased Average Carbon Cost Savings Under the Piping Alternative by Project Group, Hood River Watershed, Oregon, 2019$.[1]

Works of Improvement	Energy Savings Under Piping Alternative (kWh)	Average Annual Mt of Carbon Avoided from Reduced Pumping	Undiscounted Annual Benefit of Avoided Carbon	Discounted Average Annual NEE Benefit
Project Group 1	614,911	463	$3,000	$3,000
Project Group 2	253,041	190	$1,000	$1,000
Project Group 3	301,754	227	$2,000	$1,000
Total	**1,169,706**	**880**	**$6,000**	**$5,000**

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

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

VALUE OF CONSERVED WATER

The value of the conserved irrigation water can be looked at in two ways, depending on where the conserved water is used: the value of increased water instream, or the value of maintaining irrigated agricultural production. Of the 16.6 cfs conserved under the Piping Alternative, the District would receive 25 percent (1,322 AF per year) to augment District irrigation, while 75 percent (3,965 AF per year) would be used to augment instream flows. Additionally, in 90 percent of water years, the District's allotment of conserved water will enhance instream flow (or an annual average of 1,190 AF per year). This section explores the value of 5,155 AF per year of average enhanced instream flows.

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

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 Hood River 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 are 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 EFID, as this indicates the potential cost of purchasing water rights from these irrigators. While there have been relatively small amounts of water temporarily leased between EFID irrigators, the prices of these transactions (or other water transactions in the basin) were not available for this study (Nakamura, 2019). Prices of water rights are very basin-specific and often based on the value of water to agriculture (as agriculture is the most common seller of water rights for environmental or other water uses). We therefore rely on the agricultural value of water in the local basin as well as transaction prices for environmental water in other basins in the West to provide a basis for the economic value of instream flow augmentation.

Based on the following discussion, we assume that the economic benefit of instream flow augmentation would be at least $75 per AF per year, such that this enhanced instream flow is estimated to have a value of approximately $387,000 per year once all project groups are completed under the Piping Alternative (because of the timing, on an average annualized basis, the NEE benefit is roughly $337,000 as presented in Table 11). As most water right transactions for environmental purchases are to enhance fish habitat, this value is expected to be a conservative proxy for the value to the public of enhanced fish habitat and fish populations. (The full measure of the economic benefit of enhanced instream flow is the benefit to the public of enhanced fish and wildlife populations, water quality, ecosystem function, etc.).

Values published in the economic literature are often quite high for enhancements to salmon, trout, and other fish and wildlife populations (see Table 10), such as those that would benefit from the instream flows provided by the Piping Alternative. As quantitative information on how instream flows would improve fish and wildlife populations is not available, the analysis is not able to directly measure the economic benefit of enhanced instream flow. As such, the value of conserved water is estimated in this section using the prices of water from transactions in the Western United States. Table 11 shows the estimated average annual benefits of enhanced instream flow for the Piping Alternative.

Table 10. Studies and Values Used to Estimate the Value of Fish Enhancement.

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

Prepared April 2019

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

Table 11. Annual Estimated Instream Flow Value of Piping Alternative by Project Group, Hood River Watershed, Oregon, 2019$.[1]

Project Group	Water Conservation Going Instream (AF/year)	Undiscounted Annual Benefit to Instream Flow	Discounted Annualized Benefit to Instream Flow
Project Group 1	1,607	$121,000	$115,000
Project Group 2	2,605	$195,000	$166,000
Project Group 3	943	$71,000	$56,000
Total	**5,155**	**$387,000**	**$337,000**

Note: Totals may not sum due to rounding. Prepared April 2019
[1] Price Base: 2019 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 12):

1. *Prices paid for water by environmental buyers throughout the Western United States*. In the period 2000 to 2009, the purchase price of environmental water varied from just over $0 to nearly $1,676 per AF per year, with an average permanent sale transaction price of $166 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 in detail below, the values paid are expected to provide a low range estimate of instream flow value to society.
2. *Value of water to irrigators in EFID*. For low-value crop irrigators (likely the first to sell water for environmental purposes), this is estimated at approximately $60 to $100 per AF per year. 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 determines the willingness of the agricultural sellers to accept a price for water), and because conserved water avoids potential future reductions in EFID deliveries.

Table 12. Value per AF per Year of Water (Market Prices and Value to Agriculture), Hood River Watershed, Oregon, 2019$.

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	$1,676	~$75	$166
Value of water to EFID hay and pasture irrigators (*Income Capitalization Approach*)	$60	$100	~$80	

PAST COSTS PAID AS A PROXY FOR VALUE

Past piping projects in the Hood River 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 rights transactions from agriculture to environmental flows).

There are five irrigation districts in the Hood River Basin: Dee, East Fork, Farmers, Middle Fork, and Mount Hood. These irrigation districts have implemented a variety of projects to enhance instream flow (and provide other benefits), including piping open canals and promoting on-farm irrigation efficiencies. Six basin piping projects, along with their associated costs and water savings, are shown in Table 13. The costs range from $754,000 to $6.15 million per cfs conserved, and an estimated $2,100 to $17,000 per AF conserved.

Table 13. Cost and Water Savings of Piping Projects in the Hood River Basin.

Project	Year Complete	Water Saved (cfs)	Total Cost (2019$)[1]	Cost per Amount of Water Conserved ($/cfs)	Cost per Amount of Water Conserved ($/AF)
DID Piping Project	2013	3.0	$2,528,000	$843,000	$2,300
EFID Central Lateral Piping	2008	2.1	$12,915,000	$6,150,000	$17,000
FID Green Point Pipeline Project	2016	1.5	$1,264,000	$843,000	$2,300
EFID Highline Canal Pipeline	2016	0.5	$826,000	$1,652,000	$4,600
FID Lower District Pressurization Project	2009	7.5	$5,656,000	$754,000	$2,100
MFID Glacier Ditch Pipeline Phase 3	2012	0.3	$595,000	$1,983,000	$5,500

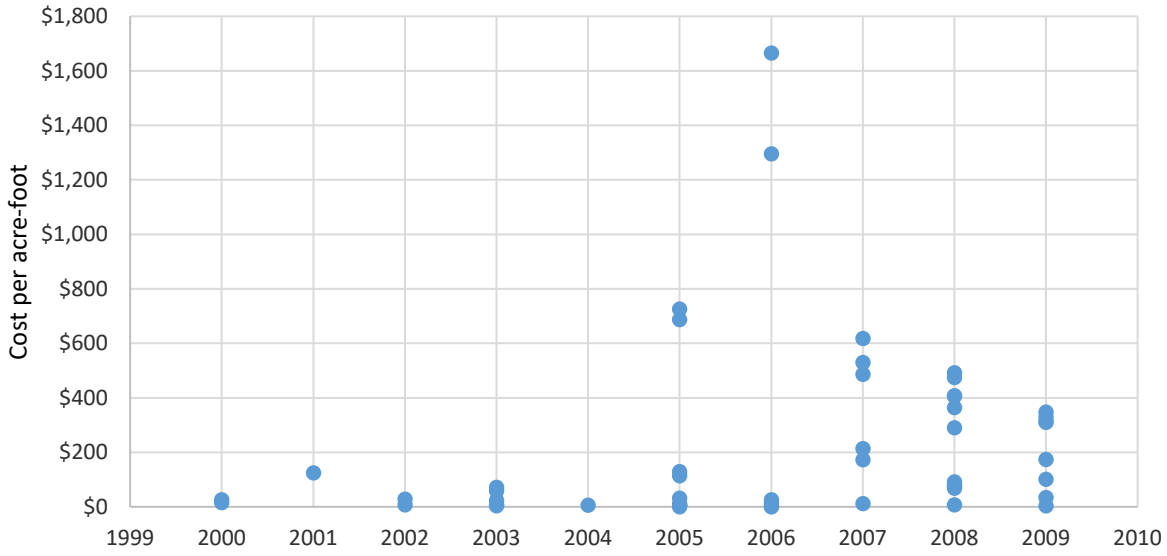
[1] Total costs were adjusted to 2019 dollars using the Consumer Price Index. Prepared April 2019
Sources: (Hood River Watershed Group, 2014; Hood River News, 2014; Christensen & Salminen, Hood River Basin Water Use Assessment, 2013; Farmers Irrigation District, 2019; Oregon Department of Agriculture, Hood River Local Advisory Committee, 2016; Oregon Water Resources Department, 2018; Craven Consulting Group, 2005).

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 $362 per AF in Oregon, while five water right leases averaged $115 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 $1,121, 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 in Figure D-1. and Figure D-2. show more recent (from 2000 to 2009) sales and leases of water rights by environmental buyers on a price per AF per year basis. The figures show how water right transaction values vary widely, but sale prices (amortized to an annual price) typically are less than $200 per year while 1-year leases typically fall below $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 D-1. Western water right purchases for environmental purposes, 2000 to 2009, price paid per acre-foot per year.

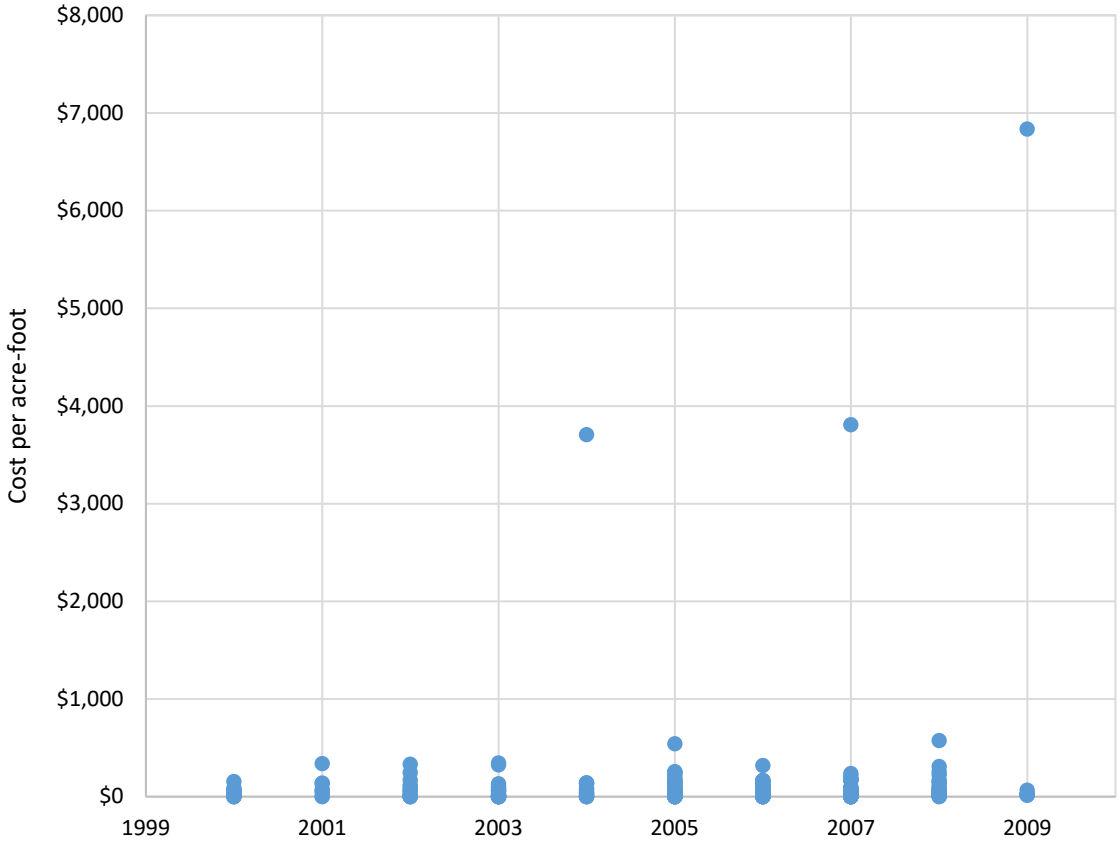


Figure D-2. 1-year water leases for environmental purposes, price paid per acre-foot in Western United States.

D.1.2.2 Benefits Considered but Not Included in Analysis

PUBLIC SAFETY AVOIDED COSTS

Piping irrigation water removes the hazard of drownings in canals, and also eliminates the potential for canals to fail, causing potential damages to downstream property and lives. While EFID canal failure is very possible, the extent of damage varies dramatically depending on the timing and location of failure. Given the limited amount of available data on the cost of these canal failures, the public safety (and property damage reduction) benefit of piping is not analyzed in this analysis. However, past drownings in the District have demonstrated the danger inherent to open canals, which can have fast-moving water and present a threat to public safety. Between 1983 and 1985, two drownings occurred in District canals; one an adult male, the other a child (Buckley, 2019a). There have been no drownings since that time. This means that from 1983 to 2018, there was an average of 0.057 deaths per year in District canals. As the population in Hood River County continues to grow, the risks to public safety will increase.

The Piping Alternative would pipe the remaining open canals in the system. This section qualitatively discusses the potential magnitude of the public safety benefit of piping the remaining exposed canals in EFID. The analysis presents some information on the potential public safety hazard of the existing irrigation canals in EFID that are proposed for 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 EFID based on past drownings in unlined canals in East Fork. The EFID System Improvement Plan (SIP) details how the District currently has approximately 17.9 miles of open canals, 17.5 miles of which would be piped under the Piping Alternative (6.1 miles in the Eastside Canal, 6.4 miles in the Main Canal, and 5.0 miles in the Dukes Valley Canal). In 2007, the 4.5-mile Central Canal was piped, meaning that from 1983 to 2007 there were 22.4 miles of open canals (Farmers Conservation Alliance, 2018). Accordingly, the length of open canals averaged 21 miles between 1983 and 2018. Given that two drowning deaths occurred during this time period (an average of 0.057 deaths per year, as described above), the annual drowning risk per mile of open canal was 0.0027. This may be an overestimate of risk if there were an abnormally high number of drownings in the last 25 years, but it may also be an underestimate of risk as the population of Hood River continues to grow.

Under the No Action Alternative, EFID would continue to have about 17.5 more miles of open canals than under the Piping Alternative. Assuming that the three drownings over the past 25 years are representative of the future drowning risk, and that the 0.0027 deaths per mile of exposed canal experienced during this period is an appropriate estimate of future risk, the unpiped canals in EFID carry a risk of 0.05 deaths per year.

D.1.3 Summary of Benefits

Table 8-6 (NWPM 506.20, Economic Table 5a) summarizes annual average NEE project benefits of the Piping Alternative that exceed the benefits under the No Action Alternative. In the table, the benefits from irrigating new acres (described in the Agricultural Damage Reduction Benefit section) and the benefits of having additional water for existing irrigated acres (described in the Agricultural Damage Reduction Benefit section) are grouped together under "Increased Agricultural Production" benefits. Avoided O&M costs to the District and to patrons (in the Operation and Maintenance Cost Savings Benefit section) are grouped under "Other - Reduced O&M" benefits. Avoided pump costs, including energy, maintenance, and replacement costs, are grouped under "Other - Pump Cost Savings."

D.1.4 Incremental Analysis

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

The engineering pipeline design (pipe diameters, pressure ratings, etc.) is independent of the number of project groups and the order that the project groups are installed. The District's SIP describes how the District designed modern pipelines to replace its open canals and laterals (Farmers Conservation Alliance, 2018). The District mapped and collected digital elevation data along its entire delivery system. The District is obligated to deliver water to patrons at 4.49 gallons per minute (gpm) but designed the system to be able to deliver 5.62 gpm.

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 or 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.

While costs are the same for each project group in the incremental analysis (as shown in Table 14), the District aims to provide a piping pressure of at least 40 pounds per square inch wherever possible. Table 14 shows the incremental analysis of the project groups.

Table 14. Incremental Analysis of Annual NEE Costs and Benefits Under the Piping Alternative for East Fork Irrigation District, Hood River Watershed, Oregon, 2019$.[1]

Groups	Total Costs	Incremental Costs	Total Benefits	Incremental Benefits	Net Benefits
1	$396,000		$462,000		$66,000
1,2	$1,424,000	$1,028,000	$1,680,000	$1,218,000	$256,000
1,2,3	$1,763,000	$339,000	$2,313,000	$633,000	$550,000

Note: Totals may not sum due to rounding Prepared April 2019

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

D.1.5 References

Bell, K., Huppert, D., & Johnson, R. (2003). Willingness to pay for local coho salmon enhancement in coastal communities. *Marine Resource Economics, 18*, 15-31. Retrieved from https://core.ac.uk/download/pdf/6679062.pdf

Bren School of Environmental Science & Management, University of California, Santa Barbara. (2017, February 22). Water Tranfer Data. Retrieved from http://www.bren.ucsb.edu/news/water_transfers.htm

Buckley, J. (2019a, February 6). East Fork Irrigation District Manager. (L. Seales, Interviewer)

Buckley, J. (2019b, February 12). East Fork Irrigation District Manager. (W. Oakley, & W. Barbara, Interviewers)

Buckley, J. (2019c, February 18). East Fork Irrigation District Manager. (K. Hart, Interviewer)

Bureau of Labor Statistics. (2017, May). Occupational Employment Statistics database. Retrieved from https://www.bls.gov/oes/current/oes_or.htm

Bureau of Reclamation. (2014). *Hood River Basin Study: Water Resource Management Model Technical Memorandum.* Pacific Northwest Regional Office. Boise, ID: U.S. Department of Interior. Retrieved from https://www.usbr.gov/pn/studies/hoodriver/reports/hrbasinstudy.pdf

Christensen, N. (2019, March 14). Watershed Professionals Network LLC. (B. Wyse, & W. Oakley, Interviewers)

Christensen, N., & Salminen, E. (2013). *Hood River Basin Water Use Assessment.* Hood River: Hood River County. Retrieved from https://www.co.hood-river.or.us/vertical/sites/%7B4BB5BFDA-3709-449E-9B16-B62A0A0DD6E4%7D/uploads/Hood_River_Basin_Water_Use_Assessment.pdf

Conner, J., Gibbs, K., & Reynolds, J. (1973). The Effects of Water Frontage on Recreational Property Values. *Journal of Leisure Research, 5*(2), 26-38.

Craven Consulting Group. (2005). *Draft Environmental Assessment - Farmers Irrigation District, Lower Distribution Pressurization Project, Phase II - Tucker Road Project, Hood River, Oregon.* Tigard, OR: U.S. Bureau of Reclamation. Retrieved from https://www.usbr.gov/pn/programs/ea/oregon/farmers/ea-fiddraft2005.pdf

Crew, K. (2018a, December 3). Black Rock Consulting. (R. Bushnell, Interviewer)

Crew, K. (2018b, December 7). Black Rock Consulting. (R. Bushnell, Interviewer)

Cronin, B. (2019, March 18). Engineer, Natural Resources Conservation Service. (W. Oakley, Interviewer)

Environmental Protection Agency. (2019). *Regulatory Impact Analysis for the Repeal of the Clean Power Plan, and the Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units.* Washington DC: Environmental Protection Agency.

Farmers Conservation Alliance. (2018). *East Fork Irrigation District System Improvement Plan.*

Farmers Irrigation District. (2019). *Projects*. Retrieved from https://www.fidhr.org/index.php/projects

Fey, J. (2019, February 26). Bryant Pipe & Supply Inc. (W. Oakley, Interviewer)

Haun, T. (2019, February 26). Hood River Supply. (W. Oakley, Interviewer)

Hood River Electric Co-op. (2019). *Irrigation*. Retrieved from https://hrec.coop/services/electric-service/irrigation/

Hood River News. (2014, March 25). EFID, Dee Irrigation present fish project results. *Hood River News*. Retrieved from http://www.hoodrivernews.com/news/2014/mar/26/efid-dee-irrigation-present-fish-project-results/

Hood River Watershed Group. (2014). *Hood River Watershed Action Plan.* Hood River. Retrieved from http://hoodriverswcd.org/cms/wp-content/uploads/2013/01/HRWG_HRWatershedActionPlan.pdf

Interagency Working Group on Social Cost of Greenhouse Gases. (2013). *Technical Support Document: Techical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*. Retrieved from https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf

Josephson, J. (2020, June 4). Real Estate Agent, Don Nunamker Relators. (W. Oakley, Interviewer)

Layton, D., Brown, G., & Plummer, M. (2001). *Valuing Multiple Programs to Improve Fish Populations.* Washington State Department of Ecology.

Loomis, J. (1996). Measuring the Economic Benefits of Removing Dams and Restoring the Elwha River: Results of a Contingent Valuation Survey. *Water Resources Research, 32*(2), 441-447.

Loomis, J., Quattlebaum, K., Brown, T., & Alexander, S. (2003). *Expanding Institutional Arrangements for Acquiring Water for Environmental Purposes: Transactions Evidence for the Western United States.* USDA Forest Service, Faculty Publications 291. Retrieved from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1290&context=usdafsfacpub

Mark. (2019, January 18). Thompson Pump & Irrigation. (W. Oakley, Interviewer)

Marsal, J., Girona, J., & Naor, A. (2012). Fruit Trees and Vines: Pears. In P. Steduto, T. Hsiao, E. Fereres, & D. Raes, *Crop Yield Response to water - FAO Irrigation and drainage paper 66* (pp. 374-388). Rome, Italy: Food and Agricultural Organization of the United Nations. Retrieved from http://www.fao.org/3/i2800e/i2800e09.pdf

Mooney, S., & Eisgruber, L. (2001). The Influence of Riparian Protection Measures on Residential Property Values: The Case of the Oregon Plan for Salmon and Watersheds. *Journal of Real Estate Finance and Economics, 22*(2/3), 273-286.

Nakamura, B. (2019, March 6). EFID President and Board Member. (B. Wyse, & W. Oakley, Interviewers)

Nelson, G., Hansz, A., & Cypher, M. (2005, Spring). The Influence of Artificial Water Canals on Residential Sale Prices. *Appraisal Journal, 73*(2), 167-174.

Nicholls, S., & Crompton, J. L. (2017). The effect of rivers, streams, and canals on property values. *River Research and Applications, 33*, 1377-1386. Retrieved from https://rpts.tamu.edu/wp-content/uploads/sites/21/2015/05/The-Effect-of-Rivers-Streams-and-Canals-on-Property-Values.pdf

Nunamaker, D. (2020, June 4). Managing Broker and Owner, Don Nunamaker Realtors. (W. Oakley, Interviewer)

Olsen, D., Richards, J., & Scott, D. (1991). Existence and sport values for doubling the size of Columbia river basin salmon and steelhead runs. *Rivers, 2*, 44-56.

Oregon Department of Agriculture, Hood River Local Advisory Committee. (2016). *Hood River Agricultural Water Qulity Management Area Plan.* Oregon Department of Agriculture. Retrieved from https://www.oregon.gov/ODA/shared/Documents/Publications/NaturalResources/HoodRiverAWQMAreaPlan.pdf

Oregon State University. (n.d.). *South Central Valley Irrigated Alfalfa.* Corvallis, OR: OSU.

Oregon Water Resources Department. (2018, August). *Water Project Grants and Loans.* Retrieved from https://www.oregon.gov/owrd/WRDPublications1/Water_Project_Grants_and_Loans_Awarded_.pdf

Richardson, L., & Loomis, J. (2009). The total economic value of threatened, endangered and rare species: An updated meta-analysis. *Ecological Economics*, 1535-1548. Retrieved from https://www.researchgate.net/profile/Leslie_Richardson/publication/222189924_The_total_economic_value_of_threatened_endangered_and_rare_species_An_updated_meta-analysis/links/02e7e5357d4544b85f000000.pdf

RSMeans. (2019). *Historical Cost Indexes.* Retrieved from https://www.rsmeansonline.com/references/unit/refpdf/hci.pdf

Scarborough, T. (2019, January 17). Cascade Pump & Irrigation Services. (W. Oakley, Interviewer)

Walker, C. (2019, February 22). Hood River Electric Cooperative. (H. Coccoli, Interviewer)

D.2 NEE Crop Enterprise Budgets

This section presents the crop enterprise budgets used in estimating agricultural NEE benefits under the Piping Alternative resulting from reduced damages associated with water shortages expected due to climate change. The agricultural production benefits are estimated using enterprise budgets that represent typical costs and returns of producing crops in the Hood River Watershed of Oregon. Enterprise budgets aim to reflect common practices and relevant costs for production in the region, but do not necessarily represent conditions of any particular farm.

We used crop budgets for pears and alfalfa hay developed, respectively, by OSU and WSU, and then adjusted values in these budgets to account for changes in prices through time and local conditions in EFID. An existing grass hay budget for Hood River County or the Columbia Basin was not available from OSU or WSU. In comparing grass hay to alfalfa hay budgets, the production costs tend to be higher for alfalfa hay per ton of production due to higher machinery, pest management, and establishment costs (Painter, 2015 Enterprise Budget: District 1 Alfalfa, 2015; Painter, 2015 Enterprise Budgets: District 1 Grass Hay, 2015; Turner & Mylen Bohle, 1995; McNeley, Williams, Carr, & Turner, 1995). As such, by using an alfalfa hay budget we expect that our estimated production costs for grass hay may be higher than typical in EFID, resulting in conservative estimates of net returns to grass hay production.

Due to the need to model years with different irrigation water availability, we developed five crop budgets. There are three budgets for pears to represent high-value crops: one for full production years under full irrigation, and two for full production years under different irrigation deficit scenarios. There are two budgets for grass hay to represent low-value crops: one for full production years under full irrigation and one for full production years under an irrigation deficit. We use the budgets of irrigation deficits to estimate the net benefits of piping to agricultural production under climate change (in the Agricultural Damage Reduction Benefit section). The following two sections outline the data and assumptions used in adjusting the Oregon State and Washington State pear and alfalfa hay budgets. Table 15 summarize the net returns to pears and grass hay modeled in the enterprise budgets.

Table 15. Per-Acre Net Returns to Crops Under Climate Change Scenarios.

Production Year	Pears	Grass Hay
Full Irrigation[1]	$3,795	$110
22% total water shortage at EFID	$1,267	$5
9% total water shortage at EFID	$3,368	$5

[1] These are the full production net returns with the amortized establishment costs subtracted out.

D.2.1 Pear Enterprise Budgets

The pear enterprise budgets (presented in full below) were primarily based on enterprise budgets for pears developed by OSU in 2016 to represent the costs and benefits of full production for pears in Hood River County (Halliday, Seavert, & Castagnoli, 2016a; Halliday, Seavert, & Castagnoli, 2016b). We updated the costs and revenues presented in the budgets to account for changing values over time and to reflect values specific to the District.

To model benefits of increased water supply reliability to existing orchards in the deficit irrigation budgets, we include establishment costs since we do not explicitly model the establishment years.[12]

D.2.1.1 Modeled Farm

The farm modeled in the original OSU budget is 70 acres total, which comprised 50 acres of pears, 5 acres of apples, 5 acres of cherries or wine grapes, and 10 acres are orchards under establishment. The budgets are based on 8 acres producing d'Anjou and fresh Bartlett pears, with 242 trees per acre.

D.2.1.2 Facilities and Equipment

Irrigation is delivered through a mix of solid set and handlines. Housing (sufficient for 10 people) is provided for summer labor and has a productive life of 30 years. Foreman housing is also provided. A 70-hp tractor is used for shredding brush, flailing, pulling the airblast sprayer, and harvesting. A 50-hp tractor is used to auger holes for new trees, spread fertilizer, pull an older air-blast sprayer, apply gopher bait, and assist during harvest. A 35-hp tractor is used to spray weeds, assist in harvest, and as a general utility tractor.

D.2.1.3 Input Costs

All costs are adjusted from the original values in the OSU budget. Wherever possible, we adopted area-specific values, which was the case for fuel prices and irrigation charges. EFID charges a flat rate of $175 for each tax lot supplied with District water and $59 per acre supplied (East Fork Irrigation District, 2018). As the average tax lot size in EFID is 10 acres, the flat rate is divided by 10 to derive the per-acre cost of the flat irrigation fee. For land costs, we use the average value of non-producing pear orchards in the area ($15,000 per acre) and multiplied it by the discount rate (2.75 percent), to generate the estimated annual cost of owning the land.

For costs that did not have area-specific values, we adjusted the value in the original budget using the national Producer Price Indices (PPIs) produced by the National Agricultural Statistics Services (NASS), which are published for a variety of farm expenses (NASS, 2018). For example, there are price indices for fertilizer, herbicides, supplies, tractors, custom work, as well as one for the farm sector in general. The PPI cost adjustments range from an 8 percent decrease in the price of fertilizer to a 10 percent increase in building materials. For the deficit irrigation budgets, the orchard establishment costs are amortized over the 25-year full production years assumed in the original OSU budget. We adjusted the establishment cost by using a discount rate of 2.75 percent (instead of the 5 percent from the original budget), and also adjusted the cost to 2019 dollars using the general Farm Sector PPI.

D.2.1.4 Labor Costs

For general farm labor, we used the average wage rate for farmworkers in the Central Oregon non-metropolitan area.[13] For equipment operator labor, we used the mean hourly wage rate for this occupation in Oregon.[14] In both cases, we adjusted the average wage rate up by 20 percent to account for non-wage

[12] In years requiring deficit irrigation, we also assume that water supply shortages would primarily affect only full-production orchards (growers prioritize watering young trees being established to protect their long-term productivity).
[13] This is the average wage for the Farmworkers and Laborers, Crop, Nursery, and Greenhouse occupation (45-2092) according the Bureau of Labor Statistics Occupational Employment Statistics data in May 2017 (Bureau of Labor Statistics, 2017). We adjust wage for inflation to 2019 dollars using the Consumer Price Index.
[14] This is the average wage for the Agricultural Equipment Operators (45-2091) according the Bureau of Labor Statistics Occupational Employment Statistics data in May 2017 (Bureau of Labor Statistics, 2017). We adjust wage for inflation to 2019 dollars using the Consumer Price Index.

employment costs, such as health care and insurance. This results in total labor costs of $15.89 and $18.13 per hour for laborers and equipment operators, respectively. The two pear budgets modeled under deficit irrigation (Table 17 and Table 18.) have their harvest labor costs adjusted downward in order to account for lower yields.

The original OSU pear budget did not include a cost for an orchard manager. To estimate the economic net benefits of the agricultural production, rather than the net returns to the time spent self-managing an orchard, we added the cost of managing the orchard to the budget. To estimate this cost, we used the wage rate for agricultural managers in Eastern Oregon (which is adjusted upward by 20 percent, similar to the other labor), resulting in a total cost of $39.77 per hour.[15] To estimate the amount of time spent per acre, we use a pear budget developed by the University of California, Davis, which models an orchard manager effectively running a 400-acre orchard (Ingles & Klonsky, 2012). Assuming this manager works 40-hour workweeks 48 weeks out of the year, each acre would require roughly 4.8 hours per week. At $39.77 per hour, we estimate that hiring an orchard manager would cost roughly $191 per acre.

D.2.1.5 Revenues

To estimate the gross revenues of pears under full irrigation, we used the full production year yield from the original OSU pear budget (50 bins of 1,050-lbs per acre) because it is specific to Hood River County and is specific to full production years. We used the average price per bin in the area as reported by an EFID board member and Quality Control Manager of Duckwall-Pooley Fruit Company, one of the largest fruit packing companies in the area: $250 per bin (Mallon, 2019). This price may be conservative given that, from 2013 to 2017, the average price in Oregon for Bartlett pears was the equivalent of $325 per bin and $353 per bin for other pears (Oregon Department of Agriculture, 2018; USDA and NASS, 2018). For the gross revenues under deficit irrigation, we adjusted the original yield downward using the yield/water relationship for pears described in the Agricultural Damage Reduction Benefit section.

D.2.1.6 Pear Enterprise Budget Tables

The tables below present the pear enterprise budgets used to estimate the net returns to high-value crops in the District under full water allocation (Table 16), under a 20 percent deficit irrigation (Table 17), and under a 5 percent deficit irrigation (Table 18.).

[15] This is the average wage for the Farmers, Ranchers, and Other Agricultural Managers (11-9013) according the Bureau of Labor Statistics Occupational Employment Statistics data in May 2017 (Bureau of Labor Statistics, 2017). We adjust wage for inflation to 2019 dollars using the Consumer Price Index.

Table 16. Pear Enterprise Budget Under Full Irrigation (Years 8–32).

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Pears	50	bins	$250	$12,500
VARIABLE COSTS				
Pruning and training labor	25.0	hrs	$15.89	$397.23
Thinning labor	18.0	hrs	$15.89	$286.01
Tree removal & replacement	1.0	ac	$17.20	$17.20
Raking and shredding bush labor	0.4	hrs	$18.13	$6.52
Fertilizer & lime	1.0	ac	$290.89	$290.89
Herbicide strip maintenance	1.0	ac	$53.35	$53.35
Insecticides & fungicides	1.0	ac	$820.80	$820.80
Pheromone disruption	1.0	ac	$112.86	$112.86
Bee rental	1.0	ac	$111.68	$111.68
Flailing/mowing orchard floor labor	2.9	hrs	$18.13	$52.13
Rodent control	1.0	ac	$43.01	$43.01
Frost protection labor	2.0	hrs	$15.89	$31.78
Irrigation water charge	1.0	ac	$59.00	$59.00
Ladders, pruning, & picking equipment	1.0	ac	$13.10	$13.10
Harvest labor	50.0	bins	$38.40	$1,920.04
Harvest - hauling fruit	50.0	bins	$3.55	$177.67
Pickup, truck & Gator	1.0	ac	$180.37	$180.37
Seasonal housing facilities	1.0	ac	$124.65	$124.65
Misc. and overhead	1.0	ac	$131.65	$131.65
Interest: operating capital	1.0	ac	$34.49	$34.49
Other general labor	7.3	hrs	$15.89	$115.99
Other tractor driver labor	8.7	hrs	$18.13	$157.16
Other machinery costs	1.0	ac	$411.88	$411.88
Total variable costs				$5,549.45
FIXED COSTS				
Irrigation service charge	1.0	ac	$17.50	$17.50
Property insurance	1.0	ac	$26.33	$26.33
Property taxes	1.0	ac	$63.19	$63.19
Management cost	1.0	ac	$190.91	$190.91
Machinery & equipment: depreciation and interest	1.0	ac	$610.53	$610.53
Pickup, truck & Gator: depreciation and interest	1.0	ac	$96.13	$96.13
Foreman housing	1.0	ac	$188.16	$188.16
Seasonal housing facilities	1.0	ac	$274.40	$274.40
Land cost	1.0	ac	$412.50	$412.50
Total fixed costs				$1,879.64
Total costs				$7,429.09
NET RETURNS PER ACRE				**$5,070.91**

Table 17. Pear Enterprise Budget Under 20-Percent Irrigation Deficiency.

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Pears	36.7	bins	$250	$9,186
VARIABLE COSTS				
Pruning and training labor	25.0	hrs	$15.89	$397.23
Thinning labor	18.0	hrs	$15.89	$286.01
Tree removal & replacement	1.0	ac	$17.20	$17.20
Raking and shredding bush labor	0.4	hrs	$18.13	$6.52
Fertilizer & lime	1.0	ac	$290.89	$290.89
Herbicide strip maintenance	1.0	ac	$53.35	$53.35
Insecticides & fungicides	1.0	ac	$820.80	$820.80
Pheromone disruption	1.0	ac	$112.86	$112.86
Bee rental	1.0	ac	$111.68	$111.68
Flailing/mowing orchard floor labor	2.9	hrs	$18.13	$52.13
Rodent control	1.0	ac	$43.01	$43.01
Frost protection labor	2.0	hrs	$15.89	$31.78
Irrigation water charge	1.0	ac	$59.00	$59.00
Ladders, pruning, & picking equipment	1.0	ac	$13.10	$13.10
Harvest labor	36.7	bins	$38.40	$1,411.04
Harvest - hauling fruit	36.7	bins	$3.55	$130.57
Pickup, truck & Gator	1.0	ac	$180.37	$180.37
Seasonal housing facilities	1.0	ac	$124.65	$124.65
Misc. and overhead	1.0	ac	$131.65	$131.65
Interest: operating capital	1.0	ac	$34.49	$34.49
Other general labor	7.3	hrs	$15.89	$115.99
Other tractor driver labor	8.7	hrs	$18.13	$157.16
Other machinery costs	1.0	ac	$411.88	$411.88
Total variable costs				$4,993.35
FIXED COSTS				
Irrigation service charge	1.0	ac	$17.50	$17.50
Property insurance	1.0	ac	$26.33	$26.33
Property taxes	1.0	ac	$63.19	$63.19
Management cost	1.0	ac	$190.91	$190.91
Machinery & equipment: depreciation and interest	1.0	ac	$610.53	$610.53
Pickup, truck & Gator: depreciation and interest	1.0	ac	$96.13	$96.13
Foreman housing	1.0	ac	$188.16	$188.16
Seasonal housing facilities	1.0	ac	$274.40	$274.40
Land cost	1.0	ac	$412.50	$412.50
Amortized establishment costs	1.0	ac	$1,045.99	$1,045.99
Total fixed costs				$2,925.63
Total costs				$7,918.98
NET RETURNS PER ACRE				**$1,267.26**

Table 18. Pear Enterprise Budget Under 5-Percent Irrigation Deficiency.

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Pears	46.8	bins	$250.00	$11,710
VARIABLE COSTS				
Pruning and training labor	25.0	hrs	$15.89	$397.23
Thinning labor	18.0	hrs	$15.89	$286.01
Tree removal & replacement	1.0	ac	$17.20	$17.20
Raking and shredding bush labor	0.4	hrs	$18.13	$6.52
Fertilizer & lime	1.0	ac	$290.89	$290.89
Herbicide strip maintenance	1.0	ac	$53.35	$53.35
Insecticides & fungicides	1.0	ac	$820.80	$820.80
Pheromone disruption	1.0	ac	$112.86	$112.86
Bee rental	1.0	ac	$111.68	$111.68
Flailing/mowing orchard floor labor	2.9	hrs	$18.13	$52.13
Rodent control	1.0	ac	$43.01	$43.01
Frost protection labor	2.0	hrs	$15.89	$31.78
Irrigation water charge	1.0	ac	$59.00	$59.00
Ladders, pruning, & picking equipment	1.0	ac	$13.10	$13.10
Harvest labor	46.8	bins	$38.40	$1,798.75
Harvest - hauling fruit	46.8	bins	$3.55	$166.44
Pickup, truck & Gator	1.0	ac	$180.37	$180.37
Seasonal housing facilities	1.0	ac	$124.65	$124.65
Misc. and overhead	1.0	ac	$131.65	$131.65
Interest: operating capital	1.0	ac	$34.49	$34.49
Other general labor	7.3	hrs	$15.89	$115.99
Other tractor driver labor	8.7	hrs	$18.13	$157.16
Other machinery costs	1.0	ac	$411.88	$411.88
Total variable costs				$5,416.93
FIXED COSTS				
Irrigation service charge	1.0	ac	$17.50	$17.50
Property insurance	1.0	ac	$26.33	$26.33
Property taxes	1.0	ac	$63.19	$63.19
Management cost	1.0	ac	$190.91	$190.91
Machinery & equipment: depreciation and interest	1.0	ac	$610.53	$610.53
Pickup, truck & Gator: depreciation and interest	1.0	ac	$96.13	$96.13
Foreman housing	1.0	ac	$188.16	$188.16
Seasonal housing facilities	1.0	ac	$274.40	$274.40
Land cost	1.0	ac	$412.50	$412.50
Amortized establishment costs	1.0	ac	$1,045.99	$1,045.99
Total fixed costs				$2,925.63
Total costs				$8,342.57
NET RETURNS PER ACRE				**$3,367.75**

D.2.2 Grass Hay Enterprise Budgets

The grass hay enterprise budgets were based on 2012 budgets developed by WSU for establishing and producing alfalfa hay in the Washington Columbia Basin (Norberg & Neibergs, 2012). These budgets include two budgets for the establishment year and one full production year budget. We selected these budgets as the basis for EFID crop production costs because they are the most recent crop budgets developed for agriculture in the Columbia Basin. As noted above, in comparing grass hay to alfalfa hay budgets, the production costs tend to be higher for alfalfa hay per ton of production due to higher machinery, pest management, and establishment costs (Painter, 2015 Enterprise Budget: District 1 Alfalfa, 2015; Painter, 2015 Enterprise Budgets: District 1 Grass Hay, 2015; Turner & Mylen Bohle, 1995; McNeley, Williams, Carr, & Turner, 1995). As such, by using an alfalfa hay budget we expect that our estimated production costs for grass hay may be higher than typical in EFID, resulting in conservative estimates of net returns for grass hay production.

As in the pear budgets, we updated the costs presented in the original budgets to account for changing values over time and to reflect conditions specific to EFID. Returns to grass hay were based on locally reported hay yields and Oregon State 5-year normalized average hay prices. We developed two hay budgets in total: one budget for hay under full production years and full irrigation (Table 19), and one budget where a 30 percent irrigation deficit causes the grower to forego the third and final hay cutting at a loss of 1 ton of hay per acre (Table 20). This results in a reduced net revenue of $105 per acre compared to a full water year.

D.2.2.1 Modeled Farm

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

D.2.2.2 Input Costs

All costs are adjusted from the original values in the WSU budget. As with the pear budgets, we used area-specific values for fuel prices, irrigation charges, and land costs. Irrigation charges are the same as those presented in the pear budget. The original WSU budget did not include the costs of land, however, we added it to the budget used in this analysis. We adopted the land value used an enterprise budget for irrigated corn in the northcentral region of Oregon in 2014, adjusted it to 2019 dollars using the CPI, and then used an annual interest rate of 2.75 percent to derive the estimated land ownership costs (Seavert & Horneck, 2014).

For costs that did not have area-specific values, we adjusted the value in the original budget using the same PPIs as were used in the pear budgets. Establishment costs are amortized over 7 years, which is roughly the average productive life of hay stands in the area (Mallon, 2019). We adjusted this cost by the general Farm Sector PPI and used a 2.75 percent interest rate. For the hay budget under deficit irrigation (Table 20), we adjust some inputs to account for the reduction in costs associated with reductions in yield, including chemical treatments and fuel costs.

D.2.2.3 Labor Costs

Because most of the labor is provided by custom work, the only direct labor costs are for an agricultural equipment operator to move the center pivots. The per hour total labor costs for this equipment operator are the same as the per hour equipment operator costs presented in the pear budget ($18.13 per hour). We adjusted the cost of custom work using the Custom Work PPI. For the hay budget under deficit irrigation

(Table 20), we adjust the labor costs (including custom, management, and other labor) proportionally to the change in yield (e.g., if yield falls by 10 percent, the amount of labor also falls by 10 percent). To the extent that labor costs fall less than this, our results will under-estimate benefits (and vice versa).

D.2.2.4 Revenues

To estimate the gross revenues of grass hay, we use the average yield reported by an EFID board member: 4.5 tons per acre (Mallon, 2019). To estimate the gross revenues per ton, we use the normalized average price per ton for hay in Oregon reported by the Economic Research Service of the USDA in 2018 (Economic Research Service, 2018). For hay under deficit irrigation, we assume that the impact of losing 30 percent of their water would cause grass hay growers to forego their third and final cutting of the season, which has an average yield of roughly 1 ton per acre in EFID (Buckley, 2019b).

D.2.2.5 Grass Hay Enterprise Budget Tables

The tables below present the two grass hay enterprise budgets used to estimate the net returns to low-value crops in the District: one budget under full irrigation (Table 19), and one budget modeling returns under a 30 percent irrigation deficit (Table 20).

Table 19. Grass Hay Enterprise Budget Under Full Irrigation (Years 1 - 6).

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Grass Hay	4.5	ton	$209.63	$943.34
VARIABLE COSTS				
Dry Nitrogen	0.0	lb	$0.34	$0.00
Dry Phosphate	51.8	lb	$0.58	$29.94
Dry Potash	78.8	lb	$0.41	$32.40
Dry Sulfur	14.1	lb	$0.20	$2.75
Zinc	2.8	lb	$1.98	$5.58
Boron	1.1	lb	$4.47	$5.03
Custom Application	1.0	ac	$9.90	$9.90
Soil Test	1.0	ac	$0.33	$0.33
Herbicide	1.1	lb	$19.14	$21.53
Custom Application	1.0	ac	$9.90	$9.90
Custom - Swath	2.5	ac	$22.00	$55.00
Custom - Rake	2.5	ac	$11.00	$27.50
Custom - Bail	4.5	ton	$18.70	$84.15
Custom - Haul & Stack	4.5	ton	$9.90	$44.55
Custom - Tarping	4.5	ton	$5.50	$24.75
Irrigation - water charge	1.0	ac	$59.00	$59.00
Irrigation - service charge	1.0	ac	$17.50	$17.50
Irrigation - repairs	1.0	ac	$16.53	$16.53
Irrigation - labor	0.5	ac	$18.13	$9.06
Haystack insurance	4.5	ton	$2.20	$9.91
Gopher control	1.0	ac	$5.58	$5.58
Fuel	2.3	gal	$2.79	$6.37
Lubricants	1.0	ac	$0.89	$0.89
Machinery repairs	1.0	ac	$1.98	$1.98
Overhead	1.0	ac	$42.33	$42.33
Operating interest	1.0	ac	$13.74	$13.74
Total variable costs				$536.20
FIXED COSTS				
Machinery depreciation	1.0	ac	$6.31	$6.31
Machinery interest	1.0	ac	$3.68	$3.68
Machinery insurance, taxes, housing, license	1.0	ac	$2.62	$2.62
Management (5% of total cost)	1.0	ac	$36.98	$36.98
Establishment cost	1.0	Ac	$56.61	$56.61
Land cost	1.0	ac	$190.86	$190.86
Total fixed costs				$297.07
Total costs				$833.27
NET RETURNS PER ACRE				**$110.07**

Table 20. Grass Hay Enterprise Budget Under 30-Percent Irrigation Deficiency.

Item	Quantity	Unit	$/Unit	Total
REVENUE				
Grass Hay	3.5	ton	$209.63	$733.71
VARIABLE COSTS				
Dry Nitrogen	0.0	lb	$0.34	$0.00
Dry Phosphate	40.3	lb	$0.58	$23.29
Dry Potash	61.3	lb	$0.41	$25.20
Dry Sulfur	10.9	lb	$0.20	$2.14
Zinc	2.2	lb	$1.98	$4.34
Boron	0.9	lb	$4.47	$3.91
Custom Application	0.8	ac	$9.90	$7.70
Soil Test	1.0	ac	$0.33	$0.33
Herbicide	0.9	lb	$19.14	$16.75
Custom Application	0.8	ac	$9.90	$7.70
Custom - Swath	1.5	ac	$22.00	$33.00
Custom - Rake	1.5	ac	$11.00	$16.50
Custom - Bail	3.5	ton	$18.70	$65.45
Custom - Haul & Stack	3.5	ton	$9.90	$34.65
Custom - Tarping	3.5	ton	$5.50	$19.25
Irrigation - water charge	1.0	ac	$59.00	$59.00
Irrigation - service charge	1.0	ac	$17.50	$17.50
Irrigation - repairs	0.8	ac	$16.53	$12.85
Irrigation - labor	0.4	ac	$18.13	$7.05
Haystack insurance	3.5	ton	$2.20	$7.71
Gopher control	1.0	ac	$5.58	$5.58
Fuel	1.8	gal	$2.79	$4.95
Lubricants	1.0	ac	$0.89	$0.89
Machinery repairs	1.0	ac	$1.98	$1.98
Overhead	1.0	ac	$42.33	$42.33
Operating interest	1.0	ac	$13.74	$13.74
Total variable costs				$433.79
FIXED COSTS				
Machinery depreciation	1.0	ac	$6.31	$6.31
Machinery interest	1.0	ac	$3.68	$3.68
Machinery insurance, taxes, housing, license	1.0	ac	$2.62	$2.62
Management (5% of total cost)	1.0	ac	$34.69	$34.69
Establishment cost	1.0	ac	$56.61	$56.61
Land cost	1.0	ac	$190.86	$190.86
Total fixed costs				$294.78
Total costs				$728.57
NET RETURNS PER ACRE				**$5.14**

D.2.3 References

Buckley, J. (2019, February 12). East Fork Irrigation District Manager. (W. Oakley, & W. Barbara, Interviewers)

Bureau of Labor Statistics. (2017, May). Occupational Employment Statistics database. Retrieved from https://www.bls.gov/oes/current/oes_or.htm

East Fork Irrigation District. (2018). *Frequently Asked Questions*. Retrieved from http://efidhr.org/faqs

Economic Research Service. (2018, September 27). Table 3-State-level normalized price received estimates for commodities for 2018 ERS report year. USDA. Retrieved from https://www.ers.usda.gov/data-products/normalized-prices/

Halliday, D., Seavert, C., & Castagnoli, S. (2016a). *Enterprise Budget, Pears, d'Anjou & Fresh Bartlett, North Central Region.* Department of Applied Economics. Hood River County: Oregon State University. Retrieved from http://arec.oregonstate.edu/oaeb/files/pdf/AEB0057.pdf

Halliday, D., Seavert, C., & Castagnoli, S. (2016b). *Orchard Economics: Establishing and Producing d'Anjou and Fresh Bartlett Pears in Hood River County.* Oregon State University Extension Service. Retrieved from http://arec.oregonstate.edu/oaeb/files/pdf/AEB0056.pdf

Ingles, C., & Klonsky, K. (2012). *Sample Costs to Produce Organic Pears.* Davis, California: University California Cooperative Extension. Retrieved from https://coststudyfiles.ucdavis.edu/uploads/cs_public/98/4c/984cc236-f5bc-4385-a5d3-ad1c9d1fe75d/pearsorg_sv2012.pdf

Mallon, C. (2019, March 1). EFID Board Member and Quality Control Manager at Duckwall-Pooley Fruit Company. (W. Oakley, Interviewer)

McNeley, S., Williams, J., Carr, J., & Turner, B. (1995). *Enterprise Budget, Native Hay, Eastern Oregon Region.* Oregon State University Extension Service. Retrieved from http://arec.oregonstate.edu/oaeb/files/pdf/EM8608.pdf

NASS. (2018). Quickstats - Producer Price Index. Retrieved from quickstats.nass.usda.gov

Norberg, S., & Neibergs, J. S. (2012). *2012 Enterprise Budget for Establishing and Producing Irrigated Alfalfa in the Washington Columbia Basin.* Pullman, WA: Washington State University Extension. Retrieved from http://ses.wsu.edu/wp-content/uploads/2018/10/FS133E.pdf

Oregon Department of Agriculture. (2018). *Oregon Agripedia: 2017 edition.* Oregon Department of Agriculture. Retrieved from https://www.nass.usda.gov/Statistics_by_State/Oregon/Publications/Annual_Statistical_Bulletin/2017/Agripedia.pdf

Oregon State University. (n.d.). *South Central Valley Irrigated Alfalfa.* Corvallis, OR: OSU.

Painter, K. (2015). *2015 Enterprise Budget: District 1 Alfalfa.* Bonners Ferry, ID: University of Idaho College of Agricultural and Life Sciences. Retrieved from https://www.uidaho.edu/-/media/UIdaho-Responsive/Files/cals/programs/idaho-agbiz/crop-budgets/Northern/2015-Dist1-AlfalfaHay-Oct30.pdf?la=en&hash=32E683D1265732142605F4C4E615F72BE6B3C37F

Painter, K. (2015). *2015 Enterprise Budgets: District 1 Grass Hay.* Bonners Ferry, ID: University of Idaho College of Agricultural and Life Sciences. Retrieved from https://www.uidaho.edu/-/media/UIdaho-

Responsive/Files/cals/programs/idaho-agbiz/crop-budgets/Northern/2015-Grass-Hay-Small-Bale.pdf?la=en&hash=ECD825C5646B6B3FF1F69D61113757E9330B678E

Seavert, C., & Horneck, D. (2014). *Enterprise Budget, Corn (Field) Under Center Pivot Irrigation, Minimum Tillage, North Central Region.* Oregon State University Extension Service. Retrieved from http://arec.oregonstate.edu/oaeb/files/pdf/AEB0050.pdf

Turner, B., & Mylen Bohle. (1995). *Enterprise Budget, Alfalfa Production (3 cutting), South Central Region.* Oregon State University Extension Service. Retrieved from http://arec.oregonstate.edu/oaeb/files/pdf/EM8604.pdf

USDA and NASS. (2018). *2018 Oregon Annual Statistical Bulletin.* Portland, OR: NASS. Retrieved from https://www.nass.usda.gov/Statistics_by_State/Oregon/Publications/Annual_Statistical_Bulletin/2018/OR_annual%20bulletin%202018.pdf

D.3 Alternatives Considered During Formulation

This appendix section presents the alternatives considered in the formulation phase.

During the formulation phase, alternatives were evaluated based on meeting both National Environmental Policy Act and environmental review requirements specific to NRCS federal investments in water resources projects (Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies [PR&G]) (Table 21). According to the National Environmental Policy Act, "agencies shall rigorously explore and objectively evaluate all reasonable alternatives" (40 Code of Federal Regulations 1502.14). According to the PR&G, alternatives should reflect a range of scales and management measures and be evaluated against the Federal Objective and Guiding Principles; against the extent to which they address the problems and opportunities identified in the purpose and need; and against the criteria of completeness, effectiveness, efficiency, and acceptability:

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

Alternatives eliminated during formulation are discussed below the table. Alternatives selected for further evaluation are discussed in the Plan-EA.

Table 21. Alternatives Considered During the Formulation Phase.

Alternative	Which criteria in the PR&G does the alternative achieve?				Selected for Further Evaluation
	Completeness	Effectiveness	Efficiency	Acceptability	
Pipeline Realignment	X	X			
Conversion to Dryland Farming			X		
Fallowing Farm Fields			X		
Market Based Approaches to include Voluntary Duty Reduction					
Partial Use of Groundwater					
Water Towers					

Alternative	Which criteria in the PR&G does the alternative achieve?				Selected for Further Evaluation
	Completeness	Effectiveness	Efficiency	Acceptability	
Rainwater					
Mix of Open Canal and Pipe	X			X	
Piping Alternative, with open Main Canal upstream of Hanel Mill	X			X	
On-Farm Efficiency Upgrades		X		X	X
Canal Lining	X	X		X	X
Piping District Infrastructure with Steel	X	X		X	X
Piping District Infrastructure with Polyvinyl Chloride (PVC)	X	X	X	X	X
No Action (Future without Project)			X		X
Piping Alternative	X	X	X	X	X

D.3.1 Pipeline Realignment

Pipeline realignment would convert the District's system to pipes. However, in some places, instead of following the same path as the existing canals and laterals, the pipes would be laid in a new alignment (or path across the landscape). New alignments would be selected to serve all patrons, but would take a more direct route to decrease the piping length needed where possible. Approximately 91 percent of land within the District is privately owned. Realignment would involve acquiring new easements across these private lands. Depending on the proposed alignment, a right-of-way across public land could potentially be necessary.

New easements would disrupt prime farmland and residential living areas, and the easements would be difficult to secure from enough landowners to be feasible. Pipeline realignment outside the existing easements would require EFID to pay market price for the easements and negotiate with many landowners, which would be a complex, expensive, and time-consuming process. Pipeline realignment was eliminated from further evaluation due to its lack of efficiency arising from high legal costs; its low acceptability, particularly with private landowners; and because it would not achieve the Federal Objective and Guiding Principles.

D.3.2 Conversion to Dryland Farming

Dryland farming is a non-structural alternative. This method of farming uses no irrigation and drought-resistant crops and practices to conserve moisture. Since fruit trees, which make up 75 percent of the irrigated acres in the District, can sustain long-term damage if they are not watered sufficiently each summer, dryland farming would not be effective in the District.

Conversion to dryland farming was eliminated from further evaluation because it would not meet the project purpose and need; its effectiveness would be uncertain since conversion to dryland farming would be voluntary and only successful for a limited number of irrigated acres in the District; it would not be acceptable because it is inconsistent with public policy supporting and maintaining existing agricultural land use; and because it would not achieve the Federal Objective and Guiding Principles.

D.3.3 Fallowing Farm Fields

Fallowing farm fields is a non-structural alternative that includes permanently transferring or temporarily leasing water rights from irrigated lands or otherwise not using water rights appurtenant to irrigated lands. Fallowing farm fields would use less irrigation water within the District and would therefore allow more water to be kept instream for fish, wildlife, and habitat. This water would be legally protected instream if the associated water rights were leased or transferred instream.

Fruit trees, which comprise 75 percent of the irrigated acres in EFID, can sustain long-term damage if they are not watered sufficiently. This precludes fallowing these crops during dry years. A portion of the remaining irrigated acres in the District, particularly annual crops like pasture, may be fallowed successfully.

Fallowing farm fields was eliminated from further evaluation because: it would not meet the project purpose and need; its effectiveness would be uncertain since fallowing fields would be voluntary and only successful for a limited number of irrigated acres in the District; it would not be acceptable because it is inconsistent with public policy supporting and maintaining existing agricultural land use; and because it would not achieve the Federal Objective and Guiding Principles.

D.3.4 Market-Based Approaches to include Voluntary Duty Reduction

Market-based approaches for the purpose of this analysis refer to patrons voluntarily accepting less than their full water delivery rate from the District, or patrons transferring water rights from the farm to the river temporarily or permanently. Although the District permanently dedicating water for instream use is part of the proposed action, it utilizes the District's established authorities and is not a part of the following discussion.

Market-based incentives as a stand-alone alternative do not address the underlying purpose and need of the project. Incorporating market-based solutions into the proposed action without corresponding regulatory and policy changes, which would be required to provide the District with the authority to carry out the transfer of patron water rights instream, is not ripe for consideration as an alternative at this time. Without a change in the framework of current lawful authorities on the part of the District, incorporating market-based incentives into the proposed action is not within the District's ability or capacity to undertake, nor is it logistically or technically feasible.

For example, a reduction in duty by a patron could mean the District diverts less water, which would leave more water instream. However, because the District is obligated to provide a certain amount of water to patrons to meet associated water rights, this alternative would be voluntary and at the discretion of individual landowners. For this reason, the District would not be able to provide certainty that water would be saved,

and that streamflow would be restored. Furthermore, in addition to EFID lacking the statutory authority or responsibility to carry out, operate, and maintain voluntary duty reduction by its patrons, doing so could create a logistically complex situation for EFID to implement. Because the system has open canals, subject to certain operating inefficiencies, the District would still have to divert enough water, accounting for end spills and seepage, to ensure those deliveries. Therefore, carrying out this alternative would be both logistically complex and technically infeasible

Market-based incentives were eliminated from further evaluation because they would not meet the project purpose; effectiveness would be uncertain since reducing duty would be a voluntary and individual decision by each patron; the District lacks the ability to carry out patron duty reductions; it would not achieve the Federal Objective and Guiding Principles; and given the current water delivery technology it is technically infeasible by the District to accomplish.

D.3.5 Partial Use of Groundwater

The conversion from surface water sourced to groundwater sourced irrigation, for some of the District, was also initially considered as a possible alternative. The use of groundwater for irrigation would have logistical and legal constraints. The District would need the authority from each patron to convert surface rights to groundwater rights; there would be no guarantee of gaining this approval from patrons. Converting from surface water rights to groundwater rights would also affect the seniority and, therefore, the reliability of the District's water rights. The District currently has senior surface water rights that minimize the chance of being impacted during drought years; however, new groundwater rights would be junior (dated the year of the application and construction) and could be subject to curtailment.

The partial use of groundwater was eliminated from further evaluation because it would not meet the project purpose and need; its effectiveness would be uncertain since conversion to groundwater would be voluntary; there are inefficiencies associated with logistical and legal constraints obtaining groundwater rights; it would not be acceptable since converting to groundwater rights would result in junior water rights; and it would not achieve the Federal Objective and Guiding Principles.

D.3.6 Water Tower

A water tower alternative would include the installation of water towers throughout the District. For this alternative, the District's canals would remain open to transport water to the water towers. Therefore, this alternative would not meet the purpose and need of the project for the same reasons the No Action alternative does not meet the purpose and need of the project.

Since new land would be needed to locate the water towers and approximately 91 percent of land within the District is privately owned, installing water towers would require the District to acquire new easements across private lands. EFID would have to pay market price for the easements and negotiate with landowners, which would be a complex, expensive, and time-consuming process. Pressurization could be obtained from the water towers; however, the District would incur a significant O&M cost to pump water up to the towers. Due to the abundance of small sediment particle sizes and limited retention time in water towers, chemical treatment or additional pressure for filtration could be needed to effectively settle sediment.

A water tower alternative was eliminated from further evaluation because it would not meet the purpose and need of the project, would not be effective, would not be efficient arising from high legal costs, and would not achieve the Federal Objective and Guiding Principles.

D.3.7 Rainwater

For a rainwater alternative, the District would capture rainwater to supplement irrigation water diverted from the East Fork Hood River. The District could not capture rainwater for irrigation water supply under its existing water rights, which are limited to diversion from the East Fork Hood River. State law allows individual landowners to collect and use rainwater from impervious surfaces without obtaining a water right (Oregon Revised Statute 537.141). However, patrons collecting rainwater to supplement irrigation water would not be an effective alternative for the District because participation would be voluntary, and the District would need to maintain its open canal system. A rainwater alternative was eliminated from further evaluation because it would not meet the purpose and need of the project, would not be effective, would not be acceptable since the District cannot capture rainwater under its water right, and would not achieve the Federal Objective and Guiding Principles.

D.3.8 Mix of Open Canal and Pipe

Under this alternative, the District would pipe sections of its canals and laterals and leave sections of canal open throughout the District. Portions of the District's conveyance system would operate as an open channel system rather than a pressurized system under this alternative. The District would continue to divert and convey more water than its patrons apply in order to maintain water deliveries, end spills would continue to be required, and water would not be conserved. The project would not address instream flow, aquatic habitat, or water quality problems and opportunities.

The open canal and lateral sections would not provide pressurization benefits for patrons on those sections, and they would limit pressurization benefits for patrons elsewhere in the system. The District would continue to incur O&M costs associated with maintaining open canals and laterals. Lastly, public safety risks would remain along the sections of open canal. A mix of open canal and pipe was eliminated from further evaluation because it would not meet the purpose and need of the project, would not be effective, and would not achieve the Federal Objective and Guiding Principles.

D.3.9 Piping Alternative with Open Canal Upstream of Hanel Mill

This alternative would be the same as the Preferred Alternative except the entire 7 miles of the Main Canal, from the District's fish screen to Hanel Mill, would remain open.

Under this alternative, the District would continue to divert approximately 4.6 cfs more water than is directly used by patrons on the seven-mile Main Canal for irrigation. This would be necessary to ensure that these patrons receive the amount of water that they need when they need it.

When a piped and pressurized conveyance system starts at a diversion on a river, any water not taken by patrons never gets diverted into the system and remains in the river. When a piped and pressurized conveyance system starts along a canal, such as in the alternative described in this comment, any water not taken by patrons never gets diverted into the pipeline and remains in the canal. A decrease in water demand along such a pipeline would likely cause water to back up at the head of the pipe and into the canal. This water would be in addition to the 4.6 cfs of water described above.

To avoid flooding at the head of the piped and pressurized conveyance system at Hanel Mill, the District would need to either continue to spill excess water at the head of the piped system; build and maintain a regulating reservoir (including obtaining property to locate the reservoir) at head of the system; increase pipe sizes and spill excess water at the bottom of the piped system; and/or install other technology to regulate irrigation water flows.

Continuing to spill excess water at either the head or tail-end of the system would not contribute to addressing instream flow, aquatic habitat, and water quality problems and opportunities in the Hood River and its tributaries. Purchasing or condemning private land, which includes residential, agricultural, commercial, and industrial uses, to site a reservoir at this location may not be acceptable because it is inconsistent with public policy supporting and maintaining existing agricultural land use.

As compared to the Preferred Alternative, leaving the Main Canal open to Hanel Mill would result in less water conservation; a smaller decrease in District O&M costs associated with dredging the open canal and eliminating debris; no pressurization benefits for patrons along the Main Canal; and decreased pressurization benefits for patrons along the piped and pressurized system. The public safety risks and District liability would also remain high along the open Main Canal because there are many residences and orchards near the Main Canal. If a reservoir was installed, public safety risks would also increase adjacent to the reservoir due to the possibility of flooding.

Leaving the Main Canal to Hanel Mill open was eliminated from further evaluation because it would not be effective and/or would not be acceptable.

D.4 Capital Costs for the Preferred Alternative

This section presents capital costs for the Preferred Alternative, the Piping Alternative, as identified in the EFID SIP (2018$). Based on input from EFID, the total length of piping in Project Group 1 was decreased from the SIP and the costs for Project Group 1 were updated accordingly. Project costs in the Plan-EA were updated to 2019$.

Table 22. Capital Costs Summary for the Preferred Alternative, the Piping Alternative (2018$).[1]

Item	Construction Cost	ECMS[2]	CMGC[3]	Contingency	Total Cost
Project Group 1					
Pipe	$7,545,000	$602,000	$754,000	$1,780,000	$10,681,000
Turnout	$696,000	$1,000	$1,000	$2,000	$700,000
PRV Station	$805,000	$0	$0	$0	$805,000
Project Group 1 Subtotal:	*$9,046,000*	*$603,000*	*$755,000*	*$1,782,000*	*$12,186,000*
Project Group 2					
Pipe	$18,810,000	$1,882,000	$2,633,000	$6,996,000	$30,321,000
Turnout	$1,264,000	$127,000	$178,000	$470,000	$2,039,000
PRV Station	$1,420,000	$145,000	$201,000	$529,000	$2,295,000
Project Group 2 Subtotal:	*$21,494,000*	*$2,154,000*	*$3,012,000*	*$7,995,000*	*$34,655,000*
Project Group 3					
Pipe	$5,009,000	$500,000	$701,000	$1,863,000	$8,073,000
Turnout	$1,120,000	$111,000	$157,000	$417,000	$1,805,000
PRV Station	$2,175,000	$221,000	$307,000	$810,000	$3,513,000
Project Group 3 Subtotal:	*$8,304,000*	*$832,000*	*$1,165,000*	*$3,090,000*	*$13,391,000*
Total Piping:	$31,364,000	$2,984,000	$4,088,000	$10,639,000	$49,075,000
Total Turnouts:	$3,080,000	$239,000	$336,000	$889,000	$4,544,000
Total PRV Station:	$4,400,000	$366,000	$508,000	$1,339,000	$6,613,000
Total Overall Costs:	**$38,844,000**	**$3,589,000**	**$4,932,000**	**$12,867,000**	**$60,232,000**

Note: These costs are from the SIP (2018$).

[1] Total costs in the Plan-EA are higher than the table above due to being updated to 2019$, shortening the length of pipe in Project Group 1, and an additional $767,000 in Project Group 2 for installation of the sedimentation basin.

[2] Engineering, Construction Management, Survey

[3] Construction Management General Contractor

Table 23. Detailed Capital Costs for the Preferred Alternative, the Piping Alternative (2018$).[1]

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Project Group 1										
Eastside Canal	Pipe	18	21	302	feet	$19,205	$1,536	$1,921	$4,532	$27,194
Eastside Canal	Pipe	20	21	130	feet	$8,294	$663	$829	$1,957	$11,744
Eastside Canal	Pipe	20	26	452	feet	$23,438	$1,875	$2,344	$5,531	$33,188
Eastside Canal	Pipe	24	21	2,456	feet	$156,151	$12,492	$15,615	$36,852	$221,110
Eastside Canal	Pipe	26	21	784	feet	$49,846	$3,988	$4,985	$11,764	$70,582
Eastside Canal	Pipe	26	26	396	feet	$34,748	$2,780	$3,475	$8,201	$49,204
Eastside Canal	Pipe	28	26	3,274	feet	$333,104	$26,648	$33,310	$78,613	$471,675
Eastside Canal	Pipe	36	26	3,376	feet	$567,827	$45,426	$56,783	$134,007	$804,044
Eastside Canal	Pipe	42	26	20,922	feet	$4,787,066	$382,965	$478,707	$1,129,748	$6,778,486
Eastside Canal	Turnout	N/A	N/A	39	each	$312,000	$800	$1,120	$2,480	$316,400
Crag Rate Pipeline	Pipe	4	17	1,816	feet	$7,151	$572	$715	$1,688	$10,126
Crag Rate Pipeline	Pipe	4	21	1,823	feet	$115,909	$9,273	$11,591	$27,355	$164,127
Crag Rate Pipeline	Pipe	4	26	1,275	feet	$3,336	$267	$334	$787	$4,724
Crag Rate Pipeline	Pipe	4	32.5	54	feet	$113	$9	$11	$27	$161
Crag Rate Pipeline	Pipe	6	11	2,092	feet	$26,518	$2,121	$2,652	$6,258	$37,549

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Crag Rate Pipeline	Pipe	6	26	1,248	feet	$7,098	$568	$710	$1,675	$10,051
Crag Rate Pipeline	Pipe	8	21	7	feet	$416	$33	$42	$98	$590
Crag Rate Pipeline	Turnout	N/A	N/A	9	each	$72,000	$0	$0	$0	$72,000
Crag Rate Pipeline	PRV Station	4	N/A	2	each	$60,000	$0	$0	$0	$60,000
Crag Rate Pipeline	PRV Station	6	N/A	1	each	$30,000	$0	$0	$0	$30,000
Dethman/Swyers Line	PRV Station	10	N/A	1	each	$45,000	$0	$0	$0	$45,000
Whiskey Creek Pipeline	Pipe	4	21	1,284	feet	$81,644	$6,532	$8,164	$19,268	$115,608
Whiskey Creek Pipeline	Pipe	4	26	703	feet	$1,838	$147	$184	$434	$2,603
Whiskey Creek Pipeline	Pipe	4	32.5	14	feet	$30	$2	$3	$7	$42
Whiskey Creek Pipeline	Pipe	5.375	19	923	feet	$4,664	$373	$466	$1,101	$6,604
Whiskey Creek Pipeline	Pipe	6	11	1,144	feet	$14,506	$1,160	$1,451	$3,423	$20,540
Whiskey Creek Pipeline	Pipe	6	32.5	1,538	feet	$7,072	$566	$707	$1,669	$10,014
Whiskey Creek Pipeline	Pipe	8	21	3,359	feet	$213,530	$17,082	$21,353	$50,393	$302,358
Whiskey Creek Pipeline	Pipe	8	26	1,469	feet	$14,174	$1,134	$1,417	$3,345	$20,071
Whiskey Creek Pipeline	Pipe	8	32.5	2,025	feet	$15,742	$1,259	$1,574	$3,715	$22,290
Whiskey Creek Pipeline	Pipe	10	26	765	feet	$11,459	$917	$1,146	$2,704	$16,225
Whiskey Creek Pipeline	Pipe	10	32.5	77	feet	$927	$74	$93	$219	$1,313

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Whiskey Creek Pipeline	Pipe	12	13.5	771	feet	$30,087	$2,407	$3,009	$7,100	$42,603
Whiskey Creek Pipeline	Pipe	12	19	534	feet	$15,174	$1,214	$1,517	$3,581	$21,486
Whiskey Creek Pipeline	Pipe	12	21	1,384	feet	$87,964	$7,037	$8,796	$20,760	$124,557
Whiskey Creek Pipeline	Pipe	14	21	388	feet	$24,640	$1,971	$2,464	$5,815	$34,891
Whiskey Creek Pipeline	Pipe	16	15.5	4,202	feet	$227,353	$18,188	$22,735	$53,655	$321,932
Whiskey Creek Pipeline	Pipe	16	21	2,120	feet	$134,764	$10,781	$13,476	$31,804	$190,826
Whiskey Creek Pipeline	Pipe	20	13.5	286	feet	$27,420	$2,194	$2,742	$6,471	$38,826
Whiskey Creek Pipeline	Turnout	N/A	N/A	17	each	$136,000	$0	$0	$0	$136,000
Whiskey Creek Pipeline	PRV Station	4	N/A	2	each	$60,000	$0	$0	$0	$60,000
Whiskey Creek Pipeline	PRV Station	6	N/A	2	each	$60,000	$0	$0	$0	$60,000
Whiskey Creek Pipeline	PRV Station	12	N/A	1	each	$45,000	$0	$0	$0	$45,000
Whiskey Creek Pipeline	PRV Station	14	N/A	1	each	$40,000	$0	$0	$0	$40,000
Kelly Pipeline	Pipe	4	26	1,476	feet	$3,862	$309	$386	$911	$5,468
Kelly Pipeline	Pipe	4	32.5	1	feet	$3	$0	$0	$1	$4
Kelly Pipeline	Pipe	5.375	11	1,530	feet	$12,784	$1,023	$1,278	$3,017	$18,102
Kelly Pipeline	Turnout	N/A	N/A	1	each	$8,000	$0	$0	$0	$8,000
Kelly Pipeline	PRV Station	4	N/A	1	each	$30,000	$0	$0	$0	$30,000

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Loop Pipeline	PRV Station	10	N/A	1	each	$30,000	$0	$0	$0	$30,000
Loop Pipeline	PRV Station	16	N/A	1	each	$55,000	$0	$0	$0	$55,000
Lower Highline Pressure Pipeline	Pipe	4	15.5	0	feet	$0	$0	$0	$0	$0
Lower Highline Pressure Pipeline	Pipe	4	17	1,039	feet	$4,090	$327	$409	$965	$5,792
Lower Highline Pressure Pipeline	Pipe	4	21	2,334	feet	$148,361	$11,869	$14,836	$35,013	$210,080
Lower Highline Pressure Pipeline	Pipe	4	26	1,861	feet	$4,869	$390	$487	$1,149	$6,895
Lower Highline Pressure Pipeline	Pipe	4	32.5	2,105	feet	$4,438	$355	$444	$1,047	$6,284
Lower Highline Pressure Pipeline	Pipe	5.375	15.5	440	feet	$2,682	$215	$268	$633	$3,798
Lower Highline Pressure Pipeline	Pipe	6	21	33	feet	$2,068	$165	$207	$488	$2,928
Lower Highline Pressure Pipeline	Pipe	6	26	2,291	feet	$13,037	$1,043	$1,304	$3,077	$18,460
Lower Highline Pressure Pipeline	Pipe	6	32.5	2	feet	$8	$1	$1	$2	$11
Lower Highline Pressure Pipeline	Pipe	8	32.5	102	feet	$794	$63	$79	$187	$1,124
Lower Highline Pressure Pipeline	Turnout	N/A	N/A	16	each	$128,000	$0	$0	$0	$128,000
Lower Highline Pressure Pipeline	PRV Station	4	N/A	3	each	$90,000	$0	$0	$0	$90,000
Lower Highline Pressure Pipeline	PRV Station	6	N/A	2	each	$60,000	$0	$0	$0	$60,000
Lower Highline Pressure Pipeline	PRV Station	8	N/A	1	each	$40,000	$0	$0	$0	$40,000
Paasch Pipeline	Pipe	10	13.5	1,078	feet	$29,906	$2,392	$2,991	$7,058	$42,347

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Paasch Pipeline	PRV Station	10	N/A	1	each	$40,000	$0	$0	$0	$40,000
Rasmussen Pipeline	PRV Station	12	N/A	1	each	$45,000	$0	$0	$0	$45,000
Tallman Pipeline	PRV Station	4	N/A	1	each	$30,000	$0	$0	$0	$30,000
Thomsen Pipeline	Pipe	4	21	1,183	feet	$75,193	$6,015	$7,519	$17,746	$106,474
Thomsen Pipeline	Pipe	4	32.5	0	feet	$1	$0	$0	$0	$1
Thomsen Pipeline	Pipe	5.375	21	2,963	feet	$188,395	$15,072	$18,840	$44,461	$266,768
Thomsen Pipeline	Pipe	8	32.5	3	feet	$21	$2	$2	$5	$30
Thomsen Pipeline	Pipe	10	32.5	1	feet	$12	$1	$1	$3	$17
Thomsen Pipeline	Turnout	N/A	N/A	5	each	$40,000	$0	$0	$0	$40,000
Thomsen Pipeline	PRV Station	10	N/A	1	each	$45,000	$0	$0	$0	$45,000
Project Group 2										
Main Canal	Pipe	66	N/A	38	feet	$20,945	$2,094	$2,932	$7,791	$33,763
Main Canal	Pipe	54	26	4,074	feet	$1,541,366	$154,137	$215,791	$573,388	$2,484,683
Main Canal	Pipe	54	41	36,434	feet	$8,876,697	$887,670	$1,242,738	$3,302,131	$14,309,236
Main Canal	Pipe	48	26	1,257	feet	$375,658	$37,566	$52,592	$139,745	$605,560
Main Canal	Pipe	48	41	24,809	feet	$4,775,854	$477,585	$668,620	$1,776,618	$7,698,676
Main Canal	Turnout	N/A	N/A	49	each	$392,000	$39,200	$54,880	$145,824	$631,904

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Main Canal	PRV Station	66	N/A	1	each	$280,000	$28,000	$39,200	$104,160	$451,360
Arens Lateral Pipeline	Pipe	4	32.5	0	feet	$0	$0	$0	$0	$0
Arens Lateral Pipeline	Pipe	6	32.5	1,334	feet	$6,135	$613	$859	$2,282	$9,889
Arens Lateral Pipeline	Turnout	N/A	N/A	2	each	$16,000	$1,600	$2,240	$5,952	$25,792
Bowcut Pipeline	Pipe	4	26	1	feet	$2	$0	$0	$1	$4
Bowcut Pipeline	Pipe	4	32.5	337	feet	$711	$71	$99	$264	$1,146
Bowcut Pipeline	Pipe	6	26	1,553	feet	$8,834	$883	$1,237	$3,286	$14,240
Bowcut Pipeline	Pipe	6	32.5	4,524	feet	$20,800	$2,080	$2,912	$7,737	$33,529
Bowcut Pipeline	Turnout	N/A	N/A	16	each	$128,000	$12,800	$17,920	$47,616	$206,336
Christopher Pipeline	PRV Station	12	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Fisher Pipeline	PRV Station	4	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Dukes Valley Canal	Pipe	30	21	2,480	feet	$157,651	$15,765	$22,071	$58,646	$254,134
Dukes Valley Canal	Pipe	32	21	13,166	feet	$837,030	$83,703	$117,184	$311,375	$1,349,293
Dukes Valley Canal	Pipe	32	26	1,327	feet	$176,368	$17,637	$24,692	$65,609	$284,306
Dukes Valley Canal	Pipe	32	32.5	1,499	feet	$160,740	$16,074	$22,504	$59,795	$259,113
Dukes Valley Canal	Pipe	34	17	1,637	feet	$367,025	$36,702	$51,383	$136,533	$591,644
Dukes Valley Canal	Pipe	34	21	6,430	feet	$408,813	$40,881	$57,234	$152,079	$659,007

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Dukes Valley Canal	Turnout	N/A	N/A	22	each	$176,000	$17,600	$24,640	$65,472	$283,712
Dukes Valley Canal	PRV Station	16	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Dukes Valley Canal	PRV Station	30	N/A	1	each	$140,000	$14,000	$19,600	$52,080	$225,680
Cameron Hill Pipeline	PRV Station	4	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Cameron Hill Pipeline	PRV Station	6	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Cameron Hill Pipeline	PRV Station	10	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Marsh/Chamberlin Pipeline	Pipe	4	21	5,367	feet	$341,199	$34,120	$47,768	$126,926	$550,013
Marsh/Chamberlin Pipeline	Pipe	4	26	6,178	feet	$16,164	$1,616	$2,263	$6,013	$26,057
Marsh/Chamberlin Pipeline	Pipe	4	32.5	2,085	feet	$4,396	$440	$615	$1,635	$7,087
Marsh/Chamberlin Pipeline	Pipe	5.375	32.5	27	feet	$81	$8	$11	$30	$130
Marsh/Chamberlin Pipeline	Pipe	6	17	688	feet	$5,851	$585	$819	$2,177	$9,433
Marsh/Chamberlin Pipeline	Pipe	6	21	5	feet	$342	$34	$48	$127	$551
Marsh/Chamberlin Pipeline	Pipe	6	26	2,807	feet	$15,972	$1,597	$2,236	$5,942	$25,747
Marsh/Chamberlin Pipeline	Pipe	6	32.5	1,853	feet	$8,518	$852	$1,193	$3,169	$13,732
Marsh/Chamberlin Pipeline	Pipe	8	26	1,516	feet	$14,628	$1,463	$2,048	$5,442	$23,580
Marsh/Chamberlin Pipeline	Pipe	8	32.5	2,583	feet	$20,075	$2,007	$2,810	$7,468	$32,360
Marsh/Chamberlin Pipeline	Pipe	10	21	1,962	feet	$124,747	$12,475	$17,465	$46,406	$201,092

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Marsh/Chamberlin Pipeline	Pipe	10	32.5	58	feet	$706	$71	$99	$262	$1,137
Marsh/Chamberlin Pipeline	Pipe	12	26	628	feet	$13,233	$1,323	$1,853	$4,923	$21,331
Marsh/Chamberlin Pipeline	Pipe	12	32.5	626	feet	$10,645	$1,065	$1,490	$3,960	$17,160
Marsh/Chamberlin Pipeline	Pipe	14	32.5	39	feet	$790	$79	$111	$294	$1,274
Marsh/Chamberlin Pipeline	Pipe	16	21	894	feet	$56,866	$5,687	$7,961	$21,154	$91,669
Marsh/Chamberlin Pipeline	Pipe	16	32.5	1,300	feet	$34,816	$3,482	$4,874	$12,952	$56,124
Marsh/Chamberlin Pipeline	Pipe	18	21	2,121	feet	$134,864	$13,486	$18,881	$50,169	$217,400
Marsh/Chamberlin Pipeline	Pipe	24	21	498	feet	$31,639	$3,164	$4,430	$11,770	$51,003
Marsh/Chamberlin Pipeline	Pipe	24	26	849	feet	$63,418	$6,342	$8,878	$23,591	$102,229
Marsh/Chamberlin Pipeline	Pipe	24	32.5	392	feet	$23,646	$2,365	$3,311	$8,796	$38,118
Marsh/Chamberlin Pipeline	Pipe	26	21	1,828	feet	$116,198	$11,620	$16,268	$43,226	$187,312
Marsh/Chamberlin Pipeline	Turnout	N/A	N/A	63	each	$504,000	$50,400	$70,560	$187,488	$812,448
Marsh/Chamberlin Pipeline	PRV Station	4	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Marsh/Chamberlin Pipeline	PRV Station	8	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Marsh/Chamberlin Pipeline	PRV Station	16	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Marsh/Chamberlin Pipeline	PRV Station	22	N/A	1	each	$100,000	$10,000	$14,000	$37,200	$161,200
Shute Road Pipeline	PRV Station	6	N/A	2	each	$150,000	$15,000	$21,000	$55,800	$241,800

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Sheirbon Hill Pipeline	Pipe	4	26	349	feet	$913	$91	$128	$340	$1,472
Sheirbon Hill Pipeline	Pipe	6	26	1,874	feet	$10,659	$1,066	$1,492	$3,965	$17,183
Sheirbon Hill Pipeline	Pipe	8	13.5	815	feet	$14,549	$1,455	$2,037	$5,412	$23,453
Sheirbon Hill Pipeline	Pipe	8	21	5	feet	$342	$34	$48	$127	$551
Sheirbon Hill Pipeline	Pipe	8	26	856	feet	$8,267	$827	$1,157	$3,075	$13,326
Sheirbon Hill Pipeline	Pipe	8	32.5	161	feet	$1,248	$125	$175	$464	$2,012
Sheirbon Hill Pipeline	Turnout	N/A	N/A	6	each	$48,000	$4,800	$6,720	$17,856	$77,376
Sheirbon Hill Pipeline	PRV Station	8	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Project Group 3										
Central Lateral Pipeline	PRV Station	8	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Central Lateral Pipeline	PRV Station	30	N/A	3	each	$420,000	$42,000	$58,800	$156,240	$677,040
Allison Pipeline	Pipe	4	26	127	feet	$331	$33	$46	$123	$534
Allison Pipeline	Pipe	6	26	1,575	feet	$8,962	$896	$1,255	$3,334	$14,446
Allison Pipeline	Pipe	6	32.5	5	feet	$23	$2	$3	$9	$37
Allison Pipeline	Pipe	8	32.5	340	feet	$2,641	$264	$370	$983	$4,258
Allison Pipeline	Pipe	10	21	2,460	feet	$156,369	$15,637	$21,892	$58,169	$252,068
Allison Pipeline	Pipe	10	32.5	465	feet	$5,637	$564	$789	$2,097	$9,086

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Allison Pipeline	Turnout	N/A	N/A	8	each	$64,000	$6,400	$8,960	$23,808	$103,168
Allison Pipeline	PRV Station	10	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Dethman Ridge Line	Pipe	4	21	5,242	feet	$333,270	$33,327	$46,658	$123,977	$537,232
Dethman Ridge Line	Pipe	4	26	3,756	feet	$9,827	$983	$1,376	$3,656	$15,841
Dethman Ridge Line	Pipe	4	32.5	2,065	feet	$4,352	$435	$609	$1,619	$7,016
Dethman Ridge Line	Pipe	5.375	26	261	feet	$980	$98	$137	$365	$1,580
Dethman Ridge Line	Pipe	6	19	1,659	feet	$12,725	$1,273	$1,782	$4,734	$20,513
Dethman Ridge Line	Pipe	6	21	5,038	feet	$320,324	$32,032	$44,845	$119,160	$516,362
Dethman Ridge Line	Pipe	6	26	1,571	feet	$8,941	$894	$1,252	$3,326	$14,413
Dethman Ridge Line	Pipe	6	32.5	3,815	feet	$17,540	$1,754	$2,456	$6,525	$28,275
Dethman Ridge Line	Pipe	8	19	2,966	feet	$38,578	$3,858	$5,401	$14,351	$62,188
Dethman Ridge Line	Pipe	8	21	1,527	feet	$97,049	$9,705	$13,587	$36,102	$156,443
Dethman Ridge Line	Pipe	8	26	148	feet	$1,432	$143	$201	$533	$2,309
Dethman Ridge Line	Pipe	8	32.5	548	feet	$4,259	$426	$596	$1,584	$6,866
Dethman Ridge Line	Pipe	10	21	723	feet	$45,989	$4,599	$6,438	$17,108	$74,134
Dethman Ridge Line	Pipe	10	26	70	feet	$1,045	$104	$146	$389	$1,684
Dethman Ridge Line	Pipe	10	32.5	2,701	feet	$32,724	$3,272	$4,581	$12,173	$52,751

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Dethman Ridge Line	Pipe	12	26	1,227	feet	$25,868	$2,587	$3,621	$9,623	$41,699
Dethman Ridge Line	Pipe	12	32.5	70	feet	$1,194	$119	$167	$444	$1,925
Dethman Ridge Line	Pipe	14	26	525	feet	$13,342	$1,334	$1,868	$4,963	$21,507
Dethman Ridge Line	Pipe	14	32.5	2,064	feet	$42,353	$4,235	$5,929	$15,755	$68,273
Dethman Ridge Line	Pipe	16	26	643	feet	$21,341	$2,134	$2,988	$7,939	$34,401
Dethman Ridge Line	Pipe	16	32.5	4	feet	$102	$10	$14	$38	$164
Dethman Ridge Line	Pipe	24	26	1,014	feet	$75,742	$7,574	$10,604	$28,176	$122,097
Dethman Ridge Line	Pipe	24	32.5	2,687	feet	$161,863	$16,186	$22,661	$60,213	$260,924
Dethman Ridge Line	Pipe	26	32.5	230	feet	$16,260	$1,626	$2,276	$6,049	$26,210
Dethman Ridge Line	Pipe	28	32.5	923	feet	$75,798	$7,580	$10,612	$28,197	$122,187
Dethman Ridge Line	Pipe	30	21	2,984	feet	$189,685	$18,968	$26,556	$70,563	$305,772
Dethman Ridge Line	Pipe	30	32.5	337	feet	$31,768	$3,177	$4,448	$11,818	$51,210
Dethman Ridge Line	Pipe	34	11	0	feet	$37	$4	$5	$14	$59
Dethman Ridge Line	Turnout	N/A	N/A	74	each	$592,000	$59,200	$82,880	$220,224	$954,304
Dethman Ridge Line	PRV Station	6	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Dethman Ridge Line	PRV Station	8	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Dethman Ridge Line	PRV Station	12	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Dethman Ridge Line	PRV Station	24	N/A	1	each	$100,000	$10,000	$14,000	$37,200	$161,200
Oanna Pipeline	Pipe	4	19	541	feet	$1,910	$191	$267	$711	$3,080
Oanna Pipeline	Pipe	4	21	2,643	feet	$168,000	$16,800	$23,520	$62,496	$270,816
Oanna Pipeline	Pipe	4	32.5	490	feet	$1,033	$103	$145	$384	$1,666
Oanna Pipeline	Pipe	5.375	21	537	feet	$34,149	$3,415	$4,781	$12,704	$55,049
Oanna Pipeline	Pipe	6	17	1,719	feet	$14,630	$1,463	$2,048	$5,442	$23,584
Oanna Pipeline	Pipe	6	21	2,646	feet	$168,212	$16,821	$23,550	$62,575	$271,157
Oanna Pipeline	Pipe	6	26	1,932	feet	$10,992	$1,099	$1,539	$4,089	$17,719
Oanna Pipeline	Pipe	6	32.5	626	feet	$2,878	$288	$403	$1,071	$4,640
Oanna Pipeline	Pipe	8	19	288	feet	$3,749	$375	$525	$1,395	$6,043
Oanna Pipeline	Pipe	8	21	382	feet	$24,275	$2,428	$3,399	$9,030	$39,132
Oanna Pipeline	Pipe	8	26	4,323	feet	$41,729	$4,173	$5,842	$15,523	$67,267
Oanna Pipeline	Pipe	8	32.5	1,006	feet	$7,822	$782	$1,095	$2,910	$12,610
Oanna Pipeline	Pipe	10	11	1,384	feet	$46,201	$4,620	$6,468	$17,187	$74,476
Oanna Pipeline	Pipe	10	26	5	feet	$68	$7	$9	$25	$109
Oanna Pipeline	Pipe	30	32.5	2	feet	$175	$18	$25	$65	$282
Oanna Pipeline	Pipe	32	13.5	2,661	feet	$653,911	$65,391	$91,548	$243,255	$1,054,105

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Oanna Pipeline	Pipe	32	21	1,139	feet	$72,403	$7,240	$10,136	$26,934	$116,714
Oanna Pipeline	Pipe	32	32.5	3,310	feet	$354,907	$35,491	$49,687	$132,025	$572,110
Oanna Pipeline	Pipe	34	26	1,967	feet	$295,028	$29,503	$41,304	$109,750	$475,585
Oanna Pipeline	Pipe	34	32.5	0	feet	$1	$0	$0	$0	$2
Oanna Pipeline	Pipe	36	21	1,008	feet	$64,086	$6,409	$8,972	$23,840	$103,307
Oanna Pipeline	Turnout	N/A	N/A	28	each	$224,000	$22,400	$31,360	$83,328	$361,088
Oanna Pipeline	PRV Station	4	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Oanna Pipeline	PRV Station	6	N/A	3	each	$225,000	$22,500	$31,500	$83,700	$362,700
Oanna Pipeline	PRV Station	8	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Oanna Pipeline	PRV Station	30	N/A	1	each	$140,000	$14,000	$19,600	$52,080	$225,680
Oanna Pipeline	PRV Station	32	N/A	1	each	$140,000	$14,000	$19,600	$52,080	$225,680
Chipping Pipeline	Pipe	4	17	653	feet	$2,572	$257	$360	$957	$4,145
Chipping Pipeline	Pipe	4	21	1,820	feet	$115,721	$11,572	$16,201	$43,048	$186,543
Chipping Pipeline	Pipe	4	26	521	feet	$1,363	$136	$191	$507	$2,197
Chipping Pipeline	Pipe	4	32.5	1,009	feet	$2,128	$213	$298	$792	$3,431
Chipping Pipeline	Pipe	5.375	13.5	1,111	feet	$7,707	$771	$1,079	$2,867	$12,423
Chipping Pipeline	Pipe	6	21	902	feet	$57,365	$5,736	$8,031	$21,340	$92,472

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Chipping Pipeline	Pipe	6	26	472	feet	$2,684	$268	$376	$999	$4,327
Chipping Pipeline	Pipe	6	32.5	2,422	feet	$11,133	$1,113	$1,559	$4,141	$17,946
Chipping Pipeline	Pipe	8	32.5	1,052	feet	$8,176	$818	$1,145	$3,042	$13,180
Chipping Pipeline	Pipe	10	19	339	feet	$6,852	$685	$959	$2,549	$11,046
Chipping Pipeline	Pipe	10	32.5	333	feet	$4,033	$403	$565	$1,500	$6,501
Chipping Pipeline	Pipe	12	21	1,542	feet	$98,048	$9,805	$13,727	$36,474	$158,053
Chipping Pipeline	Pipe	14	21	1,366	feet	$86,862	$8,686	$12,161	$32,313	$140,022
Chipping Pipeline	Pipe	14	26	1,376	feet	$34,947	$3,495	$4,893	$13,000	$56,334
Chipping Pipeline	Pipe	18	26	1,156	feet	$48,585	$4,858	$6,802	$18,074	$78,319
Chipping Pipeline	Pipe	18	32.5	324	feet	$10,997	$1,100	$1,540	$4,091	$17,728
Chipping Pipeline	Pipe	20	26	596	feet	$30,904	$3,090	$4,327	$11,496	$49,817
Chipping Pipeline	Pipe	24	11	1,936	feet	$322,239	$32,224	$45,113	$119,873	$519,449
Chipping Pipeline	Pipe	24	15.5	1,148	feet	$139,707	$13,971	$19,559	$51,971	$225,207
Chipping Pipeline	Turnout	N/A	N/A	20	each	$160,000	$16,000	$22,400	$59,520	$257,920
Chipping Pipeline	PRV Station	4	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Chipping Pipeline	PRV Station	10	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Chipping Pipeline	PRV Station	12	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Chipping Pipeline	PRV Station	18	N/A	1	each	$100,000	$10,000	$14,000	$37,200	$161,200
Gilkerson Pipeline	Pipe	4	11	1,307	feet	$7,633	$763	$1,069	$2,839	$12,304
Gilkerson Pipeline	Pipe	4	21	753	feet	$47,877	$4,788	$6,703	$17,810	$77,177
Gilkerson Pipeline	Pipe	6	21	2,089	feet	$132,821	$13,282	$18,595	$49,410	$214,108
Gilkerson Pipeline	Pipe	6	32.5	5	feet	$25	$2	$3	$9	$40
Gilkerson Pipeline	Turnout	N/A	N/A	5	each	$40,000	$4,000	$5,600	$14,880	$64,480
Gilkerson Pipeline	PRV Station	4	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Winklebleck Pipeline	Pipe	4	21	943	feet	$59,965	$5,997	$8,395	$22,307	$96,664
Winklebleck Pipeline	Pipe	4	32.5	246	feet	$518	$52	$72	$193	$834
Winklebleck Pipeline	Pipe	6	19	324	feet	$2,485	$248	$348	$924	$4,006
Winklebleck Pipeline	Pipe	6	26	473	feet	$2,690	$269	$377	$1,001	$4,337
Winklebleck Pipeline	Pipe	6	32.5	5	feet	$24	$2	$3	$9	$38
Winklebleck Pipeline	Pipe	8	13.5	1,380	feet	$24,646	$2,465	$3,450	$9,168	$39,730
Winklebleck Pipeline	Pipe	8	26	1,007	feet	$9,722	$972	$1,361	$3,617	$15,672
Winklebleck Pipeline	Pipe	8	32.5	594	feet	$4,617	$462	$646	$1,717	$7,442
Winklebleck Pipeline	Turnout	N/A	N/A	5	each	$40,000	$4,000	$5,600	$14,880	$64,480
Winklebleck Pipeline	PRV Station	6	N/A	2	each	$150,000	$15,000	$21,000	$55,800	$241,800

Pipeline Name	Item	Nominal Diameter (inches)	Pressure Rating	Quantity	Units	Construction Cost	Engineering, Construction Management, Survey	Construction Management General Contractor	Contingency Costs	Total Costs
Winklebleck Pipeline	PRV Station	8	N/A	1	each	$75,000	$7,500	$10,500	$27,900	$120,900
Total						**$38,844,000**	**$3,589,000**	**$4,932,000**	**$12,867,000**	**$60,232,000**

Notes: These costs are from the SIP (2018$). Totals are rounded to nearest $1000 and may not sum due to rounding. N/A = not applicable.
[1] Total costs in the Plan-EA are higher than the table above due to being updated to 2019$, shortening the length of pipe in Project Group 1, and an additional $767,000 in Project Group 2 for installation of the sedimentation basin.

D.5 Eliminated Alternatives

This appendix section presents dimensions and capital costs for the eliminated alternatives, which includes canal lining, steel piping, and polyvinyl-chloride (PVC) piping.

D.5.1 Canal Lining Alternative

The capital cost of the Canal Lining Alternative (Table 24) was estimated by calculating the length of geotextile membrane in existing open canals, assuming an anchor of membrane extending 7 feet on either side. The membrane would be covered by a 1-inch layer of shotcrete (fine-aggregate concrete sprayed in place). This estimate also includes fencing along both sides of the canal, and safety ladders every 750 feet in canals deeper than 2.5 feet. Costs related to earthwork and labor are estimated by a 1.5 construction cost multiplier. Turnouts were estimated at an average of $1,000 each. The cross-section length of the canals was estimated based on cross-section lengths found for an irrigation district in Central Oregon, which were calculated for each corresponding pipe diameter size using transects on a digital elevation model.

Table 24. Capital Costs for the Canal Lining Alternative.

	Cross section length (ft)	Canal Length (ft)	Turnout cost	Construction Cost	ECMS [1]	CMGC[2]	Contingency	Total
Project Group 1								
Canal	10.70	1,305		$156,478	$15,648	$21,907	$48,508	$242,541
Canal	12.74	807		$129,871	$12,987	$18,182	$40,260	$201,299
Canal	14.52	273		$48,578	$4,858	$6,801	$15,059	$75,295
Canal	22.17	525		$131,719	$13,172	$18,441	$40,833	$204,165
Canal	22.21	3,686		$925,767	$92,577	$129,607	$286,988	$1,434,938
Canal	23.61	4,318		$1,142,369	$114,237	$159,932	$354,134	$1,770,672
Canal	23.77	2,572		$684,325	$68,432	$95,805	$212,141	$1,060,703
Canal	25.33	18,606		$5,227,107	$522,711	$731,795	$1,620,403	$8,102,016
Turnout			$39,000	$58,500	$5,850	$8,190	$18,135	$90,675
Project Group 2								
Canal	25.34	26,539		$7,457,448	$745,745	$1,044,043	$2,311,809	$11,559,045
Canal	25.88	26,066		$7,458,507	$745,851	$1,044,191	$2,312,137	$11,560,686
Canal	34.39	7,285		$2,675,198	$267,520	$374,528	$829,311	$4,146,557
Turnout			$71,000	$106,500	$10,650	$14,910	$33,015	$165,075
Sedimentation Basin								$767,000
Total		**91,982**	**$110,000**	**$26,202,000**	**$2,620,000**	**$3,668,000**	**$8,123,000**	**$41,380,000**

Note: Totals are rounded to nearest $1000 and may not sum due to rounding.
[1] Engineering, Construction Management, Survey
[2] Construction Management General Contractor

D.5.2 Steel Piping Alternative

The lengths, diameters, and range of pressure ratings used to calculate the capital costs for the Steel Piping Alternative (Table 25) were estimated based on the engineering analysis completed in the District's SIP. Spiral-welded steel was selected that conforms to requirements of the American Water Works Association C200 standard. This pipe was selected because it is considered an industry consensus standard (Bambie and Keil 2013). Steel pipe typically has a design life of 50 years under irrigation water delivery applications. Unlike HDPE, steel pipe cannot be shaped to conform into canal alignments; therefore, elbows would be required. The number of elbow fittings was estimated by assuming one elbow every 100 feet of pipe. Similar to the Preferred Alternative, turnouts were costed at $8,000 and pressure-reducing-valve (PRV) stations ranged from $75,000 to $280,000 per station. These costs are based upon actual installed costs for turnouts and PRV stations in Central Oregon.

Table 25. Capital Costs for the Steel Piping Alternative.

	Length (ft)	Elbow Quantity	Construction Cost	ECMS[1]	CMGC[2]	Contingency	Total
Project Group 1							
Pipe							
Crag Rate Pipeline	8,315	83	$417,774	$33,422	$41,777	$98,595	$591,568
Eastside Canal	32,093	321	$10,837,020	$866,962	$1,083,702	$2,557,537	$15,345,220
Kelly Pipeline	3,007	30	$129,676	$10,374	$12,968	$30,604	$183,621
Lower Highline Pressure Pipeline	10,206	102	$484,802	$38,784	$48,480	$114,413	$686,479
Paasch Pipeline	1,078	11	$103,632	$8,291	$10,363	$24,457	$146,743
Thomsen Pipeline	4,150	42	$179,107	$14,329	$17,911	$42,269	$253,615
Whiskey Creek Pipeline	22,984	230	$2,259,834	$180,787	$225,983	$533,321	$3,199,924
Turnout							
Crag Rate Pipeline			$72,000				$72,000
Eastside Canal			$312,000				$312,000
Kelly Pipeline			$8,000				$8,000
Lower Highline Pressure Pipeline			$128,000				$128,000
Thomsen Pipeline			$40,000				$40,000
Whiskey Creek Pipeline			$136,000				$136,000
Valve							
Crag Rate Pipeline			$90,000				$90,000
Dethman/Swyers Line			$45,000				$45,000
Kelly Pipeline			$30,000				$30,000
Loop Pipeline			$85,000				$85,000
Lower Highline Pressure Pipeline			$190,000				$190,000
Paasch Pipeline			$40,000				$40,000
Rasmussen Pipeline			$45,000				$45,000

	Length (ft)	Elbow Quantity	Construction Cost	ECMS[1]	CMGC[2]	Contingency	Total
Tallman Pipeline			$30,000				$30,000
Thomsen Pipeline			$45,000				$45,000
Whiskey Creek Pipeline			$205,000				$205,000
Project Group 2							
Pipe							
Arens Lateral Pipeline	1,334	13	$81,112	$8,111	$11,356	$25,145	$125,724
Bowcut Pipeline	6,415	64	$383,958	$38,396	$53,754	$119,027	$595,136
Dukes Valley Canal	26,539	265	$7,806,323	$780,632	$1,092,885	$2,419,960	$12,099,801
Main Canal	66,611	666	$30,911,624	$3,091,162	$4,327,627	$9,582,603	$47,913,017
Marsh/Chamberlin Pipeline	34,304	343	$3,146,606	$314,661	$440,525	$975,448	$4,877,239
Sheirbon Hill Pipeline	4,060	41	$273,060	$27,306	$38,228	$84,649	$423,243
PRV Station							
Cameron Hill Pipeline			$225,000	$22,500	$31,500	$69,750	$348,750
Christopher Pipeline			$75,000	$7,500	$10,500	$23,250	$116,250
Dukes Valley Canal			$215,000	$21,500	$30,100	$66,650	$333,250
Fisher Pipeline			$75,000	$7,500	$10,500	$23,250	$116,250
Main Canal			$280,000	$28,000	$39,200	$86,800	$434,000
Marsh/Chamberlin Pipeline			$325,000	$32,500	$45,500	$100,750	$503,750
Sheirbon Hill Pipeline			$75,000	$7,500	$10,500	$23,250	$116,250
Shute Road Pipeline			$150,000	$15,000	$21,000	$46,500	$232,500
Turnout							
Arens Lateral Pipeline			$16,000	$1,600	$2,240	$4,960	$24,800
Bowcut Pipeline			$128,000	$12,800	$17,920	$39,680	$198,400
Dukes Valley Canal			$176,000	$17,600	$24,640	$54,560	$272,800
Main Canal			$392,000	$39,200	$54,880	$121,520	$607,600
Marsh/Chamberlin Pipeline			$504,000	$50,400	$70,560	$156,240	$781,200
Sheirbon Hill Pipeline			$48,000	$4,800	$6,720	$14,880	$74,400

	Length (ft)	Elbow Quantity	Construction Cost	ECMS[1]	CMGC[2]	Contingency	Total
Sedimentation Basin							$767,000
Project Group 3							
Pipe							
Allison Pipeline	4,971	50	$409,281	$40,928	$57,299	$126,877	$634,386
Chipping Pipeline	20,080	201	$2,168,875	$216,887	$303,642	$672,351	$3,361,756
Dethman Ridge Line	44,798	448	$4,540,914	$454,091	$635,728	$1,407,683	$7,038,417
Gilkerson Pipeline	4,154	42	$239,127	$23,913	$33,478	$74,129	$370,647
Oanna Pipeline	28,608	286	$4,200,799	$420,080	$588,112	$1,302,248	$6,511,238
Winklebleck Pipeline	4,972	50	$333,909	$33,391	$46,747	$103,512	$517,559
PRV Station							
Allison Pipeline			$75,000	$7,500	$10,500	$23,250	$116,250
Central Lateral Pipeline			$495,000	$49,500	$69,300	$153,450	$767,250
Chipping Pipeline			$325,000	$32,500	$45,500	$100,750	$503,750
Dethman Ridge Line			$325,000	$32,500	$45,500	$100,750	$503,750
Gilkerson Pipeline			$75,000	$7,500	$10,500	$23,250	$116,250
Oanna Pipeline			$655,000	$65,500	$91,700	$203,050	$1,015,250
Winklebleck Pipeline			$150,000	$15,000	$21,000	$46,500	$232,500
Turnout							
Allison Pipeline			$64,000	$6,400	$8,960	$19,840	$99,200
Chipping Pipeline			$160,000	$16,000	$22,400	$49,600	$248,000
Dethman Ridge Line			$592,000	$59,200	$82,880	$183,520	$917,600
Gilkerson Pipeline			$40,000	$4,000	$5,600	$12,400	$62,000
Oanna Pipeline			$224,000	$22,400	$31,360	$69,440	$347,200
Winklebleck Pipeline			$40,000	$4,000	$5,600	$12,400	$62,000
Total	**328,679**	**3,288**	**$76,312,000**	**$7,193,000**	**$9,897,000**	**$22,125,000**	**$116,294,000**

Note: Totals are rounded to nearest $1000 and may not sum due to rounding.
[1] Engineering, Construction Management, Survey
[2] Construction Management General Contractor

D.5.3 PVC Piping Alternative

The lengths, diameters, and range of pressure ratings used for this alternative were estimated based on the engineering analysis completed in the District's SIP. Under the PVC Piping Alternative, PVC would be used for diameters up to 54 inches and steel would be installed for larger diameter pipes, since PVC is not manufactured in larger diameters. In the current design, steel pipe would only be used for approximately 30 feet.

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

USDA-NRCS's practice standard lifespan for irrigation pipeline is 20 years (NRCS n.d.). This lifespan is based on long-term experience with primarily PVC pipe irrigation system installations (B. Cronin, personal communication, July 27, 2018). The Plastics Pipe Institute's online software indicates that with the average number of surge/water hammer events expected in a pipeline network, the lifespan of a typical 24-inch, 125 pounds per square inch pressure rated PVC pipe would be 14 years with a safety factor of two (Plastics Pipe Institute 2015). PVC is also more prone to failure under freezing conditions. During these periods, the PVC pipe system would be more likely to freeze and potentially rupture and fail. PVC piping has been installed in irrigation districts in the Deschutes Basin and experienced premature failure, especially in Districts where stock water is delivered during the winter. Considering all the information above, a PVC design life of 33 years was assumed for purposes of this analysis. Steel pipe has a design life of 50 years.

Capital costs for the PVC Piping Alternative (Table 26) account for additional elbow fittings that would be necessary for PVC pipe. The cost of elbow fittings was determined by assuming an elbow every 100 feet at a cost of $100 per 1 inch of pipe diameter. To account for additional PVC costs, an additional 5 percent cost was added. Similar to the Preferred Alternative, turnouts were costed at $8,000 and PRV stations ranged from $75,000 to $280,000 per station. These costs are based upon actual installed costs for turnouts and PRV stations in Central Oregon.

Table 26. Capital Costs for the PVC Piping Alternative.

	Length (ft)	Construction Cost	ECMS[1]	CMGC[2]	Contingency	Total
Project Group 1						
Pipe						
Crag Rate Pipeline	8,315	$119,048	$9,524	$11,905	$28,095	$168,572
Eastside Canal	32,093	$10,292,368	$823,389	$1,029,237	$2,428,999	$14,573,994
Kelly Pipeline	3,007	$38,456	$3,077	$3,846	$9,076	$54,454
Lower Highline Pressure Pipeline	10,206	$135,703	$10,856	$13,570	$32,026	$192,155
Paasch Pipeline	1,078	$39,783	$3,183	$3,978	$9,389	$56,332
Thomsen Pipeline	4,150	$55,600	$4,448	$5,560	$13,122	$78,730
Whiskey Creek Pipeline	22,984	$928,538	$74,283	$92,854	$219,135	$1,314,810
Turnout						
Crag Rate Pipeline		$72,000				$72,000
Eastside Canal		$312,000				$312,000
Kelly Pipeline		$8,000				$8,000
Lower Highline Pressure Pipeline		$128,000				$128,000
Thomsen Pipeline		$40,000				$40,000
Whiskey Creek Pipeline		$136,000				$136,000
Valve						
Crag Rate Pipeline		$90,000				$90,000
Dethman/Swyers Line		$45,000				$45,000
Kelly Pipeline		$30,000				$30,000
Loop Pipeline		$85,000				$85,000
Lower Highline Pressure Pipeline		$190,000				$190,000
Paasch Pipeline		$40,000				$40,000
Rasmussen Pipeline		$45,000				$45,000
Tallman Pipeline		$30,000				$30,000
Thomsen Pipeline		$45,000				$45,000
Whiskey Creek Pipeline		$205,000				$205,000

	Length (ft)	Construction Cost	ECMS[1]	CMGC[2]	Contingency	Total
Project Group 2						
Pipe						
Arens Lateral Pipeline	1,334	$25,024	$2,502	$3,503	$7,757	$38,787
Bowcut Pipeline	6,415	$117,784	$11,778	$16,490	$36,513	$182,566
Dukes Valley Canal	26,539	$6,347,032	$634,703	$888,585	$1,967,580	$9,837,900
Main Canal	66,611	$42,317,893	$4,231,789	$5,924,505	$13,118,547	$65,592,733
Marsh/Chamberlin Pipeline	34,304	$1,460,344	$146,034	$204,448	$452,707	$2,263,533
Sheirbon Hill Pipeline	4,060	$88,970	$8,897	$12,456	$27,581	$137,903
PRV Station						
Cameron Hill Pipeline		$225,000	$22,500	$31,500	$69,750	$348,750
Christopher Pipeline		$75,000	$7,500	$10,500	$23,250	$116,250
Dukes Valley Canal		$215,000	$21,500	$30,100	$66,650	$333,250
Fisher Pipeline		$75,000	$7,500	$10,500	$23,250	$116,250
Main Canal		$280,000	$28,000	$39,200	$86,800	$434,000
Marsh/Chamberlin Pipeline		$325,000	$32,500	$45,500	$100,750	$503,750
Sheirbon Hill Pipeline		$75,000	$7,500	$10,500	$23,250	$116,250
Shute Road Pipeline		$150,000	$15,000	$21,000	$46,500	$232,500
Turnout						
Arens Lateral Pipeline		$16,000	$1,600	$2,240	$4,960	$24,800
Bowcut Pipeline		$128,000	$12,800	$17,920	$39,680	$198,400
Dukes Valley Canal		$176,000	$17,600	$24,640	$54,560	$272,800
Main Canal		$392,000	$39,200	$54,880	$121,520	$607,600
Marsh/Chamberlin Pipeline		$504,000	$50,400	$70,560	$156,240	$781,200
Sheirbon Hill Pipeline		$48,000	$4,800	$6,720	$14,880	$74,400
Sedimentation Basin						$767,000
Project Group 3						
Pipe						
Allison Pipeline	4,971	$148,208	$14,821	$20,749	$45,944	$229,722
Chipping Pipeline	20,080	$1,100,136	$110,014	$154,019	$341,042	$1,705,211

	Length (ft)	Construction Cost	ECMS[1]	CMGC[2]	Contingency	Total
Dethman Ridge Line	44,798	$2,378,440	$237,844	$332,982	$737,316	$3,686,582
Gilkerson Pipeline	4,154	$72,269	$7,227	$10,118	$22,404	$112,018
Oanna Pipeline	28,608	$2,862,932	$286,293	$400,810	$887,509	$4,437,544
Winklebleck Pipeline	4,972	$109,452	$10,945	$15,323	$33,930	$169,651
PRV Station						
Allison Pipeline		$75,000	$7,500	$10,500	$23,250	$116,250
Central Lateral Pipeline		$495,000	$49,500	$69,300	$153,450	$767,250
Chipping Pipeline		$325,000	$32,500	$45,500	$100,750	$503,750
Dethman Ridge Line		$325,000	$32,500	$45,500	$100,750	$503,750
Gilkerson Pipeline		$75,000	$7,500	$10,500	$23,250	$116,250
Oanna Pipeline		$655,000	$65,500	$91,700	$203,050	$1,015,250
Winklebleck Pipeline		$150,000	$15,000	$21,000	$46,500	$232,500
Turnout						
Allison Pipeline		$64,000	$6,400	$8,960	$19,840	$99,200
Chipping Pipeline		$160,000	$16,000	$22,400	$49,600	$248,000
Dethman Ridge Line		$592,000	$59,200	$82,880	$183,520	$917,600
Gilkerson Pipeline		$40,000	$4,000	$5,600	$12,400	$62,000
Oanna Pipeline		$224,000	$22,400	$31,360	$69,440	$347,200
Winklebleck Pipeline		$40,000	$4,000	$5,600	$12,400	$62,000
Total	**328,679**	**$76,043,000**	**$7,222,000**	**$9,971,000**	**$22,249,000**	**$116,253,000**

Note: Totals are rounded to nearest $1000 and may not sum due to rounding.
[1] Engineering, Construction Management, Survey
[2] Construction Management General Contractor

D.5.4 References

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

Plastics Pipe Institute. (2015). Pipeline Analysis & Calculation Environment online tool. Retrieved from http://ppipace.com.

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

Watershed Protection and Flood Prevention Act of 1954, Pub. L. No. 83-566, 68 Stat. 666.

D.6 Net Present Value of Eliminated Alternatives

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

Design Life: PVC piping (33 years), steel piping (50 years), canal lining (33 years)

Discount Rate: 2.75 percent

Period of Analysis: 100 years

Table 27. Net Present Value of the Eliminated Alternatives.

Project Group	Alternatives		
	PVC Piping	**Steel Piping**	**Canal Lining**
Capital Costs[1]			
1	$17,940,000	$21,908,000	$13,182,000
2	$82,981,000	$70,961,000	$28,198,000
3	$15,332,000	$23,425,000	N/A
Total:	**$116,253,000**	**$116,294,000**	**$41,380,000**
Net Present Value of Replacement Costs[2]			
1	$5,068,000	$4,144,000	$10,044,000
2	$28,563,000	$13,611,000	$21,121,000
3	$3,188,000	$3,743,000	N/A
Total:	**$36,819,000**	**$21,498,000**	**$31,165,000**
Annual Operation and Maintenance Costs			
1	$224,000	$224,000	$555,000
2	$381,000	$381,000	$908,000
3	$295,000	$295,000	N/A
Total:	**$900,000**	**$900,000**	**$1,463,000**
Total Percent Change in O&M:	-10%	-10%	46%
Total Net Present Value of O&M Costs			
1	$7,605,000	$7,605,000	$18,843,000
2	$12,935,000	$12,935,000	$30,828,000

Project Group	Alternatives		
	PVC Piping	**Steel Piping**	**Canal Lining**
3	$10,016,000	$10,016,000	N/A
Total:	**$30,556,000**	**$30,556,000**	**$49,671,000**
Total Net Present Value of Project			
1	$30,613,000	$33,657,000	$42,069,000
2	$124,479,000	$97,507,000	$80,147,000
3	$28,536,000	$37,184,000	$0
Total:	**$183,628,000**	**$168,348,000**	**$122,216,000**

Note: Totals may not align with totals in Table 23, Table 24, and Table 25 due to rounding. N/A = not applicable.
[1] The capital cost for Project Group 2 includes $767,000 for installation of the sedimentation basin.
[2] For PVC pipe, 33 percent of the pipe was replaced at 33 years and 67 percent replaced at 66 years. For steel pipe, 25 percent was replaced at 50 years, and 75 percent replaced at 75 years. For canal lining, 100 percent was replaced at both 33 years and 66 years. The sedimentation basin was replaced fully at 50 years.

Appendix E

Other Supporting Information

E.1 Intensity Threshold Table

This section presents the intensity threshold table used to quantify effects on resources of concern because of the proposed East Fork Irrigation District Infrastructure Modernization Project.

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

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
Cultural Resources	No above or underground cultural resources are adversely affected.	Affects a cultural resource that does not have local, regional or state significance. The historic context of the affected site(s) is local. Not affect the contributing element of a property eligible for the National Register of Historic Places. Causes a slight change to a natural or physical ethnographic resource, if measurable and localized.	Affects a cultural resource with modest potential of local, regional or state significance. Changes a contributing element but would not diminish resource integrity or jeopardize National Register eligibility. Localized and measurable change to a natural or physical ethnographic resource.	Affects a cultural resource with high potential of national context. Diminishes the integrity of the resource to the extent that affects cannot be mitigated, would permanently impact the historic register eligibility of the resource, prevent a resource from meeting criteria for listing in a historic register, or reduces the ability of a cultural resource to convey its historic significance. Permanent severe change or exceptional benefit to a natural or physical ethnographic resource.
Fish and Aquatic Species	No discernable short- or long-term impacts to fish populations or aquatic habitat.	Changes in watershed conditions that may cause non-measurable degradation to aquatic habitat. Direct or indirect habitat changes that result only in non-measurable, short-term change in risk to ESA-listed or other fish populations.	Changes in watershed conditions that cause measurable degradation to aquatic habitat. Direct or indirect habitat changes that cause measurable, short- or long-term change in risk to ESA-listed or other fish populations.	Changes in watershed conditions that cause high impairment to aquatic habitat that affects population viability. The proposed action would likely jeopardize a species' continued existence or destroy or adversely affect a species' critical habitat.

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
Land Use	Existing land uses or ownership would continue as before. A short-term change or interruption to land use or access to existing land uses.	Land use changes that are consistent with existing ownership, easements, or right-of-way.	Land use changes that are inconsistent with existing ownership, easements, or right-of-way but are compatible to adjacent.	A new unauthorized land use or access that is not compatible with adjacent land use.
Public Safety	No increase in risk to human health and safety.	Any risks to public health and safety created by the project would be eliminated through mitigation.	Any risks to public health and safety created by the project would be eliminated through mitigation, but would require a short-term behavioral change by the public or present a temporary inconvenience.	Create a permanent and known health and safety risk.
Socioeconomics	No reduction in the yield of agricultural products or timber. Non-measurable change to income and/or employment levels.	Measurable, but short term, reduction to yield of agricultural products or timber. Temporary reduction to income and/or local employment levels.	Long term reduction in the yield of agricultural products or timber on the scale of individual farms. Short term reduction to income and/or local employment levels.	Long term reduction in the yield of agricultural products or timber on a district wide scale. Long term reduction to income and/or regional employment levels.
Vegetation	Project activities would not affect vegetation or it is limited to small areas.	Most effects would be localized and/or temporary. While individual plants could be affected, there would be no effects on a population scale. Any permanent effects would not be widespread nor affect sensitive species or populations.	A large proportion of one or more populations are affected but relatively localized and could be mitigated. Any effects on sensitive species could be mitigated.	Considerable effects on plant populations over large areas. Extensive mitigation required offsetting adverse effects on sensitive species, but success not assured.
Visual Resources	Project features are visually negligible or not visible.	The majority of project features do not attract attention to the landscape.	A majority of project features attract attention to the landscape.	Project features create a disruptive change and dominate the landscape.

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
		Short-term visual changes during project construction.		
Water Resources	Project activities would not disturb or alter water quantity, water quality, or groundwater quantity.	*Surface Water Quantity:* Temporary change in quantity away from the natural or target hydrograph. *Water Quality:* Short-term or non-measurable changes to water quality in waterbodies that is unlikely to result in excursions to water quality standards on the Oregon's 303(d) list. *Groundwater:* Long-term less than 10 percent change in depth to groundwater Change in depth to groundwater that does not result in any affects to groundwater users or their water rights.	*Surface Water Quantity:* Permanent change in water quantity that is measurable and that is counter to the natural or target hydrograph that does not affect other water users or water rights. *Water Quality:* Permanent measurable changes to water quality in waterbodies that is unlikely to result in excursions to water quality standards on the Oregon's 303(d) list. *Groundwater:* Measurable changes in depth to groundwater that does not reduce the availability of water for water users.	*Surface Water Quantity:* Permanent change in water quantity that is measurable and that is counter to the natural or target hydrograph that affects other water users and water rights. *Water Quality:* Permanent measurable changes to water quality in waterbodies that results in excursions to water quality standards on the Oregon's 303(d) list. *Groundwater:* Measurable changes in depth to groundwater that reduces the availability of water for water users.
Wetland, Floodplains, Riparian Zones	Does not alter wetlands or riparian areas or change the hydraulic capacity of floodplains.	Degradation of non-jurisdictional wetlands. Project does not increase the potential for flooding and damage to personal property.	Mitigated degradation of jurisdictional wetlands. Increase to the potential for flooding and damage to personal property that can be permitted and mitigated.	Permanent, non-mitigated degradation of jurisdictional wetlands. Increase to the potential for flooding and damage to personal property that cannot be mitigated.

Resource	Intensity Threshold			
	Negligible	**Minor**	**Moderate**	**Major**
Wildlife	No degradation to wildlife habitats or populations.	Degradation and recovery of wildlife populations and/or their habitats would be short-term.	Degradation and recovery of wildlife populations and/or their habitats would be long-term but would not affect the viability of any population. Habitat availability would continue to be adequate.	Long-term degradation to wildlife populations or habitats that would affect the viability of a population. Inadequate habitat availability.
Ecosystem Services	No degradation to ecosystem services.	Any degradation to ecosystem services would be temporary.	Any degradation to ecosystem services could be mitigated.	Any degradation to ecosystem services could not be mitigated.

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

E.2 Supporting Information for Land Use

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

Land Use	Percent of the Project Area Length	Project Area Length Crossing each Land Use Class (miles)
Agriculture	48%	27
Non-cultivated lands[1]	38%	21
Developed Use[2]	14%	8
Total	**100%**	**56**

Source: USGS 2011

[1] Shrub/scrub, barren land, evergreen forest, woody wetlands.

[2] High, medium, low intensity development, developed open space.

Table E-3. Water Users by Acres Served within East Fork Irrigation District.[1]

Acres Served	Total Irrigated Acreage in EFID (ac)	Total Irrigated Acreage in EFID (%)	Patrons (number)	Patrons (%)
0-5 acres	929	10%	724	74%
6-10 acres	477	5%	58	6%
11+ acres	8,000	85%	191	20%
Total	**9,397**[1]	**100%**	**973**[1]	**100%**

Source: S. Swyers, EFID Office Manager, personal communication, November 12, 2018

[1] The data varies slightly from the values presented in the Plan-EA (9,607 acres irrigated by 990 patrons).

Reference

U.S. Geological Survey (USGS). (2011). National Land Cover Database (2011 Edition). U.S. Geological Survey, Sioux Falls, SD. Retrieved from https://www.mrlc.gov/data

E.3 Supporting Information for Fish and Aquatic Resources

This appendix section presents supporting information associated with Primary Constituent Elements for critical habitat of federally listed species.

Table E-4. Primary Constituent Elements for Lower Columbia River Chinook, Coho, and Steelhead.

Primary Constituent Element Number	Habitat Description and Characteristics
PCE 1	Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
PCE 2	Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
PCE 3	Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
PCE 4	Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
PCE 5	Nearshore marine areas free of obstruction and excessive predation with: (i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
PCE 6	Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Table E-5. 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.
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.4 Supporting Information for Water Resources

This appendix section presents supporting data used to evaluate effects of the Preferred Alternative with respect to water resources.

Table E-6. ODFW Instream Water Rights for the East Fork Hood River, Hood River, and Neal Creek.

Source	From	To	Certificate	Priority Date	Instream Rates (cfs)											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
East Fork Hood River	Below EFID diversion (approx. RM 6.6)	Above Middle Fork Hood River confluence	68457	11/3/1983	100	100	100	150	150	150	100	100	100	150	150	150
East Fork Hood River	Below EFID diversion (approx. RM 6.6)	Above West Fork Hood River confluence	Pending IS-88322	12/1/2016	210	210	210	210	210	210	150	150	175	175	180	180
Hood River	RM 4.0	Mouth at Columbia River	59679	11/3/1983	170	270	270	270	170	170	130	100	100	100	100	170
Hood River	RM 4.0	Mouth at Columbia River	76155	10/8/1998	-	-	-	-	250	250	250	250	250	250	-	-
Neal Creek	Mouth at Hood River	Mouth at Hood River	59681	11/3/1983	13	13	13	20	20	20	13	13	5	20	20	13

E.5 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, which is managed by the Oregon Water Resources Department. Per OWRD (2017),

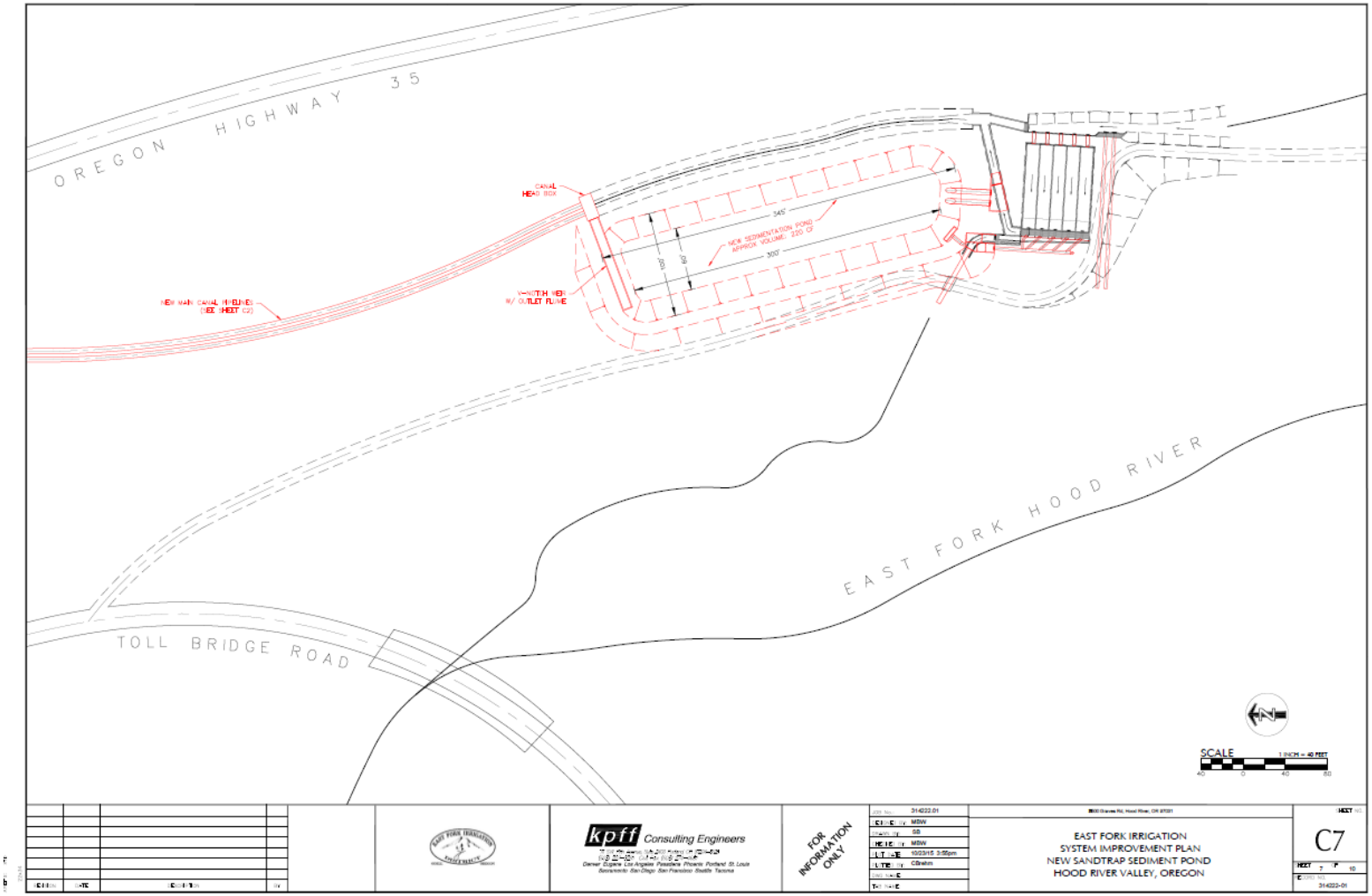
> The Allocation of Conserved Water Program allows a water user who conserves water to use a portion of the conserved water on additional lands, lease or sell the water, or dedicate the water to instream use. Use of this program is voluntary and provides benefits to both water right holders and instream 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 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 junior to the original right.

Section 2.3 of the Plan-EA describes the District's intention to allocate 75 percent of the water conserved through this project instream. Consistent with EFID's own Conserved Water Policy, adopted in 2007 and amended in 2014, the District has previously used the Allocation of Conserved Water Program (application nos. CW-86, CW-53, and CW-93) to restore a portion of the water conserved through three previous piping projects to the East Fork Hood River.

Reference

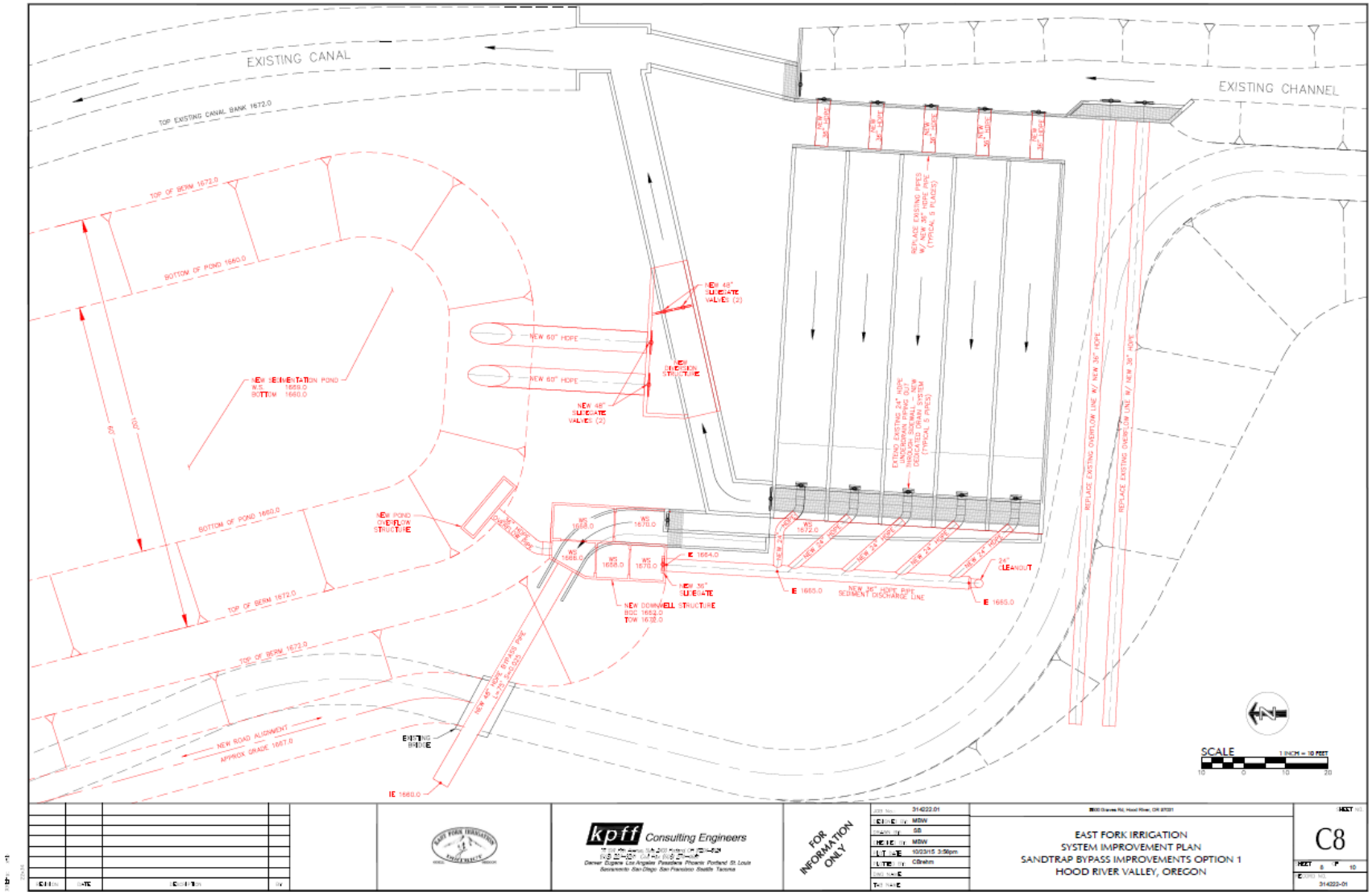
Oregon Water Resources Department (OWRD). (2017). Allocation of Conserved Water. Retrieved from http://www.oregon.gov/owrd/pages/mgmt_conserved_water.aspx

E.6 Proposed Sedimentation Basin



Source: Wharry 2016.

Figure E-1. Preliminary plan view of proposed sedimentation basin near East Fork Irrigation District's headworks.



Source: Wharry 2016.

Figure E-2. Preliminary drawing of proposed sedimentation basin.

E.7 Consultation Letters

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

RECEIVED
DEC 13 2018
USDA/NRCS
Oregon State Office

December 11, 2018

In reply refer to: EC-4

Ronald Alvarado, State Conservationist
Natural Resources Conservation Service
1201 NE Lloyd Blvd
Portland, OR 97232

RE: Formal Request to be a Cooperating Agency on the Watershed Plan-Environmental Assessment for the East Fork Irrigation District, Irrigation Modernization Project

Dear Mr. Alvarado:

Thank you for your October 5, 2018, letter requesting the Bonneville Power Administration's (BPA) participation as a cooperating agency on the Watershed Plan-Environmental Assessment (Plan-EA) that the Natural Resources Conservation Service (NRCS) is preparing pursuant to the National Environmental Policy Act (NEPA) to analyze the effects of NRCS' proposed East Fork Irrigation District Irrigation Modernization Project. Although it is unknown at this time whether BPA will have any role or decisions in the East Fork Irrigation Modernization, BPA agrees to participate as a cooperating agency on this Plan-EA.

As a cooperating agency, BPA expects to have a minor role in reviewing draft EA documents and may be able to provide special expertise on request. As such, BPA does not believe that a formal MOU or further role definition are necessary.

I have assigned BPA's cooperating agency responsibilities to Israel Duran, 503-230-3967 or induran@bpa.gov. Please contact Israel if you have any questions or concerns.

Sincerely,

Scott G. Armentrout
Executive Vice President for Environment, Fish and Wildlife

ecc:
Ronald Alvarado, State Conservationist, NRCS, ronald.alvarado@or.usda.gov
Tom Makowski, ASTC-Watershed Resources and Planning, NRCS, tom.makowski@or.usda.gov
Blayne Einechener, Biologist, CTWS, beineichner@hrecn.net

USDA
United States Department of Agriculture
Natural Resources Conservation Service

2316 South Sixth Street, Suite C
Klamath Falls, OR 97601

Phone: (541) 887-3511
rachel.gebauer@or.usda.gov

Subject: East Fork Irrigation District Modernization Project, Hood River County

Date: January 7, 2019

To: SHPO Compliance

In compliance with the National Historic Preservation Act of 1966, Oregon State Revised Statutes (ORS 358.905-961 and ORS 97.740-760) and in accordance with our State PPA between Oregon SHPO and NRCS Oregon (Signed January 2018), the Natural Resources Conservation Service would like to initiate consultation with the Oregon State Historic Preservation Office for the following federally funded irrigation piping project. The NRCS proposes to provide technical and financial assistance to the East Fork Irrigation District through the Watershed Protection and Flood Prevention Program , Public Law 83-566 (PL566).

The East Fork Irrigation District (EFID) operates and maintains 17.9 miles of open canals and laterals and 64.8 miles of mostly unpressurized pipeline. EFID proposes to modernize its infrastructure by converting its open canals to buried, gravity-pressurized pipelines; replacing 43.5 miles of older pipelines with high-density polyethylene (HDPE) piping; and by adding a settling basin to manage glacial sand and silt in its water supply. The District plans to keep 21.3 miles of its existing pipeline, and to replace piping that is at least 10 years old or more. (Figures 1-5). The project will be divided into segments for the purpose of completing the work. The Eastside Canal is intended to be the first segment addressed by the District.
The EFID canals and laterals are located in Township 3N/ Range 11E/ Section 31; Township 2N/ Range 11E/ Sections 6, 7, 18; 19, 30, 31; Township 2N/ Range 10E/ Sections 12, 13, 21- 28, 33- 36; Township 1 N/ Range 10E/ Sections 1-4, 10,14, 15,22, 27,34; Township 1S/ Range 10E/ Sections 4,5.

In accordance with state and federal laws and under our State PPA between Oregon SHPO and NRCS Oregon (Signed January 2018), NRCS plans to identify the historic properties within the area of potential effect and to evaluate and assess any adverse effects. Recognizing that there may be segments of the canals and laterals that are determined to be historically significant cultural resources, we anticipate the potential need for avoidance or mitigation.

NRCS is consulting with the Confederated Tribes of the Warm Springs, Confederated Tribes and Bands of the Yakama Nation, and the Confederated Tribes of the Umatilla.

The following items are enclosed:

- EFID Index Map,
- EFID Sheets 1-5, detailed segments of EFID modernization project

Sincerely,

Rachel L S Gebauer

Rachel Smith Gebauer, M.A., RPA, Cultural Resources Specialist
rachel.gebauer@or.usda.gov

CC:
Tom Makowski, NRCS, ASTC Watershed Resources, Portland, OR
Carly Heron – NRCS, District Conservationist, Parkdale, OR
Kevin Conroy—NRCS, Basin Team Leader, Klamath Falls, OR
Kathy Ferge – NRCS Tribal Liaison, Portland, OR

Oregon
Kate Brown, Governor

Parks and Recreation Department
State Historic Preservation Office
725 Summer St NE Ste C
Salem, OR 97301-1266
Phone (503) 986-0690
Fax (503) 986-0793
www.oregonheritage.org

March 24, 2020

Ms. Rachel Gebauer
NRCS
2316 S 6th St
Suite C
Klamath Falls, OR 97601

RE: SHPO Case No. 19-0049
USDA-NRCS, East Fork Irrigation District Modernization Project
Irrigation upgrades
Multiple Legals, Hood River County

Dear Rachel:

This letter only addresses archaeological issues in regards to the above project. Additional consulation with our office in regards to the eligibility of the canal and any required mitigation needs to occur before projct approval.

With regardfs to the project's archaeological concerns, our office recently received a report of archaeological investigations for the project referenced above. The report has been assigned SHPO Report# 30944 and added to the SHPO Library. The newly identified hisotric archaeology site has been assigned Smithsonian trinomial 35HR171. Our office concurs with your agency's determination that this archaeological site is not eligible to ther National Regsiter. We have reviewed the report and concur that a good faith effort has been implemented and the project will likely have no effect on any significant archaeological objects or sites. Based on the information provided, additional archaeological research is not anticipated for this project. In the unlikely event an archaeological object or site (i.e., historic or prehistoric) is encountered during project implementation, all ground disturbance at the location should cease immediately until a professional archaeologist can be contacted to evaluate the discovery. Under federal and state law archaeological sites, objects and human remains are protected on both public and private land in Oregon. If you have not already done so, be sure to consult with all appropriate Indian tribes regarding your proposed project. If you have any questions regarding any future discovery or this letter, feel free to contact me at your convenience.

Sincerely,

Dennis Griffin, Ph.D., RPA
State Archaeologist
(503) 986-0674
dennis.griffin@oregon.gov

cc: KC Fagen, Tillamook PUD

USDA
United States Department of Agriculture

Natural Resources Conservation Service

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

October 5, 2018

Mr. Chris Brun, HRPP Supervisor
Confederated Tribes of Warm Springs
6030 Dee Highway
Parkdale, OR 97041

SUBJECT: Formal Request to be a Cooperating Tribe on the Watershed Plan – Environmental Assessment for the East Fork Irrigation District, Irrigation Modernization Project

Dear Mr. Brun,

In accordance with the Council on Environmental Quality regulations implementing the National Environmental Policy Act (NEPA) at 40 CFR Section 1501.6, NRCS is formally requesting that your Tribe become a cooperating Tribe in the planning and development of the Watershed Plan - Environmental Assessment for the East Fork Irrigation District. This request is being made because your Tribe has been identified as having special expertise or jurisdiction by law related to this project. The Watershed Plan - Environmental Assessment (Plan-EA) is being prepared to fulfill NRCS's NEPA compliance responsibilities pertaining to our potential federal financial assistance through the Watershed Protection and Flood Prevention Program (Public Law 83-566) for this project. As your Tribe may also have NEPA compliance responsibilities concerning future projects that may be evaluated in this Plan-EA, preparation of this Plan-EA should also assist in fulfilling environmental review requirements for your Tribe or other Federal agencies and meet NEPA's intent of reducing duplication and delay between agencies.

If your Tribe is unable to participate as a cooperating Tribe, please return a brief, written explanation why your Tribe cannot participate. If we do not hear from you by November 2, 2018, we will assume you decline to be a cooperating Tribe on this project. Please note that a response declining to be a cooperating Tribe is required to also be submitted to the Council on Environmental Quality per 40 CFR Section 1501.6(c). Upon acceptance of this invitation, roles can be defined in an informal agreement or formal MOU can be established.

Thank you for your timely response and cooperation with this project. For further information contact Tom Makowski, Assistant State Conservationist for Watershed Resources and Planning, at 503-414-3202 or tom.makowski@usda.gov.

Sincerely,

RONALD ALVARADO
State Conservationist

ecc: Tom Makowski, ASTC – Watershed Resources and Planning, NRCS

USDA United States Department of Agriculture

Natural Resources Conservation Service

2316 S. 6th St., Suite. C
Klamath Falls, OR 97601

January 7, 2019

Austin Green
Tribal Chairman
Confederated Tribes of Warm Springs
P.O. Box C
Warm Springs, OR 97761

Dear Mr. Green,

The purpose of this letter is to initiate consultation under the National Historic Preservation Act, within the homeland of the Confederated Tribes of the Warm Springs, for The NRCS proposes to provide technical and financial assistance to the East Fork Irrigation District through the Watershed Protection and Flood Prevention Program , Public Law 83-566 (PL566).

The East Fork Irrigation District (EFID) operates and maintains 17.9 miles of open canals and laterals and 64.8 miles of mostly unpressurized pipeline. EFID proposes to modernize its infrastructure by converting its open canals to buried, gravity-pressurized pipelines; replacing 43.5 miles of older pipelines with high-density polyethylene (HDPE) piping; and by adding a settling basin to manage glacial sand and silt in its water supply. The District plans to keep 21.3 miles of its existing pipeline, and to replace piping that is at least 10 years old or more. The project will be divided into segments for the purpose of completing the work. The Eastside Canal is intended to be the first segment addressed by the District.
The EFID canals and laterals are located in Township 3N/ Range 11E/ Section 31; Township 2N/ Range 11E/ Sections 6, 7, 18; 19, 30, 31; Township 2N/ Range 10E/ Sections 12, 13, 21- 28, 33- 36; Township 1 N/ Range 10E/ Sections 1-4, 10,14, 15,22, 27,34; Township 1S/ Range 10E/ Sections 4,5.

All of the project areas will be reviewed and surveyed for historic properties and reports will be submitted to the Oregon SHPO in compliance with the National Historic Preservation Act.

Attached are the proposed project area maps. Please understand this is a voluntary program; therefore, not all proposed projects are implemented. A copy of the completed reports will be made available to you for your review.

If there are any sites of religious or cultural significance to the CTWS in this vicinity, that you feel may be impacted by this project, please let us know so we can adequately address these concerns. Please let us know if you have any other questions or concerns.

Sincerely,

Rachel L.S. Gebauer
NRCS Basin Cultural Resources Specialist

CC:
Robert Brunoe, CTWS THPO, Warm Springs, OR
Brad Houslet, CTWS Manager, Natural Resource Planning, Warm Springs, OR
Mike McKay, CTWS Hydrologist, Warm Springs, OR
Christian Nauer, CTWS Cultural Resources, Warm Springs, OR
Tom Makowski, NRCS, ASTC Watershed Resources, Portland, OR
Carly Heron – NRCS, District Conservationist, Parkdale, OR
Kevin Conroy—NRCS, Basin Team Leader, Klamath Falls, OR
Kathy Ferge – NRCS Tribal Liaison, Portland, OR

USDA United States Department of Agriculture

Natural Resources Conservation Service

2316 S. 6th St.
Suite C
Klamath Falls, OR
97601
541-887-3511

January 7, 2019

Ms. Carey L. Miller
Tribal Historic Preservation Officer/Archaeologist
Confederated Tribes of the Umatilla Indian Reservation
Cultural Resources Protection Program
46411 TimÍne Way
Pendleton, OR 97801

Dear Ms. Miller,

The purpose of this letter is to initiate consultation under the National Historic Preservation Act, within the homeland of the Confederated Tribes of the Umatilla Indian Reservation, for The NRCS proposes to provide technical and financial assistance to the East Fork Irrigation District through the Watershed Protection and Flood Prevention Program, Public Law 83-566 (PL566).

The East Fork Irrigation District (EFID) operates and maintains 17.9 miles of open canals and laterals and 64.8 miles of mostly unpressurized pipeline. EFID proposes to modernize its infrastructure by converting its open canals to buried, gravity-pressurized pipelines; replacing 43.5 miles of older pipelines with high-density polyethylene (HDPE) piping; and by adding a settling basin to manage glacial sand and silt in its water supply. The EFID plans to keep 21.3 miles of its existing pipeline, and to replace piping that is at least 10 years old or more. The project will be divided into segments for the purpose of completing the work. The Eastside Canal is intended to be the first segment addressed by the District.

The EFID canals and laterals are located in Township 3N/ Range 11E/ Section 31; Township 2N/ Range 11E/ Sections 6, 7, 18; 19, 30, 31; Township 2N/ Range 10E/ Sections 12, 13, 21- 28, 33- 36; Township 1 N/ Range 10E/ Sections 1-4, 10,14, 15,22, 27,34; Township 1S/ Range 10E/ Sections 4,5.

All of the project areas will be reviewed and surveyed for historic properties and reports will be submitted to the Oregon SHPO in compliance with the National Historic Preservation Act.

Attached are the proposed project area maps. Please understand this is a voluntary program; therefore, not all proposed projects are implemented. A copy of the completed reports will be made available to you for your review.

If there are any sites of religious or cultural significance to the CTUIR in this vicinity, that you feel may be impacted by this project, please let us know so we can adequately address these concerns. Please let us know if you have any other questions or concerns.

Sincerely,

Rachel LS Gebauer

Rachel L.S. Gebauer
NRCS Basin Cultural Resources Specialist

CC:

Tom Makowski, NRCS, ASTC Watershed Resources, Portland, OR
Carly Heron – NRCS, District Conservationist, Parkdale, OR
Kevin Conroy—NRCS, Basin Team Leader, Klamath Falls, OR
Kathy Ferge – NRCS Tribal Liaison, Portland, OR

USDA
United States Department of Agriculture

Natural Resources Conservation Service

2316 S. 6th St.
Suite C
Klamath Falls, OR
97601
541-887-3511

January 7, 2019

V. Kate Valdez. THPO
Confederated Tribes and Band of the Yakama Nation
P.O. Box 151, 401 Fort Road
Toppenish, WA 98948

Dear Ms. Valdez,

The purpose of this letter is to initiate consultation under the National Historic Preservation Act, within the homeland of the Yakama Nation. The NRCS proposes to provide technical and financial assistance to the East Fork Irrigation District through the Watershed Protection and Flood Prevention Program, Public Law 83-566 (PL566).

The East Fork Irrigation District (EFID) operates and maintains 17.9 miles of open canals and laterals and 64.8 miles of mostly unpressurized pipeline. EFID proposes to modernize its infrastructure by converting its open canals to buried, gravity-pressurized pipelines; replacing 43.5 miles of older pipelines with high-density polyethylene (HDPE) piping; and by adding a settling basin to manage glacial sand and silt in its water supply. The EFID plans to keep 21.3 miles of its existing pipeline, and to replace piping that is at least 10 years old or more. The project will be divided into segments for the purpose of completing the work. The Eastside Canal is intended to be the first segment addressed by the District.
The EFID canals and laterals are located in Township 3N/ Range 11E/ Section 31; Township 2N/ Range 11E/ Sections 6, 7, 18; 19, 30, 31; Township 2N/ Range 10E/ Sections 12, 13, 21- 28, 33- 36; Township 1 N/ Range 10E/ Sections 1-4, 10,14, 15,22, 27,34; Township 1S/ Range 10E/ Sections 4,5.

All of the project areas will be reviewed and surveyed for historic properties and reports will be submitted to the Oregon SHPO in compliance with the National Historic Preservation Act.

Attached are the proposed project area maps. Please understand this is a voluntary program; therefore, not all proposed projects are implemented. A copy of the completed reports will be made available to you for your review.

If there are any sites of religious or cultural significance to the Yakama Nation in this vicinity, that you feel may be impacted by this project, please let us know so we can adequately address these concerns. Please let us know if you have any other questions or concerns.

Sincerely,

Rachel LS Gebauer

Rachel L.S. Gebauer
NRCS Basin Cultural Resources Specialist

An Equal Opportunity Provider and Employer

CC:
Tom Makowski, NRCS, ASTC Watershed Resources, Portland, OR
Carly Heron – NRCS, District Conservationist, Parkdale, OR
Kevin Conroy—NRCS, Basin Team Leader, Klamath Falls, OR
Kathy Ferge – NRCS Tribal Liaison, Portland, OR

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, PORTLAND DISTRICT
P.O. BOX 2946
PORTLAND, OR 97208-2946

FEB 2 6 2020

Mr. Jay Gibbs
Acting State Conservationist
U.S. Department of Agriculture
Natural Resources Conservation Service
1201 NE Lloyd Blvd., Suite 900
Portland, OR 97232

Dear Mr. Gibbs:

We have received your January 6, 2020 letter requesting the U.S. Army Corps of Engineers (Corps) review the draft watershed plan-environmental assessment (Draft Plan-EA) for the East Fork Irrigation District Irrigation Modernization Project (Project), located in Hood River County, Oregon. You requested that we review this Project and provide comments.

The Draft Plan-EA describes the Project as multiple efforts to be completed over several years across a larger geographic area. Thus, it does not disclose the details of specific projects, but instead proposes to tier to site-specific project evaluations as they occur. As a result, we can only provide general comments on the Project in regards to Corps jurisdiction and authority.

We have reviewed the Draft Plan-EA pursuant to Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act of 1899 (RHA). Under Section 10 of the RHA, a Department of the Army (DA) permit is generally required to construct structures or perform work in or affecting navigable waters of the U.S. The Hood River and its tributaries are not regulated under Section 10 of the RHA. Therefore, based on the maps included in the Draft Plan-EA, it appears a Section 10 DA permit would not be required for the Project.

Under Section 404 of the CWA, a DA permit is generally required for the discharge of dredged or fill material (e.g., fill, excavation, or mechanized land clearing) into waters of the U.S., including wetlands. However, discharges of dredged or fill material that may result from certain activities can be exempt from regulation under Section 404.

The Corps' regulation, 33 CFR 323.4(a)(3), defines some activities not requiring a permit as the construction or maintenance of farm or stock pond or an irrigation ditch, or the maintenance (but not construction) of a drainage ditch.

Draft Plan-EA references Regulatory Guidance Letter No. 07-02, which provides additional information on the Corps' general application of this exemption. However, given the general nature of the Project description, the Corps is unable to determine if the exemption or the aforementioned Guidance Letter will apply to all the proposed activities. For example, the Draft Plan-EA states that enhancement of wetland and riparian habitat in the East Fork Hood River may be included in the project. Discharges associated with enhancement activities do not qualify for the exemption. Additionally, the exemption cited above does not apply to channelized streams which have been modified to serve as irrigation ditches or temporary discharges in waters of the U.S. that may be necessary to complete an exempt activity.

Section 14 of the Rivers and Harbors Act of 1899 and codified in 33 U.S.C. § 408 (referred to as "Section 408") authorizes the Secretary of the Army, on the recommendation of the Chief of Engineers, to grant permission for the alteration or occupation or use of a Corps federally authorized project if the Secretary determines that the activity will not be injurious to the public interest and will not impair the usefulness of the project. An alteration is defined as any action that builds upon, alters, improves, moves, occupies or otherwise affects the usefulness, or the structural or ecological integrity of a Corps federally authorized project. The Draft Plan-EA does not include sufficient information to determine if any project groups would require permission under Section 408.

The Corps Real Estate Division evaluates projects that may impact any real estate interest held by the Corps at a proposed Project location. The Draft Plan-EA does not include sufficient information to determine if any project groups would affect a real estate interest held by the Corps.

The Draft Plan-EA and your letter states that coordination and consultation with the Corps will occur prior to the implementation of each project group. I encourage this coordination with my staff regarding the applicability of the Corps jurisdiction and

authority over nonexempt activities associated with your Project. If you have any questions, please contact Ms. Carrie Bond at the letterhead address, by telephone at (503) 808-4387, or e-mail: Carrie.L.Bond@usace.army.mil.

Sincerely,

Aaron L. Dorf
Colonel, Corps of Engineers
District Commander

cc:
U.S. Army Corps of Engineers, Section 408 (Sally Bird)
U.S. Army Corps of Engineers, Real Estate (Amanda Dethman)

USDA
United States Department of Agriculture

Natural Resources Conservation Service

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

October 5, 2018

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

SUBJECT: Watershed Protection and Flood Prevention Act of 1954 Section 12 Consultation Request for the Irrigation Infrastructure Improvement projects in the East Fork Irrigation District

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 (U.S.). In parts of the Hood River basin, irrigated agriculture (the primary out-of-stream water use in the area) still relies on infrastructure that is over 100-years-old to deliver water to farms and other users. The Hood River Valley is one of Oregon's leading fruit growing regions and produces one third of the U.S. winter pear crop for fresh consumption (Stampfli et al. 2012).

Although pipelines currently serve most irrigation water deliveries within the East Fork Irrigation District, more than half of these pipelines are older and unpressurized. Additionally, three of the District's four major distribution canals and laterals still exist as open earthen ditches that are inefficient for water conveyance, pose a public safety risk, and require increased maintenance due to their age and other factors. Aging canals and inefficient water delivery systems contribute to water supply insecurity for out-of-stream users and limit streamflow, affecting aquatic habitat and water quality in the Hood River and its tributaries. To address these issues, East Fork Irrigation District (herein referred to as EFID or the District) must invest increasing amounts of funding in canal maintenance and infrastructure modernization.

EFID plans to apply for federal funding assistance for the proposed modernization project through the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) Watershed Protection and Flood Prevention Program, Public Law 83-566 (herein referred to as PL 83-566). Authorized by Congress in 1954, this program is managed by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) agency. Through this program, NRCS provides technical and financial assistance to eligible project sponsors to plan and implement authorized projects for watershed protection. A watershed plan 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 this project are to:

- Improve water conservation within the Hood River basin by reducing water losses from end spills (operational overflows) and canal seepage
- Support and maintain existing agricultural uses through improved irrigation water management on 9,596 acres in the Hood River basin
- Enhance aquatic habitat by reducing diversion rates from the East Fork Hood River and creating permanent instream water rights with a portion of the conserved water through Oregon's Allocation of Conserved Water Program
- Reduce risks to public safety on 18 miles of open irrigation canal and laterals
- Conserve energy by reducing the need for on-farm irrigation pumping
- Increase water supply security and reliability for District patrons in the face of a changing climate
- Improve financial stability and control long-term operating costs for the District

Consistent with these purposes, the project would specifically address the following concerns:

- Water losses from end spill and seepage in the District's conveyance system
- Water delivery and operational inefficiencies
- Instream flow conditions for threatened fish species
- Drowning hazard along open canals

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 States and local agencies in the development of water resources development projects in watersheds of 250,000 acres or less. NRCS provides technical, financial, and credit assistance to local sponsors in the development of projects for purposes including 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 FWS regarding 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 consider 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 recommendations on the conservation and development of fish and wildlife you feel are appropriate to the scope of the proposed action.

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

Sincerely,

RONALD ALVARADO
State Conservationist

Cc: Tom Makowski, ASTC – Watershed Resources and Planning, NRCS

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Oregon Fish and Wildlife Office
2600 SE 98th Avenue, Suite 100
Portland, Oregon 97266
Phone: (503) 231-6179 FAX: (503) 231-6195

Reply To: 01EOFW00-19FY-F-0710
File Name: 2020.06.09 LOC NRCSirr.doc
TS Number: 20-399
TAILS: 01EOFW00-2020-I-0457
Doc Type: final

6-9-20

Ronald Alvarado
Natural Resources Conservation Service
1201 NE Lloyd Blvd. Suite 900
Portland, Oregon 97232-3200

Subject: Informal consultation on the East Fork Irrigation District's Infrastructure Modernization Project, Hood River Basin, Oregon

Dear Mr. Alvarado:

This letter responds to your May 8, 2020, request for informal consultation with the Fish and Wildlife Service (Service) on potential impacts to threatened bull trout (*Salvelinus confluentus*) and its designated critical habitat. The action is the proposed Natural Resources Conservation Service (NRCS) funding of improvements to the irrigation system at the East Fork Irrigation District (Project), as described in the biological assessment (BA). Our review and concurrence are provided pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*), as amended (ESA). The consultation timeline for the proposed action was initiated on May 12, 2020, upon our receipt of your letter of request.

The Project involves the multiple improvements to the existing irrigation system, which will eliminate unnecessary water loss, conserving up to 16.6 cfs. As proposed, 75% (12.45 cfs) of the conserved water would be allocated to instream flow. The BA determined the Project "may affect, not likely to adversely affect" bull trout, based upon minor, temporary disturbance to instream and riparian habitat that may occur when the Project crosses stream channels. Based on the Project and effects analysis described in the BA, the Service concurs with your effects determination for the following reasons:

- Few, if any, bull trout are anticipated to be in the Project area during the proposed in-water work. Adult migratory bull trout would be the only likely encountered life stage, and can easily move away from any disturbance. Other life stages would not be encountered.

- The Project work includes some channel in-water work; however, multiple measures are proposed to avoid and minimize any impacts, as detailed in Section 5.1 of the BA.
- The Project provides long-term conservation of water, which will benefit aquatic habitat, including designated critical habitat, by increasing instream flow in the East Fork Hood River, its tributaries, and the mainstem Hood River during the summer months in reaches where reduced instream flows are considered a primary limiting factor for salmonid production.

This concludes the NRCS's consultation requirements under section 7(a)(2) and 7(c) of the ESA. If information reveals effects of the action may affect listed species or critical habitat in a manner or to an extent not considered in this consultation; the action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this consultation; and/or, a new species is listed or critical habitat is proposed that may be affected by this action, the NRCS would need to re-initiate consultation. If you have any questions regarding this letter, please contact Ann Gray (ann_e_gray@fws.gov) or Chris Allen (chris_allen@fws.gov) of my staff at 503-231-6179.

Sincerely,

Christopher Allen for

Paul Henson, Ph.D.
State Supervisor

ecc: Diridoni- NRCS

INTERIOR REGION 9
COLUMBIA–PACIFIC NORTHWEST
IDAHO, MONTANA*, OREGON*, WASHINGTON
*PARTIAL

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

Refer to NMFS No:
WCRO-2020-1243

July 13, 2020

Mr. Ronald Alvarado
State Conservationist
United States Department of Agriculture
Natural Resources Conservation Service
1201 NE Lloyd Blvd
Suite 900
Portland, OR 97232

Re: Endangered Species Act Section 7(a)(2) Concurrence Letter [and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response] for the East Fork Irrigation District Irrigation Modernization Project Watershed Plan (HUC 170701506)

Dear Mr. Alvarado,

On May 13, 2020, NOAA's National Marine Fisheries Service (NMFS) received your request for a written concurrence that Natural Resources Conservation Service funding of the East Fork Irrigation District Modernization Project under the Watershed Protection and Flood Prevention Act and the Regional Conservation Partnership Program of the Food Security Act of 1985 is not likely to adversely affect (NLAA) species listed as threatened or endangered or critical habitats designated under the Endangered Species Act (ESA). This response to your request was prepared by NMFS pursuant to section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402, and agency template for preparation of letters of concurrence.

NMFS also reviewed the proposed action for potential effects on essential fish habitat (EFH) designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), including conservation measures and any determination you made regarding the potential effects of the action. This review was pursuant to section 305(b) of the MSA, implementing regulations at 50 CFR 600.920, and agency template for use of the ESA consultation process to complete EFH consultation. In this case, NMFS concluded the action would not adversely affect EFH. Thus, consultation under the MSA is not required for this action.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at Portland, Oregon.

Consultation History

NRCS provided NMFS with a draft project BA for review on February 11, 2020 and a final BA and consultation request on May 13, 2020.

Proposed Action and Action Area

The East Fork Irrigation District (EFID) proposes to replace 17.5 miles of open canals and up to 38.3 miles of existing pipelines with new high-density polyethylene (HDPE) pipe for pressurized water delivery to irrigation district patrons. EFID proposes to upgrade existing turnouts[1] and install pressure-reducing valves to alleviate high pressures within the system (Figure *1*). The EFID will also excavate an off-channel, 4.93 acre-foot sedimentation basin. The EFID will periodically remove sediment that accumulates in the basin and place it in an upland area. The construction sequence of the proposed action is; excavation with a track hoe or similar heavy equipment, laying pipe, bedding pipe, replacing existing turnout gates, installing pressure reducing valves along pipelines, and re-contouring and reseeding disturbed soils following pipeline installation. Construction would occur over the course of 10 years in three project groups. The only proposed in-water construction work is the replacement of two sublateral pipelines that cross Lenz Creek. If it is necessary to replace these pipelines, EFID will use nets to herd fish away from the work sites and block them from reentering work sites.

The action area consists of; Hood River from Middle Fork Hood River river mile 14.6 to its confluence with the Columbia River, EFHR from the EFID diversion at river mile 6.6 to its confluence with the Middle Fork Hood River, West Fork Neal Creek from river mile 1.8 to the confluence with Neal Creek, Neal Creek from the West Fork Neal Creek confluence to its confluence with Hood River, Odell Creek from river mile 2.3 to its confluence with Hood River, Whiskey Creek from river mile 1.3 to its confluence with Hood River and Lenz Creek from river mile 1.2 to its confluence with Neal Creek. The action area also includes the upland areas 50 feet on each side of the canals and pipelines and 50 feet around the sediment basin near the EFID diversion.

[1] The point at which the control of the water changes from the irrigation district to the customer

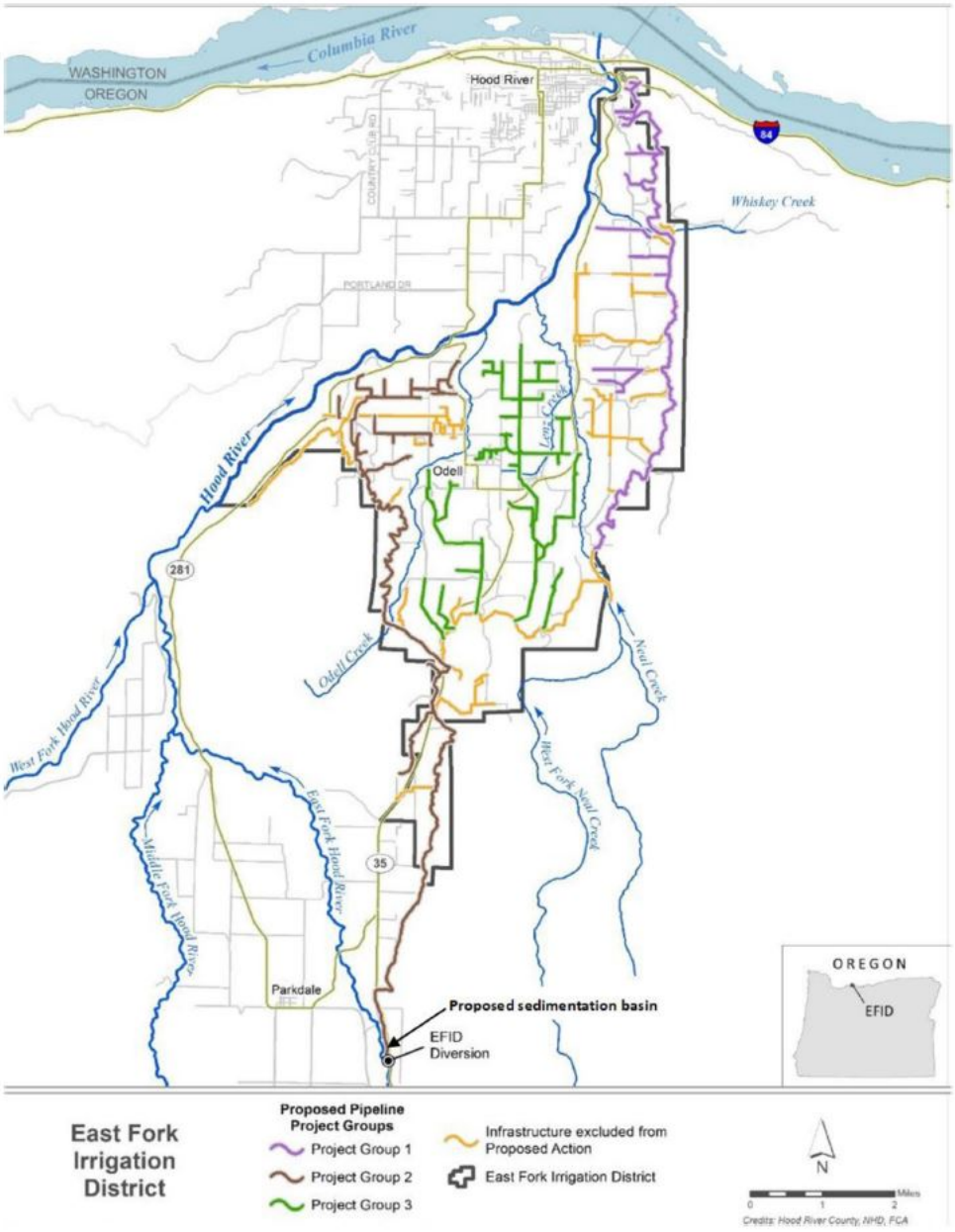


Figure 1. East Fork Irrigation District Modernization Project with phasing by project group.

We considered whether or not the proposed action would cause any other activities and determined that it would not.

Background and Action Agency's Effects Determination

The EFID diverts up to 117.36 cubic feet per second (approximately 75 percent) of the available late summer flow of the EFHR. The reach between the EFID diversion at river mile 6.6 and the point where a portion of the diverted water returns from the EFID fish screen facility at river mile 6.1 is a fish passage concern. Since the existing irrigation system is unpressurized, the EFID maintains end spills at approximately 25 locations in five EFHR tributaries. Maintaining end spill flows requires the EFID to divert an average of 16.6 cubic feet per second more flow than it uses for irrigation. End spills also transfer glacial silt and heat (Stampfli et al., 2012), insecticides, fungicides, herbicides, fertilizer, and other contaminants present in canal water to these tributaries and ultimately to the EFHR and Hood River. Pressurizing the system eliminates end spills. The EFID will leave 12.45 cubic feet per second of the no longer need 16.6 cubic feet per second in the East Fork Hood River. EFID must remove glacial silt from EFHR irrigation water to protect irrigation equipment. In the existing system, glacial silt settles in small settling basins incorporated into the irrigation canals and recovers the capacity of these basins by periodically flushing accumulated sediment into the EFHR. After pressurized pipelines replace canals, the EFID will remove glacial silt from irrigation water in the new 4.93 acre-foot settling basin. The EFID will excavate sediment that accumulates in the basin and place it in upland locations thereby reducing the mass of sediment delivered to the EFHR.

The NRCS determined that the effects of the proposed action on Hood River Chinook, coho and steelhead and their critical habitat are: 1) an increase in EFHR flow from late July through September; 2) the elimination of sediment flushing into the EFHR; 3) blocking fish movement in Lenz Creek if sublateral pipelines crossing the creek are replaced.

1) The NRCS concluded that the increase in EFHR streamflow is beneficial because streamflow is a limiting factor to Hood River Chinook, coho and steelhead passage.
2) The NRCS concluded that the elimination of sediment flushing into East Fork Hood River is beneficial because suspended sediment is detrimental to fish health and spawning redds.
3) The NRCS concluded that the temporary disruption of fish movement in Lenz Creek is insignificant because the construction will not be done during adult or smolt migration periods, rearing juveniles will be blocked from the work site with nets and work site isolation does not require fish salvage.

Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved

in the action (50 CFR 402.02). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b). When evaluating whether the proposed action is not likely to adversely affect listed species or critical habitat, NMFS considers whether the effects are expected to be completely beneficial, insignificant, or discountable. Completely beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

The effects of the proposed action include: 1) Increased EFHR streamflow. 2) Elimination of sediment flushing into EFHR. 3) Temporarily blocked fish movement in Lenz Creek.

1. NMFS concurs with the NRCS that returning 12 cubic feet per second of flow savings to EFHR is beneficial to Hood River Chinook, coho and steelhead and their critical habitat. Increased streamflow improve critical habitat physical and biological features including water quantity and quality and fish passage.

2. NMFS concurs with the NRCS that eliminating in canal sediment flushing into EFHR tributaries is beneficial to Hood River Chinook, coho and steelhead and their critical habitat. Suspended sediment can be physically injurious to salmon and steelhead and once incorporated into bedload can degrade the quality of substrate salmonids use to construct redds.

3. NMFS concurs with the NRCS that the temporary disruption of fish passage in Lenz Creek while crossing pipelines are replaces is insignificant. Lenz creek is likely to occupied by rearing coho and steelhead (Streamnet) but in-water work windows do not overlap periods of coho or steelhead smolt outmigration. If EFID replaces these pipes, they will use nets to herd fish away from, and keep fish from reentering the work sites.

Conclusion

Based on this analysis, NMFS concurs with the NRCS that the proposed action is not likely to adversely affect the subject listed species and designated critical habitats.

Reinitiation of Consultation

Reinitiation of consultation is required and shall be requested by NRCS or by NMFS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and (1) the proposed action causes take; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the written concurrence; or (4) a new species is listed or critical habitat designated that may be affected by the identified action (50 CFR 402.16). This concludes the ESA portion of this consultation.

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. The NRCS also has the same responsibilities, and informal consultation offers action agencies an opportunity to address their conservation responsibilities under section 7(a)(1).

Please direct questions regarding this letter to Tom Hausmann, at Tom.Hausmann@noaa.gov, or by calling 503-231-2315.

Sincerely,

Scott A. Hecht, Ph.D.
Branch Chief,
Washington Coast Lower Columbia River Branch
Oregon Washington Coastal Area Office

Cc: Gary Diridoni, NRCS

References

Stampfli, S., Saunders, M., Eineichner, B., and Pilz, D. (2012). EFID Central Canal Pipeline Project -Stream Flow, Water Quality, and Fish Passage Final Report (Odell, Oregon: East Fork Irrigation District).