Draft Preliminary Investigative Report for the Lone Pine Irrigation District Irrigation Modernization Project

Prepared by Farmers Conservation Alliance

Submitted to Natural Resources Conservation Service

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Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
AID	Arnold Irrigation District
cfs	cubic feet per second
PBC	Pilot Butte Canal
COID	Central Oregon Irrigation District
CWA	Clean Water Act
EA	Environmental Assessment
EFU	Exclusive Farm Use
ESA	Endangered Species Act
FCA	Farmers Conservation Alliance
HDPE	high-density polyethylene
HUC	Hydrologic Unit Code
IPaC	Information for Planning and Conservation
LPID or District	Lone Pine Irrigation District
N/A	not applicable
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
OAR	Oregon Administrative Rule
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODSL	Oregon Department of State Lands
ORBIC	Oregon Biodiversity Information Center
ORS	Oregon Revised Statute
OWRD	Oregon Water Resources Department
O&M	Operations and Maintenance
PCE	Primary Constituent Element
PIR	Preliminary Investigative Report
RM	River Mile
ROW	right-of-way

SHPO	State Historic and Preservation Office
SIP	System Improvement Plan
UGB	Urban Growth Boundary
U.S.	Unites States
USACE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
Plan-EA	Watershed Plan-Environmental Assessment

1 Introduction

Aging infrastructure, growing populations, shifting rural economies, and changing climate conditions have increased pressure on water resources across the western United States (U.S.). Irrigated agriculture is the primary out-of-stream water use in Oregon's Deschutes Basin, and relies on mainly 100-year-old infrastructure to divert, store, and deliver water to farms and ranches across the region. In recent years, improving water resource management has been a community focus within the Deschutes Basin and a coordinated focus of the eight irrigation districts within the basin (Figure 1).

Due to the basin-wide need for improved water management, the Lone Pine Irrigation District (herein referred to as LPID or the District) is pursuing water conservation strategies in an effort to construct a more efficient system and permanently restore flows in the Deschutes River. The District's aging and outdated infrastructure contributes to water delivery insecurity for out-of-stream users and limits streamflow, which affects water quality and aquatic habitat along the Deschutes River. Open irrigation canals and laterals in the District have become a public safety risk and are vulnerable to disruptions in water supplies that are likely to accompany future climate change projections. Aging infrastructure also affects the financial stability of LPID and its patrons, as the District must find new approaches to fund growing maintenance needs that are not accommodated in standard annual budgets.

The District is located in Central Oregon, northeast of the City of Redmond and east of the Deschutes River. The entire District encompasses 5,019 acres; within that area, 2,369 acres are currently irrigated by 21 patrons. The District is about 4.5 miles long (north to south) and 3.2 miles wide (east to west). LPID operates and maintains approximately 15 miles of canals and laterals; of these, approximately 2.2 miles are piped and the rest are unlined, open channels dug into volcanic soils. Approximately 20 percent of the water diverted through LPID's canals and laterals[1] currently seeps into the area's porous, volcanic soil or evaporates prior to reaching farms (LPID 2017). As a result, the District has a higher diversion rate than its on-farm delivery rate to account for the loss in the distribution system. If the distribution system were more efficient, the District would divert less water and leave more water in the Deschutes River, and patrons would continue to receive water for irrigation, supporting local agriculture and the local economy. Modernizing irrigation infrastructure offers an opportunity to conserve water, increase water delivery reliability to farms, enhance streamflow and habitat conditions for fish and aquatic species in the Deschutes Basin, reduce risks to public safety from open irrigation canals, reduce operations and maintenance (O&M) costs for the District, and reduce O&M for farmers through decreased pumping.

The Deschutes Basin Board of Control (DBBC) is the lead sponsor for the LPID Irrigation Modernization Project (herein referred to as the "project" or "proposed action"), which would improve water conservation, water delivery reliability, and public safety for District-owned canals and laterals. The proposed action would realign the canal system, eliminate up to 4.5 miles of open canal and laterals, and pipe and pressurize up to 10.5 miles of canals and laterals in order to save up to 3,219 acre-feet annually at a rate of up to 8.8 cubic feet per second (cfs). Specific details regarding the District's proposed action are further described in this document (Section 7.2.2) and in the amended System Improvement Plan (SIP) (LPID 2018a).

[1] "Laterals" are smaller canals that branch off from main canals.

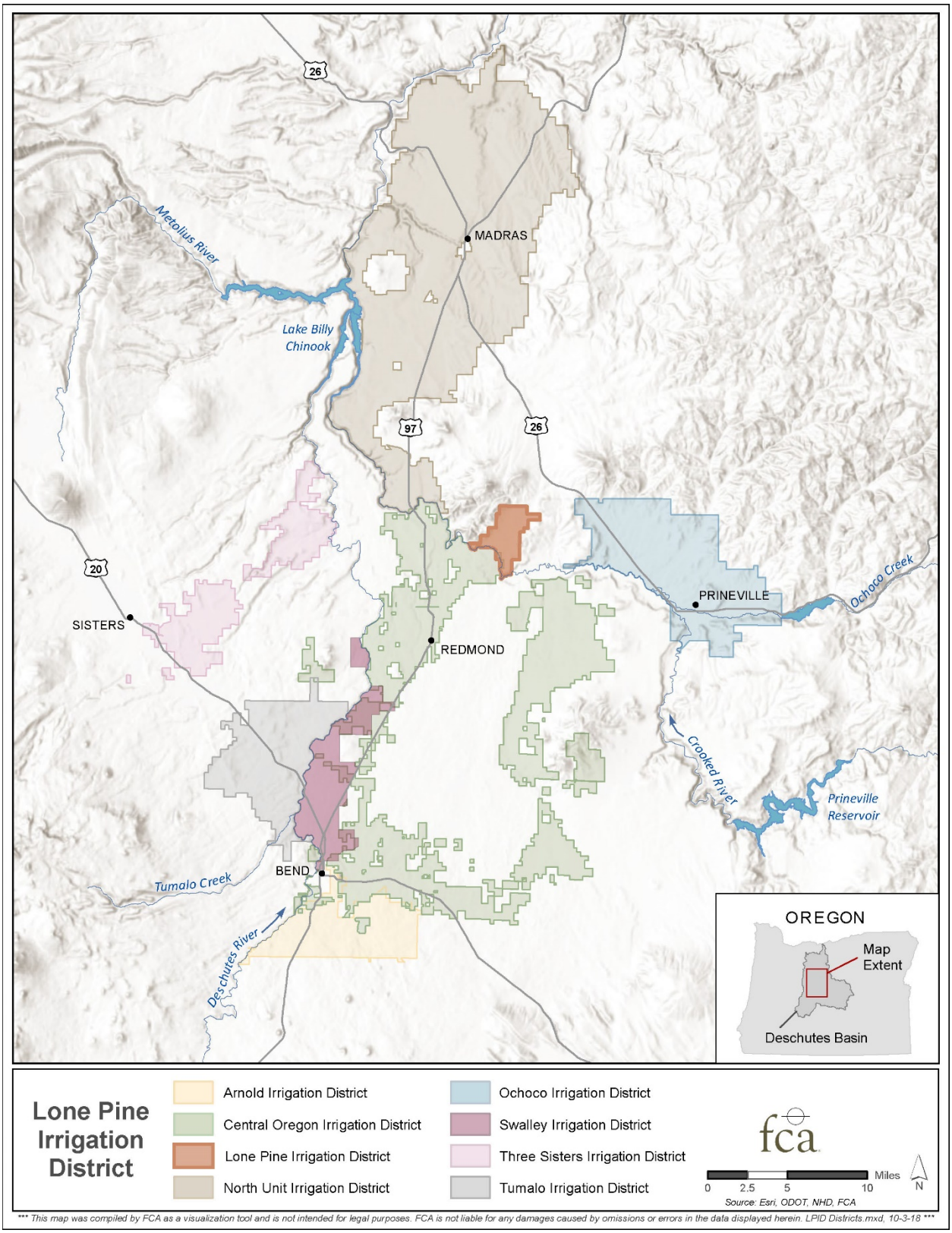


Figure 1. Irrigation districts within the Deschutes Basin.

2 Consultation and Participation with Local Partners, Agencies and Tribes

This Preliminary Investigative Report (PIR) was prepared to introduce the project, present the project's goals and objectives, and provide the information necessary for all stakeholders to evaluate the project and guide project development. This project development process is designed to work collaboratively with partners, agencies, tribes, and other stakeholders so that there is transparency, ownership, and cooperation towards a solution that fits within the framework of the purpose and need for action (Section 3). There are many organizations involved in the Deschutes Basin; therefore, during the development of the PIR, project sponsors conducted initial consultation with natural resource agencies and other stakeholders. LPID and its partners will conduct further comprehensive public scoping prior to the preparation of the Watershed Plan-Environmental Assessment (Plan-EA) as described in the scope of the Environmental Assessment (see Section 4).

2.1 Sponsors, Local Partners, Agencies and Tribal Participation

For the purpose of the project, sponsors are the agencies involved in scheduling, facilitating communication, project design and development, and document writing. The primary sponsor for the project is the Deschutes Basin Board of Control. Supporting sponsors for the project are LPID and the National Resources Conservation Service (NRCS).

Local entities that have land ownership or a shared resource within the District include:

- Crook County
- Jefferson County
- Deschutes County

State and federal agencies that are or will be involved with the project include:

- Oregon Department of Fish and Wildlife (ODFW)
- Oregon Water Resources Department (OWRD)
- State Historic and Preservation Office (SHPO)
- Oregon Department of Environmental Quality (ODEQ)
- Oregon Department of Agriculture (ODA)
- Oregon Department of State Lands (ODSL)
- National Oceanic and Atmospheric Administration (NOAA) Fisheries
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Forest Service
- U.S. Bureau of Reclamation (Reclamation)

Tribes consulted regarding the project include:

- Confederated Tribes of Warm Springs

Other stakeholders for this project are any interested parties. Currently identified stakeholders include:

- Upper Deschutes Watershed Council
- Crooked River Watershed Council
- Deschutes River Conservancy

- WaterWatch of Oregon
- Trout Unlimited
- Coalition for the Deschutes
- Interested public

2.2 Permits and Compliance

Partners anticipate that this project will utilize NRCS federal dollars for funding. Therefore, it will require a Plan-EA. This process will include compliance with all relevant state and federal permits and regulations, including Section 106 of the National Historic Preservation Act (NHPA) of 1966 (managed by SHPO), Section 7 of the Endangered Species Act (ESA; managed by NOAA Fisheries and USFWS), general permit 1200-C (managed by ODEQ) issued pursuant to Oregon Revised Statute (ORS) 468B.050 and Section 402 of the Clean Water Act (CWA), and Sections 404 and 401 of the CWA (managed by ODSL and U.S. Army Corps of Engineers [USACE]).

2.3 Mitigation

Following consultation with SHPO and the public scoping process, there may be a requirement for mitigation for loss of historic irrigation canals or other cultural resources. Mitigation for any potential impacts of the project will be outlined, designed, and completed following consultation with the corresponding agencies.

3 Purpose and Need for Action

The purpose of this project is to improve water conservation, water delivery reliability, and public safety on District-owned canals and laterals.

Federal action is needed in addressing the following watershed problems and resource concerns: water loss in District conveyance systems, water delivery and operations inefficiencies, instream flow for fish and aquatic habitat, and risks to public safety from open irrigation canals. The District has begun to address these concerns as funding opportunities have allowed. These funding opportunities are not reasonably certain to occur if the District continues to follow their current approach. Federal action would enable the District to follow a strategic, comprehensive approach to securing additional funding and addressing these issues, which are discussed below in more depth.

3.1 Watershed Problems and Resource Concerns

3.1.1 Water Loss in District Conveyance Systems

Conserving water is a key objective of the District. The District's existing infrastructure loses up to 3,219 acre-feet annually at a rate of up to 8.8 cfs through seepage and other conveyance inefficiencies, and it was determined through a flow loss analysis and hydraulic modeling that the District could save this water if the entire District conveyance system were completely piped and pressurized. Details of water losses and demands can be found in the District's SIP (LPID 2017; Appendix). Water losses due to inefficient conveyance systems also prevent the District from delivering to its patrons the full rates and duties associated with their water rights during the irrigation season (April 1 through November 1).

3.1.2 Water Delivery and Operation Inefficiencies

In addition to seepage and evaporation losses, it can take days to recharge open canals and laterals after the District reduces its diversions, further affecting the reliability of water deliveries for

patrons. When the District increases its diversion rate again to increase the water level in the canal, the ends of the District's laterals receive less or no water as the system recharges. During these periods, the District cannot always fully meet its obligations to deliver water to its patrons. The District's canals and laterals do not transport and deliver water as precisely, accurately, or efficiently as a modernized system would.

The District's antiquated canal and laterals make it difficult to deliver the correct amount of water to patrons at the correct time, particularly early and late in the irrigation season. During these periods, the District's water rights require it to divert water at a reduced rate. At these reduced flow rates, the canal and laterals are more sensitive to small changes in streamflow at the diversion or deliveries at each point of delivery. The reduced flow rates in the open canal and laterals make it more challenging for the District to deliver the sufficient amount of water that patrons need when they need it. For example, a point of delivery near the end of a lateral may receive no water in the morning and excess water in the evening. The District also has to pass excess water, known as carry water, to ensure that adequate water reaches all points-of-delivery for its patrons. When the patrons' demand subsides, this excess water is spilled onto non-productive lands at the ends of the conveyance system; the water does not return instream. This excess water is another example of the inefficiencies in the current conveyance system.

3.1.3 Instream Flow for Fish and Aquatic Habitat

The Deschutes River and its tributaries experience low streamflow every year due to the storage and diversion of water for agricultural use. Resource agencies have identified streamflow as a primary concern in the Deschutes River (UDWC 2014). Reservoir operations lead to low winter streamflow and high summer streamflow in the Deschutes River upstream from LPID's diversion.

The Deschutes River and its tributaries support sensitive species, including the Oregon spotted frog, steelhead trout, redband trout, and Chinook salmon, as well as many other fish, birds, and wildlife species. Streamflow fluctuations in the Deschutes River often limits habitat for many of these species. Low streamflow in late fall, winter, and early spring associated with upstream reservoir storage limits aquatic habitat and riparian vegetation in the upper Deschutes River upstream from North Canal Dam (River Mile [RM] 164.8). Low streamflow in the late spring, summer, and early fall due to irrigation diversions at the North Canal Dam limits aquatic habitat and riparian vegetation in the middle Deschutes River (RDG 2005). Because streamflow is strongly correlated with critical physical and biological characteristics of a river, it influences the functions of associated riparian areas (National Research Council 2002).

3.1.4 Risks to Public Safety

Open canals pose a risk to public safety during the irrigation season. In addition to multiple instances of injury, several drowning deaths or near-drowning instances have occurred in adjacent districts' canals in 1996, 1997, 2004, 2016, and 2018 (Flowers 2004; Matsumoto 2016; Beechem 2016). The District's location in a partly urbanized area heightens the potential for an accident, as the canals and laterals pass through rural residences, private lands, public lands, and irrigated fields.

During the summer, water depths in the District's canals range from 2 to 4 feet, with velocities up to 5 feet per second in places. These conditions make it difficult for a healthy, strong adult to stand in or climb out of a canal without assistance. A child or non-/weak-swimmer would be at an even higher risk of drowning in a canal with these attributes. Due to the volume and speed of the moving water, a person or animal that fell into a District canal could have serious difficulty gaining hold on

the banks in order to climb out. Barriers or fences at the top banks of the canal and laterals are not currently installed.

3.2 Watershed and Resource Opportunities

The following list of resource opportunities would be realized through project implementation:

- Improve irrigation water management and irrigation water delivery to LPID patrons by improving water conveyance efficiencies and pressurizing deliveries.
- Improve streamflow, water quality, and habitat availability in the Deschutes River by legally protecting saved water instream.
- Reduce the O&M costs involved in delivering irrigation water to LPID patrons.
- Minimize the potential for injury and loss of life associated with the open LPID canals.

4 Scope of the Environmental Assessment

NRCS and LPID will conduct public scoping as the National Environmental Policy Act (NEPA) review process proceeds. Public scoping will seek additional issues of economic, environmental, cultural, and social importance in the watershed. NRCS, LPID, and Farmers Conservation Alliance (FCA) will organize agency and public scoping meetings that will provide an opportunity to review and evaluate the project alternatives, express concerns, and gain further information. Following the scoping process, a Plan-EA will be drafted to determine if the proposed project meets the program criteria found in Title 390, National Watershed Program Manual, Part 500, Subpart A, Sections 500.3 and 500.4.

5 Affected Environment - Existing Conditions

5.1 Project Setting

LPID is in Central Oregon in an area locally known as Lone Pine Valley. The District is located between three cities: Prineville (about 11 miles southeast), Redmond (about 7 miles southwest), and Madras (about 18 miles north). Much of the District falls within Crook County, with small portions extending into Jefferson County to the north and Deschutes County to the west (see Figure 2).

The entire District is approximately 5,019 acres in area and services 2,369 irrigable acres used by 21 patrons (T. Smith, personal communication, March 5, 2018). The District is about 4.5 miles long (north to south) and 3 miles wide (east to west) and falls within two subwatersheds that have a total area of 57,998 acres (Table 5-1). These two subwatersheds comprise the Watershed Planning Area (see Section 5.1.1 below).

The area where construction activities would occur to pipe and pressurize up to 11.3 miles of the District's canals and laterals as well as decommission approximately 12.6 miles of District canals and laterals is referred to as the project area. Most construction activities would occur within the District's existing rights-of-way (ROWs), which were granted under the Carey Desert Land Act of 1894 (Carey Act). The District's ROWs under the Carey Act extends 50 feet on each side of the canal from the toe of the bank for a total easement width of 100 feet plus the width of the canal. Construction activities outside of the Districts ROWs include the development of a new point of diversion upstream of the existing point of diversion on Central Oregon Irrigation District's (COID)

Pilot Butte Canal, known as the L-Lateral, a proposed siphon river crossing approximately 2.5 miles upstream of the existing suspension bridge, and 1.8 miles of new pipe alignment between the new diversion and the river crossing (see Figure 2).

5.1.1 Watershed Planning Area

The District's service area and the project are located in two subwatersheds: Osborne Canyon-Crooked River and Lone Pine Creek (see Table 5-1 and Figure 1), which total 57,998 acres. These two subwatersheds comprise the LPID Watershed Planning Area, and are located within the larger Lower Crooked watershed (Hydrologic Unit Code [HUC] 17070305). The District's reservoir (Crane Prairie) and the river used for conveyance (the Deschutes River) are located in the Upper Deschutes watershed (HUC 17070301). Within the Upper Deschutes watershed, portions of the Deschutes River are often called the upper Deschutes River (from RM 226 to RM 164.8) and the middle Deschutes River (from RM 164.8 to RM 120). RM 164.8 divides the river based on its hydrograph, which is influenced by reservoir operations in the river's upper reaches and irrigation diversions in the river's middle reaches. Current reservoir management in the upper Deschutes River leads to low late fall, winter, and early spring flows and high summer flows in the upper Deschutes River. Six irrigation districts divert water from the Deschutes River at the City of Bend during the spring, summer, and fall, leading to lower flows in the middle Deschutes River.

Table 5-1. Lone Pine Irrigation District Watershed Planning Area

12-digit Hydrologic Unit Code	Name	Area (acres)
170703051101	Osborne Canyon-Crooked River	42,388
170703050806	Lone Pine Creek	15,610
	Total	**57,998**

5.2 Current Infrastructure

The District operates and maintains over 10.5 miles of open canals and laterals, 4.5 miles of existing piped segments, and a pumping plant. Water is diverted from the Deschutes River at North Canal Dam (RM 164.8) and conveyed through COID's Pilot Butte Canal to the terminus where it is delivered to LPID's main canal. The main canal conveys water by means of a steel pipe, traveling across the Crooked River, and then running northeast to a multi-lateral distribution point (see Figure 2). An outdated and failing suspension type bridge across the Crooked River supports a 36-inch wood stave pipe with a low-pressure-rated polyvinyl chloride (PVC) alloy liner. The liner relies on the wood-stave pipe structure to withstand any significant pressures. This suspension bridge needs replacement or repair.

From the main distribution point, the conveyance system branches into three laterals: Upper, Middle, and Lower. The Upper Lateral utilizes a pump station which raises the water 45 feet in elevation in a 500-foot pipe; the water is then fed by gravity through an open system. The Middle and Lower Laterals are open and fed entirely by gravity.

Approximately 30 percent of the conveyance system has been piped. However, these existing pipes would likely need to be replaced to withstand the water pressures associated with the District's desired fully piped system. Patron turnouts from the District's canal and laterals are typically gate-regulated, orifice-restricted, and/or weir-measured. The District's part-time ditch rider and volunteer working board of directors regulates flows to each system lateral and patron turnout as necessary.

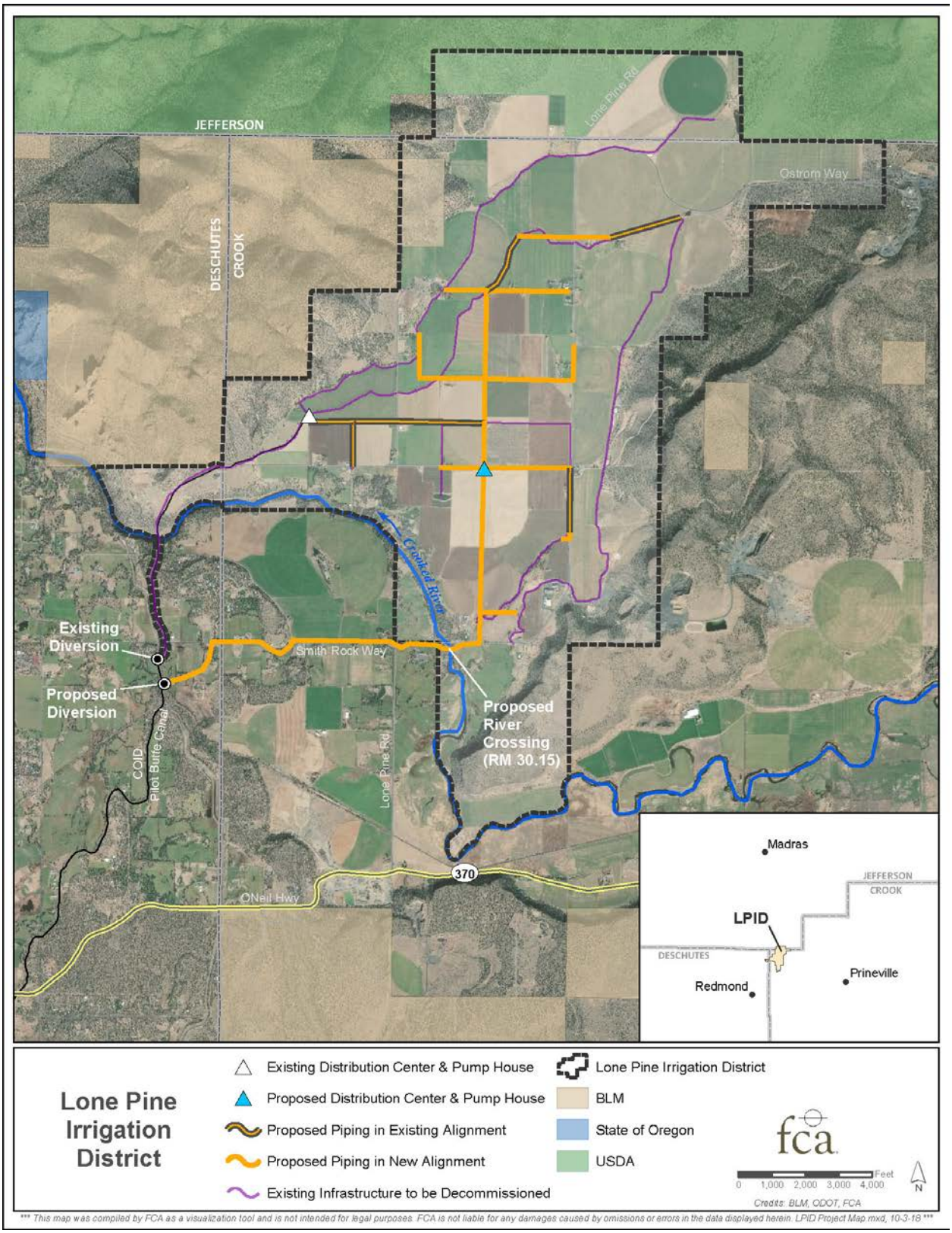


Figure 2. Lone Pine Irrigation District current infrastructure and project setting.

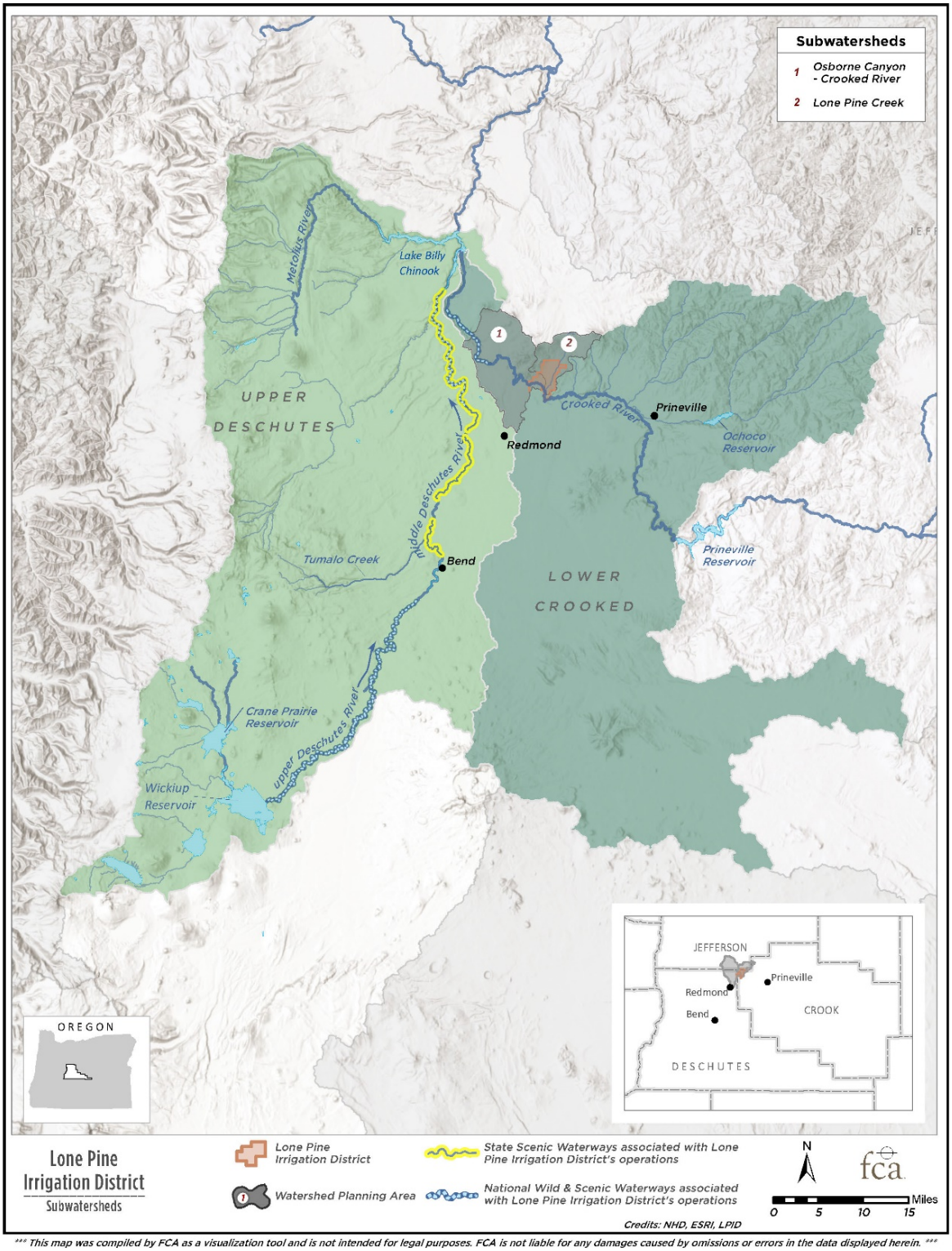


Figure 3. Lone Pine Irrigation District Watershed Planning Area.

5.3 Topography

The District is in the Lone Pine Valley, where the topography of the irrigated lands is relatively flat. The main canal drops in elevation approximately 20 feet from the terminus of the Pilot Butte Canal to the main distribution point. The Upper Lateral is located 45 feet above the main distribution point and drops 15 feet over the length of the lateral. The Middle Lateral drops 86 feet and the Lower Lateral drops 20 feet from the main distribution point.

5.4 Climate

The District is set within a semi-arid region of high desert scrubland, with scattered peaks and small mountain ranges. This region is in the rain shadow of the Cascade Mountain range, where precipitation diminishes rapidly moving from west to east across Central Oregon, away from the Cascade Mountains. The District's annual average precipitation is 10 to 12 inches, most of which arrives in the winter months, with a secondary maximum during the late spring and early summer. Irrigation is essential to crop production, and LPID irrigators rely on stored water and live flow from the Deschutes River for adequate water supplies. Summer high temperatures in the District range from 80 to 95 degrees Fahrenheit (°F), and winter lows range from 21°F to 44°F. The average growing season is approximately 180 days (J. Camarata, personal communication, April 3, 2018).

Recent yet consistent changes in climate show signs of future increased temperatures and changes in precipitation patterns. These changes will fundamentally alter the seasonal distribution of streamflow in the area and may have serious implications for natural resource managers and local farmers (Vano et al. 2015). Variable Infiltration Capacity simulations show a substantial decrease in annual streamflow. The probable response to changes in precipitation patterns and increased temperatures is a transition from snow to rain at intermediate and low elevations in the Cascade Range, causing earlier runoff and reduction in the pulse of runoff and groundwater recharge associated with spring snowmelt (Waibel 2010). Winter (October through March) warming is estimated to stimulate greater winter streamflow immediately, which partly compensates for a subsequent decrease in summer streamflow that happens because less water is available (Das et al. 2011). Increased summer (April through September) warming is estimated to increase the rate of spring snowmelt, subsequently decreasing late summer streamflow in response to the reduction of summer snow reserves.

5.5 Cultural and Historic Properties

Section 106 of the NHPA requires federal agencies to consider the potential effects of a project on historic properties listed in or eligible for listing in the National Register of Historic Places. Implementation of the NHPA in Oregon is overseen by the Oregon Parks and Recreation Department and the SHPO. Recommendations of eligibility for the National Register require consultation with SHPO, and the consulting parties must agree on a determination of effects. A finding that historic properties would be adversely affected requires that the consulting parties enter into a Memorandum of Agreement with stipulations for certain actions and timelines that mitigate the adverse effect and are acceptable to all of the consulting parties.

The District's canal and laterals have not been surveyed for cultural and historic resources to date, and the District does not have any features listed or pending for listing on the National Register. Consultation with SHPO will be necessary to determine the potential effect on cultural and historic resources, if any, from the project.

5.6 Fish & Aquatic Species

The District's conveyance system does not support resident or anadromous fish or threatened and endangered aquatic species. Fish screens compliant with ODFW standards were installed on the diversion at North Canal Dam in 2004 (Swalley 2018; Biota and R2 2013). These screens separate water diverted for consumptive use from water left instream, fish, and debris. They prevent any fish from entering the District's conveyance system.

Waterbodies affected by District operations that do support fish and aquatic species include the Crane Prairie and Wickiup reservoirs; the upper Deschutes River between Crane Prairie Dam (RM 238.5) and Wickiup Reservoir (RM 226.6) and from the Wickiup Reservoir Dam (RM 226.8) to the North Canal Dam (RM 164.8); the middle Deschutes River from the North Canal Dam (RM 164.8) to Lake Billy Chinook (RM 120); and the Crooked River from RM 30.2 to the mouth at Lake Billy Chinook (RM 0) (see Table 5-2).

Table 5-2. Waterbodies Associated with District Operations.

Name	Associated River Miles (RM)	Size	Tributary To	Project Nexus
Crane Prairie Reservoir	N/A	50,000 acre-feet	N/A	LPID holds 10,500 acre-feet of storage water rights but is currently limited to 5,000 acre-feet per a voluntary settlement.
Upper Deschutes River	Crane Prairie Reservoir (RM 238.5) to Wickiup Reservoir (RM 226.6)	N/A	Columbia River	Releases from District reservoir affect flows in this reach.
Wickiup Reservoir	N/A	200,000 acre-feet	N/A	LPID irrigation water is conveyed through Wickiup Reservoir.
Upper Deschutes River	Wickiup Reservoir (RM 226.8) to North Canal Dam (RM 164.8)	N/A	Columbia River	Releases from District reservoir affect flows in this reach.
Middle Deschutes River	North Canal Dam (RM 164.8) to Lake Billy Chinook (RM 120)	N/A	Columbia River	Diversion of up to 43.5 cfs affects flows in this reach.
Crooked River	Crooked River (RM 30.2) to mouth	N/A	Deschutes River, confluence at Lake Billy Chinook (RM 120)	LPID main canal terminates near the Crooked River, returning on average 1.34 cfs to the Crooked River during the irrigation season (J. Camarata, personal communication, April 3, 2018).

There are 18 species of fish documented (see Table 5-3). Fish species commonly found in Crane Prairie and Wickiup reservoirs include rainbow trout, kokanee, mountain whitefish, and largemouth bass. Fish species also commonly found in Wickiup Reservoir include brook trout, brown trout, and brown bullhead catfish, while additional fish species in the Crane Prairie Reservoir include black crappie, three-spined stickleback, and tui chub (USFWS 2018).

Table 5-3. Fish Species in Reaches of the Deschutes River Affected by District Operations.

Fish Species	Scientific Name	Origin
Bridgelip sucker	*Catastomus columbianus*	Indigenous
Brook trout	*Salvelinus fontinalis*	Introduced
Brown bullhead catfish	*Ictalurus nebulosus*	Introduced
Brown trout	*Salmo trutta*	Introduced
Bull trout	*Salvelinus confluentus*	Indigenous
Chinook salmon	*Oncorhynchus tshawyscha*	Indigenous
Chiselmouth	*Acrocheilus alutaceus*	Indigenous
Dace species	*Rhinichthys* spp.	Indigenous
Largescale sucker	*Catastomus macrocheilus*	Indigenous
Mountain whitefish	*Prosopium williamsoni*	Indigenous
Northern pike minnow	*Ptychocheilus oregonensis*	Indigenous
Rainbow trout	*Oncorhynchus mykiss*	Introduced
Redband trout	*Oncorhynchus mykiss*	Indigenous
Sculpin species	*Cottus* spp.	Indigenous
Sockeye salmon/kokanee	*Oncorhynchus nerka*	Indigenous
Summer steelhead	*Oncorhynchus mykiss*	Indigenous
Three-spined stickleback	*Gasterosteus aculeatus*	Introduced
Tui chub	*Gila (Siphateles) bicolor*	Introduced

Source: Starcevich 2016; Starcevich and Bailey, 2017; Carrasco and Moberly 2014; CRWC 2002

Prior to the development of irrigated agriculture in the region, the spring-fed Deschutes River had relatively consistent streamflow seasonally and annually (DRC 2012). The steady streamflow created fish habitat with cold, clear water and consistent hydrology. Since the late 1800s, changes to the Deschutes River's streamflow, construction of fish passage barriers, and reservoir management have created a very different aquatic environment with resulting changes to the fish species assemblages.

Elevated water temperatures such as those found in the middle Deschutes River in response to reduced streamflow negatively affect salmonid growth and survival (Recsetar et al. 2012). Availability of cold water refugia for temperature-sensitive fish species is of key importance when river temperatures rise above acceptable standards. Water temperatures that are out of the normal range for a given fish species can increase physiologic stress, increase susceptibility to predators, and influence growth rates, feeding, metabolism, and development (Starcevich et al. 2015; Singh et al. 2013).

In addition to fish, other aquatic species have been found within the project area or along waterbodies that are associated with District operations. These other aquatic species include bullfrog, Oregon spotted frog, western toad, Pacific treefrog, and long-toed salamander. The western toad, Pacific treefrog, and long-toed salamander are native to Oregon and may be present in open irrigation canals and adjacent banks where there is suitable vegetation (S. Wray, ODFW, personal communication, November 17, 2017). The bullfrog is considered an invasive species that

was introduced to Oregon in the early 1900s. Bullfrogs are voracious predators that eat any animal they can swallow. Except for the Oregon spotted frog, which is listed as vulnerable, all of these amphibians are listed as species of least concern by the International Union for Conservation of Nature (IUCN 2018).

5.6.1 Federally Listed Fish and Aquatic Species

The 16 United States Code [USC] 1531 et seq, as amended in 1988, establishes a national program for the conservation of species listed as threatened and endangered, and the preservation of habitats on which they depend. The ESA defines procedures for listing species, designating critical habitat for listed species, and preparing recovery plans. Section 7 of the ESA, as amended, requires organizations to consult with USFWS if listed species or designated Critical Habitat may be affected by a proposed project. If adverse impacts would occur, the ESA requires federal agencies to evaluate the likely effects of the proposed project and ensure that it neither risks the continued existence of federally listed ESA species nor results in the destruction or adverse modification of designated Critical Habitat.

A list of fish and aquatic species protected under the ESA that are known or expected to occur in waterbodies associated with District operations was obtained using the USFWS Environmental Conservation Online System Information for Planning and Conservation (IPaC). The IPaC indicated that two federally listed fish and aquatic species, bull trout and Oregon spotted frog, are or may be found in the waterbodies associated with LPID operations (USFWS 2018). Neither of these species is known to occur, nor is suitable habitat available, within LPID's irrigation infrastructure in the project area.

USFWS lists Oregon spotted frog as threatened under the ESA. The Oregon spotted frog and its designated Critical Habitat occur in the upper Deschutes River near the Old Mill District in the City of Bend (RM 173) and upstream, Wickiup Reservoir, and Crane Prairie Reservoir. USFWS has identified Primary Constituent Elements (PCEs) for Oregon spotted frog Critical Habitat (81 Fed. Reg. 29335, 2016). They represent the biological and physical features that are essential to the conservation of a species and describe habitat components that support one or more life stages of the species. PCEs for Oregon spotted frog describe areas that have appropriate water depths and refuge from predators, aquatic connectivity, and absence of non-native predators.

USFWS also lists bull trout as threatened under the ESA. Bull trout are known to be present in the Deschutes River from Big Falls (RM 132) to Lake Billy Chinook (RM 120) and approximately 0.6 miles upstream of Lake Billy Chinook to Opal Springs Dam on the Crooked River (ODFW 2003, 1996; USFWS 2002). These sections of river are also designated Critical Habitat (USFWS 2002). The PCEs for bull trout describe habitat that has aquatic connectivity, complex habitat structure, water temperatures ranging from 2 degrees Celsius (°C) to 15°C, natural variability in streamflow, a sufficient food base, and the absence of non-native predatory and competing fish (70 Fed. Reg. 56211, 2005).

5.6.2 State Listed Fish and Aquatic Species

ODFW maintains a list of native wildlife species in Oregon that have been determined to be either "threatened" or "endangered" according to criteria set forth by rule (Oregon Administrative Rule [OAR] 635-100-0105) (ODFW 2017). There are no Oregon-listed threatened, endangered, or candidate fish or aquatic species known to occur within the waterbodies associated with LPID operations or in the irrigation canals and laterals within the project area.

5.7 Geology and Soils

5.7.1 Geology

The project area is located at the interface of the John Day Formation bordering the west, north, and eastern edge of the District, and the Newberry Volcano Formation on the south. The area was primarily formed over the past 2 million years during the Quaternary Epoch. This volcanic activity resulted in complex assemblages of vents, lava flows, pyroclastic deposits, and volcanically-derived sedimentary deposits. Over the last 2 million years, erosion, sedimentation, and volcanic activity resulted in more layers of alluvium, ash, and rhyolite over the District's area. The geologic units found in the District include sedimentary rocks and deposits, basalt, alluvium, sand and gravel, rhyolite, and tuff. In areas where the underlying rock formation consists of fine-grained sedimentary deposits, dense lava flows, and pyroclastic flows, the ability of water to penetrate the layer is low. In areas with coarse-gained, unconsolidated sediments, vesicular rock, and brecciated lava flows that contain holes and cracks, water can move through easily (Lite and Gannet 2002). The region's geology influences its hydrology; many stream reaches lose water to the underlying aquifers or gain water through springs, both of which are created by these layers of volcanic rock.

5.7.2 Soils

The predominant soil map units in the project area are Court gravelly ashy sandy loam (1 to 8 percent slopes); Era series; and Deskamp-Gosney complex (0 to 8 percent slopes). The Court series of soils are moderately deep to sand and gravel, very deep to bedrock and well drained. They formed in eolian material high in ash over older alluvium and colluvium. The Era series, including Era ashy loam (0 to 3 percent slopes) and Era ashy sandy loam (0 to 8 percent slopes), consists of deep and very deep, well-drained soils formed in eolian material high in ash. Approximately 65 percent of soils in the District are classified by NRCS as Prime Farmland if irrigated and 20 percent are classified as Farmland of Statewide Importance.

5.8 Land Use, Zoning, and Ownership

5.8.1 Land Ownership

The project area traverses privately owned land, most of which is within the District's boundary and existing ROWs. Landowners in the District have acknowledged the District's right to unfettered ingress and egress for the purposes of operating and maintaining existing canal and lateral irrigation infrastructure. The current owners of the properties traversed by current District infrastructure are not opposed to formally granting new easements/ROWs to the District for any existing infrastructure or proposed new infrastructure realignments that may be proposed (J. Camarata, personal communication, April 3, 2018). The pipeline realignment involved in the project also includes construction and installation of District infrastructure along private property that is not within the District boundary. These private landowners are being consulted during the scoping phase.

5.8.2 Land Use

The District is located in a rural area consisting of large parcels of land. Of the 5,019 acres that fall within LPID's boundary, 2,369 acres are currently served by the District. All acres served by the District are for agricultural use. The crops grown are primarily alfalfa/grass hay, mint, and carrot seed. Farmers typically get three cuttings per year on hay. A mint processing plant is located in the valley. Most of the land is zoned as Exclusive Farm Use (EFU) Prineville Valley-Lone Pine Areas (EFU-2). The counties are required to inventory and protect farm lands under Statewide Goal 3,

Agricultural Land, ORS 215 and OAR 660-033. The EFU-2 designation serves to accomplish Statewide Goal 3. The purpose of EFU zoned land is to preserve and maintain Oregon's agricultural lands and the benefits they provide.

Land within the District boundary that is not served by the District is primarily undeveloped land consisting of shrub-scrub species and juniper (USGS 2011). Developed land within the District mainly consists of patrons' and other rural residences, some agricultural land that is irrigated by private groundwater, roads, the mint processing plant, and a war museum.

5.9 Public Safety

The District has approximately 10.5 miles of open canals and laterals. Although these canals and laterals are entirely on private land, they remain accessible to the public. Open canals and laterals pose a risk to public safety when they carry water. Swift water flowing through the canals can make it difficult for a child or non-swimmer to exit the canal and get to safety, and can result in tragic outcomes. Two recent deaths have occurred in other districts' canals, and District personnel and patrons would like to eliminate such risks.

5.10 Recreation

There are no public recreational opportunities on or adjacent to LPID facilities as the entirety of the project area crosses private land. Recreational use of maintenance roads and canals is not sanctioned by the District or private land owners.

The Deschutes River from the Crane Prairie Reservoir to Lake Billy Chinook would be indirectly affected by the project due to increased streamflow. Part of this section of the Deschutes River is designated as a Wild and Scenic River (see Section 5.14.5). Parks and campgrounds are found sporadically along these reaches. Crane Prairie Reservoir and the Deschutes River provide many types of recreation, including rafting, swimming, fishing, kayaking, floating, boating, and birding. National forest and public parks along these waterbodies provide areas for biking, hiking, hunting, and cross-country skiing.

5.11 Socioeconomics

The project area falls within Crook, Deschutes, and Jefferson counties. Nearby cities and towns include Redmond, Bend, Terrebonne, and Prineville. Generally, the area has seen stable growth over the past 10 years (2005 to 2015; see Table 5-4). The Oregon Office of Economic Analysis estimates that by 2040 Deschutes County could reach a population of 241,223, Crook County could reach a population of 26,117, and Jefferson County could reach a population of 29,413 (OEA 2013).

Table 5-4. Population Characteristics by City, County, and State.

Area	Year 2000 Population (number of people)[1]	Year 2015 Population (number of people)[2]	Population Growth Rate 2000 to 2015	Year 2015 Population per Square Mile (number of people)
Cities and Towns				
Redmond	13,481	27,450	104%	1,635
Terrebonne	1,469	1,182	-20%	262
Prineville	7,356	9,266	26%	849
County				
Deschutes County	115,367	166,622	44%	55
Jefferson County	19,009	22,061	16%	12
Crook County	19,182	20,956	9%	7
State				
Oregon	3,421,399	3,939,233	15%	40

Source: 1. U.S. Census Bureau 2000; 2. U.S. Census Bureau 2015

5.11.1 Area Employment and Income

The economy within the area associated with the project is described by employment/unemployment figures, employment by industry, and agricultural activity. Table 5-5 demonstrates the labor force characteristics for Deschutes County, Jefferson County, Crook County, and the State of Oregon in 2017.

Table 5-6 summarizes employment by industry classification. Educational services, health care, and social assistance provides the most employment throughout the area.

Table 5-5. Labor Force Characteristics in the State of Oregon, Deschutes County, Jefferson County, and Crook County, 2017

Indicator	Deschutes County	Jefferson County	Crook County	Oregon (State)
Labor Force	93,444	10,133	9,617	2,104,077
Employed	89,625	9,859	9,035	2,017,292
Unemployed	3,820	544	582	86,786
Unemployment Rate	4.1%	5.4%	6.1%	4.1%

Source: USBLS 2017

Table 5-6. Employment by Industry and Percent Employment Rates in the State of Oregon, Deschutes County, Jefferson County, and Crook County, 2016.

Employment Sectors	Oregon		Deschutes County		Jefferson County		Crook County	
	Number of People	Percent of Oregon Employment	Number of People	Percent of County Employment	Number of People	Percent of County Employment	Number of People	Percent of County Employment
Agriculture, forestry, fishing and hunting, and mining	60,693	3.3%	2,277	2.9%	829	10.2%	457	5.5%
Arts, entertainment, recreation, accommodation, and food services	182,571	10.0%	10,873	13.8%	898	11.0%	823	9.9%
Construction	103,772	5.7%	5,721	7.3%	423	5.2%	495	6.0%
Educational services, health care, and social assistance	421,502	23.0%	16,231	20.6%	1,671	20.6%	1,721	20.7%
Finance and insurance, real estate, rental, and leasing	104,341	5.7%	4,856	6.2%	342	4.2%	213	2.6%
Information	34,090	1.9%	2,075	2.6%	54	0.7%	125	1.5%
Manufacturing	208,442	11.4%	6,366	8.1%	1,141	14.0%	1,069	12.9%
Other services (except public administration)	88,784	4.8%	4,633	5.9%	337	4.1%	346	4.2%
Professional, scientific, management, and administrative and waste management services	196,635	10.7%	8,955	11.4%	372	4.6%	674	8.1%
Public administration	82,094	4.5%	2,622	3.3%	632	7.8%	582	7.0%
Retail trade	219,299	12.0%	10,221	13.0%	934	11.5%	1,346	16.2%

Employment Sectors	Oregon		Deschutes County		Jefferson County		Crook County	
	Number of People	Percent of Oregon Employment	Number of People	Percent of County Employment	Number of People	Percent of County Employment	Number of People	Percent of County Employment
Transportation, warehousing, and utilities	76,661	4.2%	2,352	3.0%	316	3.9%	261	3.1%
Wholesale trade	53,736	2.9%	1,628	2.1%	179	2.2%	198	2.4%
Total Employed- all sectors	**1,832,620**	**100%**	**78,810**	**100%**	**8,128**	**100%**	**8,310**	**100%**

Source: U.S. Census Bureau 2016

5.11.2 Agricultural Statistics

The 2012 U.S. Department of Agriculture (USDA) Census of Agriculture provides data for the counties surrounding the District. In Deschutes County, livestock sales represent 46 percent of the total market value of products sold and crop sales were 54 percent. The top crop item produced by acreage (21,254 acres) is forage[2]. The top livestock item produced by inventory numbers is cattle and calves. In Jefferson County, livestock sales represent 27 percent of the total market value of products sold and crop sales represent 73 percent. The top crop item produced by acreage (20,141 acres) is forage, and the top livestock item produced by inventory numbers is cattle and calves. In Crook County, livestock sales represent 68 percent of the total market value of products sold and crop sales represent 32 percent. The top crop item produced in the county by acreage (39,591 acres) is forage and the top livestock item produced by inventory numbers is cattle and calves. Table 5-7 presents agricultural information for the lands served by the District.

Table 5-7. Crops Grown in the District

Crop	Total Acreage
Carrot Seed	35
Wheat	191.6
Triticale	185.35
Alfalfa	527
Grass Hay	331
Corn	200
Mint	522
Harvested Trees	10
Pasture	367.05
Total	**2,369**

Source: LPID 2018b

5.12 Vegetation

LPID lies in the high lava plains province and within the western juniper forest zone of Central Oregon (Johnson and O'Neil 2001). Over the past 100 years, land use has changed much of the vegetation within the District. Roads, irrigated agriculture, land management, and livestock grazing are the primary causes of changes to the plant community. The introduction of cheatgrass has also threatened the survival and diversity of native perennial grasses and forbs while increasing the risk of severe hot wild fire in the project area. Due to the exclusion of fire, dense stands of small diameter juniper, sage, and bitterbrush cover vast areas of a land base once dominated by large diameter juniper and grasses.

[2] "Forage" is defined as all hay and haylage, grass silage, and greenchop.

Common vegetation found within the project area are native bunchgrasses, wild rye, tall tumble mustard, rabbit brush, big sagebrush, and a magnitude of common weeds including cheatgrass, horseweed, Russian thistle, and common mullein. Few western junipers are found along the canals and laterals. In some sections of the project area an opportunistic fringe of hydrophytic (water-loving) plants has formed along the margins of the top of the canal bank represented predominately by bulrush and tufted hairgrass.

5.12.1 Special Status Species

No plants that are ESA or Oregon-listed endangered, threatened, species of concern, or their designated critical habitats are known to occur within the project area.

5.13 Visual Resources

Generally speaking, canals and laterals are flat against the landscape; in some project-area segments, the canals and laterals are a few feet lower than the landscape level and the canal and lateral banks are part of the landscape. Within the project area, a variety of vegetation grows adjacent to canals and laterals and can obscure the view of the canals and laterals. Throughout agricultural lands, the visual characteristics of the existing canal and lateral alignments vary greatly. In some areas, the canal features are obscured by vegetation, while in others they are a prominent visual characteristic.

Viewers' experiences of canals and laterals differ throughout the year. The District's irrigation season is typically from April through November 1. During this time, the District's canals and laterals carry water. Outside of the irrigation season, from November through March, the canals and laterals do not carry water and are usually dry with a few remaining puddles in low-lying areas. Although the canals are not naturally formed waterways, the presence of open channels with flowing water could be considered an amenity by some residents as it provides a unique water feature in areas that otherwise would not have natural waterways. The proposed project would occur entirely on private lands and land owners are supportive of the project.

5.14 Water Resources

5.14.1 Water Supply

Waterbodies associated with District operations include Crane Prairie Reservoir, Wickiup Reservoir, the Deschutes River, and the Crooked River (see Table 5-2 in Section 5.6 for the list of waterbodies and their associated river miles). The upstream end of Lake Billy Chinook, at the confluence of the Deschutes, Crooked, and Metolius Rivers, serves as the downstream boundary of the area in which District operations can influence streamflow.

Approximately 67 percent of the water used by the District (10,680 acre-feet) comes from live flow in the Deschutes River. The other 33 percent (up to 10,500 acre-feet) comes from storage in Crane Prairie Reservoir, located at Deschutes RM 238.5. The District holds a live-flow water right with a priority date of October 31, 1900 for up to 29.1 cfs (LPID 2017). The District supplements their live-flow right with storage from Crane Prairie Reservoir. Both live flow and storage are diverted at COID's PBC diversion (RM 164.8), conveyed through COID's PBC to its terminus, and delivered to LPID's main canal.

Crane Prairie Reservoir is primarily fed by annual snowmelt, precipitation, and inflow from the Deschutes River. It is relatively shallow and holds 55,300 acre-feet at full capacity. Although Reclamation owns the reservoir, daily responsibility for O&M has been transferred to and is financed by COID. Crane Prairie Reservoir is federally authorized for irrigation and state authorized for multiple purposes, including instream flows for fish and wildlife. Three irrigation districts hold

water rights to store a combined 50,000 acre-feet in the reservoir: LPID (10,500 acre-feet), Arnold Irrigation District (AID; 13,500 acre-feet), and COID (26,000 acre-feet). Although LPID's storage water right allows up to 10,500 acre-feet, the District has recently voluntarily allocated 5,500 acre-feet to instream use per a settlement agreement related to the Oregon spotted frog. This settlement agreement is due to expire in July 2019. This adjustment is legally recognized but, given the temporary status of the Stipulated Settlement Agreement, an amendment to the District's water right has not yet been made.

Water from Crane Prairie Reservoir is released throughout the year. During the irrigation season, water is released as necessary to supply the Districts' water rights. This water is conveyed from Crane Prairie Reservoir, down the Deschutes River, through Wickiup Reservoir, and then north through the Deschutes River to the PBC diversion.

The irrigation season is separated into three sub-seasons, each with different certificated delivery rates (Table 5-8). During the shoulder seasons (season 1 and season 2), the District's certificated delivery rates are less than the full season live-flow diversion rate (season 3) and supplemental storage water may be needed to accommodate patron needs. Additionally, the District uses storage water to supplement live flow at the start of the season to help saturate the banks of the canals and laterals and carry water to the end of the conveyance system. During the late summer and fall, storage water may be used to supplement reduced live flow availability caused by drought or seasonal streamflow declines.

Table 5-8. LPID Certificated Diversion Flow Rates and Irrigation Season Dates per Water Right Certificate 72197.

Season	Start Date	End Date	Start Date	End Date	Season Duration (days)	Certified Delivery Rate (cfs)	Percent of Full Rate
1	April 1	April 30	Oct. 1	Nov. 1	62	1 cfs to 137.0 acres	63%
2	May 1	May 14	Sept. 15	Sept. 30	30	1 cfs to 109.0 acres	79%
3	May 15	Sept. 14	NA	NA	122	1 cfs to 86.6 acres	100.0%

Notes: Maximum live flow diversion rate is 29.1 cfs, 43.5 cfs with storage rights.

5.14.2 Surface Water Hydrology

5.14.2.1 Deschutes River (RM 238.5) to the PBC diversion at North Canal Dam (RM 164.8)

Prior to development of irrigated agriculture, the spring-fed Deschutes River had relatively consistent streamflow seasonally and annually (DRC 2012). Construction and operation of reservoirs, dams, and diversions on the river and its tributaries changed hydrologic conditions in the Deschutes River. Management of surface water for irrigation use results in lower flows downstream from reservoirs during the storage season (i.e., late fall, winter, and early spring), higher flows downstream from reservoirs during the irrigation season (April 1 to November 1), and lower flows in the middle Deschutes River downstream from irrigation diversions during the irrigation season.

Over the past 15 years, streamflow in the Deschutes River has steadily increased due to collaborative restoration efforts by the irrigation districts and their partners. July median streamflow in the Deschutes River at North Canal Dam (RM 164.8) more than tripled from 47 cfs to 158 cfs between

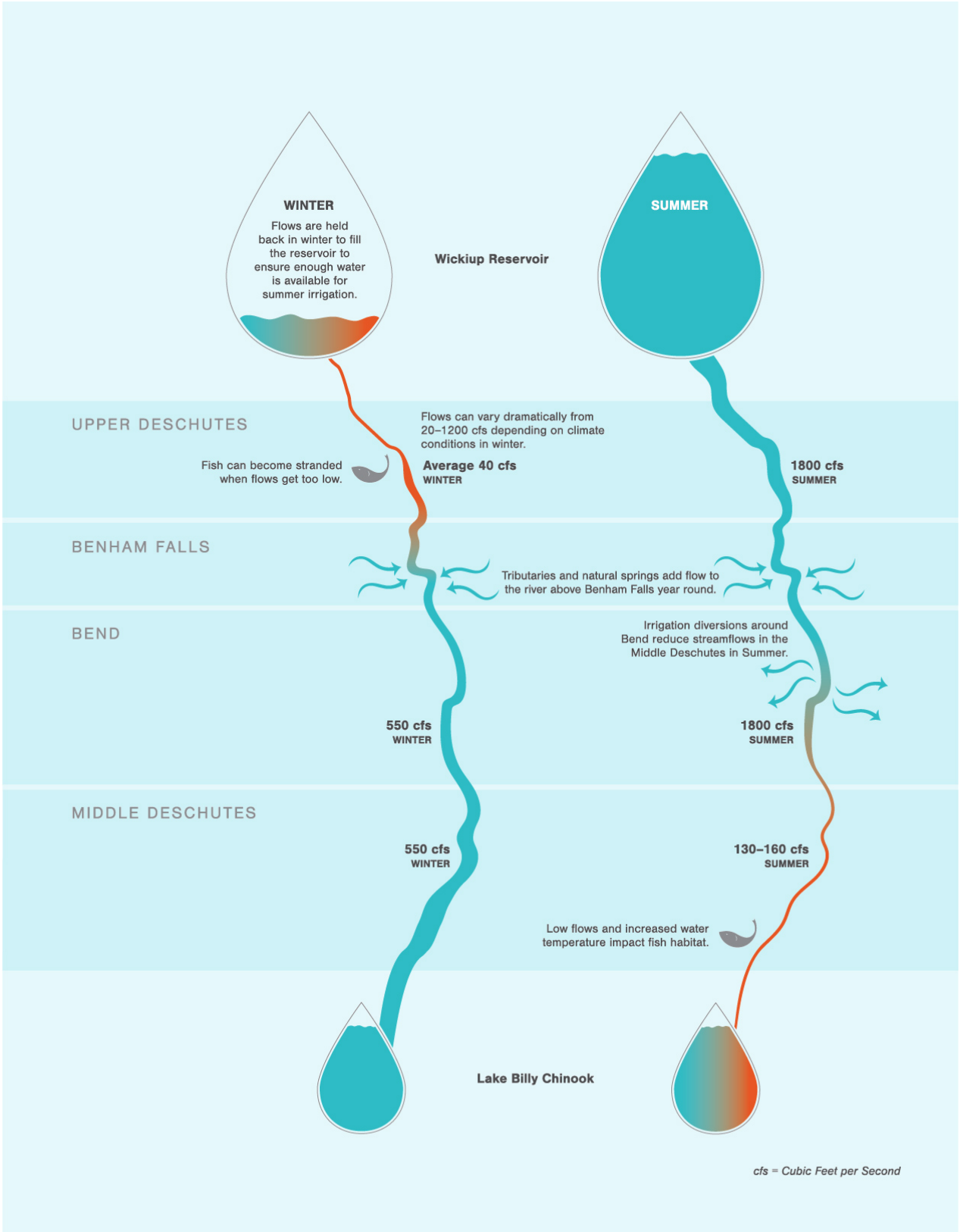
2002 to 2012 (Mork 2016). July median streamflow dropped in 2013 to 129 cfs due to a reduction in instream leases and water voluntarily left instream by irrigation districts. It has steadily crept upward since 2013 to a 2015 July median flow of 136 cfs (Mork 2016). OWRD monitors streamflow and ensures that leases, transfers, and conserved water from piping and other conservation projects remain instream.

The Deschutes Basin has experienced a general drying trend for several decades (Gannett and Lite 2013) and is susceptible to future changes in precipitation and changes in the amount and timing of spring runoff (Shelton and Fridirici 2001). Models suggest that increased rain and a decreased snowpack combined with an accelerated rate of spring snowmelt will have a growing influence on the future water supply in the area; these changes will make managing water supplies more difficult (Shelton and Fridirici 2001; Reclamation 2016).

LPID's irrigation operations affect water storage in Crane Prairie Reservoir and streamflow in the Deschutes River between Crane Prairie (RM 238.5) and Lake Billy Chinook (RM 120). The total streamflow of the Deschutes River between Wickiup Reservoir Dam (RM 226.8) and Lake Billy Chinook is a product of reservoir releases (by LPID, COID, AID, and North Unit Irrigation District), tributary inflows, irrigation diversions, and groundwater interactions. Reservoir storage and releases contribute to lower winter streamflow and higher summer streamflow upstream in the Deschutes River upstream from irrigation diversions (e.g., North Canal Dam). Downstream from irrigation diversions, the diversions contribute to lower streamflow during the irrigation season (see Figure 4).

Outside of the irrigation season, irrigation districts were historically required a minimum outflow of 20 cfs from Wickiup Reservoir (DRC 2012). In 2016, LPID and the other districts that store water in Crane Prairie Reservoir and Wickiup Reservoir agreed to voluntarily release additional streamflow from Wickiup Reservoir outside of the irrigation season. These releases were intended to benefit Oregon spotted frog populations in the Deschutes River (Stipulated Settlement Agreement; Center for Biological Diversity, et. al. v. U.S. Bureau of Reclamation et al., and Arnold Irrigation District, et al. 2016). The purpose of these releases is to improve aquatic resources and their habitat. Under the Stipulated Settlement Agreement, LPID and other districts agreed to maintain a minimum of 100 cfs in the upper Deschutes River outside of the irrigation season[3]. These additional reservoir releases are not legally protected instream against diversion.

[3] In addition to interim operation adjustments to Crane Prairie and Wickiup dams and reservoirs, this Stipulated Settlement Agreement prompted interim operation adjustments for a District operating Crescent Lake dam and the completion of the consultation and biological opinion by USFWS on effects of such operations on the Oregon spotted frog.



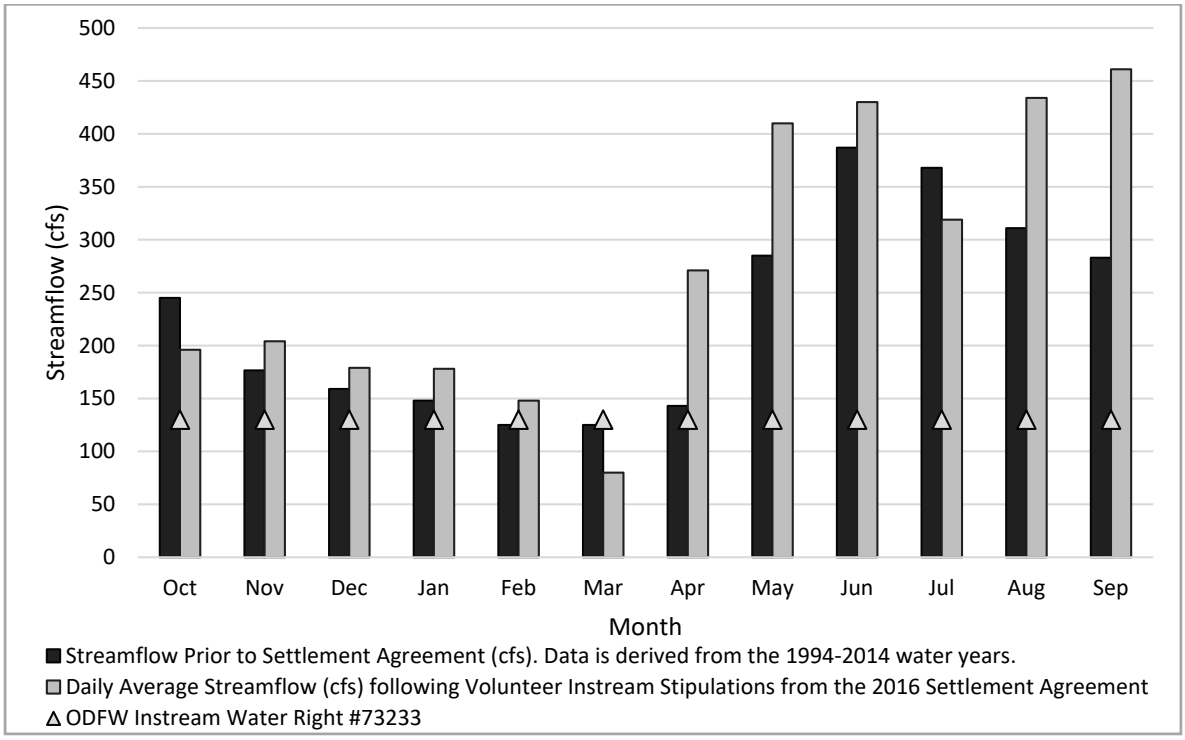
Source: COID 2018

Figure 4. Upper and Middle Deschutes River (RM 226.6 – RM 120) seasonal flow management.

The Deschutes River downstream from Crane Prairie Reservoir has instream water rights that have serve as preliminary streamflow targets. The instream water rights were intended to support aquatic life and minimize pollution. These water rights are as follows:

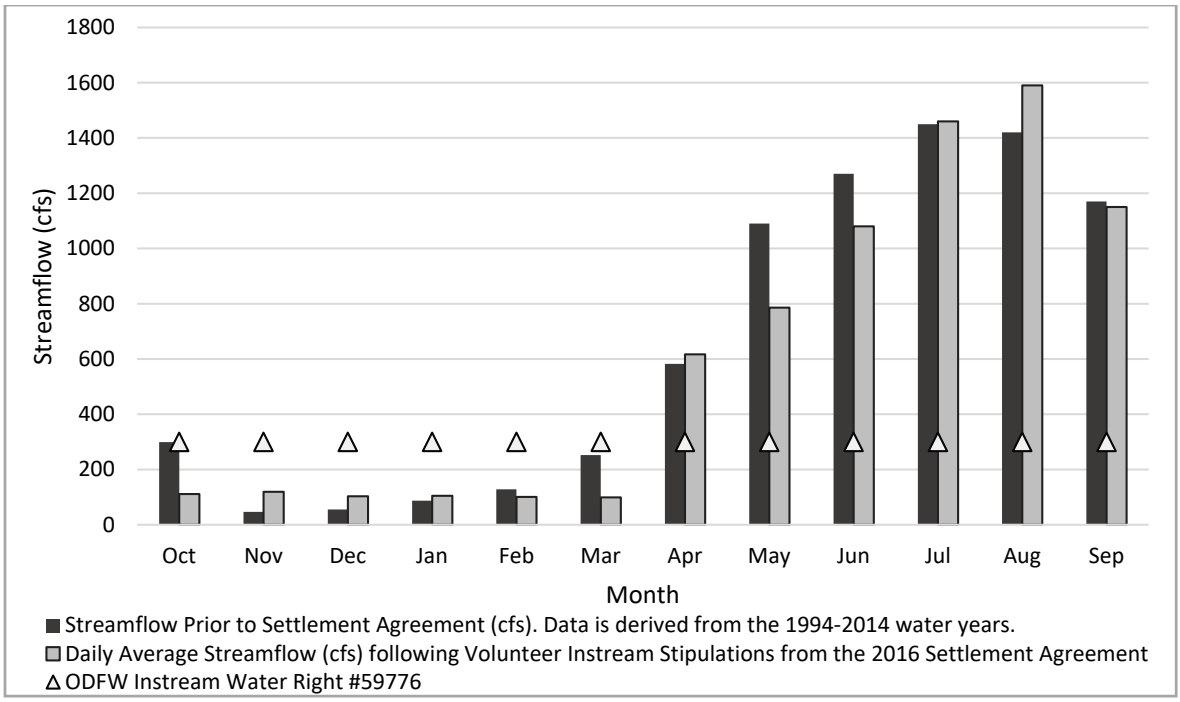
- 130 cfs with an October 11, 1990, priority date between Crane Prairie Reservoir (RM 237.0) and Wickiup Reservoir (RM 238.5) (certificate #73233)
- 300 cfs with a November 3 1983, priority date between Wickiup Reservoir Dam (RM 226.8) and the confluence with the Little Deschutes River (RM 192.5) (certificate #59776)
- 400 cfs with a November 3, 1983, priority date between the mouth of the Little Deschutes River (RM 192.5) to the mouth of the Spring River (RM 190.4) (certificate #59777)
- 660 cfs with a November 3, 1983, priority date between the mouth of the Spring River (RM 190.4) and the North Canal Dam (RM 164.8) (certificate #59778)

Figure 5, Figure 6, and Figure 7 display the Deschutes River's daily average streamflow prior to the Stipulated Settlement Agreement (1994 to 2014) and the daily average streamflow (October 2016 to September 2017) following the Stipulated Settlement Agreement. Beginning in the 1990s, irrigation districts and their partners initiated water conservation projects that allocated water instream; therefore, streamflow prior to the Stipulated Settlement Agreement is better represented using data from the 1994 to 2014 water years.



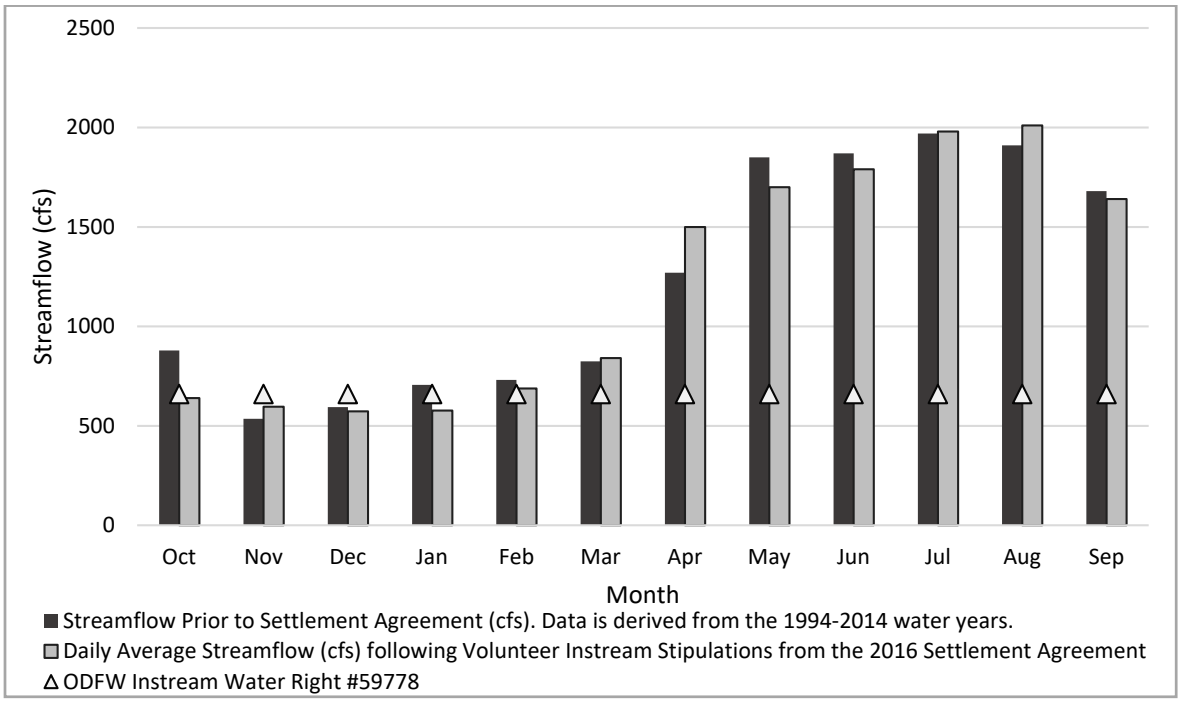
Source: OWRD 2018a

Figure 5. Daily average streamflow in the Deschutes River downstream from Crane Prairie Reservoir at OWRD Gauge No. 14054000.



Source: OWRD 2017a

Figure 6. Daily average streamflow in the Deschutes River downstream from Wickiup Reservoir at OWRD Gauge No. 14056500.



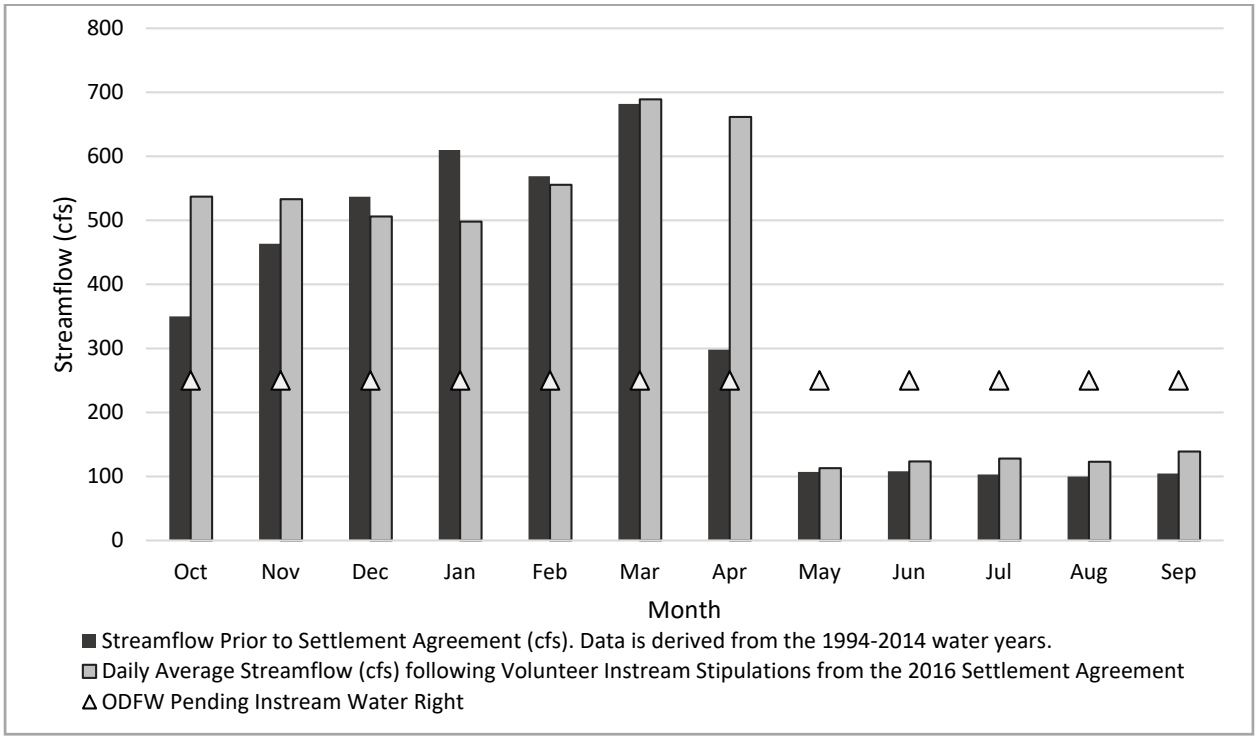
Source: OWRD 2017b

Figure 7. Daily average streamflow in the Deschutes River at Benham Falls at OWRD Gauge No. 14064500.

5.14.2.2 Deschutes River, PBC diversion at North Canal Dam (RM 164.8) to Lake Billy Chinook (RM 120)

LPID, COID, AID, Swalley Irrigation District, Tumalo Irrigation District, and North Unit Irrigation District divert water from the Deschutes River at or near the North Canal Dam, influencing streamflow patterns in the Deschutes River downstream to Lake Billy Chinook. Historically, these irrigation districts maintained a minimum of 30 cfs instream in this reach during the irrigation season under a voluntary agreement. Extensive conservation efforts by the irrigation districts and their partners starting in the 2000s have enhanced streamflow during the irrigation season increasing the average flows to 70 cfs. Following the Stipulated Settlement Agreement in 2016, these irrigation districts have maintained an average of 125 cfs downstream from their diversions during the summer irrigation season (see Figure 8).

ODFW has a pending water right requesting a year-round flow of 250 cfs in this reach. This pending water right provides a preliminary target for streamflow needed for fish, wildlife, their habitat quality, or recreation between the North Canal Dam to Round Butte Reservoir (RM 119.5).



Source: OWRD 2018b

Figure 8. Daily average streamflow in the Deschutes River downstream from North Canal Dam at OWRD Gauge No. 14070500.

5.14.2.3 Crooked River (RM 30.2) to Lake Billy Chinook (mouth)

The project may affect streamflow rates in the Crooked River. The Crooked River is a tributary to the Deschutes River. It joins the Deschutes River at Lake Billy Chinook. Currently, reservoir releases from Ochoco and Prineville Reservoirs, tributary inflows, irrigation diversions, irrigation return flows, and groundwater interactions drive streamflow patterns in this reach (see Figure 9 and Figure 10).

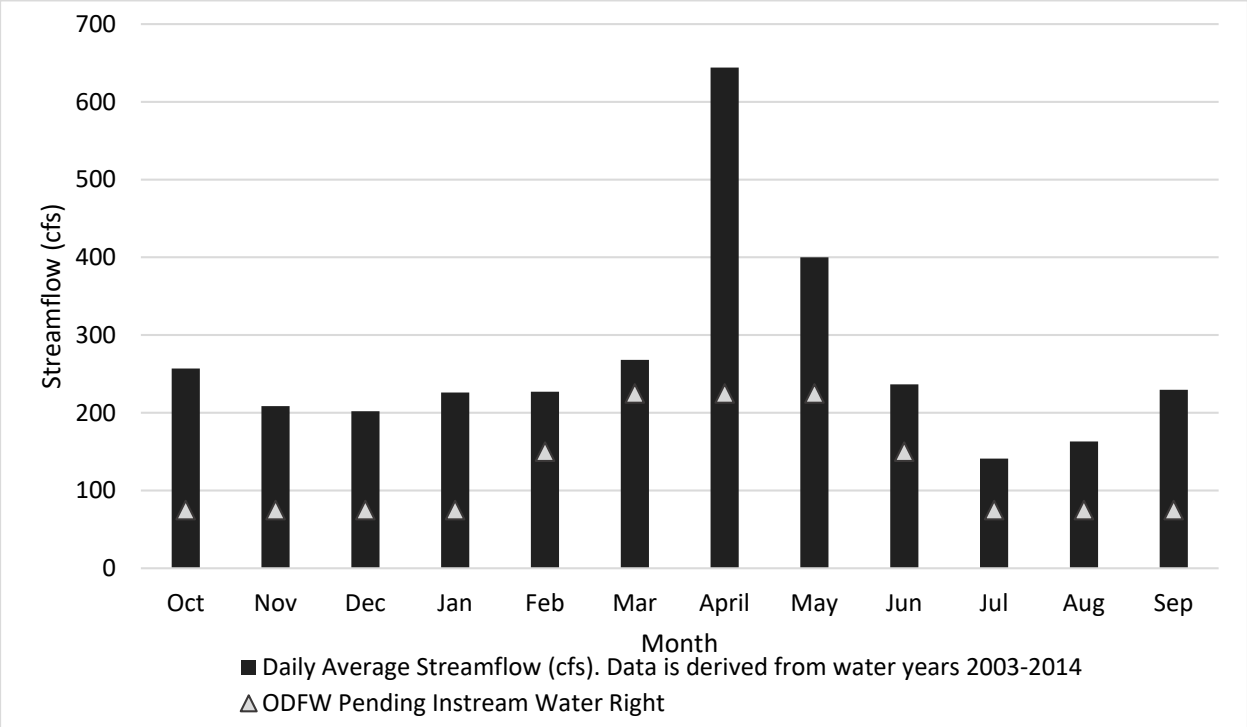
A segment of the Crooked River associated with the project is federally designated as a Wild and Scenic River. This segment includes a total of 9.8 miles from RM 17.8 at the National Grasslands boundary near Ogden wayside to RM 8, south of Opal Spring (BLM 1992).

This reach of the Crooked River has a pending instream water right that has served as a preliminary streamflow restoration target (see Table 5-9). This water right, applied for by ODFW, identifies monthly streamflow for the Crooked River between Bowman Dam (RM 70.5) to Round Butte Reservoir (RM 0).

Table 5-9. Target Streamflow in the Crooked River between RM 70.5 and Mouth of the Crooked River based on Pending ODFW Water Right

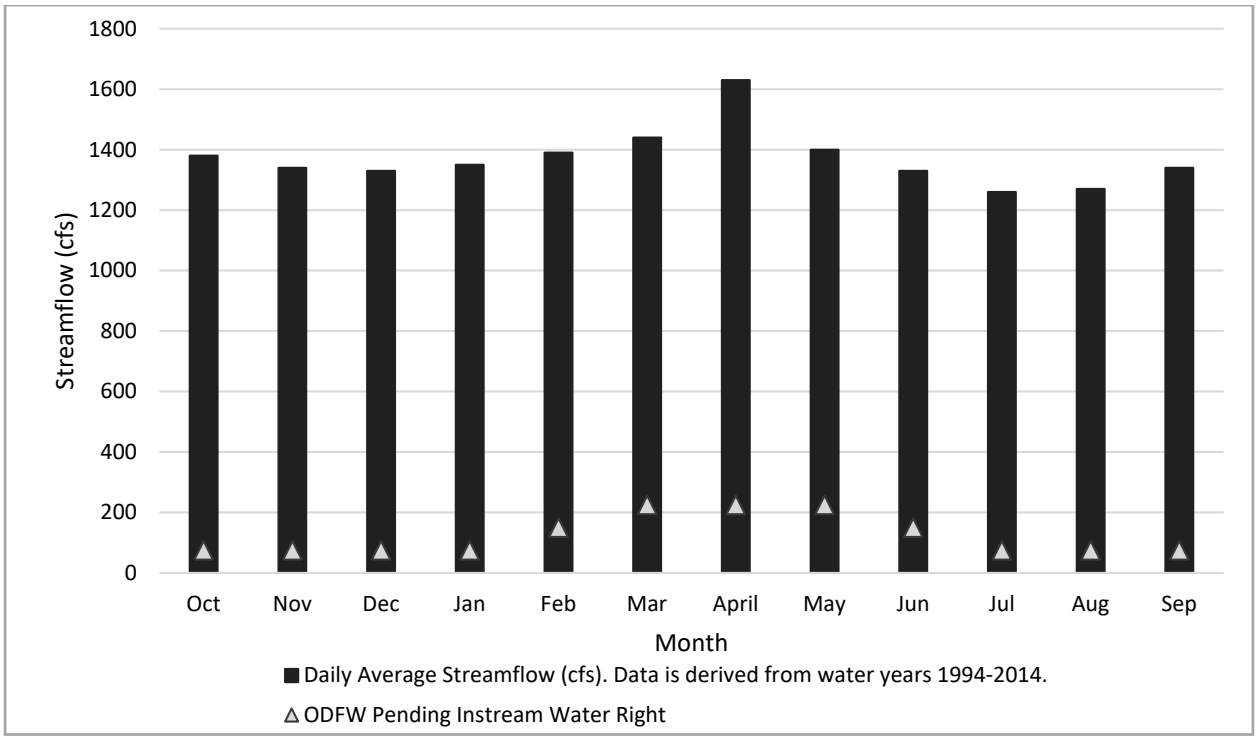
Instream Rates (cfs)											
Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
75	**75/150**	**225**	**225**	**225**	**150**	**75**	**75**	**75**	**75**	**75**	**75**

The District uses one operational spill from its system to the Crooked River at RM 30.2. This spill occurs throughout the irrigation season when there is excess water in the system due to changes in weather or patrons not using their full water rights. This excess water at the end of the District's system is referred to as tailwater. The District has kept detailed recordings of its tailwater flows, showing on average 1.34 cfs of daily instantaneous flow over a term of 182 days to the Crooked River at the beginning and end of the irrigation season (J. Camarata, personal communication, April 3, 2018).



Source: OWRD 2018c
Note: Streamflow data is only available for OWRD Gauge No. 14087380 beginning in the 2003 water year.

Figure 9. Daily average streamflow in the Crooked River downstream from Osborne Canyon at OWRD Gauge No. 14087380.



Source: OWRD 2018d

Figure 10. Daily average streamflow in the Crooked River downstream from Opal Springs at OWRD Gauge No. 14087400.

5.14.3 Water Quality

The ODEQ maintains a list of all surface waters in the state that are considered impaired because they do not meet water quality standards under Section 303(d) of the CWA (33 USC 1251 et seq.). This list is referred to as the 2012 303(d) list and is effective for CWA purposes. The waterbodies associated with District operations are included on Oregon's 303(d) list for not meeting water quality standards for one or more of aquatic weeds or algae, temperature, dissolved oxygen, pH, sedimentation, turbidity, and chlorophyll a (see Table 5-9).

Water management in the Deschutes Basin has altered seasonal streamflow patterns, increasing streamflows above historical levels in some reaches and decreasing streamflows below historical levels in other reaches. Low flows affect water quality in the Deschutes River by exacerbating temperature and dissolved oxygen problems. In addition, water quality often dictates the spread and extent of invasive aquatic species, and these problems interact to degrade wildlife habitat within and around the Deschutes River. The following sections describe existing 303(d)-listed impairments in the waterbodies associated with District operations. ODEQ is required to develop total maximum daily loads for rivers and streams in the upper Deschutes Basin.

Table 5-10. Impaired Waterbodies Associated with District Operations.

Waterbody Name	River Miles (RM) Associated with District Operations	Parameters Included on Oregon's 303(d) List
Crane Prairie Reservoir	N/A	Aquatic Weeds or Algae
Upper Deschutes River	Crane Prairie Reservoir (RM 238.5) to Wickiup Reservoir (RM 226.8)	Temperature
Wickiup Reservoir	N/A	Aquatic Weeds or Algae
Upper Deschutes River	Wickiup Reservoir Dam (RM 226.8) to Pilot Butte Canal diversion at North Canal Dam (RM 164.8)	Temperature Dissolved oxygen pH Sedimentation Turbidity Chlorophyll a
Middle Deschutes River	Pilot Butte Canal diversion at North Canal Dam (RM 164.8) to Lake Billy Chinook (RM 120)	Temperature Dissolved oxygen
Crooked River	River mile 30.2 to mouth (RM 0)	Temperature Dissolved oxygen pH *E. Coli* Biological criteria

Source: ODEQ 2012

Notes: The impaired waterbodies may continue outside of the area associated with District operations.

5.14.3.1 Temperature

The Deschutes River and the Crooked River do not meet stream temperature criteria within the area associated with District operations (see Table 5-10). The temperature criterion that applies throughout the area is 18°C (64.4°F), which is designed to protect salmon and trout rearing and migration. Elevated stream temperatures affect aquatic species including native fish by exacerbating conditions that cause stress and disease, raising their metabolism, and reducing growth rates. Low streamflow downstream of North Canal Dam, reduced streamside vegetation, and widened channels can all contribute to elevated stream temperatures.

5.14.3.2 Dissolved Oxygen

The Deschutes River and the Crooked River do not meet Oregon's standards for dissolved oxygen (Table 5-10). In the Deschutes River reach of RM 120 to 222.2, the dissolved oxygen levels are not high enough to meet Oregon's standards during trout spawning seasoning from January 1 to May 15 and do not meet Oregon's standards year-round from Deschutes RM 171.7 to RM 223.3 (ODEQ 2012). In the Crooked River, the dissolved oxygen levels in these reaches are not high enough to meet Oregon's standards year-round (ODEQ 2012). Low dissolved oxygen levels can affect aquatic life by reducing habitat quality and quantity, changing behavior, or reducing growth rates. Excess nutrient inputs, associated algae growth and die-off, and elevated stream temperatures can all contribute to lower dissolved oxygen levels.

5.14.3.3 pH

pH is a measure of the acidity or alkalinity of a waterbody. The Deschutes River exceeds Oregon's pH standard with higher, or more alkaline values from RM 126.4 to RM 162.6 all year and RM 162.6 to 168.2 during summer (ODEQ 2012; see Table 5-10). In the Crooked River, pH standards in the reach associated with District operations exceed Oregon's standards during the summer (ODEQ 2012). Higher pH can affect aquatic life by changing the solubility or biological availability of chemicals in the water.

5.14.3.4 Sedimentation

Sedimentation refers to deposits of silt, sand, or other small particles in a river. The upper Deschutes River from RM 168.2 to 222.2, does not meet Oregon's standards for sedimentation (ODEQ 2012; see Table 5-10). ODEQ set this standard to protect resident fish and aquatic life and salmonid fish spawning and rearing in the river. In the Deschutes River, lower winter flows and higher summer flows have contributed to increased bank erosion. Increased bank erosion contributes to increased sediment in the river. The river carries this sediment downstream and deposits it along the riverbed. Deposited sediment can affect fish and aquatic life by reducing the quantity and quality of available habitat.

5.14.3.5 Turbidity

Turbidity is a measure of water cloudiness. The upper Deschutes River from RM 168.2 to RM 222.2, does not meet Oregon's turbidity standard during the spring and summer (ODEQ 2012; see Table 5-10). This standard is set to protect aesthetics, resident fish and aquatic life, and water supply in the river. Suspended sediment, algae, and other suspended or dissolved materials contribute to increased turbidity.

5.14.3.6 Chlorophyll a

Chlorophyll a is a specific type of chlorophyll that is measured to evaluate the amount of algae in a waterbody. Monitoring chlorophyll levels is a direct way of tracking algal growth; surface waters that have high chlorophyll conditions are typically in correlation with high levels of nutrients, commonly phosphorus and nitrogen. The Deschutes River from RM 168.2 to RM 189.4 does not meet Oregon's standards during the summer (ODEQ 2012). The ODEQ set this standard to protect multiple uses in the river, including resident fish and aquatic life. High chlorophyll a indicates excess algal growth in the river. Excess algae often contributes to low dissolved oxygen concentrations. Excess algal growth can be caused by both natural influences and nutrient inputs (from sources such as fertilizer or leaking septic tanks) into the waterbody.

5.14.3.7 *E. Coli*

Escheria coli (*E. coli*) is a bacteria used as an indicator for fecal contamination. In the Crooked River, the *E. coli* levels in the reach associated with District operations exceed Oregon's standards during the summer (ODEQ 2012; see Table 5-10). ODEQ set this standard to protect multiple uses in the river including recreation and domestic purposes. High levels of bacteria can cause human illness.

5.14.3.8 Aquatic Weeds or Algae

The aquatic weeds and algae parameter on the 303(d) list indicates that a waterbody has received health advisories for algal blooms. Crane Prairie Reservoir and Wickiup Reservoir have been issued health advisories for exceeding toxicity levels (ODEQ 2012; see Table 5-10). The ODEQ set this standard to protect multiple uses in the waterbodies. Algal blooms can produce toxic substances, which pose danger to people and animals that drink or come into contact with affected waters.

5.14.4 Groundwater

Due to the porous geology of the area, groundwater levels and stream discharge are tied to the frequent movement of water between surface and groundwater sytems. Irrigation canals in LPID's service area show seepage losses due to the area's permeable geology. A loss assessment study in 2016 measured up to 8.8 cfs of peak-season loss in LPID's canals due to seepage (LPID 2017). Gannet and Lite's (2001) groundwater flow model suggests that this seepage water enters the region's groundwater system and discharges into the Crooked River near Opal Springs.

5.14.5 Wild and Scenic Rivers

Three federally designated Wild and Scenic Rivers (Public Law 90-542; 16 USC 1271 et seq.) are associated with District operations.

- The Deschutes River from Wickiup Reservoir (RM 226.8) to the Bend Urban Growth Boundary (UGB) at the southwest corner of Section 13, T18S, R11E (approximately RM 172) is classified as both "Scenic" and "Recreation" with Outstandingly Remarkable Values including Cultural, Fish, Geologic, Historic, Recreation, Scenery, Wildlife, and Botany.
- The Deschutes River from Odin Falls (RM 139.9) to the upper end of Lake Billy Chinook (RM 120) is classified as "Scenic" with its Outstandingly Remarkable Values including Cultural, Fish, Geologic, Recreation, Scenery, Wildlife, Hydrology, Botanical/Ecological, and Wilderness.
- The Crooked River from the National Grasslands boundary (RM 25.8) to Dry Creek (RM 8) is classified as "Recreation" with Outstanding Remarkable Values including Geologic, Recreation, Scenery, Wildlife, Hydrology, and Botanical/Ecological.

In addition to federally designated Wild and Scenic Rivers, several waterways affected by LPID operations are designated as Oregon Scenic River Waterways through the Oregon State Scenic Waterway Act (ORS 390.826). These locations and classifications are detailed in Table 5-11.

Table 5-11. Designated Oregon Scenic River Waterways Associated with District Operations

River	Reach	Classification [1,2,3,4]
Upper Deschutes River	From RM 224.5 to RM 204, with the exception of Pringle Falls (RM 217.5 to RM 216.5)	Scenic River Area
Upper Deschutes River	From the Deschutes National Forest boundary in Section 20, T19S, R11E (approximately RM 184.8) to the Bend UGB(approximately RM 172)	Scenic River Area
Upper Deschutes River	From RM 226.4 to approximately RM 224.5; from RM 217.5 to RM 216.8; from RM 204 to about RM 199; and from RM 172 to RM 171	River Community Area
Upper Deschutes River	From RM 190.6 to approximately RM 184.8	Recreational River Area

River	Reach	Classification [1,2,3,4]
Middle Deschutes River	From Deschutes Market Road (approximately RM 157) to the south boundary of the Wilderness Study Area (approximately RM 131), with the exception of the Clines Falls Dam and powerhouse between State Highway 126 Bridge (RM 144.9) and RM 144 and the Crooked River Ranch River Community Area (RM 129.9 to RM 131.5)	Scenic River Area
Middle Deschutes River	From RM 164 to approximately RM 161; from RM 129.9 to RM 131.5; and from RM 124.3 to RM 125.25	River Community Area
Middle Deschutes River	From the northern Bend UGB (RM 161) to Tumalo State Park (RM 158)	Recreational River Area
Middle Deschutes River	From the south boundary of the Wilderness Study Area as approximately RM 131 to Lake Billy Chinook (RM 120), with the exception of RM 129.9 to RM 131.5.	Natural River Area

Notes:

1. Those designated scenic waterways or segments with related adjacent lands and shorelines still largely primitive and largely undeveloped, except for agriculture and grazing, but accessible in places by roads. These classified areas will be administered to maintain or enhance their high scenic quality, recreational value, fishery, and wildlife habitat, while preserving their largely undeveloped character and allowing continuing agricultural uses.
2. Those designated areas of a scenic waterway where density of structures or other developments already exist and provide for precludes application of a more restrictive classification.
3. Those designated scenic waterways that are readily accessible by road or railroad, that allow a wide range of compatible river-oriented public outdoor recreation opportunities, to the extent that these do not impair substantially the natural beauty of the scenic waterway or diminish its esthetic, fish and wildlife, scientific, and recreational values.
4. Those designated scenic waterways that are generally inaccessible except by trail or the river, with related adjacent lands and shorelines essentially primitive. These classified scenic waterways will be administered to preserve their natural, wild, and primitive condition, essentially unaltered by the effects of man, while allowing compatible recreational uses, other compatible existing uses, and protection of fish and wildlife habitat.

5.15 Wetland and Riparian Areas

Wetlands perform several valuable functions including water storage, water filtration, and biological productivity. They can also support complex food chains that provide sources of nutrients to plants and animals and specialized habitat for a wide variety of aquatic and terrestrial species. Wetlands in the area associated with the project may be subject to federal or state regulations depending on their characteristics. Within the State of Oregon, wetlands are managed under two laws, the CWA, and Oregon Removal-Fill Law. The USACE administers Section 404 of the CWA with the oversight of the U.S. Environmental Protection Agency. This law regulates the dredge or fill of wetlands over which the USACE has jurisdiction (or "jurisdictional wetlands").

Section 404 of the CWA defines wetlands as "those areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances

do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (USACE 1986).

The ODSL implements the Removal-Fill Law (ORS 196.800-990), which regulates the removal or fill of material in wetlands or waterways, requiring any person who plans to "remove or fill" material within "waters of the state" to obtain a permit from ODSL.

Per the Oregon Removal-Fill statute OAR 141-085-0515(9), an irrigation ditch is not jurisdictional under Oregon Removal-Fill permitting if it meets both of the following (ODSL 2013):

- The ditch is operated and maintained for the primary purpose of irrigation; and
- The ditch is dewatered[4] outside of the irrigation season except for isolated puddles in low areas.

Language provided in the 1986 Final Rule for Regulatory Programs of the Corps of Engineers (1986 Final Rule) identified that irrigation ditches are generally not considered Waters of the United States for determining CWA Section 404(f)(1)(C) applicability. However, EPA reserved the "right to determine on a case-by-case basis if any of these waters are "Waters of the United States…" including, "…irrigation ditches excavated on dry land…" (USACE 1986). In 2006, a "significant nexus" jurisdiction standard from Rapanos v. United States (547 U.S. 715 2006) was established, which has been used to determine if identified waters are Waters of the United States.

In 2015, the Clean Water Rule: Definition of "Waters of the United States" (2015 Final Rule) (USEPA 2015) was published and provided clear exclusions for certain types of ditches. However, the U.S. Court of Appeals for the Sixth Circuit stayed the 2015 Final Rule nationwide pending further action of the court. This reinstated the "significant nexus" jurisdiction standard from Rapanos v. United States.

National Wetland Inventory geographic information systems data (USFWS 2016) does not describe wetland resources within the project area. Wetlands, including riverine and palustrine types, are found within and sporadically adjacent to the 106.8 miles of the Deschutes River and the 30.2 miles of the Crooked River associated with District operations.

Water typically flows through the canals and laterals in the project area during the irrigation season, between April 1 and November 1. Water may also occasionally flow through these canals outside of the irrigation season for stock water deliveries or be present as standing water following rain or snow events. Although some canals and laterals may have hydrology and vegetation indicative of a wetland, they only contain water during the irrigation season, do not meet the functional criteria of wetlands, and are not regulated as wetlands by ODSL or USACE. These canals and laterals meet exemptions under the Oregon Removal-Fill Law for specific agricultural activities in wetlands and other waters of the state.

Riparian areas are transition zones between waterbodies and adjacent upland areas that support hydrophytic vegetation that is dependent upon the hydrology of the waterbody. Riparian areas as defined by Section 404 of the CWA are "areas next to or substantially influenced by water. These may include areas adjacent to rivers, lakes, or estuaries" (USEPA 2015).

[4] "Dewatered" means that the source of the irrigation water is turned off or diverted from the irrigation ditch. A ditch that is dewatered outside of the irrigation season may be used for temporary flows associated with stormwater collection, stock water runs, or fire suppression.

Riparian areas of varying size and quality occur adjacent to natural waterbodies associated with District operations. Low late fall, winter, and early spring streamflow associated with upstream reservoir storage limits riparian vegetation in the Deschutes River as do irrigation withdrawals downstream of LPID's diversion (RDG 2005). Because streamflow is strongly correlated with critical physical and biological characteristics of the river, it influences the functions of associated riparian areas (National Research Council 2002). Reestablishing a more natural hydrologic regime in these reaches allows the river channel to supply water to riparian areas via infiltration through channel banks, thus enhancing riparian function by facilitating processes such as hyporheic exchange, physical and chemical transformations, and supporting riparian plant communities and aquatic habitat (National Research Council 2002).

5.16 Wildlife

Generally, wildlife present within LPID's agricultural lands consists of habitat generalists or edge species with the ability to adapt to or exploit the agricultural environment. These species are tolerant to disturbance and include species such as deer, coyote, skunk, grey squirrel, raccoon, and red-tailed hawk (Blair 1996; Ditchkoff et al. 2006; McKinney 2002; and Shochat et al. 2006).

Wildlife within the LPID's ROW may use the canal and lateral system as a water source and dispersal corridor. Additionally, where not cleared, vegetation along canals and laterals can provide food, cover, and breeding sites for many wildlife species throughout the year.

5.16.1 Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act Species

There are multiple bird species with potential to occur within the LPID project area, some of which are protected under the Migratory Bird Treaty Act or the Bald and Golden Eagle Protection Act. Although migratory birds are known to occur in the project area and its vicinity, limited habitat is provided within the project area and LPID's ROW due to maintenance activities that remove vegetation on an annual basis. Consultation with a USFWS biologist will occur during the development of the Plan-EA.

5.16.2 Federally Protected Species

A review of available USFWS and Oregon Biodiversity Information Center's (ORBIC) data showed no federal threatened, or endangered wildlife species, designated critical habitat, or federal species of concern occur within the project area. Consultation with a USFWS biologist will occur during the development of the Plan-EA.

5.16.3 State Listed Species

The ODFW maintains a list of native wildlife species in Oregon that have been determined to be either threatened or endangered according to criteria set forth by rule (OAR 635-100-0105) (ODFW 2017). In addition, a "sensitive" species classification was created under Oregon's Sensitive Species Rule (OAR 635-100-0040) which focuses fish and wildlife conservation, management, and research and monitoring activities on species that need conservation attention. Information from the Oregon Biodiversity Information Center (ORBIC) shows there are no state-listed terrestrial species known to occur within the irrigation canals or any other areas where construction associated with the project would occur (ORBIC 2018).

5.17 Ecosystem Services

Ecosystem services are defined as the benefits people obtain from ecosystems, and can be categorized as supporting, provisioning, regulating, and cultural services (Millennium Ecosystem

Assessment 2005). Examples include such benefits and services as food, water, pollination, medicinal resources, waste decomposition, nutrient recycling, water purification, soil formation, as well as recreation, spiritual, and educational experiences. Modernizing LPID's irrigation infrastructure through piping and pressurizing open canals has the potential to strengthen ecosystem services by restoring streamflow, improving water quality, reducing carbon emissions, and improving habitat conditions for threatened fish species.

6 Technical Evaluations

A number of studies and technical evaluations pertaining to modernization of LPID were used to provide technical background for this PIR and will be further used as a Plan-EA is developed for this District. Relevant documents are as follows.

- **Lone Pine Irrigation District System Improvement Plan.** Completed by Black Rock Consulting and FCA in August 2017 and amended in April 2018, this document describes the specific infrastructure requirements for modernization of LPID's distribution system. This document is integral to the formulation of the project and is attached to this PIR as an appendix.
- **Upper Deschutes Basin Study.** A collaborative effort between Bureau of Reclamation and the Deschutes Basin Study Work Group to develop a comprehensive analysis of water supply and demand for current and future conditions in the Upper Deschutes Basin. This work is currently underway and is expected to be complete by the end of 2018.
- **Deschutes Basin Multi-Species Habitat Conservation Plan.** The USFWS is currently working to complete a Habitat Conservation Plan regarding the potential effects of current water management and operations in the Upper Deschutes on bull trout, middle Columbia River steelhead, Oregon spotted frog, sockeye salmon, and Chinook salmon in Crook, Deschutes, Jefferson, Klamath, Sherman, and Wasco counties, Oregon.

7 Alternatives

7.1 Formulation Process

To determine the most viable alternatives to meet the project's purpose and need, NRCS and LPID are considering the needs of the water users, goals for conservation and restoration, resources and funding available for both the District and the water users, and the status of the District's previous improvements. Alternatives considered during project development but proposed for elimination from the detailed study were evaluated based on the criteria in USDA's Guidance for Conducting Analysis Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water and Resource Investments (USDA 2017). Pursuant to this guidance, alternatives that become "unreasonable due to cost, logistics, existing technology, social or environmental reasons," or general inability to address the purpose and need for action, may be removed from consideration. Final analyses will be included in the Plan-EA to support full disclosure and transparency in the decision making process; each alternative plan, strategy, or action is formulated to consider the following four criteria: completeness, effectiveness, efficiency, and acceptability (USDA 2017). Alternatives considered by LPID during project development but proposed for elimination are discussed in Section 7.3. The No Action Alternative is described in Section 7.2.1, and the Piping and Pressurization Alternative is described in Section 7.2.2.

7.2 Description of Alternatives Considered

7.2.1 No Action Alternative (Future without Federal Investment)

Under the No Action Alternative, the District would continue to operate and maintain its existing canal, lateral, and pipe system in its current condition. This alternative assumes that modernization of the District's system to meet the purposes and needs of the Project would not be reasonably certain to occur. Under this alternative, the District would only modernize its infrastructure on a project-by-project basis as public interest funding became available. This funding is not reasonably certain to be available under a project-by-project approach at the large scale necessary to modernize the District's infrastructure.

The No Action Alternative is a near-term continuation of the District's standard operations and maintenance. Streamflow provided by the District for instream uses would remain the same. District energy consumption for pumping and individual on-farm pumps would continue to require an estimated 1,325,708 kilowatt hours per year. Irrigated agriculture in LPID would continue to be susceptible to inconsistent water supply and increased operational costs over time.

The No Action Alternative does not contribute to the purpose and need as follows:

- Improve water conservation: This alternative continues ongoing water loss from canal seepage and evaporation in the District's system of up to 3,219 acre-fee at a rate of up to 8.8 cfs of water annually.

- Increase water delivery reliability to farms: This alternative maintains existing operations and infrastructure and would only improve irrigation water delivery reliability if the District secures additional funding sources.

- Reduce O&M costs: This alternative maintains existing energy use and associated costs for farmers and O&M costs for the District. The use of individual patron pumps requires 1,325,708 kilowatt hours of energy per year across the District at a cost of approximately $200,000 per year (LPID 2018a). Additionally, the existing pump house supplying water to the Upper Lateral would remain in use. District canal and maintenance costs would either remain the same and or increase over time as District personnel continue system maintenance that includes the removal of debris and foreign material and repairs to the banks and slopes of the open canal and lateral system as necessary.

- Enhance streamflow and habitat conditions for fish and aquatic species: The District may allocate conserved water instream incrementally as projects are completed if additional sources of funding were to become available over time, however these projects are not reasonably certain to occur. Should this happen, this alternative would affect streamflow and habitat conditions along the Deschutes River as projects are completed.

- Improve public safety: This alternative would not reduce the drowning risks associated with open canals.

7.2.2 Piping and Pressurization Alternative (Future with Federal Investment)

The Piping and Pressurization Alternative is LPID's proposed alternative. The District has determined through engineering analysis that this alternative is feasible and addresses the project's purpose and need.

Under this alternative, the District would:

- Cross under the Crooked River at a location southeast of the current crossing, (see Figure 11), where the river is narrower, and the crossing distance is shorter. LPID would abandon the existing wood-stave bridge.
- Realign the entire LPID conveyance system with the intention of achieving the most hydraulically efficient design possible. The pipeline realignment would total 11.3 miles of high-density polyethylene (HDPE) pipe with pipe diameters ranging from 42 inches in the main pipeline down to 8 inches on the smaller laterals. In addition, the District would replace approximately 1 mile of existing pipe with HDPE pipe to withstand the systems new pressure ratings.
- Replace the current pump station with a centralized, variable frequency drive pump allowing for pressurization of the entire District. This pump station will be used until the Smith Rock Project Group of the COID system is piped and pressurized, allowing for a dynamic pressure of 67 pounds per square inch entering the LPID main pipeline.
- Utilize a new point of diversion from the COID L Lateral, abandon the Upper Lateral, and serve patrons via the realigned main pipeline and laterals from the new variable frequency drive pump to reduce energy needed for individual and District pumping.

The main construction tasks associated with this alternative include excavating trenches, pipe welding and placement, and backfill of the trenches. New ROWs (where necessary) will be created as the system is redirected to better serve the patrons and minimize costs.

A full description of this alternative, including detailed pipe sizing, pipe materials, project alignment, water loss assessment, and hydraulic modeling of the system can be found in the LPID SIP (LPID 2018a).

This alternative would contribute to the project's objectives as follows:

- Improve water conservation: This alternative would reduce water loss from canal seepage and evaporation by up to 3,219 acre-feet, at a rate of up to 8.8 cfs, annually by installing pressurized HDPE pipe for all open canals and laterals. Saved water would be allocated between the District and the state of Oregon (i.e., instream) following the approach outlined in Oregon Revised Statues 537.470 (3), with 25 percent of the saved water allocated to the District and 75 percent of the saved water allocated instream.

- Increase water delivery reliability to farms: Modernizing the system would improve irrigation water delivery reliability for 2,369 acres of irrigated land. This alternative would improve operational efficiencies to ensure that patrons receive the water they need at the time that they need it. A piped and pressurized system greatly increases conveyance efficiency, allowing existing carry water to be available for patrons and reducing the need to spill excess water.

- Reduce O&M costs: HDPE pipes are UV resistant, water hammer resistant, and have high tensile strength. During installation HDPE pipes are welded together and therefore, the need for expensive fittings and thrust blocks are minimized. HDPE pipe is easy to install, pliable, and retains its properties between -220°F and 180°F, and has a design life of 100 years. In addition, a pressurized pipeline allows for the reduction of individual pumps serving farms across the District and allow patrons to conserve approximately 1,325,708 kilowatt hours per year. It would reduce patron pumping costs and decrease carbon dioxide emissions.

- Enhance streamflow and habitat conditions for fish and aquatic species: This alternative would enhance streamflow and habitat conditions for fish and aquatic species by permanently allocating an estimated 2,414 acre-feet (75 percent of the saved water) instream. The District would allocate the saved water instream incrementally following completion of each project group and verification of operational stability. Streamflow and habitat conditions along the Deschutes River would therefore also benefit incrementally.

- Improve public safety: Converting open canals and laterals to buried pipe would eliminate the risk of drowning and flooding.

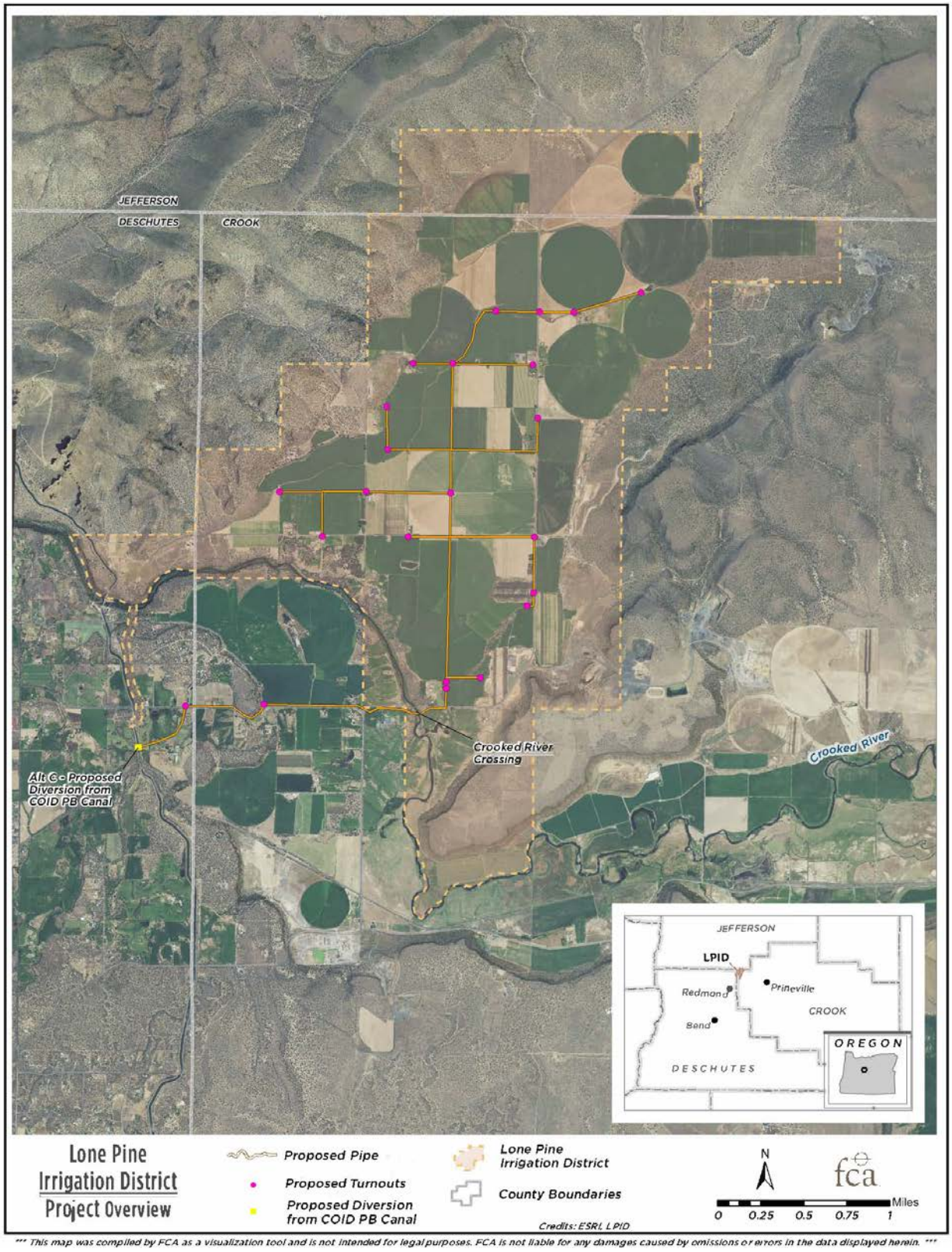


Figure 11. Lone Pine Irrigation District's Piping and Pressurization Alternative

7.3 Alternatives Proposed for Elimination from Detailed Study

7.3.1 Exclusive or Partial Use of Groundwater for Irrigation

Exclusive or partial use of groundwater for irrigation would leave more surface water in streams and rivers. The exclusive or partial use of groundwater for irrigation would cause irrigators to forgo up to 11,162 acre feet per year of surface water to exclusively pump groundwater to meet irrigation needs in the District. This alternative would require multiple wells, each with a pump to draw water from the ground, which would have high electricity and installation costs. The exclusive or partial use of a conversion from surface water to groundwater for irrigation is proposed to be eliminated from consideration due to the exorbitant annual costs of installing and operating individual wells and pumps and the logistical and legal constraints associated with obtaining associated groundwater rights.

7.3.2 Fallowing of Farm Fields

Fallowing of farm fields would mean permanently or temporarily transferring water rights from irrigated lands or not using water rights appurtenant to irrigated lands. Fallowing farm fields would reduce agricultural water needs and allow more water to remain instream. Fallowing of farm fields is proposed to be eliminated because it would not improve water delivery reliability and public safety for District-owned canal and lateral infrastructure and would be contrary to public policy (i.e., Oregon's land use goals) that supports maintaining existing agricultural land uses.

7.3.3 On-Farm Efficiency Upgrades

On-farm efficiency refers to LPID patrons' improving privately owned on-farm infrastructure (e.g., converting to center pivot irrigation or installing soil moisture sensors) and farm management practices (e.g., deficit irrigation). LPID is responsible for delivering water to the traditional high point (or delivery point) of the land. The District's responsibility for delivering water ends at this delivery point. Private on-farm infrastructure begins at this delivery point, and the District neither owns nor holds easements to the private infrastructure and lands associated with on-farm irrigation conveyances. On-farm efficiency upgrades would meet the objective of conserving water; however, this alternative is proposed to be eliminated because it would not improve water delivery reliability nor improve public safety issues for District-owned canal and lateral infrastructure.

7.3.4 Canal Lining

Canal lining would involve the installation of an impervious system to cover the 10.5 miles of canals and laterals; current piping in the system would not be replaced with lined canals. Materials typically employed include geomembranes, rubber liners, shotcrete, and/or similar materials. Implementation of this alternative would require the reshaping of the current canals to a trapezoidal form, sub-grade preparation, installation of the liner, and applying a shotcrete coating for protection. Canal lining increases canal capacity, makes the canal section stable, prevents bank erosion and breaches, assures economical water distribution, and reduces maintenance costs. Canal lining has a varying lifespan and can require extensive maintenance to continue operating at high efficiency (Reclamation 2002). Lined canals are vulnerable to tears or cracks in the lining substrate; when the lined substrate are torn or cracked, leakage from lined canals is like that from unlined canals. Over a 50-year life cycle, canal lining may be less expensive to implement in its first installation cycle than piping. However, canal lining requires significant maintenance and replacement cycles that ultimately cause it to exceed the cost of piping over time (LPID 2018a).

Lining would increase water velocity in the canal and laterals because the shotcrete cover is a smoother surface than the existing underlying rock. This makes the sides of the canal and laterals slippery and more difficult for people in the water to grasp onto and climb out of. Fences would need to be installed along the length of the canal and laterals to prevent public access to the channels to increase public safety and reduce District liability. Canal lining reduces water loss due to seepage and would meet the objective of conserving water. However, pressurization of on-farm deliveries and subsequent decrease in energy use would not occur. This alternative is proposed for elimination because it does not meet all the project's objectives and the project would have higher annual costs over its lifetime.

7.4 Economics

A National Economic Efficiency analysis will be completed for the project during the Plan-EA process.

8 References

Beechem, M. (2018) *Hwy. 97 driver swerves to miss deer, lands in canal.* (Retrieved from https://www.ktvz.com). Accessed September 11, 2018.

Biota Pacific Environmental Sciences, Inc. and R2 Resource Consultants (Biota and R2). (2013). Deschutes Basin Habitat Conservation Plan Study Report: Study 14: Assessment of Fish Passage and Screening at Diversions Covered by the DBHCP – Phase 1. Deschutes Basin Board of Control and City of Prineville, Oregon. March. Retrieved from: https://www.fws.gov/oregonfwo/Documents/DeschutesHCP/studies/9.DBHCP,%20Study%2014%20-%20Phase%201%20Report,%20March%202013.pdf. Accessed October 1, 2018.

Blair, R.B. (1996). Land Use and Avian Species Diversity along an Urban Gradient. *Ecological Applications*: 6(2). pp. 506-519.

Carrasco, R. and Moberly, E. (2014). *2013 Middle Deschutes Fisheries Monitoring Report: Fish Distribution and Abundance in the Middle Deschutes River.* Bend, OR: Oregon Department of Fish and Wildlife.

Center for Biological Diversity, et al. v. U.S. Bureau of Reclamation, et al., and Arnold Irrigation District, et al. (2016). *Stipulated Settlement Agreement and Order.* United States District Court District of Oregon: Eugene Division.

Central Oregon Irrigation District, Maps (COID). (2018). *Deschutes Flow*. Retrieved from: http://coid.org/maps/. Accessed October 5, 2018.

Crooked River Watershed Council (CRWC). (2002). *Crooked River Watershed Assessment.* Prineville, OR: Crooked River Watershed Council.

Das, T., Pierce, D. W., Cayan, D.R., Vano, J.A., & Lettenmaier, D.P. (2011). The importance of warm season warming to western U.S. streamflow changes. *Geophysical Research Letters,* 38(23).

Deschutes River Conservancy (DRC). (2012). *Upper Deschutes River Background Paper.* Bend, OR: Deschutes River Conservancy.

Ditchkoff, S.S., Saalfeld, P.S., and Gibson, C.J. (2006). Animal behavior in urban ecosystems: modifications due to human-induced stress. *Urban Ecosystems* 9: pp. 5-12.

Flowers, E. (2004). *Boy's death renews concerns over safety of urban canals.* (Retrieved from http://www.bendbulletin.com) Accessed July 18, 2018.

Gannett, M.W., Lite, K.E. Jr., Morgan, D.S., and Collins, C.A. (2001). *Ground-water hydrology of the upper Deschutes Basin, Oregon*: U.S. Geological Survey Water-Resources Investigations Report 00–4162 p. 77.

Gannett, M.W. and Lite, K.E. Jr. (2013). *Analysis of 1997–2008 Groundwater Level Changes in the Upper Deschutes Basin, Central Oregon* (Scientific Investigations Report 2013-5092). Reston, WA: U.S. Geological Survey.

International Union for Conservation of Nature (IUCN). (2018). *Red List of Threatened Species.* Retrieved from: http://www.iucnredlist.org. Accessed July 06, 2018.

Johnson, D. H and T. A. O'Neil. (2001). *Wildlife-Habitat Relationships in Oregon and Washington.* Oregon State University Press, Corvallis. 736 pp.

Lite, K.E. Jr. and Gannett, M. (2002). *Geologic Framework of the Regional Ground-Water Flow System in the Upper Deschutes Basin, Oregon* (Water-Resources Investigations Report 02–4015). Portland, OR: U.S. Geological Survey.

Lone Pine Irrigation District (LPID). (2018a). *System Improvement Plan-Addendum*. Bend, OR: Lone Pine Irrigation District.

Lone Pine Irrigation District (LPID). (2018b). *Crops Grown in the District*. Lone Pine, OR: Lone Pine Irrigation District.

Lone Pine Irrigation District (LPID). (2017). *System Improvement Plan*. Bend, OR: Lone Pine Irrigation District.

Matsumoto, S. (2016) *Teen girl saved from drowning after her car crashed into irrigation canal.* (Retrieved from http://www.oregonlive.com). Accessed May 29, 2018.

McKinney, M. L. (2002). Urbanization, biodiversity, and conservation. *Biosciences* 52: pp. 88-890.

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being.* Washington, D.C: Island Press.

Mork, L. (2016). *Middle Deschutes River Instream Flow Restoration and Temperature Responses 2001-2015*. Bend, OR: Upper Deschutes Watershed Council.

National Research Council. (2002). *Riparian Areas: Functions and Strategies for Management.* Washington, DC: The National Academies Press.

Oregon Biodiversity Information Center. (ORBIC). (2018). Biotics Rare Species Database. Data System Search for Rare, Threatened, and Endangered Plants and Animals in the Deschutes basin. February.

Oregon Department of Environmental Quality (ODEQ). (2012). 2012 *Water Quality Report Geodatabase*. Retrieved from: http://www.oregon.gov/deq/Data-and-Reports/Pages/GIS.aspx. Accessed April 2018.

Oregon Department of Fish and Wildlife (ODFW). (1996). *Upper Deschutes River Subbasin Fish Management Plan.* Retrieved from:

https://nrimp.dfw.state.or.us/nrimp/information/docs/fishreports/Upper%20Deschutes%20River%20subbasin%201996%20Final.pdf. Accessed August 29, 2017.

Oregon Department of Fish and Wildlife (ODFW). (2003). Anadromous Fish and Bull Trout Management in the Upper Deschutes, Crooked, and Metolius River Subbasins. Website: https://www.fws.gov/pacific/fisheries/hatcheryreview/Reports/warmsprings/WS--015%20UpperDeschutesRe-IntroPlan.pdf. Accessed August 21, 2018.

Oregon Department of Fish and Wildlife (ODFW). (2017). *Threatened and Endangered Species List.* Retrieved from: http://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_candidate_list.asp. Accessed: March 26, 2018.

Oregon Department of State Lands (ODSL). (2013). *A Guide to the Removal-Fill Permit Process.* Salem, OR: Oregon Department of State Lands.

Oregon Office of Economic Analysis. (OEA). (2013). Forecasts of Oregon's County Populations and Components of Change, 2010-2050. Department of Administrative Services: Salem, Oregon. Retrieved from: http://www.oregon.gov/das/OEA/Pages/forecastdemographic.aspx.

Oregon Water Resources Department (OWRD). (2017a). Near Real Time Hydrographics Data. Retrieved from Streamgauge #14056500 Deschutes R BL Wickiup Res NR La Pine, Oregon.

Oregon Water Resources Department (OWRD). (2017b). Near Real Time Hydrographics Data. Retrieved from Streamgauge #14064500 Deschutes R At Benham Falls NR Bend, Oregon.

Oregon Water Resources Department (OWRD). (2018a). Near Real Time Hydrographics Data. Retrieved from Streamgauge #14054000 Deschutes R BL Crane Prairie Res NR La Pine, Oregon.

Oregon Water Resources Department (OWRD). (2018b). Near Real Time Hydrographics Data. Retrieved from Streamgauge #14070500 Deschutes R BL Bend, Oregon.

Oregon Water Resources Department (OWRD). (2018c). Near Real Time Hydrographics Data. Retrieved from Streamgauge #14087380 Crooked R BL Osborne Can, NR Opal City, OR.

Oregon Water Resources Department (OWRD). (2018d). Near Real Time Hydrographics Data. Retrieved from Streamgauge #14087400 Crooked R BL Opal Springs NR Culver, OR.

Recsetar, R., M. Zeigler, D. Ward, S. Bonar, C. Caldwell. (2012). Relationship Between Fish Size and Thermal Tolerance. *Transaction of the America Fisheries Society* 141:1433-1438.

River Design Group, Inc. (RDG). (2005). *Deschutes River – Bank Stabilization Projects Assessment.* Retrieved from: http://www.deschutesriver.org/Deschutes-River-Bank-Stabilization-Project-Assessment.pdf. Accessed August 26, 2017.

Shelton, M.L. & Fridirici, R. (2001). Water Supply and Climate Change in the Upper Deschutes Basin, Oregon. *Yearbook of the Association of Pacific Coast Geographers 63,* 77-96.

Shochat, E., Warren, P.S., Faeth, S.H., McIntyre, N.S., & Hope, D. (2006). From Patterns to Emerging Processes in Mechanistic Urban Ecology. *Trends in Ecology and Evolution, 21,* 186-191.

Singh, S.P., Sharma, J.G., Ahmad, T., and Chakrabarti, R. (2013). Effect of water temperature on the physiological responses of Asian Catfish *Clarias batrachus* (Linnaeus 1758). *Asian Fisheries Science*, 26, 26-38.

Starcevich, S., Doran, N., Carrasco, R., (2015). *Monitoring salmonid occupancy using cataraft electrofishing in the upper Deschutes River*. Information Report Oregon Department of Fish and Wildlife.

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

Starcevich, S and Bailey B. (2017) *2015 Deschutes River Fisheries Monitoring Report: Assessing Redband Trout status in the middle and upper Deschutes River basin using young-of-the-year occupancy surveys in lateral habitats*. Oregon Department of Fish and Wildlife Monitoring Report.

Swalley Irrigation District. (2018). Retrieved from: https://www.swalley.com/fishscreen. Accessed October 1, 2018.

U.S. Army Corps of Engineers (USACE). (1986). Final Rule for Regulatory Programs of the Corps of Engineers. *Federal Register, 51*(219), 41206-41260. November 13, 1986.

U.S. Bureau of Labor Statistics. (USBLS). (2017). *Local Area Unemployment Statistics*. Washington DC. Retrieved from: https://www.bls.gov/lau/. Accessed April 2018.

U.S. Bureau of Reclamation. (Reclamation). (2002). *Canal-Lining Demonstration Project Year 10 Final Report*. Retrieved from: https://www.usbr.gov/pn/programs/wat/reports/demoprojectyear10.pdf. Accessed April 2018.

U.S. Bureau of Reclamation (Reclamation). (2016). *SECURE Water Act Section 9503(c)- Reclamation Climate Change and Water 2016*: Chapter 2 Hydrology and Climate Assessment. Denver, CO: Policy and Administration. Retrieved from: https://www.usbr.gov/climate/secure/docs/2016secure/2016SECUREReport-chapter2.pdf. Accessed April 2018.

US Census Bureau. (2000). *Census 2000: General Demographic Characteristics Summary File 1*. American Fact Finder-Community Facts. Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed: October 3, 2018.

US Census Bureau. (2015). *2016 American Community Survey – Demographic and Housing Estimates. 2011-1015, American Community Survey 5-Year Estimates*. Washington DC: American Fact Finder-Community Facts. Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed: October 3, 2018.

US Census Bureau, American Fact Finder-Community Facts-Business and Industry. (2016). *2016 American Community Survey Industry by Sex and Median Earnings, Industry by Sex for the Civilian Employed Population 16 Years and Over, American Community Survey 5-Year Estimates*. Retreived from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

U.S. Census Bureau. (2017). *Selected Economic Characteristics*. Washington DC: U.S. Census Bureau. Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed April 2018.

U.S. Department of Agriculture (USDA). (2017). *Guidance for Conducting Analysis Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water and Resource Investments* (DM 9500-013). Washington, DC: USDA.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). (2015). *Title-390 National Watershed Program Manual* (4th ed.). January. Retrieved from: https://directives.sc.egov.usda.gov/ViewerFS.aspx?hid=36702. Accessed April 2018.

U.S. Department of the Interior, Bureau of Land Management (BLM). (1992). Lower Crooked Wild and Scenic River (Chimney Rock Segment) Management Plan.

U.S. Environmental Protection Agency (USEPA). (2015). Clean Water Rule: Definition of "Waters of the United States; Final Rule. *Federal Register, 80*(124), 37054–37127. June 29, 2015.

U.S. Fish and Wildlife Service (USFWS). (2002). Chapter 7, Deschutes Recovery Unit, Oregon 62 p. *In:* U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS). (2016). *National Wetlands Inventory Mapping*. Retrieved from: https://www.fws.gov/wetlands/Data/Mapper.html. Accessed April 2018.

U.S. Fish and Wildlife Service (USFWS). (2018). *IPaC ECOS* (Environmental Conservation Online System). Retrieved from: https://ecos.fws.gov/ipac/location/index. Accessed May 2018.

U.S. Geological Survey (USGS). (2011). Gap Analysis Program (GAP). National Land Cover, Version 2. Retrieved from: https://gapanalysis.usgs.gov/gaplandcover/data/download/. Accessed Fall 2017

Upper Deschutes Watershed Council (UDWC). (2014). *Middle Deschutes River Instream Flow Restoration and Temperature Responses 2001-2013*. Bend, OR: Upper Deschutes Watershed Council.

Vano, J.A., Nijssen, B., & Lettenmaier, D.P. (2015). Seasonal hydrologic responses to climate change in the Pacific Northwest. *Water Resources Research,* 51(4), pp. 1959-1976.

Waibel, M.S. (2010). *Model Analysis of the Hydrologic Response to Climate Change in the Upper Deschutes Basin, Central Oregon.* Portland: US Geological Survey.

9 Appendix A-B

Appendices are provided in a separate document.

Appendix A. System Improvement Plan
Appendix B. Other Supporting Information